学生手册 2026

化学选择题全基础题型

Cambridge IGCSE Co-ordinated Sciences · 0654 · Core / Extended · 2022–2026 真题

目　录

化学·粒子模型、状态变化与扩散 6

1.1 粒子模型、状态变化与扩散 6

题型 1：用粒子间距与运动解释物态性质（考频★★☆☆☆） 6

题型 2：从粒子图或熔沸点辨认状态变化（考频★★☆☆☆） 7

题型 3：用粒子随机运动解释扩散现象（考频★☆☆☆☆） 8

题型 4：按相对分子质量比较气体扩散快慢（考频★☆☆☆☆） 9

化学·元素、化合物、原子与离子 11

1.2 元素、化合物、原子与离子 11

题型 1：由核素记号和粒子数求质子中子电子（考频★★★★☆） 11

题型 2：从组成和粒子图区分元素化合物混合物（考频★★★☆☆） 14

题型 3：按电子得失判离子的电荷和电子排布（考频★★★☆☆） 16

题型 4：用质子数和电子排布辨认同位素（考频★★★☆☆） 17

题型 5：辨认原子与亚原子粒子的基本属性（考频★☆☆☆☆） 19

题型 6：辨认溶质溶剂和溶液（考频★☆☆☆☆） 20

化学·离子键、共价键与物质结构 22

1.3 离子键、共价键与物质结构 22

题型 1：按元素类型和成键方式判断离子或分子物质（考频★★★☆☆） 22

题型 2：由离子或简单分子结构推断物理性质（考频★★☆☆☆） 24

题型 3：从连接方式识别金刚石石墨和二氧化硅（考频★★☆☆☆） 26

题型 4：用自由电子解释金属与合金导电（考频★★☆☆☆） 27

题型 5：核对点叉图的电子转移与离子晶格排列（考频★☆☆☆☆） 28

题型 6：按常见化合价核对共价点叉图和共享电子（考频★★★☆☆） 29

化学·化学式、方程式与物质的量 33

1.4 化学式、方程式与物质的量 33

题型 1：数化学式中的元素种类和原子数（考频★★★★☆） 33

题型 2：把质量粒子数和气体体积换成物质的量（考频★★★★☆） 36

题型 3：由化合价或离子电荷写化学式（考频★★☆☆☆） 38

题型 4：按原子守恒核验和配平反应式（考频★★★★☆） 40

题型 5：按方程式摩尔比换算反应质量或气体体积（考频★★★☆☆） 42

题型 6：删去旁观离子写沉淀离子方程式（考频★☆☆☆☆） 44

题型 7：计算反应剩余百分比或判断限制反应物（考频★☆☆☆☆） 44

化学·电解与氢氧燃料电池 46

1.5 电解与氢氧燃料电池 46

题型 1：由电解质及电极判断电解产物（考频★★★★☆） 46

题型 2：辨认电解装置的两极和电解质状态（考频★★★☆☆） 52

题型 3：用电解提取铝或活泼金属（考频★★☆☆☆） 55

题型 4：按电子守恒写电极半反应和氧化还原（考频★★★☆☆） 56

题型 5：把电解产物对应到颜色和气体检验（考频★★☆☆☆） 59

题型 6：辨认铜精炼和电镀的接线与离子来源（考频★☆☆☆☆） 60

题型 7：追踪电解后离子浓度和溶液酸碱性（考频★★☆☆☆） 62

化学·放热、吸热与键能 64

1.6 放热、吸热与键能 64

题型 1：由温度变化和能量流向判断吸热放热（考频★★★★★） 64

题型 2：区分断键吸能和成键释能（考频★☆☆☆☆） 70

题型 3：读能量图判断反应热与活化能（考频★★★☆☆） 71
题型 4：计算温差并比较吸热放热大小（考频★★☆☆☆） 75
题型 5：由反应种类判断能量方向（考频★★☆☆☆） 78
化学 · 物理变化、化学变化与反应速率 81
1.7 物理变化、化学变化与反应速率 81
题型 1：根据是否生成新物质区分物理和化学变化（考频★★★★☆） 81
题型 2：用浓度温度表面积判断速率条件（考频★★★☆☆） 84
题型 3：选择测反应速率的装置和测量量（考频★★★☆☆） 87
题型 4：按温度计刻度求初终读数差（考频★☆☆☆☆） 91
题型 5：用碰撞频率和能量解释反应速率（考频★★★★☆） 91
题型 6：由数据间隔求速率并比较曲线斜率和终点（考频★★★☆☆） 95
化学 · 氧化还原与电子转移 101
1.8 氧化还原与电子转移 101
题型 1：用氧的得失识别被氧化或还原物质（考频★★★★☆） 101
题型 2：用电子得失判氧化还原及氧化剂还原剂（考频★★★★☆） 103
题型 3：区分氧化还原与中和沉淀或分解（考频★★☆☆☆） 107
化学 · 酸、碱、氧化物与制盐 109
1.9 酸、碱、氧化物与制盐 109
题型 1：按酸与金属碱或碳酸盐的反应判产物（考频★★★☆☆） 109
题型 2：用 pH 和指示剂颜色判断酸碱变化（考频★★★☆☆） 111
题型 3：由元素类型和 pH 辨认酸性或碱性氧化物（考频★★★☆☆） 114
题型 4：用过量不溶固体与酸制取可溶盐（考频★★★☆☆） 117
题型 5：由同时与酸碱反应辨认两性氧化物（考频★☆☆☆☆） 121
题型 6：写碳酸钙热分解制取生石灰（考频★☆☆☆☆） 122
题型 7：从盐溶液浓缩结晶过滤并干燥（考频★★☆☆☆） 122
题型 8：用可溶盐溶液沉淀制取不溶盐（考频★★☆☆☆） 123
化学 · 周期表与元素族趋势 125
1.10 周期表与元素族趋势 125
题型 1：用高熔点高密度彩色化合物辨认过渡金属（考频★★★★☆） 125
题型 2：沿 I 族比较熔点密度与水反应（考频★★★★☆） 129
题型 3：应用稀有气体满外层与低反应性（考频★★★★☆） 133
题型 4：沿 VII 族比较分子外观物态和沸点（考频★★★☆☆） 135
题型 5：由周期表位置和电子排布判元素类别（考频★★★☆☆） 138
题型 6：用卤素反应性决定置换方向（考频★★☆☆☆） 140
化学 · 金属、活泼性、腐蚀与提取 142
1.11 金属、活泼性、腐蚀与提取 142
题型 1：用金属与碳的相对活泼性选择提取法（考频★★★★☆） 142
题型 2：区分隔绝水氧与牺牲保护防锈（考频★★★☆☆） 146
题型 3：用金属物性和用途匹配材料（考频★★★☆☆） 148
题型 4：从大小不同原子解释合金硬度和组成（考频★★★☆☆） 150
题型 5：追踪高炉制 CO 还原铁矿的反应（考频★★★☆☆） 151
题型 6：按水酸反应或标准序列比较金属活泼性（考频★★☆☆☆） 153
题型 7：用更活泼者置换较不活泼金属（考频★★★☆☆） 155
题型 8：追踪石灰石分解与成渣除杂（考频★★☆☆☆） 159
化学 · 水、空气与环境化学 161
1.12 水、空气与环境化学 161

题型 1：按空气百分数组成读图或计算体积（考频★★★☆☆） 161
题型 2：按过滤吸附和氯化的功能排列净水步骤（考频★★★☆☆） 163
题型 3：用温室气体和燃烧解释气候变化（考频★★☆☆☆） 165
题型 4：把污染物来源对应到危害与去除法（考频★★★☆☆） 167
题型 5：追踪催化转化器的进出气体及反应（考频★★★☆☆） 169
化学 · 有机化学、燃料与聚合物 171
1.13 有机化学、燃料与聚合物 171
题型 1：从碳链键型与官能团辨认名称和类别（考频★★★★☆） 171
题型 2：按石油分馏产物匹配用途和位置（考频★★★★☆） 175
题型 3：辨认单体聚合物与加成聚合过程（考频★★★☆☆） 178
题型 4：用通式与结构比较同系物（考频★★★☆☆） 180
题型 5：按完全燃烧写烃或醇的产物（考频★★★☆☆） 182
题型 6：追踪烯烃加成反应的产物（考频★★☆☆☆） 183
题型 7：用溴水褪色辨认碳碳双键（考频★★☆☆☆） 184
题型 8：辨认化石燃料和天然气的主要成分（考频★★☆☆☆） 186
题型 9：辨认葡萄糖发酵制乙醇及后续反应（考频★★☆☆☆） 187
题型 10：判裂解产物并核验原子守恒（考频★★☆☆☆） 189
题型 11：用产物和链接区分加成与缩合聚合（考频★★★☆☆） 190
题型 12：打开单体双键画加成聚合物链（考频★★★☆☆） 193
题型 13：由碳链长度比较馏分和烷烃物性（考频★★☆☆☆） 196
题型 14：从加成重复单元反推烯烃单体（考频★☆☆☆☆） 198
题型 15：在分子中逐个计数酰胺链接（考频★☆☆☆☆） 199
化学 · 分离、色谱、滴定与定性分析 200
1.14 分离、色谱、滴定与定性分析 200
题型 1：用颜色变化检验水及水合状态（考频★★★★☆） 200
题型 2：按挥发性与沸点选择简单或分馏（考频★★★☆☆） 204
题型 3：按气体检验或受热生成气体识别气体（考频★★★☆☆） 207
题型 4：用沉淀颜色与过量试剂辨认离子（考频★★★☆☆） 208
题型 5：用热碱释放氨检验铵根离子（考频★★☆☆☆） 210
题型 6：用过滤与结晶分开不溶和可溶固体（考频★★☆☆☆） 211
题型 7：按读数需求选择量取液体或收集气体的仪器（考频★☆☆☆☆） 212
题型 8：用熔沸点范围或加热曲线判纯度（考频★☆☆☆☆） 213
题型 9：根据碱性与指示剂颜色选择检验结果（考频★☆☆☆☆） 214
题型 10：按火焰颜色识别金属离子（考频★☆☆☆☆） 215
题型 11：识别正确的纸色谱初始装置（考频★☆☆☆☆） 216
题型 12：用铝箔和热碱检验硝酸根离子（考频★☆☆☆☆） 216
题型 13：读取纸色谱的成分与纯混合状态（考频★★☆☆☆） 217
题型 14：从同一基线计算 Rf 或反求距离（考频★★☆☆☆） 219
题型 15：合并两项定性检验确定完整盐（考频★★☆☆☆） 222
化学 · 旧纲工业过程与碳酸盐 224
1.15 旧纲工业过程与碳酸盐 224
题型 1：沿接触法原料中间体和可逆步骤追踪（考频★★★★☆） 224
题型 2：配接触法反应步骤与操作条件（考频★★★☆☆） 226
题型 3：把石灰石用途与中和酸性联系（考频★★★☆☆） 228
题型 4：写石灰石热分解制生石灰与二氧化碳（考频★★☆☆☆） 230
题型 5：配哈伯法制氨的催化剂温度压力（考频★★☆☆☆） 231

题型 6：按 NPK 元素核验肥料成分（考频★☆☆☆☆） 232
题型 7：辨认工业制氨原料氢氮来源（考频★☆☆☆☆） 232

化学 · 粒子模型、状态变化与扩散

1.1 粒子模型、状态变化与扩散

题型 1：用粒子间距与运动解释物态性质（考频★★☆☆☆）

知识点 物质的物态由温度和压强决定；在同一条件下，固体粒子间距最小，气体粒子间距最大。
固体粒子排列紧密，在_____附近振动；液体粒子仍靠得很近，但可相互移动。
熔化时，粒子间作用力被_____克服，粒子不再处于固定位置。

答案：固定位置；部分

怎么认 题目出现室温、状态变化、固定位置或粒子间距时，先确定物态，再判断粒子的排列与运动。

例题 1

In which substance are the particles closest together at room temperature?

A CO_2 **B** Ne **C** N_2 **D** Zn

（2022 Oct/Nov · 0654/13 · Question 14 · Core；同题：2022 Oct/Nov · 0654/23 · Question 14 · Extended）

解：室温下，CO_2、Ne 和 N_2 均为气体，Zn 为固体。
固体粒子排列紧密，气体粒子间距很大，故 Zn 中的粒子最近。
故选 D。

针对练习

1. Which change of state results in the greatest increase in the separation of particles?

A gas to liquid

B liquid to gas

C liquid to solid

D solid to liquid

（2025 May/Jun · 0654/11 · Question 14 · Core）

2. Which properties are used to distinguish between solids and gases?

1 compressibility

2 melting point

3 flammability

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

（2022 Oct/Nov · 0654/11 · Question 14 · Core；同题：2022 Oct/Nov · 0654/21 · Question 14 · Extended）

3. Which statement describes what happens to the particles in a solid when it melts?

A They are no longer in fixed positions because the forces between them are completely overcome.

B They are no longer in fixed positions because the forces between them are partially overcome.

C They move further apart and do **not** touch because the forces between them are completely overcome.

D They move further apart and do **not** touch because the forces between them are partially overcome.

（2026 May/Jun · 0654/21 · Question 14 · Extended）

题型 2：从粒子图或熔沸点辨认状态变化（考频★★☆☆☆）

知识点 固体粒子排列紧密且规则，只能在固定位置振动；液体粒子排列紧密但不规则，粒子能够相互移动；气体粒子间距很大，运动自由。

在通常压强下，温度低于熔点时物质为_____，熔点与沸点之间为_____，高于沸点时为_____；熔点和沸点常用摄氏度（°C）表示。

物质由气态变为液态称为凝结，由固态变为液态称为熔化。

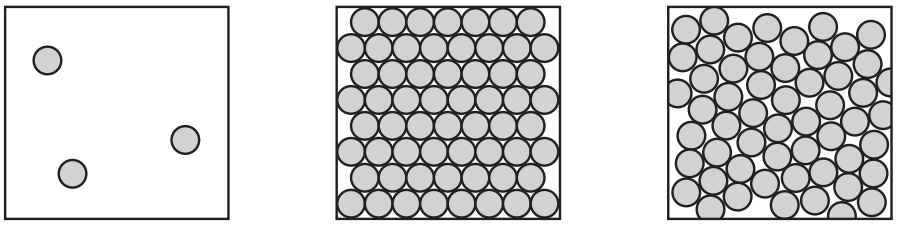
降温跨过沸点时发生凝结，升温跨过熔点时发生熔化。

答案：固态；液态；气态

怎么认 题目出现粒子图或熔点、沸点及温度变化时，先判起始状态和终止状态。

例题 1

The three states of matter are represented by particle diagrams X, Y and Z.



X　　Y　　Z

Which row identifies each state of matter?

	solid	liquid	gas
A	Y	X	Z
B	Y	Z	X
C	X	Z	Y
D	Z	Y	X

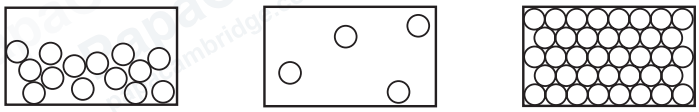
（2025 Feb/Mar · 0654/12 · Question 14 · Core）

解：X 中粒子间距大且分散，故 X 为气体；Y 中粒子排列紧密且规则，故 Y 为固体；Z 中粒子排列紧密但不规则，故 Z 为液体。

故选 B。

针对练习

1. The three states of matter are represented by diagrams R, S and T.



R S T

Which change represents condensation?

A R to S **B** R to T **C** S to R **D** T to R

（2026 Feb/Mar · 0654/22 · Question 14 · Extended）

2. Cyclopentane is a hydrocarbon.

The melting point of cyclopentane is –94 °C and its boiling point is 49 °C.

In process 1, the temperature of cyclopentane changes from 55 °C to 45 °C.

In process 2, the temperature of cyclopentane changes from –100 °C to –90 °C.

Which row identifies the changes in processes 1 and 2?

	1	2
A	boiling	freezing
B	boiling	melting
C	condensation	freezing
D	condensation	melting

（2024 May/Jun · 0654/11 · Question 14 · Core）

题型 3：用粒子随机运动解释扩散现象（考频★☆☆☆☆）

知识点 扩散是粒子因不停地作_____运动，从浓度较_____的区域向浓度较_____的区域分散的现象。

气体和液体中的粒子能够扩散；温度越高，粒子运动越快，扩散通常越快。

答案：无规则；高；低

怎么认 题目出现气味传到远处或同类粒子由集中变分散时，先判断为扩散。

例题 1

A few drops of petrol are dropped onto the floor on one side of a room. A short time later, someone on the other side of the room smells the petrol.

What is the reason for this?

A The petrol flows over the floor to the other person.

B The petrol evaporates and then condenses.

C Petrol molecules dissolve in air molecules.

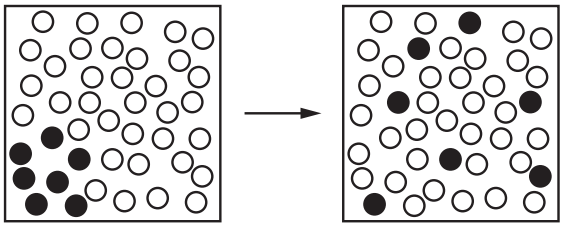
D Petrol molecules diffuse to the other side of the room.

（2026 Feb/Mar · 0654/12 · Question 14 · Core）

解：汽油挥发形成汽油蒸气，汽油分子不停地作无规则运动，从浓度较高的一侧向浓度较低的一侧扩散，因而到达房间另一侧。故选 D。

针对练习

1. Which change is represented by the diagram?



A condensation

B diffusion

C evaporation

D solidification

（2022 Oct/Nov · 0654/12 · Question 14 · Core；同题：2022 Oct/Nov · 0654/22 · Question 14 · Extended）

题型 4：按相对分子质量比较气体扩散快慢（考频★☆☆☆☆）

知识点 相对分子质量 M_r 是分子中各原子的相对原子质量之和，没有单位。

扩散是气体粒子从高浓度区域向低浓度区域运动，直至均匀分布的过程。

在温度和压强相同的条件下，$r \propto \frac{1}{\sqrt{M_r}}$；相对分子质量越_____，扩散速率越_____。

扩散速率的单位由距离和时间的单位决定，常用 $\frac{\text{cm}}{\text{s}}$。

答案：小；大

怎么认 题目出现多种气体的分子式并问扩散最快者时，先计算并比较相对分子质量。

例题 1 Which row compares the rates of diffusion of fluorine and hydrogen?

	diffuses faster	reason
A	fluorine	higher molecular mass
B	fluorine	lower molecular mass
C	hydrogen	lower molecular mass
D	hydrogen	higher molecular mass

（2025 Feb/Mar · 0654/22 · Question 14 · Extended）

解：由相对原子质量得

$M_{r(\text{H}_2)} = 2 \times 1 = 2$

$M_{r(\text{F}_2)} = 2 \times 19 = 38$

在相同条件下，M_r 较小的气体扩散较快，故氢气扩散较快，原因是氢气的相对分子质量较小。故选 C。

针对练习

1. Information about four gases is shown.

gas	molecular formula
ammonia	NH_3
butane	C_4H_{10}
carbon dioxide	CO_2
chlorine	Cl_2

Which gas has the greatest rate of diffusion?

A ammonia

B butane

C carbon dioxide

D chlorine

（2025 May/Jun · 0654/21 · Question 15 · Extended）

1.2 元素、化合物、原子与离子

题型 1：由核素记号和粒子数求质子中子电子（考频★★★★☆）

知识点 核子数（质量数）A 等于原子核内质子数 p 与中子数 n 之和，即 _____；质子数（原子序数）$Z = p$。
核素记号中，元素符号左上角为核子数 A，左下角为质子数 Z，故 $n = A - Z$。
中性原子中，电子数与质子数相等，即 _____；带正电荷数为 q 的阳离子有 $e = Z - q$ 个电子。
以上关系适用于单个原子或离子的粒子数计算，各粒子数均为计数值，_____单位。

答案：$A = p + n$；$e = Z$；不带

怎么认 题目出现核素记号或 p、n、e 数量时，先区分核子数与电荷。

例题 1

What is the nucleon number of the potassium isotope $^{40}_{19}K$?

A 19　　**B** 21　　**C** 40　　**D** 59

（2025 Oct/Nov · 0654/11 · Question 15 · Core）

解：由核素记号可知，钾的核子数 $A = 40$。故选 C。

针对练习

1. How many neutrons are in one atom of the isotope $^{35}_{17}Cl$?

A 17　　**B** 18　　**C** 35　　**D** 52

（2022 Oct/Nov · 0654/13 · Question 15 · Core；同题：2022 Oct/Nov · 0654/23 · Question 15 · Extended）

2. An atom of an element contains 9 protons, 10 neutrons and 9 electrons.

What is the nucleon number (mass number) of this element?

A 9　　**B** 10　　**C** 19　　**D** 28

（2022 Oct/Nov · 0654/12 · Question 15 · Core；同题：2022 Oct/Nov · 0654/22 · Question 15 · Extended）

3. Which row shows the particles in the nucleus of an atom of $^{25}_{12}Mg$?

	protons	neutrons
A	12	12
B	12	13
C	13	12
D	13	13

（2024 Feb/Mar · 0654/12 · Question 15 · Core）

4. An atom of phosphorus has a nucleon number of 31 and a proton number of 15.

How many neutrons are there in this atom?

A 15　　**B** 16　　**C** 31　　**D** 46

（2025 May/Jun · 0654/11 · Question 15 · Core）

5. Which row describes an atom that has the nucleon number 24?

	number of protons	number of neutrons	number of electrons
A	8	8	8
B	12	12	12
C	21	24	21
D	24	28	24

（2023 May/Jun · 0654/11 · Question 16 · Core；同题：2023 May/Jun · 0654/21 · Question 16 · Extended）

6. An atom of fluorine is represented by $^{19}_{9}F$.

How many electrons does this atom contain?

A 9 **B** 10 **C** 19 **D** 28

（2022 Oct/Nov · 0654/11 · Question 15 · Core；同题：2022 Oct/Nov · 0654/21 · Question 15 · Extended）

7. An atom of osmium is represented by $^{190}_{76}Os$.

How many neutrons are in this atom?

A 76 **B** 114 **C** 190 **D** 266

（2023 May/Jun · 0654/12 · Question 16 · Core；同题：2023 May/Jun · 0654/13 · Question 16 · Core、2023 May/Jun · 0654/22 · Question 16 · Extended）

8. One atom of an isotope of fluorine is represented by $^{15}_{9}F$.

How many neutrons does this atom have?

A 6 **B** 9 **C** 10 **D** 15

（2025 Feb/Mar · 0654/12 · Question 15 · Core）

9. Which row describes an atom of phosphorus, $^{31}_{15}P$?

	number of electrons	**number of protons**	**number of nucleons**
A	5	15	16
B	5	16	31
C	15	15	16
D	15	15	31

（2026 Feb/Mar · 0654/12 · Question 15 · Core）

10. The nucleon number of a hydrogen atom is 1.

What is present inside the nucleus of this atom?

A one proton and one electron

B one proton and one neutron

C one proton only

D one neutron only

（2023 Oct/Nov · 0654/11 · Question 16 · Core；同题：2023 Oct/Nov · 0654/21 · Question 16 · Extended）

11. An atom of indium has the atomic number 49 and the nucleon number 115.

Which row shows the numbers of protons, neutrons and electrons in this atom?

	number of protons	number of neutrons	number of electrons
A	49	66	49
B	49	115	49
C	66	49	49
D	49	66	66

（2023 May/Jun · 0654/23 · Question 15 · Extended）

12. Which row describes particles present in $^{25}_{12}Mg^{2+}$?

	neutrons	electrons
A	12	10
B	12	12
C	13	12
D	13	10

（2025 May/Jun · 0654/12 · Question 14 · Core；同题：2025 May/Jun · 0654/13 · Question 14 · Core）

13. Atoms of element X have 11 nucleons and 6 neutrons.

What is element X?

A boron

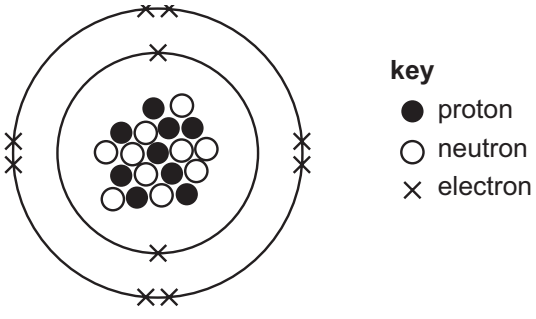
B carbon

C chlorine

D sodium

（2025 May/Jun · 0654/23 · Question 14 · Extended）

14. The protons, neutrons and electrons in a particle are shown.



What is the symbol for this particle?

A F **B** F^- **C** Ne **D** Ne^+

（2026 Feb/Mar · 0654/22 · Question 15 · Extended）

PapaCambridge

题型 2：从组成和粒子图区分元素化合物混合物（考频★★★☆☆）

知识点 元素只含_____原子，不能用化学方法分解成更简单的物质。

化合物含两种或两种以上不同原子，这些原子发生_____结合，只能用化学方法分解。

混合物由两种或两种以上物质混合而成，各成分没有化学结合，可用_____方法分离。

两个或更多原子结合形成分子；同种原子形成元素分子，不同种原子形成化合物分子。

答案：一种；化学；物理

怎么认 题目出现化学式、粒子图或分离方法时，先看原子种类是否结合，再判定物质类别。

例题 1

What do the chemical symbols N_2 and Ni represent?

	N_2	Ni
A	a compound	a compound
B	a compound	an element
C	an element	a compound
D	an element	an element

（2023 Oct/Nov · 0654/11 · Question 15 · Core；同题：2023 Oct/Nov · 0654/21 · Question 15 · Extended）

解：N_2 中两个氮原子结合，且只含一种原子，表示元素；
Ni 是镍元素的化学符号，也表示元素。
故选 D。

针对练习

1. A mixture contains carbon, potassium nitrate and sulfur.

Which description of this mixture is correct?

A one compound and two elements

B two compounds and one element

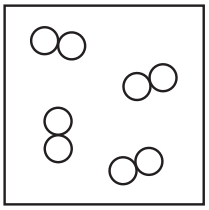
C three elements

D four elements

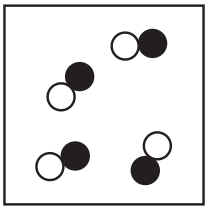
（2025 Oct/Nov · 0654/12 · Question 14 · Core；同题：2025 Oct/Nov · 0654/13 · Question 14 · Core）

2. Which diagram represents molecules of a compound?

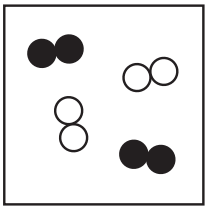
A



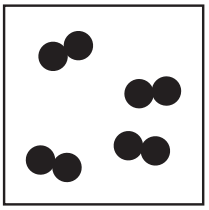
B



C

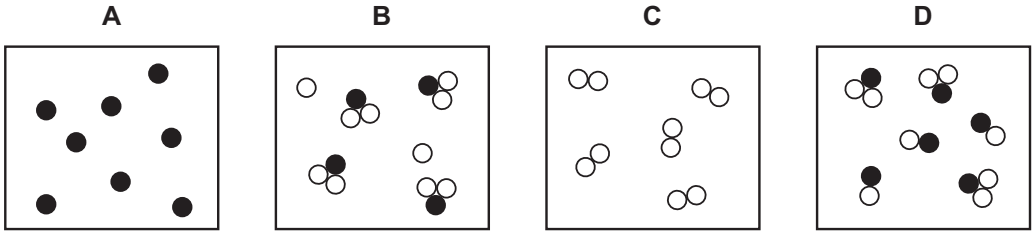


D



（2023 Feb/Mar · 0654/12 · Question 15 · Core；同题：2023 Feb/Mar · 0654/22 · Question 15 · Extended）

3. Which diagram represents a mixture of an element and a compound?



（2023 Oct/Nov · 0654/13 · Question 15 · Core；同题：2023 Oct/Nov · 0654/23 · Question 15 · Extended）

4. Which statement about elements, compounds and mixtures is correct?

A Compounds contain more than one type of atom.

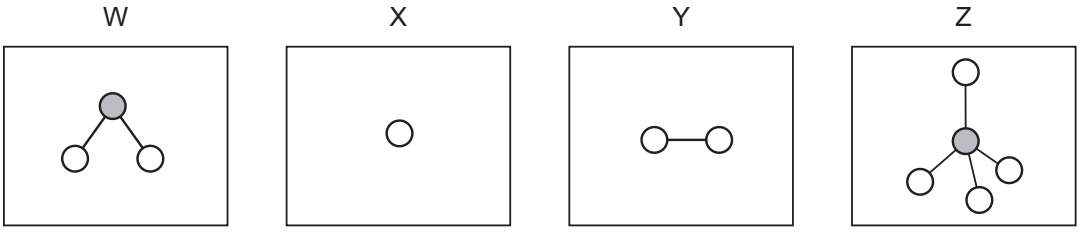
B Elements only exist as single, unbonded atoms.

C Mixtures of compounds can only be separated by chemical processes.

D Mixtures of elements are separated by electrolysis.

（2025 Oct/Nov · 0654/11 · Question 14 · Core）

5. W, X, Y and Z are diagrams representing atoms and molecules.



Which statement is correct?

A W and Z are molecules and X and Y are atoms.

B W, X and Z are molecules and Y is an atom.

C W, Y and Z are molecules and X is an atom.

D X, Y and Z are molecules and W is an atom.

（2024 May/Jun · 0654/22 · Question 14 · Extended）

6. Substance P is separated into different parts using simple physical techniques.

Substance Q is only separated into simpler parts using chemical processes.

Substance R is not separated into simpler parts by either physical or chemical processes.

Which type of substance are P, Q and R?

	P	Q	R
A	compound	mixture	element
B	element	compound	mixture
C	mixture	element	compound
D	mixture	compound	element

（2022 Feb/Mar · 0654/12 · Question 14 · Core；同题：2022 Feb/Mar · 0654/22 · Question 14 · Extended）

题型 3：按电子得失判离子的电荷和电子排布（考频★★★☆☆）

知识点 原子得失电子后形成带电粒子，称为离子；形成离子时质子数_____。
中性原子失去电子形成带正电的_____，得到电子形成带负电的_____。
单原子离子的电荷写在元素符号右上角，电荷数无单位；得失电子数等于电荷数的绝对值。
正离子的电子数比质子数少，负离子的电子数比质子数多；电子排布按离子的电子总数填写。

答案：保持不变；阳离子；阴离子

怎么认 题目出现离子符号、电子得失或电子排布时，先由右上角电荷确定电子数，质子数保持不变。

例题 1

Which statement about ions is correct?

A Ions are charged atoms.

B Cations are negative ions.

C Metal ions are negatively charged.

D Non-metal ions are positively charged.

（2026 May/Jun · 0654/12 · Question 14 · Core）

解：原子得失电子后形成带电粒子，故 A 对。
阳离子带正电，故 B 错；金属原子通常失电子，故 C 错；非金属原子通常得电子，故 D 错。
故选 A。

针对练习

1. What happens to a tellurium atom when it forms a tellurium ion, Te^{2-}?

A It gains two electrons.

B It gains two protons.

C It loses two electrons.

D It loses two protons.

（2025 May/Jun · 0654/11 · Question 17 · Core）

2. An aluminium atom forms an aluminium ion, Al^{3+}.

Which statement describes what happens to the aluminium atom?

A It gains 3 electrons.

B It gains 3 protons.

C It loses 3 electrons.

D It loses 3 protons.

（2025 May/Jun · 0654/21 · Question 17 · Extended）

3. Magnesium forms an ionic compound with chlorine.

Which row describes the formation of the magnesium ion and the formula of the magnesium ion?

	formation of the ion	formula of the ion
A	electron gain	Mg^{2+}
B	electron gain	Mg^{2-}
C	electron loss	Mg^{2+}
D	electron loss	Mg^{2-}

（2025 Oct/Nov · 0654/11 · Question 16 · Core）

4. Which particle has the same number of electrons in its outer shell as an atom of sodium, $^{23}_{11}Na$?

A $^{23}_{11}Na^{+}$ **B** $^{23}_{11}Na^{-}$ **C** $^{24}_{11}Na$ **D** $^{24}_{12}Na^{2+}$

（2025 Oct/Nov · 0654/21 · Question 14 · Extended）

5. Which row shows the electronic configuration of a calcium atom and of a fluoride ion?

	calcium atom	fluoride ion
A	2,8,8	2,7
B	2,8,8	2,8
C	2,8,8,2	2,7
D	2,8,8,2	2,8

（2025 Oct/Nov · 0654/22 · Question 14 · Extended）

6. Which statement about ions is **not** correct?

A Atoms form ions by gaining or losing electrons.

B Ions are formed by non-metal atoms only when they lose electrons.

C Ions in a solid ionic compound form a lattice structure.

D Ions with opposite charges attract each other.

（2022 Oct/Nov · 0654/23 · Question 16 · Extended）

题型 4：用质子数和电子排布辨认同位素（考频★★★☆☆）

知识点 同位素是质子数相同、中子数不同的同一种元素的原子；粒子带电时，判断同位素仍比较原子核内的质子数和中子数。

质子数决定元素种类，判断时先比较_____；相同后再比较_____，后者不同才是同位素。

中性同位素原子的电子排布相同，最外层电子数相同，因而化学性质_____；离子的电子数由所带电荷决定。

质子数、中子数和电子数都是粒子个数，不带单位。

答案：质子数；中子数；相同

怎么认 题目出现质子数、中子数、电子排布或粒子符号时，先看质子数判元素，再看中子数判同位素；问性质时再看电子。

例题 1

Which statement about isotopes of the same element is correct?

A They have the same number of protons but different number of electrons.

B They have the same number of protons but different number of neutrons.

C They have the same number of neutrons but different number of electrons.

D They have the same number of neutrons but different number of protons.

（2023 Oct/Nov · 0654/12 · Question 15 · Core；同题：2023 Oct/Nov · 0654/22 · Question 15 · Extended）

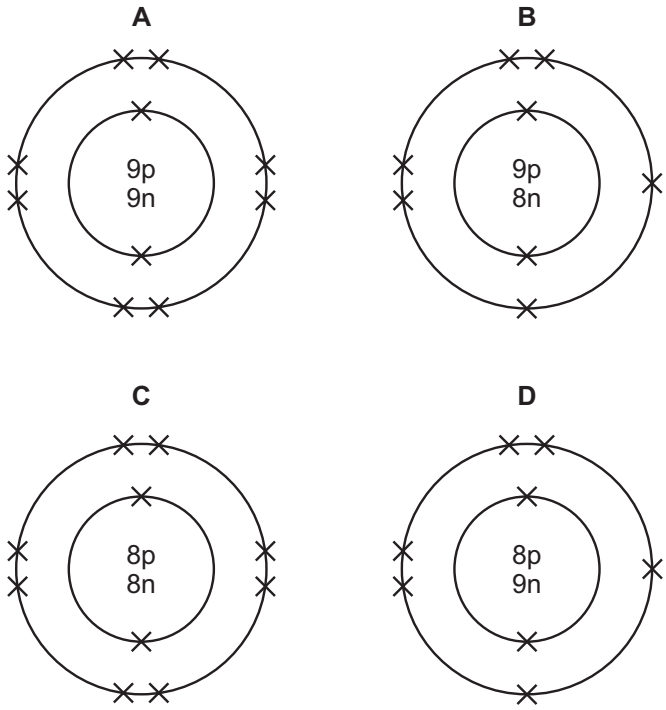
解：同位素属于同一种元素，故质子数相同；不同同位素的中子数不同。
故选 B。

针对练习

1.

One isotope of oxygen is represented by $^{16}_{8}O$.

Which diagram represents a different isotope of oxygen?



（2024 May/Jun · 0654/23 · Question 15 · Extended）

2.

X and Y are isotopes of the same element.

Which statement about X and Y is correct?

A They have the same nucleon number but different numbers of protons.

B They have the same number of neutrons but different numbers of electrons.

C They have the same atomic number but different numbers of electrons.

D They have the same number of protons but different numbers of neutrons.

（2023 Oct/Nov · 0654/13 · Question 16 · Core；同题：2023 Oct/Nov · 0654/23 · Question 16 · Extended）

3. Which statement explains why isotopes of the same element have the same properties?

A They have equal numbers of protons and electrons.

B They have the same number of electrons in their outer shell.

C They have the same number of protons.

D They have the same number of electron shells.

（2025 May/Jun · 0654/23 · Question 15 · Extended）

4. Which statement explains why isotopes of an element have the same chemical properties?

A They have the same atomic mass.

B They have the same number of neutrons.

C They have the same electronic configuration.

D They have the same density.

（2025 Oct/Nov · 0654/22 · Question 15 · Extended）

5. The numbers of protons, neutrons and electrons in four particles are shown.

particle	number of protons	number of neutrons	number of electrons
W	20	20	20
X	19	20	19
Y	20	22	18
Z	21	24	21

Which two particles are isotopes of the same element?

A W and X **B** W and Y **C** X and Y **D** Y and Z

（2024 Oct/Nov · 0654/23 · Question 14 · Extended）

6. The symbols representing four different particles are shown.

$^{1}_{1}P$ $^{2}_{1}Q^{-}$ $^{2}_{1}R$ $^{3}_{1}S^{+}$

Which particles have the same chemical properties?

A $^{1}_{1}P$ and $^{2}_{1}R$ only

B $^{2}_{1}Q^{-}$ and $^{3}_{1}S^{+}$ only

C $^{2}_{1}Q^{-}$ and $^{2}_{1}R$ only

D $^{1}_{1}P$, $^{2}_{1}Q^{-}$, $^{2}_{1}R$ and $^{3}_{1}S^{+}$

（2025 Feb/Mar · 0654/22 · Question 15 · Extended）

题型 5：辨认原子与亚原子粒子的基本属性（考频★☆☆☆☆）

知识点 原子是保持元素化学性质的_____；元素由原子的质子数决定。

同一元素的原子质子数_____，中子数可以不同；这类原子称为同位素。

中性原子的质子数_____，质子带正电，中子不带电，电子带负电。

质子和中子的相对质量均约为 1，电子的相对质量远小于 1；相对质量和相对电荷均无单位。

答案：最小粒子；相同；等于电子数

怎么认 题目出现原子定义或质子、中子、电子的质量与电荷时，先对照基本属性。

例题 1

Which statement about atoms is correct?

A All atoms contain equal numbers of neutrons and protons.

B All atoms of the same element have the same number of neutrons.

C The Periodic Table lists atoms in order of increasing mass number.

D The smallest unit of an element is an atom.

（2024 May/Jun · 0654/12 · Question 14 · Core；同题：2024 May/Jun · 0654/13 · Question 14 · Core）

解：A 错，中性原子的质子数等于电子数，质子数不一定等于中子数；
B 错，同一元素的同位素中子数可以不同；
C 错，元素周期表按质子数递增排列；D 对，元素的最小单位是原子。
故选 D。

针对练习

1. Atoms consist of protons, neutrons and electrons.

Which statement is correct?

A An electron has a relative mass of 1 and a negative charge.

B A proton has a relative mass of 1 and a positive charge.

C A proton has a relative mass of less than 1 and a negative charge.

D A neutron has a relative mass of less than 1 and no charge.

（2025 Oct/Nov · 0654/12 · Question 15 · Core；同题：2025 Oct/Nov · 0654/13 · Question 15 · Core）

题型 6：辨认溶质溶剂和溶液（考频★☆☆☆☆）

知识点 当一种物质溶解在另一种物质中时，被溶解的物质称为_____，起溶解作用的物质称为_____。
溶质均匀分散在溶剂中形成的混合物称为_____；三者表示物质的不同角色，没有单位。

答案：溶质；溶剂；溶液

怎么认 题目出现物质溶于液体并问三者名称时，先找被溶解者，再找溶解它的液体。

例题 1

Sea water is a mixture that contains sodium chloride dissolved in water.

Which row describes sea water?

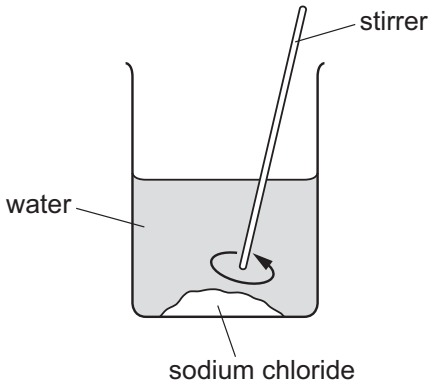
	solvent	solute	solution
A	water	sea water	sodium chloride
B	sea water	sodium chloride	water
C	water	sodium chloride	sea water
D	sodium chloride	water	sea water

（2024 Oct/Nov · 0654/11 · Question 15 · Core）

解：由氯化钠溶解在水中得，氯化钠是溶质，水是溶剂。
氯化钠溶解后形成的海水是溶液。
故选 C。

针对练习

1. Sodium chloride is dissolved in water.



Which word describes the water used in this process?

A solvent

B solution

C solute

D sediment

（2025 Feb/Mar · 0654/12 · Question 26 · Core）

1.3 离子键、共价键与物质结构

题型 1：按元素类型和成键方式判断离子或分子物质（考频★★★☆☆）

知识点 离子键是带相反电荷的离子之间的强_____；离子化合物通常由金属元素和非金属元素形成，并以规则晶格存在。

共价键由两个非金属原子_____电子形成；简单分子物质通常挥发性较高且不导电。

金属与非金属反应时通常发生电子_____，非金属原子彼此成键时通常发生电子共享。

常见非金属元素有氢、碳、氮、氧、氟、磷、硫、氯、溴和碘；钠、镁、铝、钾、钙、铁、铜等属于金属元素。

稀有气体通常以单原子存在；氯气、乙醇等以共价分子存在，氯化钠等离子化合物以离子晶格存在。

答案：静电吸引；共享；转移

怎么认 题目出现元素组合、成键方式、分子或晶格粒子时，先按元素类型分类，再判断电子转移或共享。

例题 1

Which elements react together to form an ionic compound?

A carbon and oxygen

B nitrogen and hydrogen

C potassium and bromine

D sodium and lithium

（2024 May/Jun · 0654/11 · Question 16 · Core）

解：钾是金属元素，溴是非金属元素，二者反应时发生电子转移，形成离子化合物。故选 C。

针对练习

1. Which elements react to form an ionic compound?

A carbon and hydrogen

B fluorine and potassium

C chlorine and hydrogen

D hydrogen and nitrogen

（2026 May/Jun · 0654/22 · Question 14 · Extended）

2. Which substances exist as covalent molecules?

1 helium

2 chlorine

3 sodium chloride

4 ethanol

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2024 May/Jun · 0654/12 · Question 15 · Core；同题：2024 May/Jun · 0654/13 · Question 15 · Core）

3. Which statement about simple molecules is correct?

A They contain both metallic and non-metallic elements.

B They have good electrical conductivity.

C They contain covalent bonds.

D They have high melting points.

（2025 Oct/Nov · 0654/12 · Question 16 · Core；同题：2025 Oct/Nov · 0654/13 · Question 16 · Core）

4. Which statement describes the lattice structure of sodium chloride, NaCl?

A It is a random arrangement of equal numbers of sodium atoms and chlorine atoms.

B It is a random arrangement of equal numbers of sodium ions and chloride ions.

C It is a regular arrangement of alternating sodium atoms and chlorine atoms.

D It is a regular arrangement of alternating sodium ions and chloride ions.

（2022 Oct/Nov · 0654/21 · Question 16 · Extended）

5. Compounds are made up from two or more different elements ……1…… bonded together.

Compounds cannot be broken down into simpler substances by ……2…… processes.

Compounds and their elements have ……3…… properties.

Which words complete gaps 1, 2 and 3?

	1	2	3
A	chemically	chemical	similar
B	chemically	physical	different
C	physically	chemical	similar
D	physically	physical	different

（2025 May/Jun · 0654/21 · Question 23 · Extended）

6. Which row identifies the types of elements that form covalent compounds and a physical property of covalent compounds?

	types of elements	physical property
A	metals and non-metals	high volatility
B	metals and non-metals	low volatility
C	non-metals only	high volatility
D	non-metals only	low volatility

（2024 Feb/Mar · 0654/22 · Question 15 · Extended）

7. The bonding in potassium iodide is ionic.

Which row describes the potassium iodide lattice structure?

	positive ions	negative ions	attractive force between ions
A	iodide	potassium	strong
B	iodide	potassium	weak
C	potassium	iodide	strong
D	potassium	iodide	weak

（2024 Oct/Nov · 0654/22 · Question 14 · Extended）

8. Magnesium and chlorine react together to form magnesium chloride.

The particles in magnesium chloride are held together by 1 between 2 .

Which words complete gaps 1 and 2?

	1	2
A	electrostatic attraction	atoms
B	electrostatic attraction	ions
C	sharing of electrons	atoms
D	sharing of electrons	ions

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（2026 May/Jun · 0654/13 · Question 14 · Core）

9. Different minerals contain different elements.

Which mineral contains three non-metallic elements?

	mineral	formula
A	chalcopyrite	$CuFeS_2$
B	cryolite	Na_3AlF_6
C	gypsum	$CaSO_4•2H_2O$
D	ilmenite	$FeTiO_3$

（2024 May/Jun · 0654/12 · Question 22 · Core；同题：2024 May/Jun · 0654/13 · Question 22 · Core）

题型 2：由离子或简单分子结构推断物理性质（考频★★☆☆☆）

知识点 典型简单分子物质由非金属元素通过共价键形成，分子间作用力较弱，熔点和沸点通常较低，挥发性较_____。

简单分子物质中没有可自由移动的带电粒子，固态和熔融态通常_____导电。

离子化合物由正、负离子构成；熔融或溶于水时离子可以移动，因而能够导电，固态时不能导电。

离子化合物通常熔点高；其水溶性须根据具体物质判断，钠盐通常_____于水。

答案：高；不能；易溶

怎么认 题目出现物质类别及熔点、挥发性或导电性时，先判定结构，再判断有无可移动带电粒子。

例题 1

Which pair of elements forms a compound that does **not** conduct electricity when it is molten?

A carbon and hydrogen

B lithium and bromine

C magnesium and chlorine

D potassium and iodine

（2025 Feb/Mar · 0654/12 · Question 17 · Core）

解：碳和氢均为非金属元素，形成共价化合物。
共价化合物熔融时没有可自由移动的带电粒子，不能导电。
锂与溴、镁与氯、钾与碘均形成离子化合物，熔融时离子可移动。
故选 A。

针对练习

1. Which row describes the properties of a covalent compound?

	volatility	electrical conductivity when molten
A	high	none
B	high	high
C	low	none
D	low	high

（2024 May/Jun · 0654/22 · Question 15 · Extended）

2. What is a property of a typical covalent compound?

A low electrical conductivity

B high melting point

C low volatility

D soluble in water

（2024 Oct/Nov · 0654/21 · Question 16 · Extended）

3. Hexane is a simple molecular compound.

Sodium phosphate is an ionic compound.

Which row describes the properties of hexane and sodium phosphate?

	hexane	**sodium phosphate**
A	high melting point	insoluble in water
B	low melting point	soluble in water
C	poor electrical conductivity	low boiling point
D	good electrical conductivity	high boiling point

（2026 May/Jun · 0654/21 · Question 16 · Extended）

题型 3：从连接方式识别金刚石石墨和二氧化硅（考频★★☆☆☆）

知识点 金刚石中，每个碳原子与_____个碳原子形成强共价键，构成立体网络。
石墨中，每个碳原子与三个碳原子相连，形成层状_____环；层间作用力较弱。
二氧化硅中，每个硅原子与_____个氧原子相连，每个氧原子与两个硅原子相连，形成三维网络。
巨型共价结构的强共价键越多，结构越坚硬，熔点越高。

答案：四；六边形；四

怎么认 题目出现结构图、原子连接数或切割工具用途时，先辨认层状六角环或四配位网络。

例题 1

Which statement explains why diamonds are used to make cutting tools?

A Diamond is a giant covalent structure.

B Diamond is a pure substance made only from carbon atoms.

C The carbon atoms in diamond are arranged in layers.

D The carbon atoms in diamond are held together by strong covalent bonds.

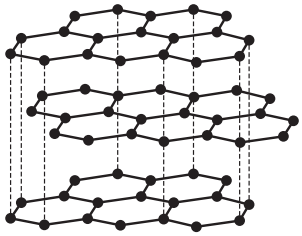
（2026 May/Jun · 0654/22 · Question 15 · Extended）

解：金刚石中，碳原子之间以强共价键相连。
破坏其结构需要克服许多强共价键，故金刚石硬度很大，可制成切割工具。
故选 D。

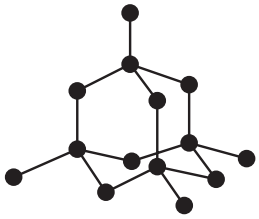
针对练习

1. Which diagram shows the structure of graphite?

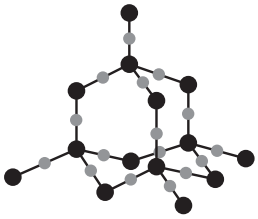
A



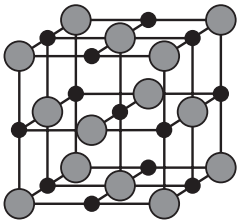
B



C



D



（2024 May/Jun · 0654/12 · Question 16 · Core；同题：2024 May/Jun · 0654/13 · Question 16 · Core）

2. Which statement describes the bonding in diamond?

A each carbon atom covalently bonded to four other carbon atoms

B a flat structure of hexagonal rings of covalently bonded carbon atoms

C an electrostatic attraction between positive carbon ions and a sea of delocalised electrons

D each carbon atom bonded to another carbon atom by a double covalent bond

（2026 May/Jun · 0654/23 · Question 14 · Extended）

3. Which statements describe the structure of silicon(IV) oxide?

1 Each oxygen atom is attached to two silicon atoms.

2 Each oxygen atom is attached to four silicon atoms.

3 Each silicon atom is attached to two oxygen atoms.

4 Each silicon atom is attached to four oxygen atoms.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2024 May/Jun · 0654/21 · Question 17 · Extended）

题型 4：用自由电子解释金属与合金导电（考频★★☆☆☆）

知识点 金属由规则排列的正离子和离域电子（delocalised electrons）组成。

正离子固定在晶格位置附近，能在整个金属晶格中自由移动的粒子是_____。

有电势差时，离域电子定向移动形成电流，因此金属和合金均能_____。

合金是两种或多种元素形成的_____，其中至少一种元素是金属。

答案：离域电子；导电；混合物

怎么认 题目出现金属晶格中的移动粒子或金属、合金导电时，先找离域电子。

例题 1

Which particles are free to move in a giant metallic lattice?

	positive ions	negative ions	electrons
A	✓	✓	✗
B	✓	✗	✓
C	✗	✓	✗
D	✗	✗	✓

（2025 Oct/Nov · 0654/22 · Question 18 · Extended）

解：金属晶格由固定在晶格位置附近的正离子和可自由移动的离域电子组成。

故正离子不能自由移动，晶格中不存在负离子，电子可以自由移动。

故选 D。

针对练习

1. Which statement explains why metals conduct electricity?

A There is a ‘sea’ of delocalised electrons.

B The positive ions move over each other.

C There is an electrostatic attraction between the oppositely charged particles.

D The particles in a metal vibrate and pass on the electric current.

（2025 May/Jun · 0654/22 · Question 14 · Extended）

2. Alloys are formed by dissolving one metal in another.

Alloys are ……1…… .

……2…… alloys conduct electricity.

Which words complete gaps 1 and 2?

	1	2
A	compounds	All
B	compounds	Some
C	mixtures	All
D	mixtures	Some

（2022 Oct/Nov · 0654/11 · Question 23 · Core；同题：2022 Oct/Nov · 0654/12 · Question 23 · Core、2022 Oct/Nov · 0654/13 · Question 23 · Core、2022 Oct/Nov · 0654/21 · Question 23 · Extended；同题：2022 Oct/Nov · 0654/22 · Question 23 · Extended）

题型 5：核对点叉图的电子转移与离子晶格排列（考频★☆☆☆☆）

知识点 离子键是带相反电荷的离子之间的静电吸引，金属原子失去电子形成阳离子，非金属原子得到电子形成阴离子。

点叉图中的离子须标方括号和电荷；在氯化钠中，Na^+和Cl^-的最外层均有_____个电子。

离子化合物形成巨型离子晶格，相邻位置由_____离子交替排列；Na^+与Cl^-的个数比为_____。

答案：8；带相反电荷的；1 : 1

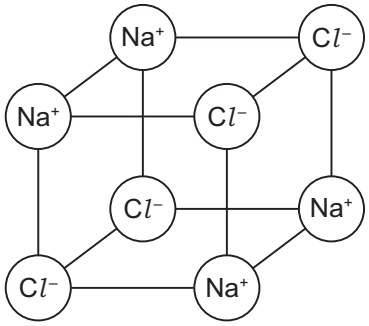
怎么认 题目出现离子点叉图或晶格排列图时，先核对电荷、满外层、正负离子交替及离子比例。

例题 1 Which diagram represents the structure of sodium chloride, NaC*l*?

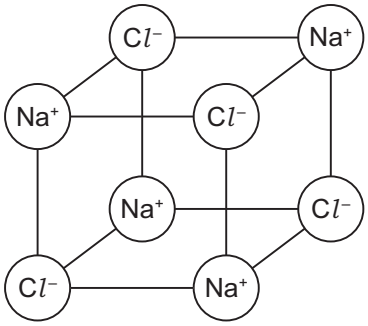
A



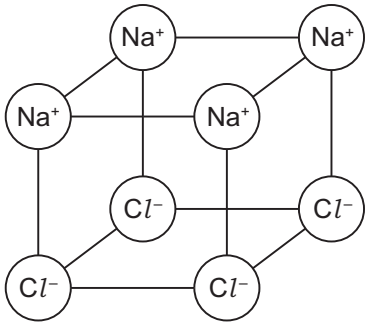
B



C



D



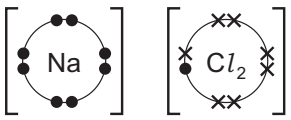
（2025 May/Jun · 0654/23 · Question 16 · Extended）

解：NaCl由Na^+和Cl^-构成巨型离子晶格。
晶格中相邻位置为异号离子，且$n(Na^+):n(Cl^-)=1:1$。
C 中正、负离子交替排列且数目比为1 : 1，符合氯化钠的结构。故选 C。

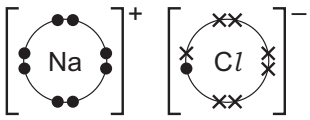
针对练习

1. Which dot-and-cross diagram represents sodium chloride?

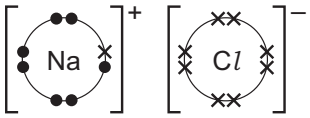
A



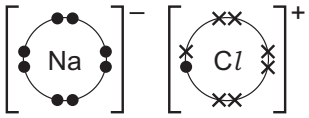
B



C



D



（2025 Feb/Mar · 0654/12 · Question 16 · Core）

题型 6：按常见化合价核对共价点叉图和共享电子（考频★★★☆☆）

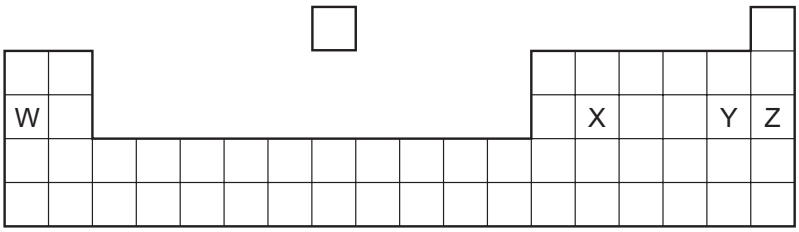
知识点 共价键是原子间通过共享电子对形成的化学键；每一对共享电子构成一个共价键。
常见中性原子的成键数为：H 为 _____，C 为 _____，N 为 3，O 为 2；成键数无单位。
核对点叉图时，先检查共享电子对，再数孤对电子；N 通常有 1 对孤对，O 通常有 2 对孤对。

答案：1；4

怎么认 题目出现点叉图、显示式或共享电子时，先按氢 1、碳 4、氮 3、氧 2 核对成键数，再数孤对。

例题 1

Part of the Periodic Table is shown.



Which elements form a bond by sharing electrons?

A W and X　　**B** W and Y　　**C** X and Y　　**D** Y and Z

（2025 Oct/Nov · 0654/11 · Question 17 · Core）

解：由周期表中的位置可知，W 位于第 1 族，为金属；X、Y 位于周期表右侧，均为非金属；Z 位于第 18 族，外层电子排布稳定。
非金属 X 与非金属 Y 通过共享电子形成共价键。
故选 C。

针对练习

1. The displayed formula of a molecule is shown.

H—C≡N

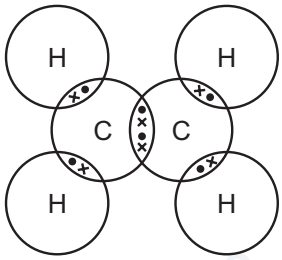
How many covalent bonds are formed by the carbon atom in this molecule?

A 1 **B** 2 **C** 3 **D** 4

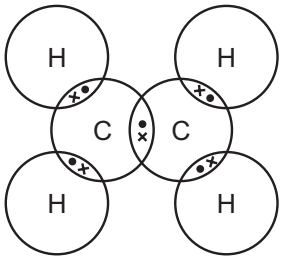
（2026 Feb/Mar · 0654/12 · Question 25 · Core）

2. Which dot-and-cross diagram represents the bonding in a molecule of ethene?

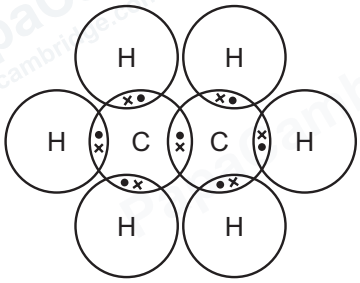
A



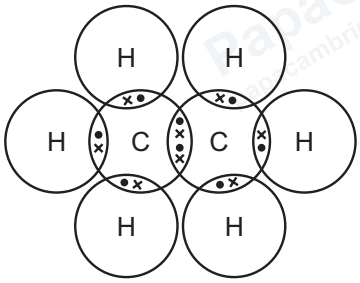
B



C



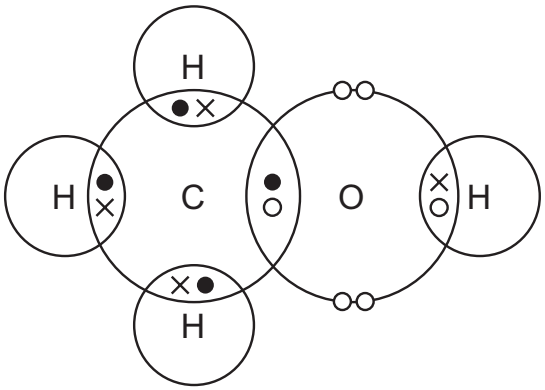
D



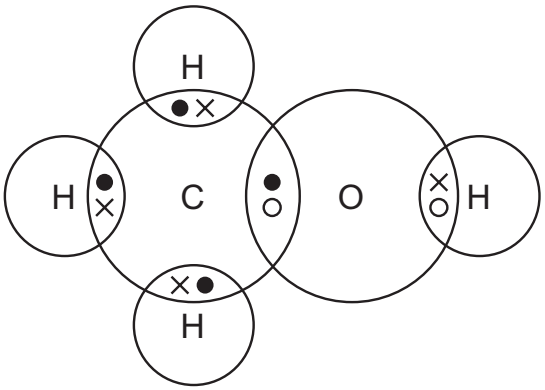
（2026 Feb/Mar · 0654/22 · Question 16 · Extended）

3. Which dot-and-cross diagram represents the outer-shell electrons in a molecule of methanol?

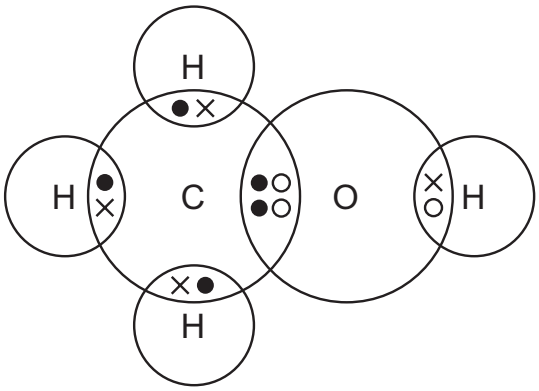
A



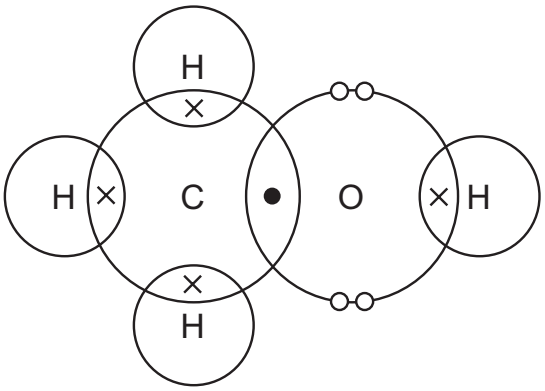
B



C



D



(2024 May/Jun · 0654/21 · Question 16 · Extended)

4. Which dot-and-cross diagram shows the outer-shell electrons in a molecule of carbon dioxide?

A



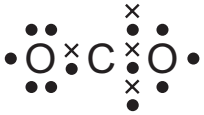
B



C



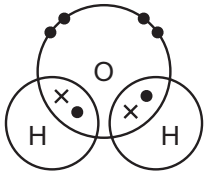
D



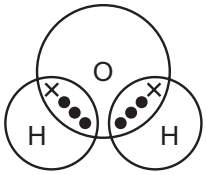
(2025 Oct/Nov · 0654/21 · Question 15 · Extended)

5. What is the dot-and-cross diagram for a water molecule?

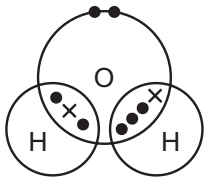
A



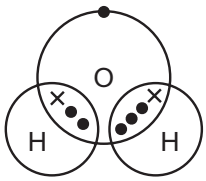
B



C



D



(2024 Oct/Nov · 0654/11 · Question 16 · Core)

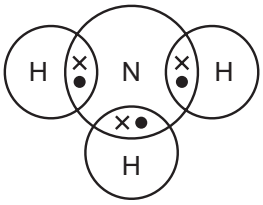
6. In which molecule are **all** the outer-shell electrons of the atoms used to form the covalent bonds?

A HCl **B** H_2O **C** NH_3 **D** CH_4

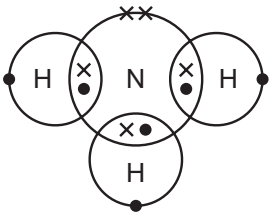
(2025 May/Jun · 0654/11 · Question 18 · Core)

7. Which dot-and-cross diagram represents a molecule of ammonia?

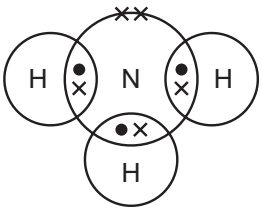
A



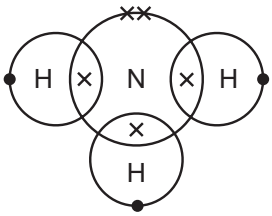
B



C

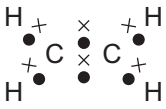
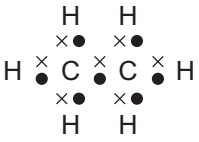
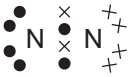
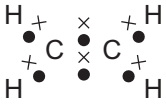
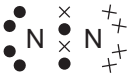
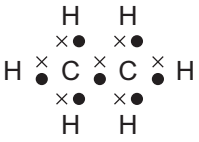


D



（2024 Feb/Mar · 0654/12 · Question 16 · Core）

8. Which row shows the dot-and-cross diagrams for nitrogen and ethene?

	nitrogen	ethene
A		
B		
C		
D		

（2025 Oct/Nov · 0654/22 · Question 17 · Extended）

1.4 化学式、方程式与物质的量

题型 1：数化学式中的元素种类和原子数（考频★★★★☆）

知识点 化学式中，一个大写字母或一个大写字母与其后的小写字母组成一个_____；不同元素符号的个数就是元素种类数。
元素符号右下角的数字表示一个粒子中该元素的_____，省略下标时按 1 计；括号外下标乘括号内各元素的原子数。
统计混合物中的不同元素时，应合并各物质中重复出现的元素；原子个数比由相应原子数相比并化为最简整数比。
结构图按元素符号逐个计数，重复元素合并，所得种类数、原子数和原子个数比均无单位。

答案：元素符号；原子个数

怎么认 题目出现化学式、结构图或原子数关系时，先逐种写出元素符号并统计原子数。

例题 1

A mixture contains water, H_2O, copper chloride, $CuCl_2$, and barium sulfate, $BaSO_4$.

How many different non-metallic elements are in the mixture?

A 2 **B** 4 **C** 7 **D** 12

（2022 Oct/Nov · 0654/13 · Question 16 · Core）

解：由各化学式得，混合物中的元素为 H, O, Cu, Cl, Ba, S。
其中金属元素为 Cu, Ba，非金属元素为 H, O, Cl, S。
非金属元素种类数为 4，故选 B。

针对练习

1. The formula of ethanol is C_2H_5OH.

How many different elements are present in ethanol?

A 1 **B** 3 **C** 4 **D** 9

（2025 May/Jun · 0654/12 · Question 15 · Core；同题：2025 May/Jun · 0654/13 · Question 15 · Core）

2. Which formula contains the most elements?

A NaOH **B** Rb_2S **C** $SiCl_4$ **D** SnO_2

（2024 Oct/Nov · 0654/12 · Question 16 · Core；同题：2024 Oct/Nov · 0654/13 · Question 16 · Core）

3. There are three times as many hydrogen atoms as carbon atoms in one molecule of hydrocarbon X.

What is the formula of X?

A CH_4 **B** C_2H_4 **C** C_2H_6 **D** C_2H_5OH

（2022 Oct/Nov · 0654/12 · Question 16 · Core）

4. Which oxides of nitrogen have the same ratio of nitrogen atoms to oxygen atoms?

1 N_2O

2 NO

3 NO_2

4 N_2O_4

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2024 May/Jun · 0654/12 · Question 17 · Core；同题：2024 May/Jun · 0654/13 · Question 17 · Core）

5. The element phosphorus burns in air, as shown.

$$4P + 5O_2 \rightarrow P_4O_{10}$$

What does the formula P_4O_{10} show?

A a mixture of atoms of two elements

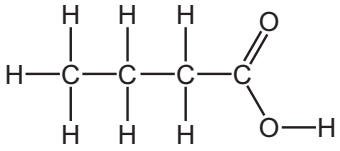
B a mixture of molecules of two elements

C a molecule of a compound

D an atom of a compound

（2023 May/Jun · 0654/11 · Question 15 · Core；同题：2023 May/Jun · 0654/21 · Question 15 · Extended）

6. The structure of an organic compound is shown.

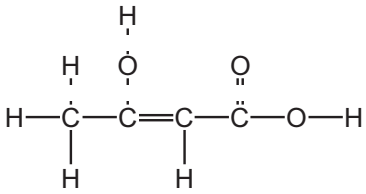


What is the formula of this compound?

A $C_3H_7O_2$ **B** $C_3H_8O_2$ **C** $C_4H_7O_2$ **D** $C_4H_8O_2$

（2025 Oct/Nov · 0654/11 · Question 18 · Core）

7. The structure of a molecule of an organic compound is shown.



What is the formula of this compound?

A $C_4H_4O_3$ **B** $C^4H^4O^3$ **C** $C_4H_6O_3$ **D** 4C6H3O

（2024 Feb/Mar · 0654/12 · Question 17 · Core）

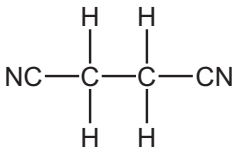
8. Magnesium hydroxide contains twice as many atoms of both oxygen and hydrogen than atoms of magnesium.

What is the formula of magnesium hydroxide?

A MgOH **B** MgO_2H_2 **C** $Mg(OH)_2$ **D** $Mg_2(OH)$

（2025 Feb/Mar · 0654/12 · Question 18 · Core）

9. A diagram of one molecule of an organic compound is shown.

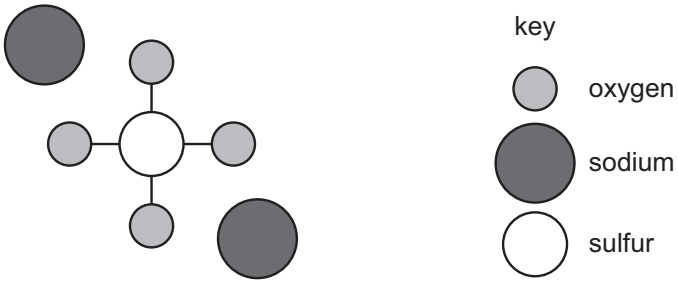


What is the molecular formula of this organic compound?

A C_2H_2N **B** $C_2H_4N_2$ **C** C_4H_6 **D** $C_4H_4N_2$

(2026 May/Jun · 0654/12 · Question 16 · Core)

10. The diagram represents an ionic compound formed from three types of atom.



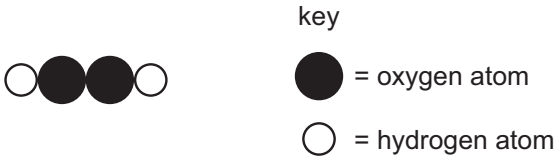
What is the chemical formula for this compound?

A Na_2S_4O **B** NaO_4S_2 **C** Na_2SO_4 **D** S_4O_2Na

(2023 Oct/Nov · 0654/11 · Question 17 · Core)

11. Hydrogen peroxide is a compound.

A molecule of hydrogen peroxide can be represented as shown.

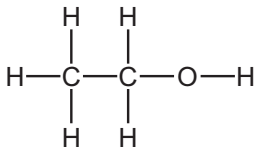
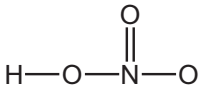
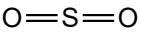


What is the formula of hydrogen peroxide?

A HO **B** H_2O_2 **C** H_2O **D** 2OH

(2024 May/Jun · 0654/11 · Question 17 · Core)

12. The structures of some compounds are shown.

	structure	formula
1		C_2H_6O
2		CO_2
3		HNO_3
4		SO_4

In which rows does the formula match the structure?

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2023 May/Jun · 0654/12 · Question 17 · Core；同题：2023 May/Jun · 0654/13 · Question 17 · Core）

题型 2：把质量粒子数和气体体积换成物质的量（考频★★★★☆）

知识点 相对原子质量 A_r 是元素原子的平均质量与一个碳-12 原子质量的 $\frac{1}{12}$ 之比，没有单位。

1 mol 任何粒子都含有 _____ 个粒子，$N = nN_A$。

质量换算为物质的量时，$n = \frac{m}{M}$；m 的单位为 g，M 的单位为 g mol^{-1}。

室温和压强（r.t.p.）下，1 mol 气体体积为 _____ dm^3，故 $n = \frac{V}{24}$；溶液中 $n = cV$，c 的单位为 mol dm^{-3}，V 须用 _____。

答案：6.02×10^{23}；24；dm^3

怎么认 题目出现质量、粒子数、r.t.p.气体体积或溶液浓度与体积时，先统一换算为物质的量。

例题 1

Which description of mass is used to define relative atomic mass, A_r?

A the mass of $\frac{1}{12}$ of a mole of ^{12}C atoms

B the mass of one mole of ^{12}C atoms

C the mass of $\frac{1}{12}$ the mass of one atom of ^{12}C

D the mass of one atom of ^{12}C

（2025 May/Jun · 0654/21 · Question 19 · Extended）

解：设一个碳-12 原子的质量为 m，则相对原子质量的质量基准为 $m_0 = \frac{1}{12}m$。

故选 C。

针对练习

1. Which statement about the Avogadro constant is correct?

A It is the volume of 1 mole of a gas at room temperature and pressure.

B It is the mass of 1 mole of a substance.

C It is the number of particles in 1 mole of a substance.

D It has a value of 24 dm^3.

（2025 Oct/Nov · 0654/22 · Question 20 · Extended）

2. What is the definition of the *relative atomic mass*, A_r, of an element?

A the average mass of atoms of the element on a scale in which an atom of ^{12}C has a mass of exactly 12 units

B the average mass of atoms of the element on a scale in which an atom of ^{1}H has a mass of exactly 1 unit

C the average mass of atoms of the element on a scale in which an atom of ^{12}C has a mass of exactly 1 unit

D the mass in grams of one mole of atoms of the element

（2024 Oct/Nov · 0654/22 · Question 15 · Extended）

3. 1 g of hydrogen contains 6×10^{23} atoms.

The relative atomic mass of helium is 4.

How many atoms does 1 g of helium contain?

A 1.5×10^{23} **B** 3×10^{23} **C** 6×10^{23} **D** 2.4×10^{24}

（2022 Oct/Nov · 0654/21 · Question 17 · Extended；同题：2022 Oct/Nov · 0654/22 · Question 17 · Extended）

4. A sample of methane has mass 16.0 g at r.t.p. and contains the Avogadro number of molecules.

What is the volume of 4.0 g of methane at r.t.p.?

A 4.0 dm^3 **B** 6.0 dm^3 **C** 16 dm^3 **D** 24 dm^3

（2024 Oct/Nov · 0654/23 · Question 15 · Extended）

5. Which sample of gas contains the most molecules?

A 2 g of hydrogen, H_2

B 48 g of oxygen, O_2

C 56 g of nitrogen, N_2

D 64 g of sulfur dioxide, SO_2

（2026 May/Jun · 0654/22 · Question 16 · Extended）

6. 36 cm^3 of carbon dioxide is produced in a reaction at room temperature and pressure.

What is the mass of carbon dioxide gas produced?

A 0.0015 g **B** 0.0018 g **C** 0.066 g **D** 0.079 g

（2026 May/Jun · 0654/23 · Question 16 · Extended）

7. Which statements about the mole are correct?

1 One mole of ^{12}C contains twice as many atoms as one mole of ^{24}Mg.

2 One mole of ^{12}C has a mass of 12 g.

3 One mole of C contains Avogadro's number of atoms.

4 One mole of oxygen gas at room temperature and pressure occupies 32 dm^3.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2023 Feb/Mar · 0654/22 · Question 16 · Extended）

8. Which quantities, when measured at room temperature and pressure, contain one mole of oxygen molecules?

1 16 g of oxygen molecules

2 12 dm^3 of oxygen molecules

3 the Avogadro constant number of oxygen molecules

4 24 dm^3 of oxygen molecules

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2025 May/Jun · 0654/21 · Question 20 · Extended）

9. Hydrogen chloride is a gas. It dissolves in water to form an acidic solution.

Three different samples of hydrogen chloride are listed.

1 73.0 g of hydrogen chloride gas

2 7.30 dm^3 of hydrogen chloride gas at r.t.p.

3 730 cm^3 of 1.00 mol / dm^3 aqueous hydrogen chloride

Which row shows the relative number of moles of hydrogen chloride in these samples?

	fewest ⟶		most
A	1	2	3
B	1	3	2
C	2	3	1
D	3	2	1

（2022 Feb/Mar · 0654/22 · Question 15 · Extended）

题型 3：由化合价或离子电荷写化学式（考频★★☆☆☆）

知识点 离子化合物的化学式表示组成离子的最简整数比，化合物整体呈电中性。

确定下标时，各离子的总正电荷与总负电荷必须_____；Ⅰ族简单离子带 +1 电荷，Ⅶ族简单离子带 −1 电荷。

共价化合物中，各原子的成键数应满足其常见价键数；碳通常形成四个键，氢通常形成一个键。

多原子离子出现两个或以上时用_____括起后标下标；化学式无单位。

答案：相互抵消；括号

怎么认 题目出现元素所属族、电子结构或离子电荷并要求写化学式时，先确定成键数或电荷比。

例题 1

What is the molecular formula of the compound sodium fluoride?

A NaF **B** NaF*l* **C** SF **D** SF*l*

（2026 May/Jun · 0654/13 · Question 15 · Core）

解：钠离子为 Na^+，氟离子为 F^-。
$1\times(+1)+1\times(-1)=0$，故钠离子与氟离子的个数比为 1 : 1。
化学式为 NaF。故选 A。

针对练习

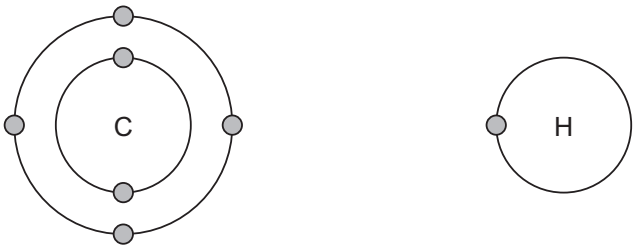
1. Lithium is in Group I and bromine is in Group VII of the Periodic Table.

What is the formula of lithium bromide?

A LiBr **B** $LiBr_2$ **C** Li_2Br **D** Li_2Br_2

（2023 May/Jun · 0654/11 · Question 17 · Core）

2. The electronic structures of carbon and of hydrogen are shown.



What is the formula of a compound formed between carbon and hydrogen?

A CH_2 **B** CH_3 **C** C_4H **D** CH_4

（2024 Oct/Nov · 0654/11 · Question 17 · Core）

3. The formula of an ammonium ion is NH_4^+.

The formula of a phosphate ion is PO_4^{3-}.

What is the formula of ammonium phosphate?

A $(NH_4)_3PO_4$ **B** $(NH_4)_2PO_4$ **C** NH_4PO_4 **D** $NH_4(PO_4)_3$

（2024 Oct/Nov · 0654/21 · Question 17 · Extended）

4. Sodium phosphate, Na_3PO_4, contains sodium ions, Na^+.

Aluminium sulfate, $Al_2(SO_4)_3$, contains sulfate ions, SO_4^{2-}.

What is the formula of aluminium phosphate?

A $AlPO_4$ **B** $Al(PO_4)_2$ **C** $Al_2(PO_4)_3$ **D** $Al_3(PO_4)_2$

（2022 May/Jun · 0654/21 · Question 16 · Extended；同题：2022 May/Jun · 0654/22 · Question 16 · Extended、2022 May/Jun · 0654/23 · Question 16 · Extended）

题型 4：按原子守恒核验和配平反应式（考频★★★★☆）

知识点 化学方程式配平遵循_____，反应前后每种元素的原子数分别相等。
配平时只改变化学式前的_____，不得改动化学式中的下标。
各化学计量数通常取最简整数比，化学计量数无单位。
燃烧反应通常按_____的顺序配平，再核验氧原子数。

答案：原子守恒；化学计量数；碳、氢、氧

怎么认 题目出现反应式候选或待定系数时，先逐元素统计反应前后的原子数。

例题 1

Which equation is balanced?

A $2H_2 + O_2 \rightarrow 2H_2O_2$

B $MgO + 2H_2SO_4 \rightarrow MgSO_4 + 2H_2O$

C $Na + H_2O \rightarrow NaOH + H_2$

D $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

（2022 May/Jun · 0654/12 · Question 16 · Core；同题：2022 May/Jun · 0654/13 · Question 16 · Core）

解：逐元素计数，D 项反应式为
$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$
反应前后 Na、C、O、H、Cl 的原子数均依次为 $2, 1, 3, 2, 2$，符合原子守恒。
故选 D。

针对练习

1. Which symbol equation is **not** balanced?

A $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

B $Fe_3O_4 + 2H_2 \rightarrow 3Fe + 2H_2O$

C $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

D $2Na + 2H_2O \rightarrow 2NaOH + H_2$

（2023 May/Jun · 0654/21 · Question 17 · Extended）

2. Which equation represents the reaction between aluminium and oxygen?

A $2Al + 3O \rightarrow Al_2O_3$

B $Al_2 + 3O \rightarrow Al_2O_3$

C $2Al_2 + 3O_2 \rightarrow 2Al_2O_3$

D $4Al + 3O_2 \rightarrow 2Al_2O_3$

（2023 Oct/Nov · 0654/12 · Question 16 · Core）

3. What is the balanced equation for the combustion of hydrogen?

A $2H + O \rightarrow H_2O$

B $H_2 + O_2 \rightarrow H_2O$

C $H_2 + O \rightarrow H_2O$

D $2H_2 + O_2 \rightarrow 2H_2O$

（2025 May/Jun · 0654/21 · Question 18 · Extended）

4. Dilute hydrochloric acid reacts with sodium carbonate to form sodium chloride, carbon dioxide and water.

The equation for the reaction is shown.

$$w\mathrm{HC}l + \mathrm{Na_2CO_3} \rightarrow x\mathrm{NaC}l + y\mathrm{CO_2} + z\mathrm{H_2O}$$

What are the values of *w*, *x*, *y* and *z*?

	w	*x*	*y*	*z*
A	1	1	3	1
B	2	1	1	1
C	2	2	3	2
D	2	2	1	1

(2023 Oct/Nov · 0654/13 · Question 17 · Core)

5. Propene, $\mathrm{C_3H_6}$, burns in excess oxygen to form carbon dioxide and water.

$$w\mathrm{C_3H_6} + x\mathrm{O_2} \rightarrow y\mathrm{CO_2} + z\mathrm{H_2O}$$

Which values of *w*, *x*, *y* and *z* balance this equation?

	w	*x*	*y*	*z*
A	1	9	3	3
B	1	5	3	6
C	2	9	6	6
D	2	5	6	3

(2022 Feb/Mar · 0654/12 · Question 15 · Core)

6. Propanol, $\mathrm{CH_3CH_2CH_2OH}$, burns in oxygen to produce carbon dioxide and water.

$$2\mathrm{CH_3CH_2CH_2OH} + 9\mathrm{O_2} \rightarrow x\mathrm{CO_2} + y\mathrm{H_2O}$$

Which values of *x* and *y* balance the equation?

	x	*y*
A	3	4
B	3	8
C	6	4
D	6	8

(2022 May/Jun · 0654/11 · Question 16 · Core)

7. Pentane, $\mathrm{C_5H_{12}}$, burns in a limited air supply to produce some carbon dioxide and some carbon monoxide.

What is a balanced equation for this reaction?

A $\mathrm{C_5H_{12}} + 7\mathrm{O_2} \rightarrow 3\mathrm{CO_2} + 2\mathrm{CO} + 6\mathrm{H_2O}$

B $\mathrm{C_5H_{12}} + 9\mathrm{O_2} \rightarrow \mathrm{CO_2} + 4\mathrm{CO} + 12\mathrm{H_2O}$

C $\mathrm{C_5H_{12}} + 14\mathrm{O} \rightarrow 3\mathrm{CO_2} + 2\mathrm{CO} + 6\mathrm{H_2O}$

D $\mathrm{C_5H_{12}} + 18\mathrm{O} \rightarrow \mathrm{CO_2} + 4\mathrm{CO} + 12\mathrm{H_2O}$

(2023 May/Jun · 0654/23 · Question 16 · Extended)

8. Phosphorus pentachloride, PCl_5, reacts with water to form phosphoric acid, H_3PO_4, and substance Y.

The incomplete equation for the reaction is shown.

$$PCl_5 + 4H_2O \rightarrow H_3PO_4 + xY$$

Which row identifies substance Y and gives the value of *x*?

	Y	*x*
A	HCl	5
B	HCl	10
C	Cl_2	5
D	Cl_2	10

（2026 May/Jun · 0654/23 · Question 15 · Extended）

9. Copper reacts with dilute nitric acid to form copper(II) nitrate, nitrogen dioxide and water.

The equation for the reaction is shown.

$$Cu(s) + qHNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + sNO_2(g) + tH_2O(l)$$

Which row shows the numerical values of *q* and *s*?

	q	*s*
A	2	1
B	2	2
C	4	1
D	4	2

（2025 Feb/Mar · 0654/22 · Question 16 · Extended）

题型 5：按方程式摩尔比换算反应质量或气体体积（考频★★★☆☆）

知识点 物质的量 n 表示物质所含基本粒子的多少；已知质量时，计算式为 _____，其中 m 为质量，M 为摩尔质量，单位分别为 g 和 g mol^{-1}。
配平方程式中，各物质的化学计量数之比等于反应时的_____之比。
室温和常压下，气体的摩尔体积为 _____；由气体体积求物质的量时，体积单位应保持一致。

答案：$n = \frac{m}{M}$；物质的量；$24 dm^3 mol^{-1}$

怎么认 题目出现配平方程式、已知一种物质的质量或气体体积并求另一物质时，先把已知量换算为物质的量。

例题 1 The equation for the combustion of magnesium is shown.

$$2Mg + O_2 \rightarrow 2MgO$$

What is the mass of magnesium oxide formed from 12 g of magnesium?

A 20 g **B** 24 g **C** 40 g **D** 80 g

（2024 May/Jun · 0654/21 · Question 18 · Extended）

解：由相对原子质量得 $M_{Mg} = 24 g\ mol^{-1}$
$M_{MgO} = (24 + 16) g\ mol^{-1} = 40 g\ mol^{-1}$
$n_{Mg} = \frac{12}{24} = 0.50\ mol$
由方程式中 $Mg : MgO = 2 : 2$ 得
$n_{MgO} = 0.50 \times \frac{2}{2} = 0.50\ mol$
$m_{MgO} = 0.50 \times 40 = 20\ g$
故选 A。

针对练习

1. The equation for the reaction of sodium with water is shown.

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

Which mass of sodium produces 30 cm^3 of hydrogen?

A 0.0288 g **B** 0.0575 g **C** 28.8 g **D** 57.5 g

（2024 May/Jun · 0654/22 · Question 16 · Extended）

2. Nonane, C_9H_{20}, burns in oxygen to form carbon dioxide and water.

The equation for this reaction is shown.

$$C_9H_{20} + 14O_2 \rightarrow 9CO_2 + 10H_2O$$

What is the mass of oxygen required for the complete combustion of 64 g of nonane?

A 32 g **B** 224 g **C** 396 g **D** 448 g

（2023 Oct/Nov · 0654/23 · Question 17 · Extended）

3. The equation for the complete combustion of methane is shown.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

What is the volume of oxygen, at room temperature and pressure, that is required for the complete combustion of 16 g of methane?

A 12 dm^3 **B** 24 dm^3 **C** 32 dm^3 **D** 48 dm^3

（2026 May/Jun · 0654/21 · Question 15 · Extended）

4. When magnesium carbonate reacts with dilute hydrochloric acid, carbon dioxide gas is released.

The equation for this reaction is shown.

$$MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$$

Which volume of carbon dioxide, collected at room temperature and pressure, is released when 4.2 g of magnesium carbonate reacts with excess dilute hydrochloric acid?

A 1.2 dm^3 **B** 2.4 dm^3 **C** 4.8 dm^3 **D** 12 dm^3

（2023 Oct/Nov · 0654/21 · Question 17 · Extended）

5. Lead sulfate, $PbSO_4$, is prepared by reacting lead oxide, PbO, with excess dilute sulfuric acid.

The equation for the reaction is shown.

$$PbO + H_2SO_4 \rightarrow PbSO_4 + H_2O$$

What is the mass of lead oxide required to produce 22.6 g of lead sulfate?

A 15.4 g **B** 16.6 g **C** 17.6 g **D** 17.8 g

（2025 Oct/Nov · 0654/22 · Question 21 · Extended）

题型 6：删去旁观离子写沉淀离子方程式（考频★☆☆☆☆）

知识点 离子方程式表示溶液中实际参加反应的离子及生成物，未参加反应的离子称为_____。
水溶液中生成难溶沉淀时，保留形成沉淀的离子，删去反应前后形式和数目均不变的离子。
方程式必须同时满足原子守恒和_____守恒，并标明 (aq)、(s) 等状态符号；此关系无单位。

答案：旁观离子；电荷

怎么认 题目出现水溶液混合后生成不溶固体并求离子方程式时，先找形成沉淀的两种离子。

例题 1

When dilute sodium hydroxide is added to aqueous iron(II) sulfate, insoluble iron(II) hydroxide and aqueous sodium sulfate are formed.

What is the ionic equation for this reaction?

A $Fe^{2+}(aq) + 2OH^{-}(aq) \rightarrow Fe(OH)_2(s)$

B $Fe^{2+}(aq) + SO_4^{2-}(aq) + 2Na^{+}(aq) + 2OH^{-}(aq) \rightarrow Fe(OH)_2(s) + 2Na^{+}(aq) + SO_4^{2-}(aq)$

C $FeSO_4(aq) + 2NaOH(aq) \rightarrow Fe(OH)_2(s) + Na_2SO_4(aq)$

D $SO_4^{2-}(aq) + 2Na^{+}(aq) \rightarrow Na_2SO_4(aq)$

（2023 Oct/Nov · 0654/22 · Question 16 · Extended）

解： 生成的难溶物为 $Fe(OH)_2$。
形成沉淀的离子为 $Fe^{2+}(aq)$ 和 $OH^{-}(aq)$，$Na^{+}(aq)$ 与 $SO_4^{2-}(aq)$ 反应前后不变，删去后得
$Fe^{2+}(aq) + 2OH^{-}(aq) \rightarrow Fe(OH)_2(s)$
方程式两边原子数和总电荷均相等。故选 A。

题型 7：计算反应剩余百分比或判断限制反应物（考频★☆☆☆☆）

知识点 同温同压下，各气体的体积比等于化学方程式中的_____比，可由产物体积求反应物的消耗体积。
两种反应物同时存在时，按方程式系数比计算各自可反应的量，先耗尽的物质是_____。
剩余量等于初始量减去消耗量，剩余百分比 $=\frac{\text{剩余量}}{\text{初始量}}\times 100\%$；物质的量常用 mol，气体体积常用 dm^3，质量常用 g。

答案：化学计量数；限制反应物

怎么认 题目出现两种反应物的量或反应后产物的量，并求剩余百分比或完全反应物时，先按方程式系数比求消耗量。

例题 1

Ammonia decomposes when heated in a sealed container in the presence of an iron catalyst.

The equation for the reaction is shown.

$$2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$$

40.0 dm^3 of ammonia is heated. After several hours, 21.0 dm^3 of hydrogen is present.

The volumes are measured at r.t.p.

What is the percentage of unreacted ammonia?

A 35.0%　　**B** 47.5%　　**C** 52.5%　　**D** 65.0%

（2025 May/Jun · 0654/22 · Question 15 · Extended）

解： 由同温同压下气体体积比等于方程式系数比，
$V(NH_3) : V(H_2) = 2 : 3$

消耗的氨体积为
$21.0\mathrm{dm}^3 \times \frac{2}{3} = 14.0\mathrm{dm}^3$
剩余的氨体积为
$40.0\mathrm{dm}^3 - 14.0\mathrm{dm}^3 = 26.0\mathrm{dm}^3$
$\frac{26.0}{40.0} \times 100\% = 65.0\%$
故选 D。

针对练习

1. In an experiment, 2.4 g of magnesium, Mg, is burned in 5.0 g of oxygen, O_2.

The equation for the reaction is shown.

$$2Mg + O_2 \rightarrow 2MgO$$

Which row identifies the substance that reacts completely and shows the mass of magnesium oxide formed?

	substance that reacts completely	mass of magnesium oxide formed / g
A	magnesium	4.0
B	magnesium	7.4
C	oxygen	4.0
D	oxygen	7.4

（2024 Feb/Mar · 0654/22 · Question 16 · Extended）

化学 · 电解与氢氧燃料电池

1.5 电解与氢氧燃料电池

题型 1：由电解质及电极判断电解产物（考频★★★★☆）

知识点 电解时，阴极是负极，阳离子在阴极得到电子，发生_____；阳极是正极，阴离子在阳极失去电子，发生_____。
判断电解产物时，先判定电解质是熔融物还是水溶液，再确认电极是否为惰性电极；熔融物中只有组成离子放电。
惰性电极电解水溶液时，金属活动性排在氢前，阴极通常生成氢气；排在氢后，阴极生成金属。
阳极为惰性电极时，浓氯化物水溶液生成_____，其他常见水溶液通常生成氧气。

答案：还原；氧化；氯气

怎么认 题目出现电解质状态、电极材料或正负极标记时，先写是否为水溶液和电极材料，再判断阴、阳极放电。

例题 1

Which gas is formed at the cathode during electrolysis?

A carbon dioxide

B chlorine

C hydrogen

D oxygen

（2025 May/Jun · 0654/21 · Question 21 · Extended）

解：阴极发生还原反应，题目所求为阴极形成的气体。
阴极形成的气体为氢气。故选 C。

针对练习

1. Which elements are formed at the electrodes during the electrolysis of concentrated aqueous sodium chloride?

	anode	cathode
A	chlorine	sodium
B	chlorine	hydrogen
C	hydrogen	chlorine
D	sodium	chlorine

（2024 Oct/Nov · 0654/11 · Question 18 · Core）

2. Dilute aqueous potassium chloride is electrolysed using inert electrodes.

Which substance is produced at the cathode?

A chlorine

B hydrogen

C oxygen

D potassium

（2023 Feb/Mar · 0654/22 · Question 17 · Extended）

3. What are the products of the electrolysis of dilute sulfuric acid using inert electrodes?

A hydrogen and sulfur dioxide

B oxygen and hydrogen

C oxygen and sulfur

D oxygen and sulfur dioxide

（2024 Oct/Nov · 0654/12 · Question 17 · Core；同题：2024 Oct/Nov · 0654/13 · Question 17 · Core）

4. Dilute sulfuric acid, H_2SO_4, is electrolysed using platinum electrodes.

What is formed at the electrodes during this process?

A hydrogen only

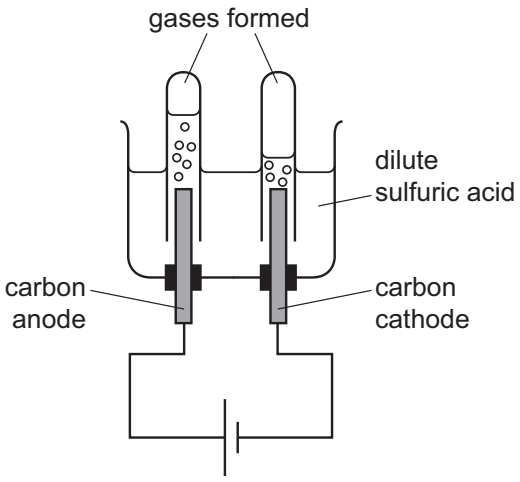
B hydrogen and sulfur dioxide

C oxygen and sulfur dioxide

D hydrogen and oxygen

（2026 May/Jun · 0654/11 · Question 16 · Core）

5. Dilute sulfuric acid is electrolysed using the apparatus shown.



Which product forms at the cathode?

A hydrogen

B oxygen

C sulfur dioxide

D water vapour

（2023 Feb/Mar · 0654/12 · Question 17 · Core）

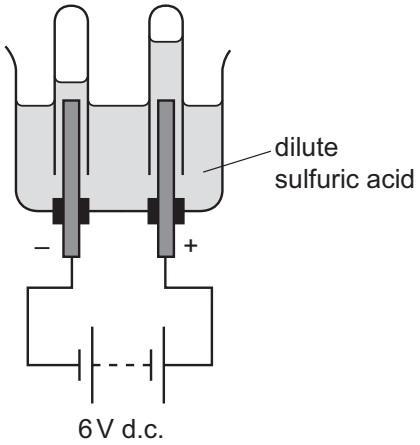
6. Molten lead(II) bromide is electrolysed using inert electrodes.

Which row describes the products of this electrolysis?

	a grey metal forms at the positive electrode	a red-brown gas forms at the negative electrode	lead and bromine are the only products
A	yes	no	no
B	yes	yes	yes
C	no	no	yes
D	no	yes	no

(2025 May/Jun · 0654/11 · Question 19 · Core)

7. The diagram shows the electrolysis of dilute sulfuric acid using inert electrodes.



Which substance is produced by electrolysis at the negative electrode?

A hydrogen

B oxygen

C sulfur dioxide

D water vapour

(2023 Oct/Nov · 0654/11 · Question 18 · Core)

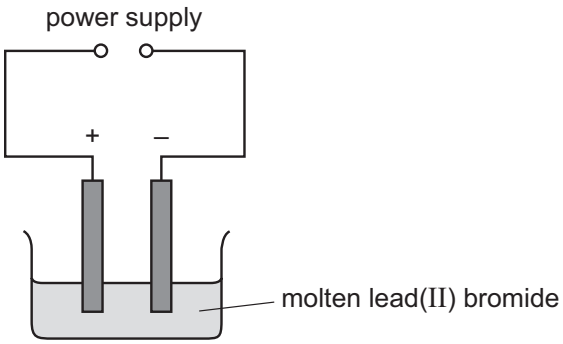
8. Concentrated aqueous sodium chloride is electrolysed using inert electrodes.

Which row shows the products at the electrodes?

	anode	cathode
A	chlorine	chlorine
B	chlorine	hydrogen
C	sodium	chlorine
D	sodium	hydrogen

(2025 Feb/Mar · 0654/12 · Question 19 · Core)

9. Molten lead(II) bromide is electrolysed using inert electrodes as shown.



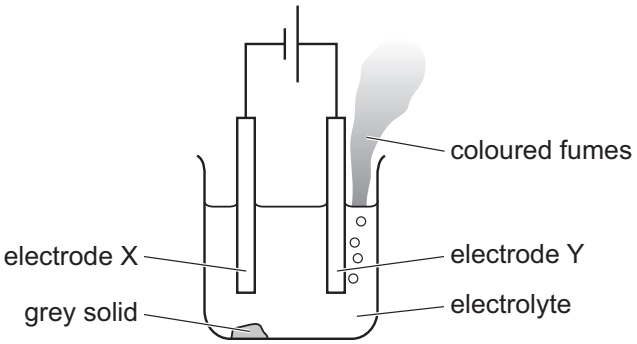
An element is produced at the negative electrode.

What is the name of the element and of the negative electrode?

	element	negative electrode
A	bromine	anode
B	bromine	cathode
C	lead	anode
D	lead	cathode

（2023 May/Jun · 0654/12 · Question 18 · Core；同题：2023 May/Jun · 0654/13 · Question 18 · Core）

10. The diagram shows the electrolysis of molten lead(II) bromide using inert electrodes.



Which statement about this experiment is correct?

A Electrode X is positively charged.

B The coloured fumes are produced at the negative electrode.

C The electrolyte is lead(II) bromide.

D The grey solid is lead(II) bromide.

（2024 Oct/Nov · 0654/23 · Question 16 · Extended）

11. Which reaction or process produces hydrogen?

A the electrolysis of concentrated aqueous sodium chloride

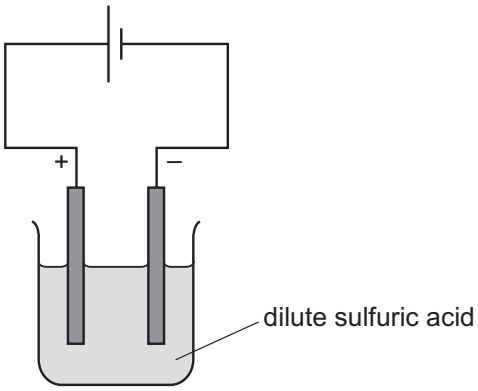
B the thermal decomposition of limestone

C the reaction of steam with ethene

D the reaction of sodium oxide with hydrochloric acid

（2026 Feb/Mar · 0654/22 · Question 17 · Extended）

12. The diagram shows the electrolysis of dilute sulfuric acid using inert electrodes.



Which row shows the products formed at each electrode and describes the bonding in sulfuric acid?

	anode	cathode	type of bonding
A	oxygen	hydrogen	ionic
B	oxygen	hydrogen	covalent
C	hydrogen	oxygen	ionic
D	hydrogen	oxygen	covalent

（2022 May/Jun · 0654/11 · Question 17 · Core；同题：2022 May/Jun · 0654/12 · Question 17 · Core；同题：2022 May/Jun · 0654/13 · Question 17 · Core）

13. Aqueous copper(II) sulfate is electrolysed using carbon electrodes.

Which row describes this electrolysis?

	gas bubbles are seen at the anode	oxygen is produced at the negative electrode	copper ions are reduced
A	no	no	no
B	yes	yes	yes
C	yes	no	yes
D	no	yes	no

（2024 Feb/Mar · 0654/22 · Question 17 · Extended）

14. Aqueous copper(II) sulfate is electrolysed using inert electrodes.

Which statement about this electrolysis is correct?

A Copper ions are attracted to the cathode.

B Electrons move from the cathode to the anode.

C Electrolyte ions are oxidised at the cathode.

D Sulfate ions are reduced to sulfur dioxide.

（2022 May/Jun · 0654/21 · Question 17 · Extended）

15. Concentrated aqueous sodium chloride, molten lead(II) bromide, aqueous copper(II) sulfate and dilute sulfuric acid are electrolysed using carbon electrodes.

Which rows show the correct products that form at each electrode?

	electrolyte	cathode	anode
1	concentrated aqueous sodium chloride	sodium	chlorine
2	molten lead(II) bromide	lead	bromine
3	aqueous copper(II) sulfate	copper	oxygen
4	dilute sulfuric acid	oxygen	hydrogen

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

(2026 May/Jun · 0654/23 · Question 17 · Extended)

16. Aqueous copper(II) sulfate is electrolysed using carbon electrodes.

Which row describes the observations and products at each electrode during this process?

	cathode observation	cathode product	anode observation	anode product
A	bubbles	hydrogen	anode decreases in size	copper(II) ions
B	bubbles	hydrogen	bubbles	oxygen
C	orange-brown solid	copper	bubbles	oxygen
D	orange-brown solid	copper	anode decreases in size	copper(II) ions

(2022 May/Jun · 0654/23 · Question 17 · Extended)

17. Which substance produces hydrogen at the cathode during electrolysis?

A aqueous copper(II) sulfate using copper electrodes

B molten sodium chloride using carbon electrodes

C dilute sulfuric acid using carbon electrodes

D molten sodium hydroxide using platinum electrodes

(2026 May/Jun · 0654/21 · Question 17 · Extended)

18. Which statements about the electrolysis of aqueous copper(II) sulfate are correct?

1 Oxygen is produced at the anode when carbon electrodes are used.

2 Copper is produced at the cathode when copper electrodes are used.

3 Hydrogen is produced at the cathode when carbon electrodes are used.

4 Electrolysis does not occur when inert electrodes are used.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

(2024 Oct/Nov · 0654/22 · Question 16 · Extended)

19. Two electrolysis experiments are done using inert electrodes.

Experiment 1 is the electrolysis of aqueous copper(II) sulfate.

Experiment 2 is the electrolysis of molten lithium bromide.

Which row describes the products at each electrode in these experiments?

	experiment 1		experiment 2	
	cathode	anode	cathode	anode
A	copper	oxygen	bromine	lithium
B	oxygen	copper	lithium	bromine
C	copper	oxygen	lithium	bromine
D	oxygen	copper	bromine	lithium

（2024 May/Jun · 0654/21 · Question 19 · Extended）

题型 2：辨认电解装置的两极和电解质状态（考频★★★☆☆）

知识点 电解是电流通过电解质，使物质分解成较简单物质的过程。

电解质中必须有能自由移动的_____；离子化合物通常须处于_____或水溶液状态，固态时不能电解。

电解池中，阳极接电源正极，阴极接电源_____极；这些名称不带单位。

答案：离子；熔融态；负

怎么认 题目出现电源正负极、电极标签或电解质状态时，先按阳正阴负，再判水溶液或熔融态。

例题 1

Which substance does **not** undergo electrolysis?

A aqueous copper chloride

B copper wire

C dilute sulfuric acid

D molten lead(II) bromide

（2023 Oct/Nov · 0654/12 · Question 17 · Core）

解：由电解条件，电解质中须含有能自由移动的离子。

氯化铜水溶液、稀硫酸和熔融溴化铅(II)中均有可移动离子；铜丝以电子导电，不发生电解。

故选 B。

针对练习

1. Aqueous potassium iodide contains ions.

What happens to aqueous potassium iodide during electrolysis?

A combustion

B decomposition

C neutralisation

D no reaction

（2026 May/Jun · 0654/12 · Question 17 · Core）

2. Which process is used to produce sodium and chlorine from the compound sodium chloride?

A chromatography

B cracking

C distillation

D electrolysis

（2022 Oct/Nov · 0654/11 · Question 17 · Core；同题：2022 Oct/Nov · 0654/12 · Question 17 · Core、2022 Oct/Nov · 0654/13 · Question 17 · Core）

3. Which statement describes what happens during electrolysis?

A Covalent compounds produce more complex substances.

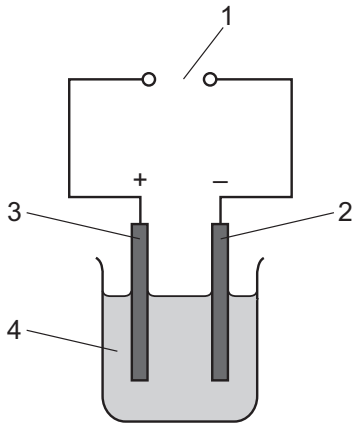
B Covalent compounds produce simpler substances.

C Ionic compounds produce more complex substances.

D Ionic compounds produce simpler substances.

（2024 Oct/Nov · 0654/21 · Question 18 · Extended）

4. The apparatus used in the electrolysis of concentrated aqueous sodium chloride is shown.

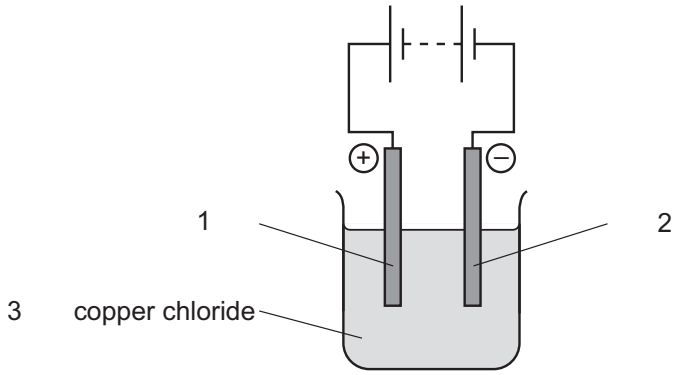


Which row identifies the electrolyte and the cathode?

	electrolyte	cathode
A	1	2
B	1	3
C	4	2
D	4	3

（2025 May/Jun · 0654/12 · Question 16 · Core；同题：2025 May/Jun · 0654/13 · Question 16 · Core）

5. The apparatus used for the electrolysis of copper chloride is shown.

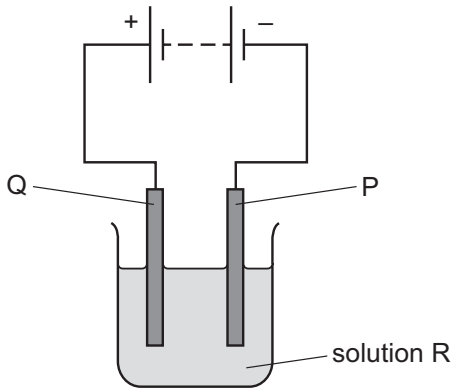


Which words complete labels 1, 2 and 3?

	1	2	3
A	anode	cathode	aqueous
B	anode	cathode	solid
C	cathode	anode	aqueous
D	cathode	anode	solid

（2023 Oct/Nov · 0654/13 · Question 18 · Core）

6. The apparatus for the electrolysis of solution R is shown.

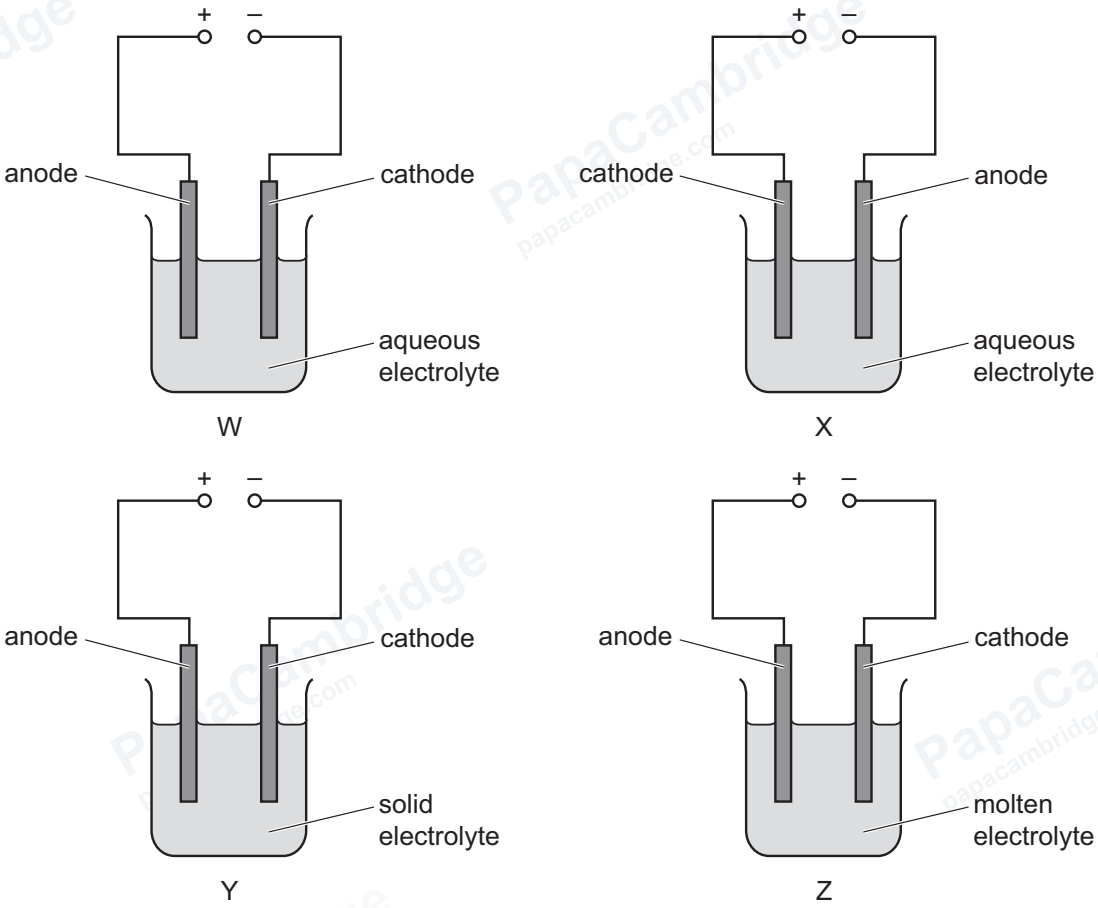


What are the names of P, Q and R?

	P	Q	R
A	anode	cathode	electrode
B	anode	cathode	electrolyte
C	cathode	anode	electrode
D	cathode	anode	electrolyte

（2025 Oct/Nov · 0654/12 · Question 17 · Core；同题：2025 Oct/Nov · 0654/13 · Question 17 · Core）

7. A student draws four diagrams, W, X, Y and Z.



Which diagrams show a correct electrolytic cell?

A W and X **B** X and Y **C** Y and Z **D** W and Z

（2026 May/Jun · 0654/13 · Question 17 · Core）

题型 3：用电解提取铝或活泼金属（考频★★☆☆☆）

知识点 金属的提取方法由其在活泼性序列中的位置决定；位于碳以上的金属不能用碳还原，需电解其_____离子化合物。

铝由氧化铝电解制得；氧化铝溶解在熔融_____中，组成电解质，并使混合物的熔点降低。

阴极上，铝离子得到电子，被_____为铝。

答案：熔融；冰晶石；还原

怎么认 题目出现从矿石提取金属或铝的电解时，先把金属放进活泼性序列，再判断电解质。

例题 1

Which metal is extracted from its ore by electrolysis?

A aluminium

B copper

C gold

D iron

（2023 Oct/Nov · 0654/11 · Question 24 · Core）

解：铝在活泼性序列中位于碳以上，不能用碳还原其化合物。
由活泼金属的提取方法，铝需从熔融离子化合物中电解制取。故选 A。

针对练习

1. Which metal can **only** be extracted from its ore using electrolysis?

A calcium

B copper

C iron

D zinc

（2023 Oct/Nov · 0654/23 · Question 23 · Extended）

2. Aluminium is extracted from aluminium oxide by electrolysis.

What is added to aluminium oxide in this process?

A concentrated aqueous sodium chloride

B cryolite

C dilute sulfuric acid

D water

（2022 Feb/Mar · 0654/22 · Question 16 · Extended）

3. Which statement about the extraction of aluminium from its ore by electrolysis is correct?

A Aluminium gains electrons from the anode.

B Aluminium ions are oxidised at the cathode.

C Aluminium ore is called cryolite.

D Aluminium oxide is in the electrolyte.

（2023 May/Jun · 0654/22 · Question 18 · Extended）

题型 4：按电子守恒写电极半反应和氧化还原（考频★★★☆☆）

知识点 电解时，阴极吸引阳离子；在阴极放电的粒子_____电子，发生还原反应。
阳极吸引阴离子；在阳极放电的粒子_____电子，发生氧化反应。
阴极半反应把电子写在反应物一侧，阳极半反应把电子写在生成物一侧，并使原子数与总电荷分别守恒。
水溶液中须比较溶质离子与水电离出的离子，确定_____；熔融电解质中只考虑其所含离子。

答案：得到；失去；实际放电的粒子

怎么认 题目出现电解质状态、电极种类及所求电极半反应时，先确认该电极实际放电的离子。

例题 1

Aqueous copper(II) sulfate is electrolysed using graphite electrodes.

What is the ionic half-equation for the reaction that takes place at the cathode?

A $2H^+(aq) + 2e^- \rightarrow H_2(g)$

B $4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$

C $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

D $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

（2026 May/Jun · 0654/22 · Question 17 · Extended）

解：阴极发生还原反应，电子写在反应物一侧。
硫酸铜水溶液中，Cu^{2+} 在阴极放电并得到 $2e^-$。
$Cu^{2+} + 2e^- \rightarrow Cu$
故选 D。

针对练习

1. Molten calcium bromide is electrolysed using inert electrodes.

What is the ionic half-equation at the cathode?

A $Ca^+ \rightarrow Ca + e^-$

B $Ca^+ + e^- \rightarrow Ca$

C $Ca^{2+} \rightarrow Ca + 2e^-$

D $Ca^{2+} + 2e^- \rightarrow Ca$

（2022 Oct/Nov · 0654/23 · Question 18 · Extended）

2. During electrolysis, reactions occur at the cathode and anode.

Which statements about the electrode reactions are correct?

1 At the anode, anions gain electrons and are reduced.

2 At the anode, anions lose electrons and are oxidised.

3 At the cathode, cations gain electrons and are reduced.

4 At the cathode, cations lose electrons and are oxidised.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2025 Oct/Nov · 0654/21 · Question 16 · Extended）

3. Which changes take place at the electrodes during electrolysis?

	anode	cathode
A	negatively charged ions gain electrons	positively charged ions lose electrons
B	negatively charged ions lose electrons	positively charged ions gain electrons
C	positively charged ions gain electrons	negatively charged ions lose electrons
D	positively charged ions lose electrons	negatively charged ions gain electrons

(2025 Oct/Nov · 0654/22 · Question 16 · Extended)

4. Which statement correctly describes how aluminium is changed during the electrolysis of aluminium oxide?

A At the anode, aluminium ions gain electrons and so are oxidised.

B At the anode, aluminium ions lose electrons and so are oxidised.

C At the cathode, aluminium ions gain electrons and so are reduced.

D At the cathode, aluminium ions lose electrons and so are reduced.

(2023 Oct/Nov · 0654/23 · Question 18 · Extended)

5. Which statement about electrolysis is correct?

A At the anode, anions are oxidised by gaining electrons.

B At the anode, cations are reduced by gaining electrons.

C At the cathode, anions are oxidised by gaining electrons.

D At the cathode, cations are reduced by gaining electrons.

(2022 May/Jun · 0654/22 · Question 17 · Extended)

6. Concentrated aqueous sodium chloride is electrolysed using inert electrodes.

What is the ionic half-equation for the reaction at the cathode?

A $2Cl^- \rightarrow Cl_2 + 2e^-$

B $2H^+ + 2e^- \rightarrow H_2$

C $Na^+ + e^- \rightarrow Na$

D $NaCl \rightarrow Na^+ + Cl^-$

(2025 Oct/Nov · 0654/23 · Question 14 · Extended)

7. Which ions gain and lose electrons during the electrolysis of concentrated aqueous sodium chloride?

	ions gaining electrons	ions losing electrons
A	H^+	Cl^-
B	H^+	OH^-
C	Na^+	Cl^-
D	Na^+	OH^-

(2022 Oct/Nov · 0654/22 · Question 18 · Extended)

8. Which row shows the ionic half-equation for the reaction at the cathode during the electrolysis of the named electrolyte?

	electrolyte	equation
A	molten aluminium oxide	$Al^{3+} + 3e^- \rightarrow Al$
B	molten aluminium oxide	$2O^{2-} \rightarrow O_2 + 4e^-$
C	concentrated aqueous sodium chloride	$H_2 \rightarrow 2H^+ + 2e^-$
D	concentrated aqueous sodium chloride	$Na^+ + e^- \rightarrow Na$

(2024 May/Jun · 0654/23 · Question 16 · Extended)

题型 5：把电解产物对应到颜色和气体检验（考频★★☆☆☆）

知识点 电解时，阴极是负极，阳离子在阴极得电子；阳极是正极，阴离子在阳极失电子。

氢气是无色气体，用燃着的木条检验时发出_____；氧气能使带火星的木条_____。

氯气是黄绿色气体，能使湿润的有色石蕊试纸_____。

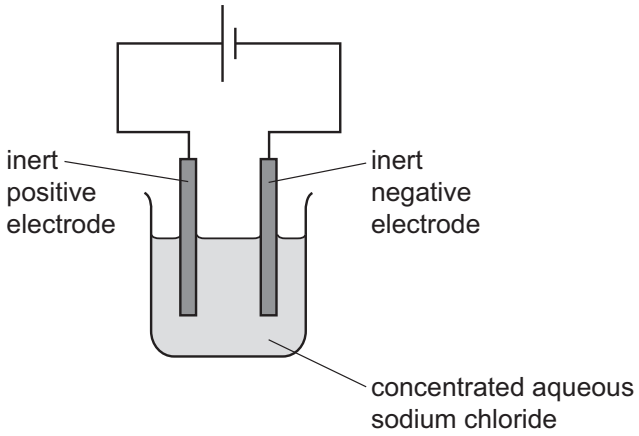
用惰性电极电解浓氯化钠水溶液时，阴极生成氢气，阳极生成氯气。

答案：爆鸣声；复燃；褪色

怎么认 题目出现电解装置、电极正负和气体检验现象时，先由电解质和电极判断产物身份。

例题 1

The electrolysis of concentrated aqueous sodium chloride is shown.



Which statement describes the product at the cathode?

A It is a colourless gas that pops with a lighted splint.

B It is a colourless gas that relights a glowing splint.

C It is a grey-black solid.

D It is a pale yellow-green gas that bleaches litmus paper.

（2025 Oct/Nov · 0654/11 · Question 19 · Core）

解：阴极发生还原：

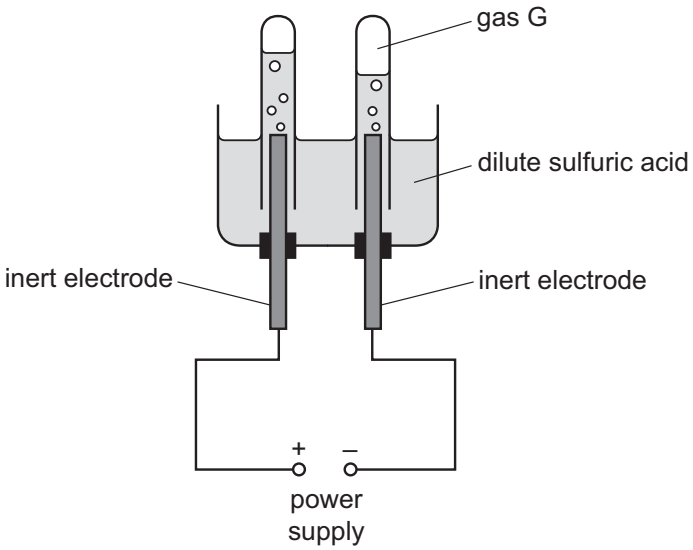
$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

生成的氢气为无色气体，用燃着的木条检验时发出爆鸣声。

故选 A。

针对练习

1. The diagram shows the electrolysis of dilute sulfuric acid.



Gas G ignites with a 'pop' when it is tested with a lighted splint.

What is gas G and at which electrode is it formed?

	gas G	electrode
A	hydrogen	anode
B	hydrogen	cathode
C	oxygen	anode
D	oxygen	cathode

（2022 Feb/Mar · 0654/12 · Question 16 · Core）

2. Concentrated aqueous sodium chloride is electrolysed using inert electrodes.

Which row describes observations of the tests on the gases collected at the electrodes?

	anode gas	cathode gas
A	turns damp red litmus paper blue	'pops' with a lighted splint
B	turns damp red litmus paper blue	relights a glowing splint
C	turns damp red litmus paper white	'pops' with a lighted splint
D	turns damp red litmus paper white	relights a glowing splint

（2024 Feb/Mar · 0654/12 · Question 18 · Core）

题型 6：辨认铜精炼和电镀的接线与离子来源（考频★☆☆☆☆）

知识点 电解精炼是使粗金属在阳极溶解，并使金属离子在阴极还原成纯金属的过程。

精炼铜时，粗铜接_____极，纯铜接_____极，电解质可用硫酸铜水溶液。

电镀是利用电解在物体表面沉积金属镀层；需要镀层的物体接阴极，镀层金属接阳极。

用铜电镀镍时，电解质选含 Cu^{2+} 的_____，阴极反应为 $Cu^{2+} + 2e^- \rightarrow Cu$。

答案：正；负；铜盐水溶液

怎么认 题目出现铜精炼或铜镀层的电极接线、电解质图时，先确定沉积铜的阴极。

例题 1

Copper is refined by electrolysis.

Which statements about this process are correct?

1 Aqueous copper(II) sulfate is the electrolyte.

2 Inert anodes are used.

3 Cu^{2+} ions are reduced at the cathode.

4 Pure copper is deposited at the anode.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

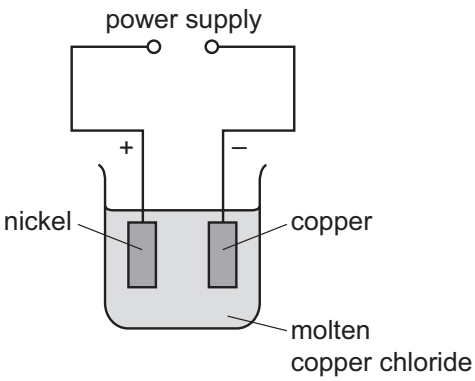
（2023 May/Jun · 0654/23 · Question 17 · Extended）

解：电解精炼铜时，粗铜作阳极，纯铜作阴极，硫酸铜水溶液作电解质。
阴极上发生还原：
$Cu^{2+} + 2e^- \rightarrow Cu$
故第 1、3 项正确，第 2、4 项错误，故选 B。

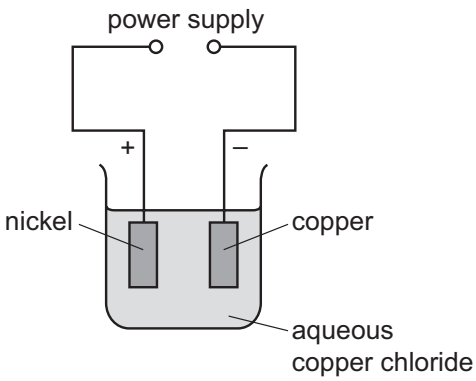
针对练习

1. Which diagram shows equipment used to electroplate nickel with copper?

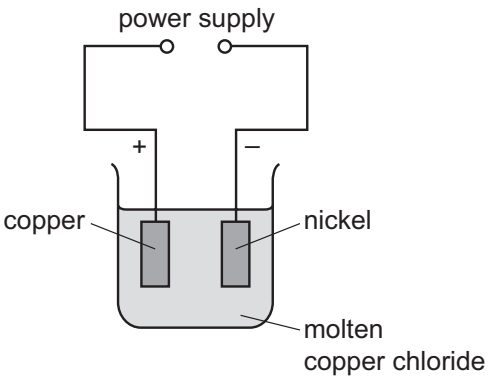
A



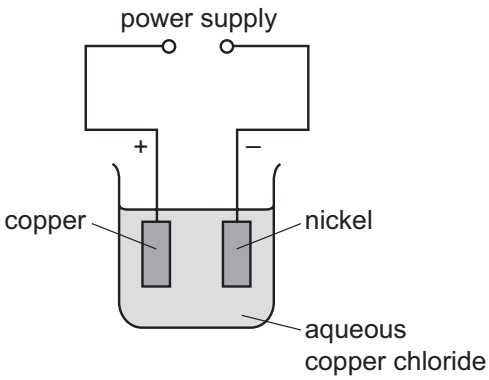
B



C



D



（2023 May/Jun · 0654/11 · Question 18 · Core）

题型 7：追踪电解后离子浓度和溶液酸碱性（考频★★☆☆☆）

知识点 电解后离子数目或浓度的变化由电极反应决定：被放电的离子减少，未放电的离子不变，可溶性电极还会补充对应的金属离子。

用惰性电极电解浓氯化钠水溶液时，Na^+数目_____，Cl^-数目_____。

阴极生成OH^-，与溶液中的Na^+对应的溶质为_____，溶液呈碱性。

电解硫酸铜溶液时，碳电极不补充Cu^{2+}；铜阳极溶解，可补充阴极消耗的Cu^{2+}。

答案：不变；减少；氢氧化钠

怎么认 题目出现电解后离子数目、浓度或溶液酸碱性时，先沿阴阳极记录消耗与补充的离子。

例题 1

When concentrated aqueous sodium chloride is electrolysed using inert electrodes, the remaining solution turns red litmus paper to blue.

Which substance causes this colour change?

A chlorine

B hydrogen

C hydrochloric acid

D sodium hydroxide

（2024 May/Jun · 0654/11 · Question 18 · Core）

解：阴极水分子得电子，

$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

阳极氯离子失电子，

$2Cl^- \rightarrow Cl_2 + 2e^-$

阴极生成的OH^-与溶液中的Na^+对应形成氢氧化钠，使红色石蕊试纸变蓝。故选 D。

针对练习

1. Sodium hydroxide is manufactured by the electrolysis of concentrated aqueous sodium chloride.

During the process, a gas is given off at each electrode and the aqueous sodium hydroxide collects around one of the electrodes.

Which row identifies the gas at each electrode and the electrode around which the aqueous sodium hydroxide collects?

	at the anode	at the cathode	electrode at which sodium hydroxide collects
A	chlorine	hydrogen	cathode
B	chlorine	hydrogen	anode
C	oxygen	chlorine	cathode
D	oxygen	chlorine	anode

（2023 May/Jun · 0654/21 · Question 18 · Extended）

2. Concentrated aqueous sodium chloride is electrolysed using inert electrodes.

Which row describes how the number of sodium ions and the number of chloride ions changes during the electrolysis?

	number of sodium ions	number of chloride ions
A	decreases	decreases
B	decreases	no change
C	no change	decreases
D	no change	no change

(2023 Oct/Nov · 0654/22 · Question 17 · Extended)

3. Copper(II) sulfate can be electrolysed using either carbon electrodes or copper electrodes.

What happens to the concentration of copper(II) ions in the electrolyte during electrolysis using these electrodes?

	using carbon electrodes	using copper electrodes
A	decreases	decreases
B	decreases	no change
C	no change	decreases
D	no change	increases

(2022 Oct/Nov · 0654/21 · Question 18 · Extended)

化学 · 放热、吸热与键能

1.6 放热、吸热与键能

题型 1：由温度变化和能量流向判断吸热放热（考频★★★★★）

知识点 吸热反应从周围环境_____热能；在未受外界持续加热时，反应混合物和周围环境的温度通常降低。
放热反应向周围环境_____热能；在未受外界持续冷却时，反应混合物和周围环境的温度通常升高。
温度用摄氏度（℃）表示；温度降低配吸热，温度升高配_____。

答案：吸收；释放；放热

怎么认 题目出现温度升降或热量流向时，先判断体系吸收或释放热能，再配对吸热或放热。

例题 1

Which word describes reactions that give out heat energy?

A endothermic

B exothermic

C oxidation

D reduction

（2022 May/Jun · 0654/12 · Question 18 · Core；同题：2022 May/Jun · 0654/13 · Question 18 · Core）

解：题干说明反应放出热能，热能由反应体系传递到周围环境。
向周围环境释放热能的反应为放热反应（exothermic）。
故选 B。

针对练习

1. Ammonium nitrate is dissolved in a beaker of water.

The temperature of the water decreases by 5 °C.

Which type of reaction occurs?

A endothermic

B exothermic

C oxidation

D reduction

（2022 Feb/Mar · 0654/12 · Question 17 · Core）

2. Potassium chloride is added to water.

The temperature of the solution decreases as the potassium chloride dissolves.

Which type of reaction occurs?

A endothermic

B exothermic

C oxidation

D reduction

（2023 May/Jun · 0654/12 · Question 19 · Core；同题：2023 May/Jun · 0654/13 · Question 19 · Core）

3. Magnesium is added to aqueous copper(II) sulfate.

The temperature of the reaction mixture increases.

Which type of reaction occurs?

A decomposition

B endothermic

C exothermic

D neutralisation

（2026 May/Jun · 0654/11 · Question 17 · Core）

4. Which row describes an endothermic reaction?

	thermal energy is transferred to the surroundings	the temperature of the reaction mixture decreases
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

（2025 Oct/Nov · 0654/12 · Question 18 · Core；同题：2025 Oct/Nov · 0654/13 · Question 18 · Core）

5. Some observations about two reactions are shown.

In reaction 1, heat is taken in from the surroundings.

In reaction 2, heat is released to the surroundings.

Which row describes each reaction?

	reaction 1	reaction 2
A	endothermic	endothermic
B	endothermic	exothermic
C	exothermic	exothermic
D	exothermic	endothermic

（2024 Oct/Nov · 0654/12 · Question 18 · Core；同题：2024 Oct/Nov · 0654/13 · Question 18 · Core）

6. Which row describes what happens in an endothermic reaction?

	transfer of thermal energy	temperature of the surroundings
A	to the surroundings	decreases
B	to the surroundings	increases
C	from the surroundings	decreases
D	from the surroundings	increases

（2026 Feb/Mar · 0654/12 · Question 16 · Core）

7. When magnesium reacts with dilute hydrochloric acid, the temperature of the mixture increases.

Which statement about this reaction is correct?

A It is endothermic as thermal energy is taken in from the surroundings.

B It is endothermic as thermal energy is transferred to the surroundings.

C It is exothermic as thermal energy is taken in from the surroundings.

D It is exothermic as thermal energy is transferred to the surroundings.

（2025 Oct/Nov · 0654/22 · Question 22 · Extended）

8. In a test-tube, magnesium reacts with dilute hydrochloric acid to form a salt and hydrogen.

The reaction makes the test-tube warm.

Which statement about the reaction explains this observation?

A It is a combustion reaction.

B It is a neutralisation reaction.

C It is endothermic.

D It is exothermic.

（2024 Feb/Mar · 0654/12 · Question 19 · Core）

9. Which statements about endothermic reactions are correct?

1 Thermal energy is taken in from the surroundings.

2 Thermal energy is released to the surroundings.

3 The temperature of the reaction mixture decreases.

4 The temperature of the reaction mixture increases.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2025 May/Jun · 0654/12 · Question 17 · Core；同题：2025 May/Jun · 0654/13 · Question 17 · Core）

10. Which statement describes an endothermic reaction?

A An endothermic reaction transfers thermal energy to the surroundings leading to an increase in the temperature of the surroundings.

B An endothermic reaction transfers thermal energy to the surroundings leading to a decrease in the temperature of the surroundings.

C An endothermic reaction takes in thermal energy from the surroundings leading to an increase in the temperature of the surroundings.

D An endothermic reaction takes in thermal energy from the surroundings leading to a decrease in the temperature of the surroundings.

(2026 May/Jun · 0654/13 · Question 18 · Core)

11. Which statement about exothermic and endothermic reactions is correct?

A An endothermic reaction involves heat energy being taken in by the reactants.

B An exothermic reaction involves heat energy being taken in by the products.

C In an endothermic reaction, the temperature of the reaction mixture increases.

D In an exothermic reaction, the temperature of the reaction mixture decreases.

(2023 May/Jun · 0654/11 · Question 19 · Core)

12. Which row describes changes that occur during an endothermic reaction?

	temperature of surroundings	thermal energy
A	decreases	absorbed from the surroundings
B	decreases	released to the surroundings
C	increases	absorbed from the surroundings
D	increases	released to the surroundings

(2026 May/Jun · 0654/12 · Question 18 · Core)

13. What describes an endothermic reaction?

A a reaction in which all the bonds in all the reactants are broken

B a reaction in which energy is released to the surroundings

C a reaction which goes to completion

D a reaction in which energy is taken in from the surroundings

(2024 Oct/Nov · 0654/22 · Question 17 · Extended)

14. Magnesium ribbon is added to dilute hydrochloric acid.

Which observation shows that this process is exothermic?

A The pH of the solution decreases.

B The pH of the solution increases.

C The temperature of the solution decreases.

D The temperature of the solution increases.

(2025 Oct/Nov · 0654/11 · Question 20 · Core)

15. The temperature change as the result of a chemical reaction may go up or down.

	temperature	type of reaction
1	decreases	endothermic
2	increases	endothermic
3	increases	exothermic
4	decreases	exothermic

Which rows about reactions are correct?

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

(2022 Oct/Nov · 0654/12 · Question 18 · Core)

16. Which statement about chemical reactions is correct?

A Endothermic reactions result in a temperature decrease.

B Endothermic reactions result in a temperature increase.

C Exothermic reactions always produce a large temperature rise.

D Exothermic reactions always produce a small temperature rise.

(2023 May/Jun · 0654/23 · Question 18 · Extended)

17. The table shows the initial and final temperatures of four different reactions.

reaction	initial temperature / °C	final temperature / °C
1	20	20
2	20	30
3	25	20
4	25	30

Which reactions are exothermic?

A 1 and 3 **B** 2 and 3 **C** 2 and 4 **D** 3 and 4

(2025 May/Jun · 0654/22 · Question 16 · Extended)

18. Hydrogen reacts with iodine to form hydrogen iodide.

The equation for this reaction is shown.

$$H_2 + I_2 \rightarrow 2HI$$

During this reaction the temperature increases.

Which statement explains why the temperature increases?

A One molecule of hydrogen is forming two molecules of hydrogen iodide.

B The reaction is exothermic.

C The reaction is very fast.

D The reaction takes in energy.

(2022 May/Jun · 0654/11 · Question 18 · Core)

19. The temperature of solution Q is 21 °C. The temperature of solution P is 24 °C.

The two solutions are mixed. The temperature of the mixture is 31 °C.

Which statement is correct?

A An endothermic reaction occurs and the reacting chemicals gain energy.

B An endothermic reaction occurs and the reacting chemicals lose energy.

C An exothermic reaction occurs and the reacting chemicals gain energy.

D An exothermic reaction occurs and the reacting chemicals lose energy.

(2023 Oct/Nov · 0654/21 · Question 18 · Extended)

20. When aqueous sodium hydroxide reacts with dilute hydrochloric acid, the temperature of the reaction mixture increases.

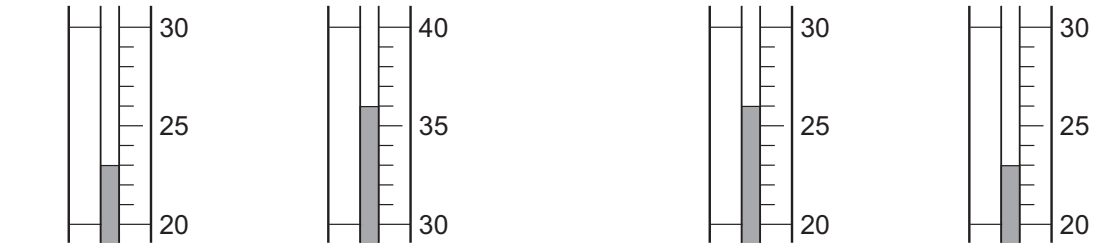
Ice cubes take in energy when they melt.

Which row is correct?

	sodium hydroxide + hydrochloric acid	melting ice cubes
A	endothermic	exothermic
B	exothermic	endothermic
C	endothermic	endothermic
D	exothermic	exothermic

(2024 May/Jun · 0654/11 · Question 19 · Core)

21. The initial and final temperatures in two experiments, X and Y, are shown.



Which row shows the types of change that take place in these two experiments?

	experiment X	experiment Y
A	endothermic	endothermic
B	endothermic	exothermic
C	exothermic	endothermic
D	exothermic	exothermic

(2023 Feb/Mar · 0654/12 · Question 18 · Core)

题型 2：区分断键吸能和成键释能（考频★☆☆☆☆）

知识点 断开化学键需要从外界_____能量，因此断键属于_____过程；形成化学键会向外界_____能量，因此成键属于放热过程。

题干只涉及断键或成键时，应分别判断能量转移方向；能量通常用 kJ 或 kJ/mol 表示。

答案：吸收；吸热；释放

怎么认 题目出现断键、成键或能级图时，先判断断键吸能、成键释能。

例题 1

Which row describes the type of energy change and the energy transfer when bonds are broken during a chemical reaction?

	type of change	energy transfer
A	endothermic	given out
B	endothermic	taken in
C	exothermic	given out
D	exothermic	taken in

（2022 Oct/Nov · 0654/22 · Question 19 · Extended）

解：断开化学键需要吸收能量，属于吸热变化。

因此吸热且能量被吸收的一行为 B。

故选 B。

针对练习

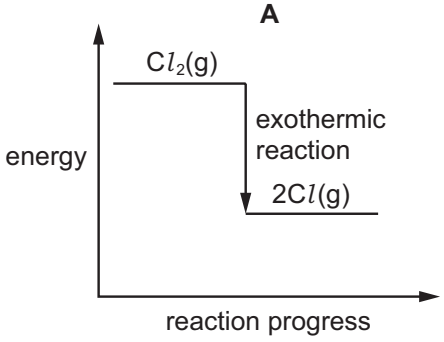
1. Ultraviolet light causes a chlorine molecule to break down to form two chlorine atoms.

The equation for the reaction is shown.

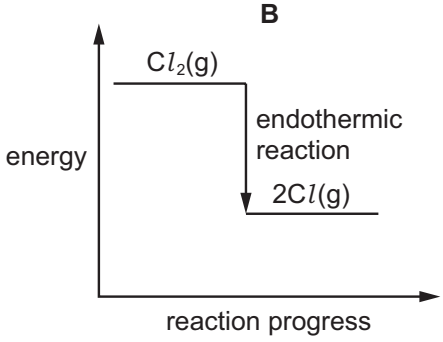
$$Cl_2(g) \rightarrow 2Cl(g)$$

What is the energy level diagram for this reaction?

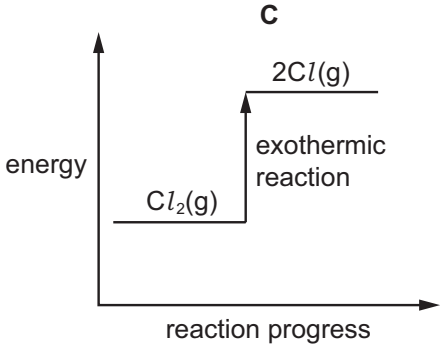
A



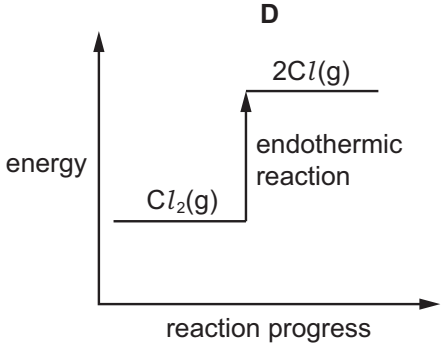
B



C



D



（2024 Feb/Mar · 0654/22 · Question 18 · Extended）

题型 3：读能量图判断反应热与活化能（考频★★★☆☆）

知识点 反应路径图中，横轴表示反应进程，纵轴表示能量；从左到右依次找反应物能级、峰顶能级和产物能级。

产物能级低于反应物时为_____反应，热量放出；产物能级高于反应物时为_____反应，热量吸收。

活化能 E_a 是反应物发生反应所需的最小能量，等于峰顶能级与_____能级之差。

催化剂提供活化能较低的反应路径，不改变反应物与产物的能级差。

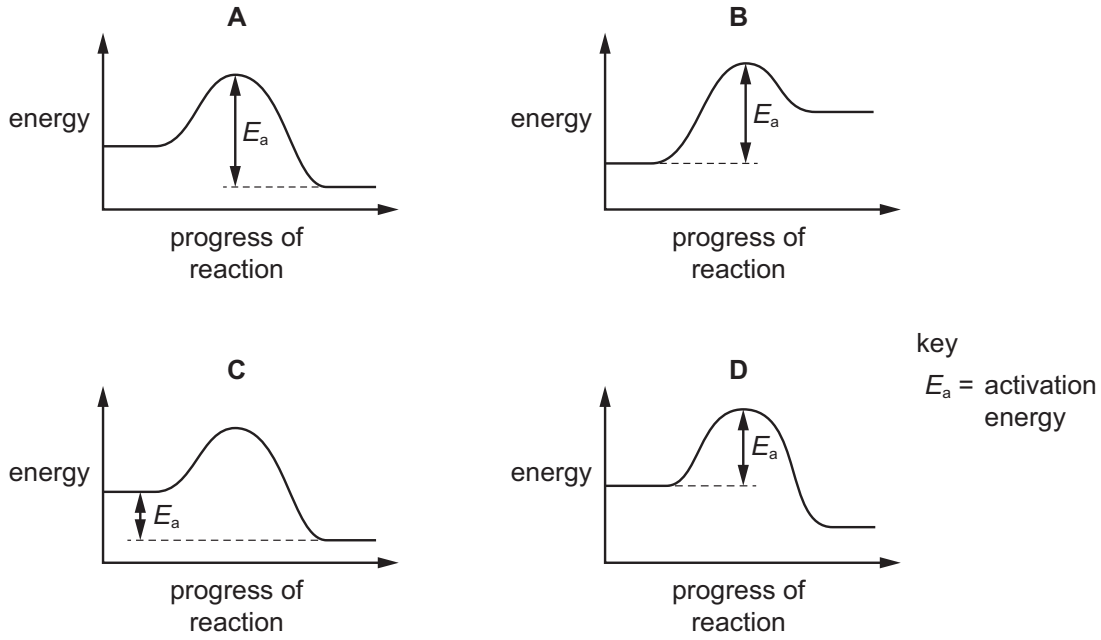
能量差由纵轴数值相减，纵轴的单位通常为 kJ/mol。

答案：放热；吸热；反应物

怎么认 题目出现反应路径图并要求判断反应热或活化能时，先找反应物、产物和峰顶三个高度。

例题 1

Which energy level diagram correctly represents an exothermic reaction?



（2022 Oct/Nov · 0654/23 · Question 19 · Extended）

解： 放热反应的产物能级低于反应物能级，且活化能为峰顶能级与反应物能级之差。

图 D 同时满足这两个条件。

故选 D。

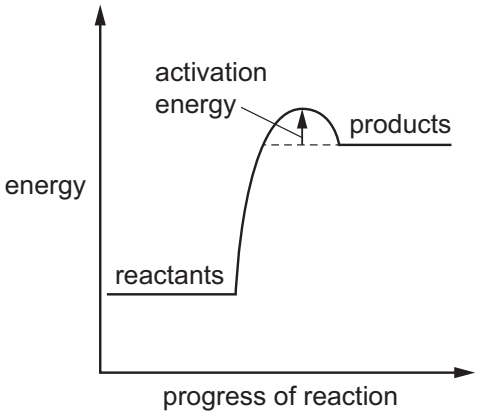
针对练习

1. Magnesium reacts with dilute hydrochloric acid.

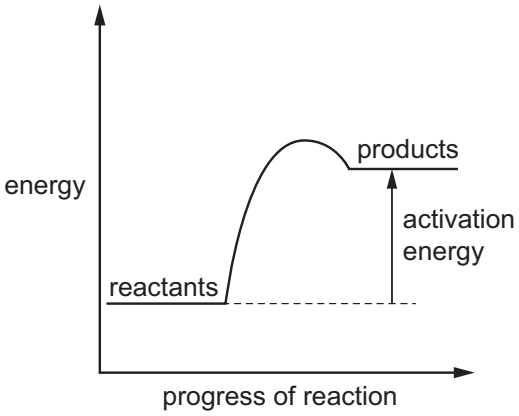
During the reaction, the reaction mixture becomes warm.

What is the reaction pathway diagram for this reaction?

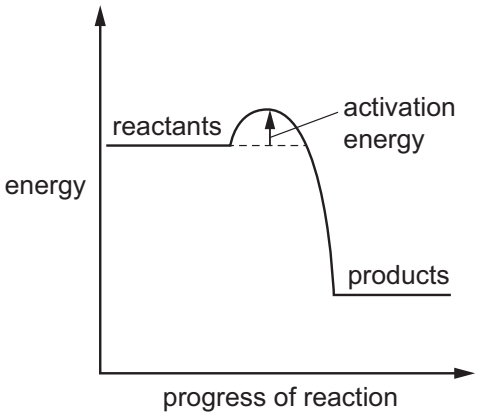
A



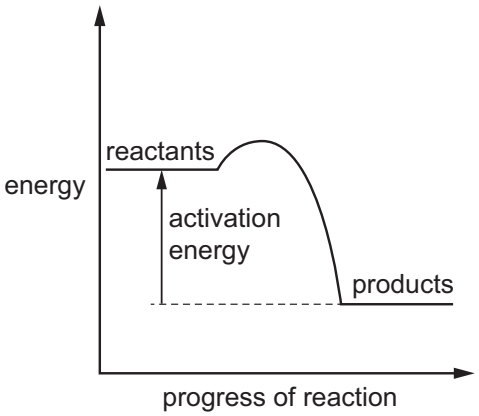
B



C



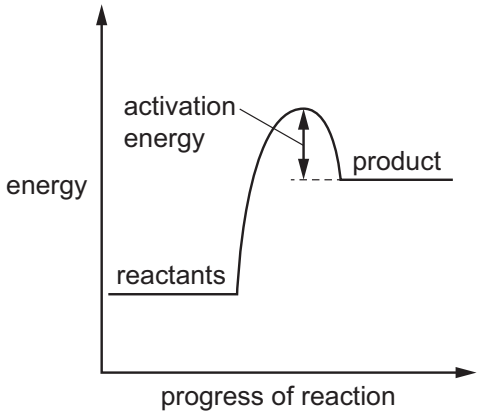
D



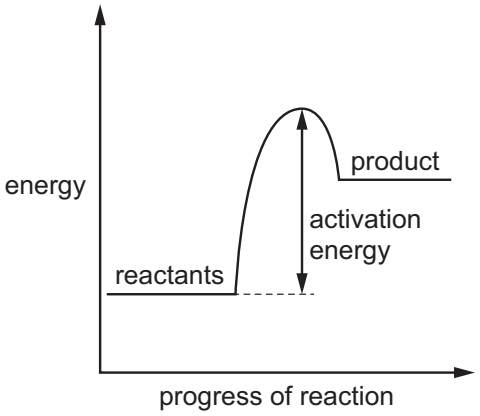
（2025 Oct/Nov · 0654/23 · Question 15 · Extended）

2. Which energy level diagram shows the activation energy for an exothermic reaction?

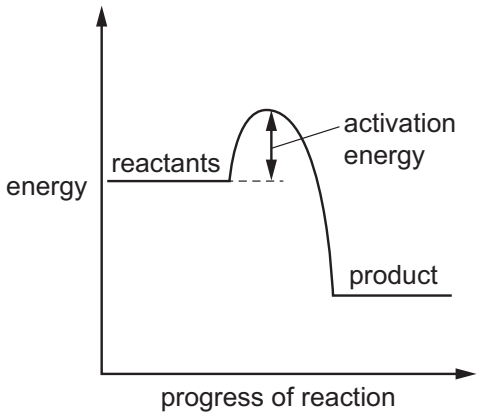
A



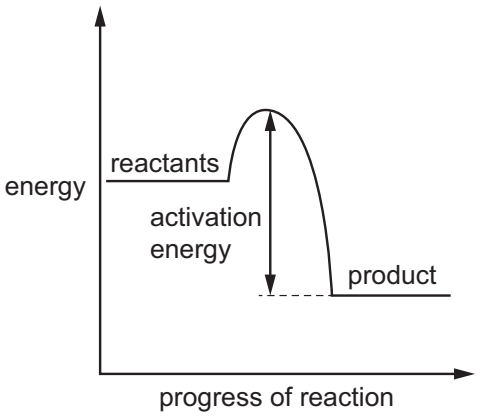
B



C

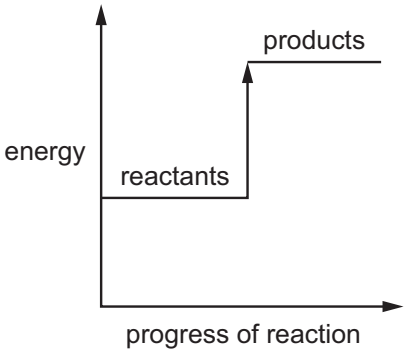


D



(2024 Oct/Nov · 0654/23 · Question 17 · Extended)

3. The energy level diagram for a reaction is shown.



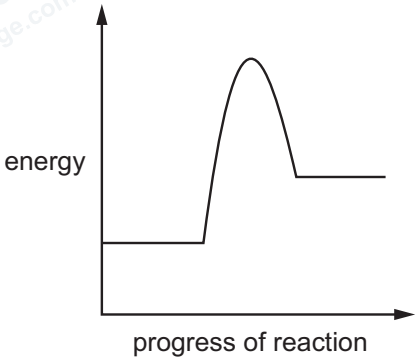
The diagram represents an 1 reaction. Heat is 2 during this reaction.

Which words complete gaps 1 and 2?

	1	2
A	endothermic	given out
B	endothermic	taken in
C	exothermic	given out
D	exothermic	taken in

(2024 May/Jun · 0654/22 · Question 18 · Extended)

4. An unlabelled reaction pathway diagram is shown.



Which row describes the reaction and gives a correct explanation?

	description of reaction	explanation
A	endothermic	the reactants contain less energy than the products
B	endothermic	the reactants contain more energy than the products
C	exothermic	the reactants contain less energy than the products
D	exothermic	the reactants contain more energy than the products

(2026 May/Jun · 0654/21 · Question 18 · Extended)

5. Which statement about energy changes in chemical reactions is correct?

A Activation energy is the maximum energy required by the reactants for a reaction to occur.

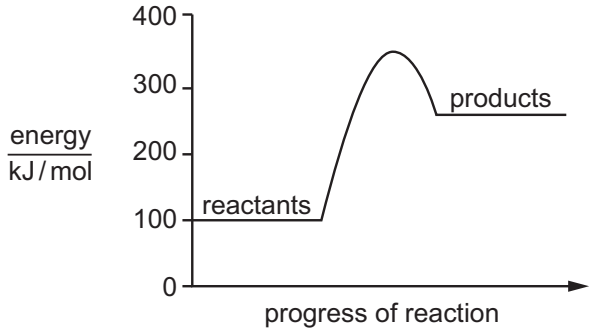
B Bond forming is an endothermic process.

C In an exothermic reaction, the energy level of the reactants is higher than the energy level of the products.

D Increasing temperature increases the minimum energy required by the reactants for a reaction to occur.

(2022 Oct/Nov · 0654/21 · Question 19 · Extended)

6. A reaction pathway diagram for a reaction is shown.

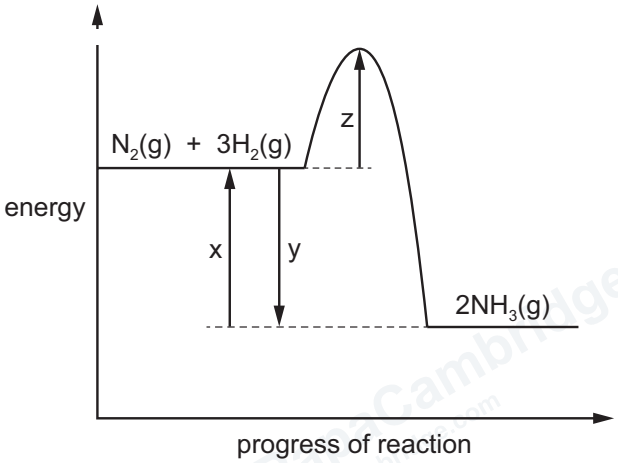


What is the value of the activation energy for this reaction?

A 100 kJ / mol **B** 150 kJ / mol **C** 250 kJ / mol **D** 350 kJ / mol

(2025 May/Jun · 0654/21 · Question 22 · Extended)

7. The reaction pathway diagram for the formation of ammonia from nitrogen and hydrogen is shown.

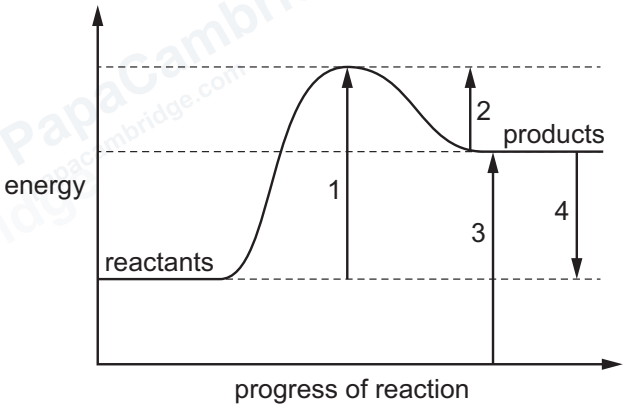


What is the activation energy for this reaction?

A x + z **B** y + z **C** y **D** z

（2026 Feb/Mar · 0654/22 · Question 18 · Extended）

8. Which statement describes the effect of a catalyst on an energy change shown in the reaction pathway diagram?



A A catalyst decreases the energy change labelled 1.

B A catalyst increases the energy change labelled 2.

C A catalyst decreases the energy change labelled 3.

D A catalyst increases the energy change labelled 4.

（2026 May/Jun · 0654/22 · Question 18 · Extended）

题型 4：计算温差并比较吸热放热大小（考频★★☆☆☆）

知识点 温度变化定义为终温与初温之差：$\Delta T = T_{终} - T_{初}$，单位为 °C。

若 $\Delta T > 0$，温度升高，反应为_____反应；若 $\Delta T < 0$，温度降低，反应为_____反应。

在反应物用量、溶液体积和装置等条件相同，或题目只给温度数据时，ΔT 越负，吸热程度越大；ΔT 越正，放热程度越大。

答案：放热；吸热

怎么认 题目出现初温、终温或温度升降及吸放热大小比较时，先计算各组 $\Delta T = T_{终} - T_{初}$。

例题 1

The initial and final temperatures of four different experiments are measured.

Which experiment is the most endothermic?

	initial temperature / °C	final temperature / °C
A	20	19
B	20	27
C	21	26
D	22	20

（2025 Feb/Mar · 0654/12 · Question 20 · Core）

解： 由 $\Delta T = T_{终} - T_{初}$，得

$\Delta T_A = 19 - 20 = -1°\ \mathrm{C}$

$\Delta T_B = 27 - 20 = 7°\ \mathrm{C}$

$\Delta T_C = 26 - 21 = 5°\ \mathrm{C}$

$\Delta T_D = 20 - 22 = -2°\ \mathrm{C}$

$\Delta T < 0$ 表示吸热，D 的温度降幅最大，吸热程度最大。故选 D。

针对练习

1. Equal masses of four substances are added separately to different samples of 10 cm^3 of dilute hydrochloric acid at 22 °C.

The final temperature of each reaction mixture is measured.

Which reaction is most endothermic?

	final temperature / °C
A	29
B	27
C	20
D	17

（2025 May/Jun · 0654/11 · Question 20 · Core）

2. Four different substances are added to the same acid of the same concentration in reactions W, X, Y and Z.

The initial temperature of the acid before each reaction is 21 °C.

The final temperatures of the mixtures are measured.

The results are shown.

reaction	W	X	Y	Z
final temperature / °C	28	19	26	17

Which row is correct?

	most endothermic reaction	most exothermic reaction
A	W	Z
B	Z	W
C	X	Y
D	Y	X

(2024 Oct/Nov · 0654/11 · Question 19 · Core)

3. Equal amounts of substances W, X, Y and Z are reacted separately with equal amounts of dilute acid.

The following temperature changes are recorded.

substance	temperature change / °C
W	increases by 8
X	decreases by 6
Y	increases by 9
Z	decreases by 4

Which substances produce the most exothermic and the least endothermic reactions?

	most exothermic	least endothermic
A	W	X
B	W	Z
C	X	Y
D	Y	Z

(2022 Oct/Nov · 0654/11 · Question 18 · Core)

题型 5：由反应种类判断能量方向（考频★★☆☆☆）

知识点 反应过程中向环境释放热量的反应叫作_____反应，产物能量低于反应物；从环境吸收热量的反应叫作_____反应，产物能量高于反应物。

燃烧和中和通常放热；热分解、沸腾和蒸发等状态变化通常吸热。

能量图中纵轴表示能量，反应物与产物的能量差常用单位为 kJ mol^{-1}；判断能量方向时，须比较同一反应中反应物和产物的能量高低。

答案：放热；吸热

怎么认 题目出现反应种类、状态变化或能量图时，先判断吸热或放热，再比较反应物与产物的能量高低。

例题 1

Which process is exothermic?

A boiling water

B cracking a long chain alkane

C decomposition of limestone

D identification of hydrogen using a lighted splint

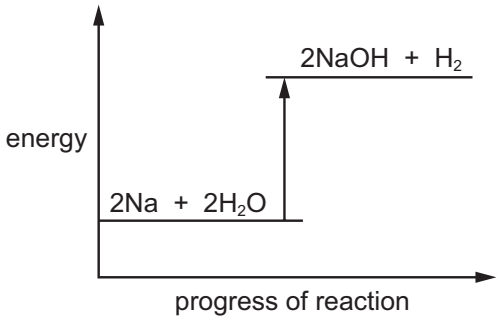
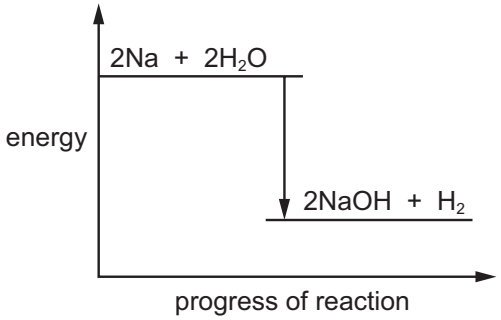
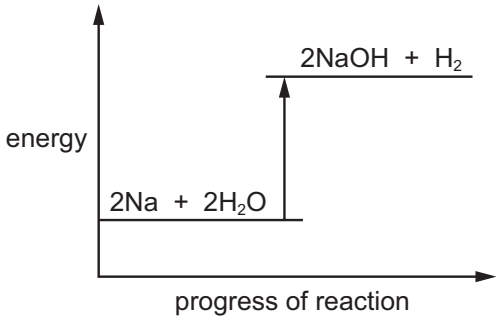
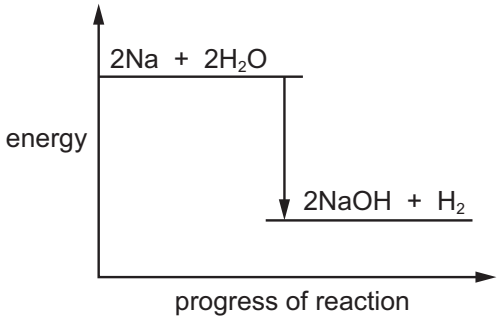
（2023 Feb/Mar · 0654/22 · Question 18 · Extended）

解：沸腾、长链烷烃裂化和石灰石分解均需吸收能量；点燃氢气发生燃烧，释放能量。故选 D。

针对练习

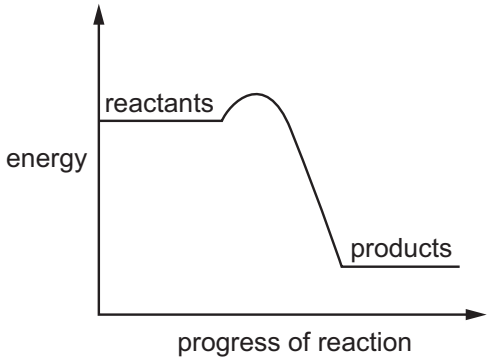
1. A piece of sodium is added to water.

Which row shows the type of reaction and the energy level diagram for the reaction?

	type of reaction	energy level diagram
A	endothermic	
B	endothermic	
C	exothermic	
D	exothermic	

（2024 May/Jun · 0654/21 · Question 20 · Extended）

2. A reaction pathway diagram for a reaction is shown.



Which reactions have a reaction pathway diagram like the one shown?

1 $C + O_2 \rightarrow CO_2$

2 $CaCO_3 \rightarrow CaO + CO_2$

3 $2C_3H_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$

4 $H_2O(l) \rightarrow H_2O(g)$

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2025 May/Jun · 0654/23 · Question 18 · Extended）

1.7 物理变化、化学变化与反应速率

题型 1：根据是否生成新物质区分物理和化学变化（考频★★★★☆）

知识点 物理变化中没有新物质生成，物质的化学组成_____；化学变化中有_____生成。
判断时比较变化前后的物质种类；仅发生状态改变、分离或未反应的溶解，属于物理变化。
燃烧、锈蚀、中和、分解、聚合有新物质生成，属于化学变化；温变或气体产生不能单独定类，本知识点无单位。

答案：不变；新物质

怎么认 题目出现某一过程或变化后物质的描述时，先判断变化后是否生成新物质。

例题 1

Which process is a chemical change?

A boiling

B dissolving

C melting

D neutralisation

（2022 May/Jun · 0654/23 · Question 15 · Extended）

解：沸腾和熔化仅改变物态，溶解未生成新物质，均为物理变化。
中和反应生成盐和水，有新物质生成，属于化学变化。
故选 D。

针对练习

1. Which process involves a chemical change?

A burning a wooden splint

B dissolving sodium chloride in water

C evaporating water

D distilling petroleum

（2024 Oct/Nov · 0654/12 · Question 15 · Core；同题：2024 Oct/Nov · 0654/13 · Question 15 · Core）

2. Which change is a physical change?

A combustion of ethanol

B rusting of iron

C dissolving sodium chloride in water

D polymerisation of ethene to poly(ethene)

（2026 May/Jun · 0654/12 · Question 19 · Core）

3. Which changes are chemical changes?

1 iron rusting

2 burning coal

3 dissolving sugar in water

4 boiling water

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2024 Feb/Mar · 0654/22 · Question 14 · Extended）

4. Which change is a chemical change?

A combustion of hydrocarbons

B filling a balloon with air

C freezing a glass of water

D mixing salt and sand

（2024 Feb/Mar · 0654/12 · Question 14 · Core）

5. Which change is a chemical change?

A boiling water

B combustion of alkanes

C filtering a mixture of sand and water

D fractional distillation of petroleum

（2025 Oct/Nov · 0654/12 · Question 19 · Core；同题：2025 Oct/Nov · 0654/13 · Question 19 · Core）

6. When solid zinc carbonate is heated, a different solid and a gas are formed.

Which type of change occurs?

A chemical

B exothermic

C physical

D separation

（2023 May/Jun · 0654/12 · Question 15 · Core；同题：2023 May/Jun · 0654/22 · Question 15 · Extended；同题：2023 May/Jun · 0654/13 · Question 15 · Core）

7. Which process is a physical change?

A Molecules of a single substance join together to make new molecules.

B Monomer molecules form a polymer.

C Molecules of a substance separate from each other.

D Solid calcium carbonate decomposes to give carbon dioxide gas.

（2026 May/Jun · 0654/22 · Question 19 · Extended）

8. Which processes are physical changes?

1 Hydrogen gas joins with oxygen gas to form steam.

2 Liquid water turns into steam.

3 $Cl_2(g) \rightarrow 2Cl(g)$

4 $CH_4(l) \rightarrow CH_4(g)$

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2025 May/Jun · 0654/22 · Question 17 · Extended）

9. Three different processes are listed.

1 heating ice to form water

2 lighting a match

3 removing zinc from sodium chloride solution by filtration

Which processes are physical changes?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

（2022 May/Jun · 0654/11 · Question 15 · Core；同题：2022 May/Jun · 0654/21 · Question 15 · Extended）

10. Which changes are chemical changes?

1 the burning of magnesium

2 the melting of sulfur

3 the rusting of iron

4 the reduction of iron(III) in iron(III) oxide

A 1, 2 and 3 **B** 1, 3 and 4 **C** 1 and 3 only **D** 2 and 4

（2026 Feb/Mar · 0654/12 · Question 17 · Core）

11. Which statements about chemical changes are correct?

1 The separation of petroleum into gasoline, naphtha and diesel is a chemical change.

2 The separation of water into hydrogen and oxygen is a chemical change.

3 In a chemical change, a new substance is always formed.

4 In a chemical change, heat is always released.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2024 May/Jun · 0654/11 · Question 15 · Core）

12. Some physical and chemical changes are listed.

1 burning methane

2 dissolving sugar in water

3 evaporating ethanol

4 rusting iron

Which changes are chemical changes?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2022 May/Jun · 0654/12 · Question 15 · Core；同题：2022 May/Jun · 0654/13 · Question 15 · Core、2022 May/Jun · 0654/22 · Question 15 · Extended）

13. Some changes involving sodium chloride are listed.

1 Sodium and chlorine are combined to form sodium chloride.

2 Solid sodium chloride is dissolved in water.

3 Aqueous sodium chloride decomposes when an electric current is passed through it.

4 Solid sodium chloride is heated until it turns to a liquid.

Which changes are chemical changes?

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2026 May/Jun · 0654/13 · Question 16 · Core）

14. When a match burns, heat and light energy are produced.

Which row describes the type of change and the type of reaction taking place?

	type of change	type of reaction
A	chemical	endothermic
B	chemical	exothermic
C	physical	endothermic
D	physical	exothermic

（2024 Oct/Nov · 0654/21 · Question 19 · Extended）

15. The boiling point of ammonia is –33 °C.

The temperature of a sealed flask containing ammonia is changed from –35 °C to –30 °C.

Which row describes and explains the type of change that happens in the flask?

	type of change	explanation
A	chemical	no new substance is formed
B	chemical	hydrogen and nitrogen are formed
C	physical	no new substance is formed
D	physical	hydrogen and nitrogen are formed

（2024 May/Jun · 0654/21 · Question 15 · Extended）

题型 2：用浓度温度表面积判断速率条件（考频★★★☆☆）

知识点 反应速率表示单位时间内反应物的减少量或生成物的增加量；测体积时单位可用 $\frac{cm^3}{s}$，测质量时可用 $\frac{g}{s}$。

在其他条件相同时，增大反应物浓度或升高温度，单位时间内的有效碰撞次数增多，反应速率_____。

加入合适的催化剂能增大反应速率；同质量的固体颗粒越小，总表面积越_____，反应速率越大。

溶液浓度不变而仅增大体积时，初始反应速率通常_____；加水使浓度降低时，反应速率降低。

答案：增大；大；不变

怎么认 题目出现浓度、温度、溶液体积或固体颗粒大小的改变时，先分清浓度与体积，再由表面积判断速率。

例题 1

Dilute hydrochloric acid reacts with solid calcium carbonate.

Which change decreases the rate of the reaction?

A decreasing the concentration of the hydrochloric acid

B decreasing the size of the calcium carbonate pieces

C increasing the surface area of the calcium carbonate

D increasing the temperature of the acid

（2024 Oct/Nov · 0654/11 · Question 20 · Core）

解：降低盐酸浓度，单位体积内反应粒子数减少，单位时间内的有效碰撞次数减少，反应速率降低。故选 A。

针对练习

1. Dilute hydrochloric acid reacts with calcium carbonate.

The equation for the reaction is shown.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

Which change increases the rate of the reaction?

A decreasing the temperature of the hydrochloric acid

B increasing the concentration of the hydrochloric acid

C increasing the size of the calcium carbonate particles

D increasing the volume of the hydrochloric acid

（2024 May/Jun · 0654/11 · Question 20 · Core）

2. Solid zinc carbonate reacts with excess dilute hydrochloric acid.

Which changes in the conditions increase the rate of this reaction?

1 Increase the concentration of hydrochloric acid.

2 Increase the temperature of the reaction mixture.

3 Increase the volume of hydrochloric acid.

4 Use larger pieces of zinc carbonate.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2025 May/Jun · 0654/11 · Question 21 · Core）

3. The equation for the reaction between calcium carbonate and dilute hydrochloric acid is shown.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

Which change increases the rate of this reaction?

A Decrease the temperature.

B Increase the particle size of the calcium carbonate.

C Increase the concentration of the acid.

D Increase the volume of the acid.

（2025 Feb/Mar · 0654/12 · Question 21 · Core）

4. Which actions increase the rate of a reaction?

1 Add a catalyst.

2 Increase the concentration of a reactant.

3 Increase the size of solid particles.

4 Decrease the temperature of the reaction.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

(2026 May/Jun · 0654/11 · Question 18 · Core)

5. Which statement about rates of reaction is correct?

A Catalysts never affect the rate of reaction.

B Decreasing the temperature of a reaction increases the rate of reaction.

C Increasing the concentration of a reacting solution decreases the rate of reaction.

D Using smaller sized pieces of a solid increases the rate of reaction.

(2023 Feb/Mar · 0654/12 · Question 19 · Core)

6. Magnesium ribbon is reacted with 50 cm^3 of dilute hydrochloric acid.

Which change does **not** increase the rate of the reaction?

A Increase the concentration of the hydrochloric acid.

B Increase the temperature of the hydrochloric acid.

C Increase the volume of the hydrochloric acid.

D Use powdered magnesium.

(2024 May/Jun · 0654/21 · Question 21 · Extended)

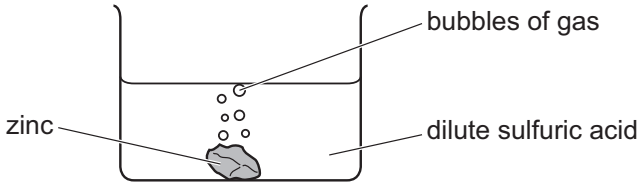
7. A fixed mass of zinc reacts with 100 cm^3 of dilute sulfuric acid.

Which row identifies changes that increase the rate of the reaction?

	change to the size of the zinc particles	change to the acid
A	decrease	decrease the concentration
B	decrease	increase the temperature
C	increase	decrease the temperature
D	increase	increase the concentration

(2025 Feb/Mar · 0654/22 · Question 17 · Extended)

8. The diagram shows zinc reacting with dilute sulfuric acid.



Which change does **not** increase the rate of the reaction?

A Add a catalyst.

B Increase the concentration of dilute sulfuric acid.

C Increase the temperature of dilute sulfuric acid.

D Decrease the surface area of zinc.

（2025 Oct/Nov · 0654/12 · Question 20 · Core；同题：2025 Oct/Nov · 0654/13 · Question 20 · Core）

9. Four beakers each contain 50 cm^3 dilute hydrochloric acid of equal concentration.

50 cm^3 of water is added to two of the beakers.

4.0 g magnesium carbonate is then added to each beaker. The particle sizes of the magnesium carbonate added to some of the beakers are different.

Which experiment has the lowest rate of reaction?

	volume of dilute hydrochloric acid / cm^3	volume of water / cm^3	mass of magnesium carbonate / g	size of pieces of magnesium carbonate
A	50	50	4.0	small
B	50	0	4.0	small
C	50	50	4.0	large
D	50	0	4.0	large

（2024 Oct/Nov · 0654/12 · Question 19 · Core；同题：2024 Oct/Nov · 0654/13 · Question 19 · Core）

题型 3：选择测反应速率的装置和测量量（考频★★★☆☆）

知识点 反应速率表示反应物减少或生成物增加的快慢，通常用_____内某物理量的变化表示。

有气体生成时，可测气体体积的增加量或装置总质量的减少量，分别有 $r_V = \frac{\Delta V}{\Delta t}$、$r_m = \frac{|\Delta m|}{\Delta t}$。

体积法需测气体体积，质量法需测装置总质量；两种方法均需_____记录时间。

气体体积可用气体注射器或带刻度的集气装置读取；移液管用于量取液体，量筒刻度较粗时准确度较低。

研究温度对速率的影响时还需_____；常用速率单位为 $cm^3 s^{-1}$ 或 $g\ s^{-1}$。

答案：单位时间；计时器；温度计

怎么认 题目出现气体体积、质量随时间变化或比较温度时，先写测量量和时间，再配读数装置。

例题 1

During a reaction, a gas is given off.

Which pieces of apparatus are essential to measure the rate of this reaction?

A balance and volumetric pipette

B beaker and stop-watch

C gas syringe and stop-watch

D pipette and stop-watch

（2026 May/Jun · 0654/13 · Question 19 · Core）

解：反应放出气体，需测气体体积变化量 ΔV 和相应时间 Δt。
由 $r_V = \frac{\Delta V}{\Delta t}$，气体体积用气体注射器读取，时间用计时器记录。
故选 C。

针对练习

1. The rate of reaction between calcium carbonate and dilute hydrochloric acid is determined either by measuring the change in gas volume per unit time or by measuring the change in mass per unit time.

Which piece of apparatus must be used for **both** methods?

A a balance

B a gas syringe

C a stop-clock

D a thermometer

（2023 Oct/Nov · 0654/21 · Question 19 · Extended）

2. Calcium carbonate reacts with dilute hydrochloric acid in a flask. The reaction releases carbon dioxide gas.

The decrease in the mass of the flask and its contents is measured over time.

Which pieces of apparatus must be used?

1 balance

2 pipette

3 thermometer

4 stop-clock

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2024 Oct/Nov · 0654/12 · Question 14 · Core；同题：2024 Oct/Nov · 0654/13 · Question 14 · Core）

3. A student adds 5 g of magnesium ribbon to 20 cm^3 of dilute hydrochloric acid in a beaker.

The student measures how long it takes for the effervescence to stop.

Which pieces of apparatus does the student use in this experiment?

	balance	measuring cylinder	stop-clock	thermometer
A	✓	✓	✗	✓
B	✓	✗	✓	✓
C	✓	✓	✓	✗
D	✗	✓	✓	✓

key

✓ = uses the apparatus

✗ = does not use the apparatus

(2024 Oct/Nov · 0654/11 · Question 14 · Core)

4. The rate of a reaction that produces carbon dioxide gas is investigated.

Which piece of apparatus gives the **least** accurate measurement for the gas production?

A burette

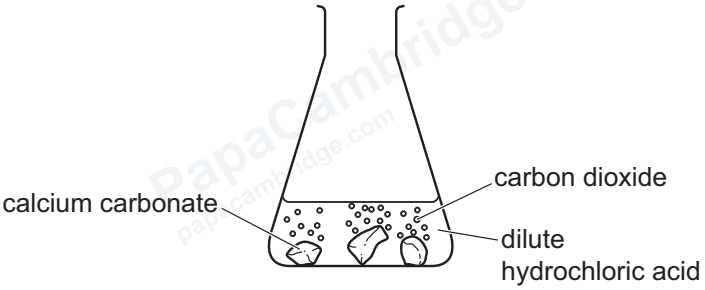
B gas syringe

C measuring cylinder

D 3-decimal-place digital balance

(2024 Oct/Nov · 0654/22 · Question 18 · Extended)

5. Calcium carbonate is added to dilute hydrochloric acid in a conical flask. Carbon dioxide gas is produced.



Which methods are used to investigate the rate of this reaction?

1 Connect the conical flask to a gas syringe and measure the volume of carbon dioxide collected every 15 seconds.

2 Place the apparatus on a balance and measure the mass every 15 seconds.

3 Measure the volume of hydrochloric acid in the flask every 15 seconds.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

(2026 Feb/Mar · 0654/12 · Question 18 · Core)

6. An experiment is assembled to measure the rate of reaction between limestone and hydrochloric acid.

In the experiment a gas is released. The volume of gas produced is measured every five seconds.

Which piece of apparatus **cannot** be used to measure the volume of gas?

A burette

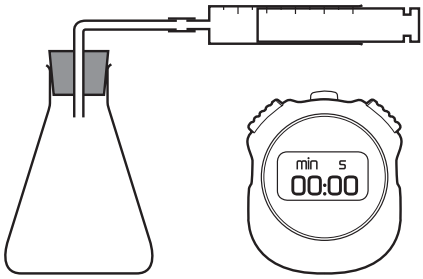
B measuring cylinder

C pipette

D gas syringe

(2024 Oct/Nov · 0654/21 · Question 15 · Extended)

7. The apparatus used to determine the rate of a chemical reaction is shown.



For which reaction is the rate determined using this apparatus?

A $CaCO_3 \rightarrow CaO + CO_2$

B $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

C $MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$

D $Cl_2 + 2NaBr \rightarrow Br_2 + 2NaCl$

(2024 Oct/Nov · 0654/23 · Question 18 · Extended)

8. When dilute hydrochloric acid reacts with calcium carbonate, carbon dioxide is produced.

Which pieces of apparatus are used to investigate the effect of temperature on the rate of this reaction?

1



2



3



A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

(2024 May/Jun · 0654/23 · Question 17 · Extended)

题型 4：按温度计刻度求初终读数差（考频★☆☆☆☆）

知识点 相邻两个标数之差除以两标数间的_____，所得数值为温度计的分度值，每小格代表的温度相等。

读数取液柱顶端所对应的刻度，摄氏温度的单位为_____。

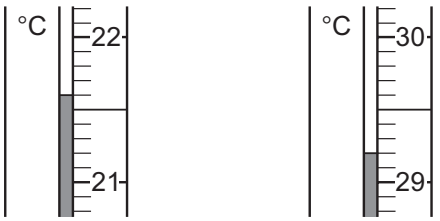
温度变化量 ΔT 等于最终读数减去初始读数；升温时 ΔT 为_____。

答案：小格数；摄氏度（°C）；正数

怎么认 题目出现温度计初、终刻度图并求温度变化时，先读每小格温度，再求终读数与初读数之差。

例题 1

The initial and final readings on a sensitive thermometer used in an experiment are shown.



initial　　final

What is the temperature change for this experiment?

A 0.4　　**B** 4.0　　**C** 6.8　　**D** 7.6

（2024 May/Jun · 0654/21 · Question 14 · Extended）

解：相邻标数之间有 10 小格，每小格表示

$d = \frac{22-21}{10} = 0.1\ ^\circ\mathrm{C}$

初始读数为 21.6 °C，最终读数为 29.2 °C，故

$\Delta T = 29.2\ ^\circ\mathrm{C} - 21.6\ ^\circ\mathrm{C} = 7.6\ ^\circ\mathrm{C}$

故选 D。

题型 5：用碰撞频率和能量解释反应速率（考频★★★★☆）

知识点 反应速率取决于单位时间内发生的有效碰撞次数；碰撞粒子的能量达到或超过活化能，碰撞才可能引发反应。

升高温度，粒子运动加快，碰撞频率_____，达到活化能的碰撞比例_____；反应的活化能不随温度改变。

增大浓度、增大气体压强或增大固体表面积，主要使碰撞频率增大；催化剂通过降低_____来增大有效碰撞的比例。

反应速率以浓度随时间的变化表示时，常用单位为 $\mathrm{mol\ dm^{-3}\ s^{-1}}$。

答案：增加；增加；活化能

怎么认 题目出现条件变化并询问反应速率、碰撞频率或粒子能量时，先分别判断碰撞次数和达到活化能的比例。

例题 1

Which row describes the effect of increasing temperature on the collisions between particles in a chemical reaction?

	frequency of collisions	energy of collisions
A	decreases	increases
B	decreases	decreases
C	increases	decreases
D	increases	increases

（2023 May/Jun · 0654/23 · Question 19 · Extended）

解：升高温度后，粒子的平均动能增大，运动加快，碰撞频率增加；碰撞时的能量也增大。
表中两项均为增加，对应 D。故选 D。

针对练习

1. Which row explains why increasing the concentration of a reactant increases the rate of reaction?

	proportion of particles with the minimum energy to react	collision frequency between reacting particles
A	increases	increases
B	increases	stays the same
C	stays the same	increases
D	stays the same	stays the same

（2023 May/Jun · 0654/21 · Question 19 · Extended）

2. Which statement explains why increasing the concentration of reactants increases the rate of a reaction?

A The proportion of particles that possess the activation energy is greater.

B The particles collide more frequently.

C The particles collide more slowly.

D The particles collide with greater energy.

（2023 May/Jun · 0654/22 · Question 19 · Extended）

3. Dilute hydrochloric acid is reacted with magnesium. The reaction is repeated using a higher concentration of acid.

Which statement about the second reaction is **not** correct?

A The rate of reaction is greater.

B The particles have more energy.

C There are more frequent collisions between reacting particles.

D There are more reacting particles.

（2023 Oct/Nov · 0654/23 · Question 19 · Extended）

4. Which change decreases the frequency of collisions between reactant particles?

A increasing the concentration of reactant solutions

B increasing the pressure on gaseous reactants

C increasing the temperature of the reaction mixture

D using larger pieces of a solid reactant

(2023 Oct/Nov · 0654/22 · Question 18 · Extended)

5. A reaction is carried out at two different temperatures.

Which statement about the reaction at the higher temperature is **not** correct?

A A greater proportion of reacting particles possess the activation energy.

B Reacting particles collide more frequently.

C Reacting particles have greater kinetic energy.

D The activation energy of the reaction decreases.

(2024 Feb/Mar · 0654/22 · Question 19 · Extended)

6. Which change to the conditions of a reaction can produce the same number of successful collisions between reacting particles per second?

	temperature	reactant concentration
A	higher	lower
B	higher	unchanged
C	lower	lower
D	lower	unchanged

(2025 Oct/Nov · 0654/22 · Question 23 · Extended)

7. Calcium carbonate and dilute hydrochloric acid react together in a beaker.

When the reaction mixture is heated, the rate of the reaction increases.

Which statements explain this observation?

1 The frequency of particle collisions increases.

2 More colliding particles have energy greater than the activation energy.

3 The gas pressure in the beaker increases.

4 The activation energy decreases.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

(2025 Oct/Nov · 0654/23 · Question 16 · Extended)

8. Increasing the temperature of a reaction mixture increases the rate of the reaction.

Which statements explain this increase in the rate of the reaction at higher temperatures?

1 The activation energy is increased.

2 The reacting particles are closer together.

3 There are more frequent collisions between reacting particles.

4 More collisions between reacting particles result in a reaction.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

(2025 Oct/Nov · 0654/21 · Question 17 · Extended)

9. A student adds excess zinc to a fixed volume of dilute sulfuric acid of concentration 1.0 mol / dm^3 at different temperatures.

Hydrogen gas is produced.

The results are shown.

experiment	temperature of sulfuric acid / °C	time for effervescence to end / s
1	30	240
2	40	120

Which statement about the rate of reaction in these experiments is correct?

A Experiment 1 has a higher rate because more collisions have an energy exceeding the activation energy and the frequency of collisions between particles is smaller.

B Experiment 2 has a higher rate because more collisions have an energy exceeding the activation energy and the frequency of collisions between particles is greater.

C Experiment 1 has a higher rate because the activation energy is lower at lower temperatures and the frequency of collisions between particles is greater.

D Experiment 2 has a higher rate because the activation energy is lower at higher temperatures and the frequency of collisions between particles is smaller.

(2026 May/Jun · 0654/21 · Question 19 · Extended)

10. Solid P reacts with dilute acid.

Which change in reaction conditions increases both the frequency of particle collisions and the number of colliding particles that have the minimum energy needed to react?

A Decrease the particle size of solid P.

B Increase the concentration of the acid.

C Increase the surface area of solid P.

D Increase the temperature of the reaction.

(2025 May/Jun · 0654/23 · Question 19 · Extended)

11. The equation for the reaction between sulfur dioxide and oxygen is shown.

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

Which statements explain why the rate of this reaction increases at higher temperatures?

1 The molecules move closer together so they collide more frequently.

2 The molecules move more quickly so they collide more frequently.

3 The activation energy is decreased.

4 More colliding particles possess the activation energy.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2024 Oct/Nov · 0654/21 · Question 20 · Extended）

题型 6：由数据间隔求速率并比较曲线斜率和终点（考频★★★☆☆）

知识点 反应速率可用单位时间内生成物体积的变化量表示：$r = \frac{\Delta V}{\Delta t}$；$\Delta V$与$\Delta t$须取同一时段，常用单位为$\frac{cm^3}{s}$或$\frac{cm^3}{min}$。

气体体积-时间图像中，曲线越陡，反应速率越_____；水平部分的纵坐标表示气体的_____。

提高反应物浓度、升高温度、加入催化剂或减小固体颗粒，通常使反应速率增大；提高浓度或增大固体总表面积会使有效碰撞更频繁，催化剂降低激活能。

若限量反应物的量不变，改变反应速率通常不改变曲线终点；浓度相同而溶液体积改变时，初始速率可相同，但反应物的_____改变，气体总量可随之改变。

质量-时间图像中，气体逸出使体系质量减小；曲线下降越陡，反应速率越大，初始质量与终点质量之差表示逸出气体的总质量。

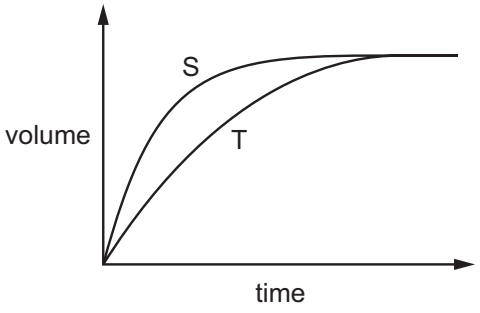
答案：大；最终总体积；物质的量

怎么认 题目出现气体体积-时间曲线、质量-时间曲线或分时段数据时，先比较斜率，再独立比较终点。

例题 1

A fixed mass of a solid is reacted with a liquid.

The volume of gas given off from the reaction over time is shown by line S.



Which change to the reaction conditions produces line T on the graph?

A increasing the amount of catalyst added

B increasing the concentration of the liquid

C increasing the particle size of the solid

D increasing the temperature of the reaction

（2022 May/Jun · 0654/11 · Question 19 · Core）

解： 由图得，曲线 T 的初始斜率小于曲线 S，故 T 的反应速率较低；两曲线终点相同，故生成气体总量相同。

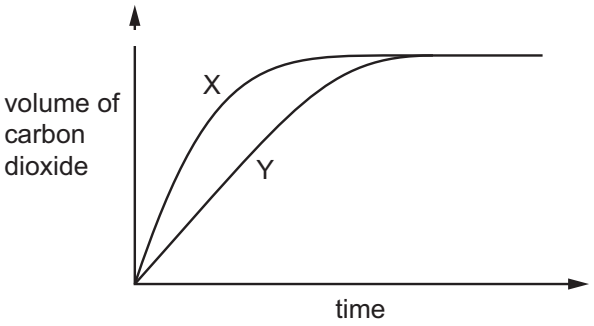
增大固体颗粒使固体总表面积减小，有效碰撞频率降低，反应速率降低；固体质量不变，生成气体总量不变。
故选 C。

针对练习

1. Two separate experiments X and Y are used to investigate the rate of the reaction between equal masses of calcium carbonate and excess dilute hydrochloric acid.

The volume of carbon dioxide given off is measured over time.

A graph of the results is shown.



Which statement explains the difference between experiments X and Y?

A A catalyst is added to Y.

B A higher temperature is used in Y.

C Larger pieces of calcium carbonate are used in X.

D The acid is more concentrated in X.

（2022 Oct/Nov · 0654/12 · Question 19 · Core）

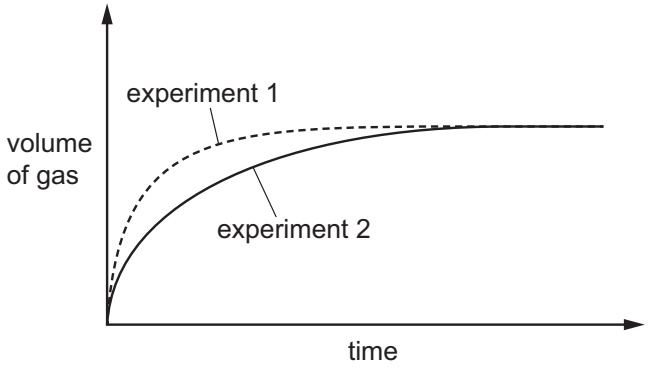
2. Dilute hydrochloric acid reacts with calcium carbonate. The equation for the reaction is shown.

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$$

The effect of concentration of the acid on the rate of this reaction is investigated.

The volume of gas produced over time is measured for two different concentrations of the acid.

The results for experiments 1 and 2 are shown.



Which row shows the reaction that has the higher rate of reaction and explains why?

	higher rate	reason
A	experiment 1	the activation energy is lower in experiment 1
B	experiment 1	the collision frequency is greater in experiment 1
C	experiment 2	the activation energy is lower in experiment 1
D	experiment 2	the collision frequency is greater in experiment 1

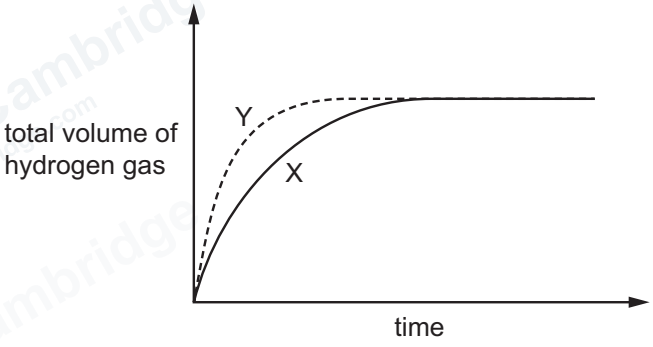
(2023 Feb/Mar · 0654/22 · Question 19 · Extended)

3. Experiments X and Y investigate the rate of reaction between magnesium and excess dilute hydrochloric acid.

In each experiment, the total volume of hydrogen gas produced is measured over time.

There is only **one** difference in the conditions between experiment X and experiment Y.

Graphs of the results of both experiments are shown.



Which statement about the experiments is correct?

A A catalyst is used only in X.

B The hydrochloric acid in X is more concentrated than in Y.

C The temperature of Y is lower than X.

D Smaller pieces of magnesium are used in Y compared to X.

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(2026 Feb/Mar · 0654/22 · Question 19 · Extended)

4. The rate of a reaction between a powdered metal and a dilute acid is investigated by measuring the volume of hydrogen gas produced per minute.

The investigation is repeated using a catalyst. The same mass of powdered metal and the same volume and concentration of acid is used.

Which statement about the second investigation is correct?

A The rate of the reaction is higher and a greater total volume of hydrogen is produced.

B The rate of the reaction is higher and the same total volume of hydrogen is produced.

C The rate of the reaction is lower and a smaller total volume of hydrogen is produced.

D The rate of the reaction is lower and the same total volume of hydrogen is produced.

(2022 Oct/Nov · 0654/11 · Question 19 · Core)

5. A chemical reaction produces a gas.

The volume of gas given off over time is measured.

The results are shown.

time / s	0	10	20	30	40	50	60	70	80
volume of gas / cm^3	0	27	48	63	77	86	89	90	90

During which time period is the rate of reaction greatest?

A 0–10 seconds

B 20–30 seconds

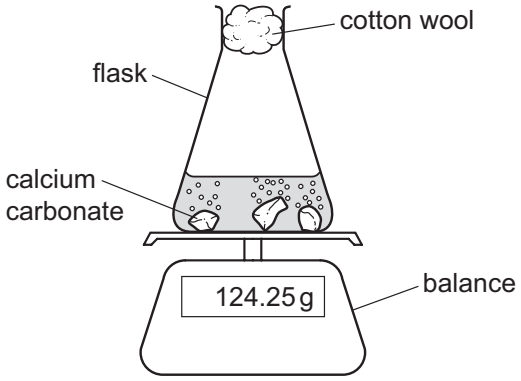
C 40–50 seconds

D 60–70 seconds

(2022 Oct/Nov · 0654/13 · Question 19 · Core)

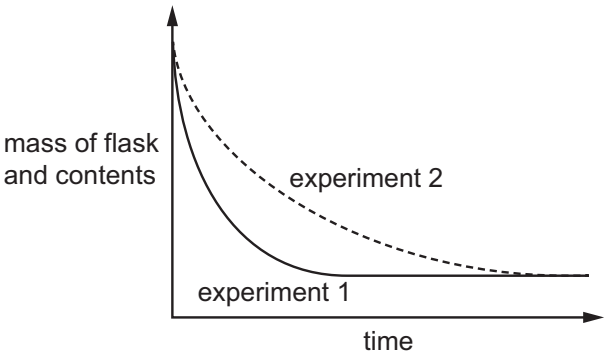
6. When solid pieces of calcium carbonate are added to dilute hydrochloric acid in a flask, carbon dioxide gas is given off.

The mass of the flask and its contents are measured over time.



Two different experiments are carried out. In both experiments the acid is in excess.

The results of these two experiments are shown.



Which statement explains the different shapes of the curves?

A Experiment 2 uses a catalyst.

B Experiment 2 uses acid at a higher temperature.

C Experiment 2 uses acid that is more dilute.

D Experiment 2 uses powdered calcium carbonate.

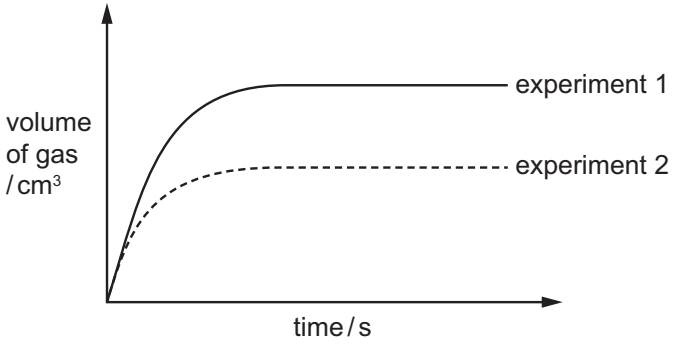
（2022 May/Jun · 0654/12 · Question 19 · Core；同题：2022 May/Jun · 0654/13 · Question 19 · Core）

7. Equal masses of limestone pieces are reacted with acid in two experiments.

Only one change to the conditions is made between experiment 1 and experiment 2.

The volume of gas produced is measured over time.

The results are shown.



Which statement about the experiments is correct?

A The concentration of acid used in experiment 2 is higher than in experiment 1.

B The temperature used in experiment 2 is lower than in experiment 1.

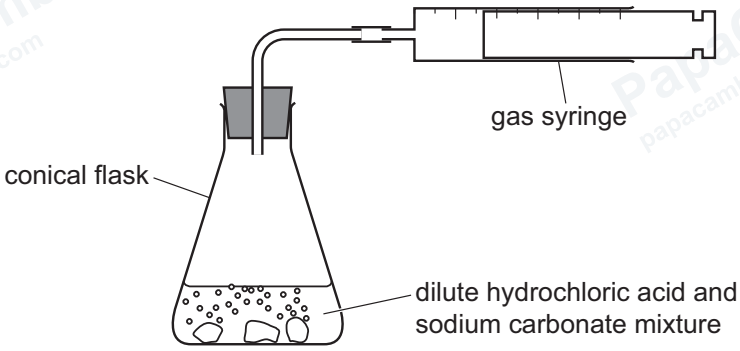
C The limestone pieces used in experiment 1 are larger than in experiment 2.

D The volume of acid used in experiment 1 is greater than in experiment 2.

(2025 May/Jun · 0654/22 · Question 18 · Extended)

8. When 50 cm^3 of dilute hydrochloric acid and excess solid sodium carbonate are mixed, they react to form carbon dioxide gas.

The gas is collected in a gas syringe as shown.



The experiment is repeated using 25 cm^3 of the same concentration of dilute hydrochloric acid.

Which statement about the second experiment compared to the first experiment is correct?

A It has the same initial rate of reaction and produces a lower volume of gas.

B It has the same initial rate of reaction and produces the same volume of gas.

C It has a lower initial rate of reaction and produces a lower volume of gas.

D It has a lower initial rate of reaction and produces the same volume of gas.

(2026 May/Jun · 0654/22 · Question 20 · Extended)

1.8 氧化还原与电子转移

题型 1：用氧的得失识别被氧化或还原物质（考频★★★★☆）

知识点 氧化是物质_____氧的过程，还原是物质_____氧的过程。

沿同一元素从反应物追踪到产物，所结合的氧增多时，该物质被氧化；所结合的氧减少时，该物质被还原。

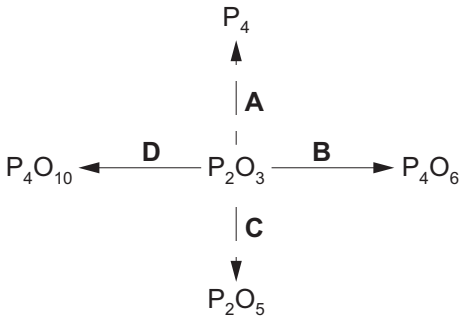
从电子转移判断，失去电子是氧化，得到电子是还原；两种判断所得结论一致。

答案：得到；失去

怎么认 题目出现氧化物、氧气或含氧产物并问氧化、还原时，先沿同一元素比较反应前后氧的得失。

例题 1

In which change is the oxide of phosphorus, P_2O_3, reduced?



（2023 Oct/Nov · 0654/13 · Question 19 · Core）

解：还原是失去氧。

在变化 A 中，P_2O_3 变为 P_4，含氧的氧化物变为不含氧的单质，说明它失去氧。

故选 A。

针对练习

1. The equation for the reaction between copper(II) oxide and carbon is shown.

$$2CuO + C \rightarrow 2Cu + CO_2$$

Which substance is oxidised in this reaction?

A C　　**B** CO_2　　**C** Cu　　**D** CuO

（2025 Oct/Nov · 0654/12 · Question 21 · Core；同题：2025 Oct/Nov · 0654/13 · Question 21 · Core）

2. Which statement explains why the rusting of iron is an oxidation reaction?

A Iron gains oxygen.

B Iron is a transition element.

C Iron is very reactive.

D Iron loses oxygen.

（2024 Feb/Mar · 0654/12 · Question 20 · Core）

3. Which statements about oxidation and reduction are correct?

1 Oxidation is the gain of oxygen.

2 Oxidation is the loss of oxygen.

3 Reduction is the gain of oxygen.

4 Reduction is the loss of oxygen.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2025 Oct/Nov · 0654/22 · Question 24 · Extended）

4. The equation for the reaction between iron(III) oxide, Fe_2O_3, and carbon is shown.

$$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$$

Which statement about this reaction is correct?

A C is oxidised.

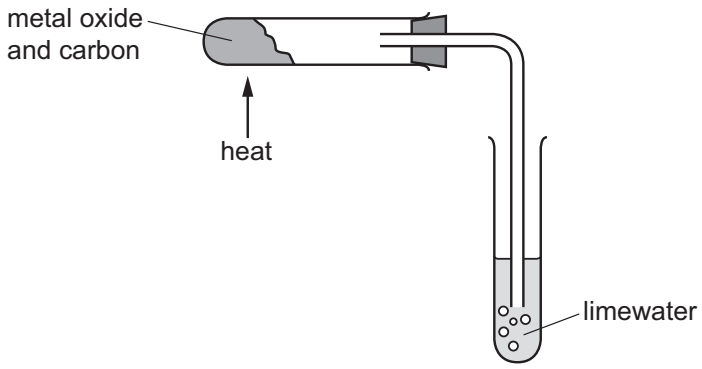
B CO_2 is reduced.

C Fe is oxidised.

D Fe_2O_3 is oxidised.

（2024 May/Jun · 0654/12 · Question 19 · Core；同题：2024 May/Jun · 0654/13 · Question 19 · Core）

5. To extract a metal from its ore, a metal oxide is mixed with carbon and heated as shown.



The limewater turns cloudy.

Which term describes what happens to the metal oxide?

A combustion

B neutralisation

C oxidation

D reduction

（2023 Oct/Nov · 0654/12 · Question 18 · Core）

6. Which statement shows that methane, CH_4, is oxidised when it burns?

A The products of the reaction are gaseous.

B The products of the reaction are water and carbon dioxide.

C The reaction is exothermic.

D The total number of oxygen atoms has increased during the reaction.

（2023 May/Jun · 0654/11 · Question 20 · Core）

7. Which statement about oxidation is correct?

A It occurs when an element or compound chemically combines with oxygen.

B It occurs when an element or compound forms a mixture with oxygen.

C It occurs when an element or compound is separated from a mixture with oxygen.

D It occurs when a compound loses oxygen.

（2024 Oct/Nov · 0654/11 · Question 21 · Core）

8. Which equation shows the oxidation of a metal?

A $CuO + H_2 \rightarrow Cu + H_2O$

B $CuO + Zn \rightarrow Cu + ZnO$

C $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

D $2ZnO + C \rightarrow 2Zn + CO_2$

（2025 May/Jun · 0654/11 · Question 22 · Core）

9. Which reactions involve oxidation?

1 $C + O_2 \rightarrow CO_2$

2 $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

3 $2Mg + O_2 \rightarrow 2MgO$

4 $CaCO_3 \rightarrow CaO + CO_2$

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2024 May/Jun · 0654/11 · Question 21 · Core）

10. In a reaction, iron(II) oxide is converted to iron(III) oxide.

Which row shows what happens to the iron(II) oxide?

	gain of oxygen	gain of an electron
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

（2026 May/Jun · 0654/23 · Question 18 · Extended）

题型 2：用电子得失判氧化还原及氧化剂还原剂（考频★★★★☆）

知识点 氧化是物质_____电子的过程，伴随有关元素化合价升高；还原是物质_____电子的过程，伴随有关元素化合价降低。

氧化和还原在同一反应中同时发生，这一判断适用于发生电子转移的反应。

被还原的物质是氧化剂；被氧化的物质是_____。氧化剂、还原剂没有单位。

答案：失去；得到；还原剂

怎么认 题目出现反应方程式并求氧化、还原或氧化剂、还原剂时，先找谁失电子、谁得电子。

例题 1

Sodium reacts with chlorine to form sodium chloride.

The equation is shown.

$$2Na + Cl_2 \rightarrow 2NaCl$$

During the reaction, sodium atoms 1 electrons and chlorine molecules act as 2 .

Which row completes gaps 1 and 2?

	1	2
A	gain	an oxidising agent
B	gain	a reducing agent
C	lose	an oxidising agent
D	lose	a reducing agent

（2022 May/Jun · 0654/21 · Question 18 · Extended）

解：钠由 0 价变为 NaCl 中的 +1 价，故钠原子失去电子。

$2Na \rightarrow 2Na^+ + 2e^-$

$Cl_2 + 2e^- \rightarrow 2Cl^-$

氯分子得到电子而被还原，故氯分子是氧化剂。故选 C。

针对练习

1. Iron displaces copper ions from its aqueous salts.

An equation for this reaction is shown.

$$Fe + Cu^{2+} \rightarrow Fe^{2+} + Cu$$

What is the reducing agent in this reaction?

A Cu **B** Cu^{2+} **C** Fe **D** Fe^{2+}

（2023 Oct/Nov · 0654/22 · Question 19 · Extended）

2. Magnesium reacts with chlorine to form magnesium chloride.

$$Mg(s) + Cl_2(g) \rightarrow MgCl_2(s)$$

Which statement about this reaction is correct?

A The magnesium is being reduced.

B The oxidising agent is chlorine.

C The reaction involves oxidation but not reduction.

D There is no oxygen involved so there is no oxidation.

（2022 May/Jun · 0654/23 · Question 18 · Extended）

3. Solid zinc reacts with aqueous copper(II) sulfate. The ionic equation for the reaction is shown.

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

Which row identifies the substance being oxidised and the reducing agent?

	substance being oxidised	reducing agent
A	Cu^{2+}	Cu^{2+}
B	Cu^{2+}	Zn
C	Zn	Cu^{2+}
D	Zn	Zn

(2024 May/Jun · 0654/23 · Question 18 · Extended)

4. The equation for the reaction between magnesium and zinc sulfate is shown.

$$Mg + ZnSO_4 \rightarrow Zn + MgSO_4$$

What happens to magnesium in this reaction?

A It is oxidised because it gains electrons.

B It is oxidised because it loses electrons.

C It is reduced because it gains electrons.

D It is reduced because it loses electrons.

(2024 Oct/Nov · 0654/23 · Question 19 · Extended)

5. Which statements about the reaction between a metal and a non-metal are correct?

1 Metal atoms gain electrons.

2 Metal atoms lose electrons.

3 The non-metal is the reducing agent.

4 The non-metal is the oxidising agent.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

(2022 Oct/Nov · 0654/22 · Question 16 · Extended)

6. In which equation is the underlined zinc an oxidising agent?

A $\underline{Zn} + Cl_2 \rightarrow ZnCl_2$

B $\underline{Zn} + 2H^+ \rightarrow Zn^{2+} + H_2$

C $\underline{Zn}^{2+} + Mg \rightarrow Zn + Mg^{2+}$

D $2\underline{Zn} + O_2 \rightarrow 2ZnO$

(2023 Feb/Mar · 0654/22 · Question 20 · Extended)

7. In which equation is the underlined substance acting as an oxidising agent?

A $AgNO_3 + \underline{NaCl} \rightarrow AgCl + NaNO_3$

B $Cl_2 + \underline{2KBr} \rightarrow Br_2 + 2KCl$

C $Fe_2O_3 + \underline{3CO} \rightarrow 2Fe + 3CO_2$

D $H_2 + \underline{PbO} \rightarrow Pb + H_2O$

(2024 May/Jun · 0654/22 · Question 19 · Extended)

8. In which equation is the underlined substance reduced?

A $\underline{Cl_2} + 2KBr \rightarrow 2KCl + Br_2$

B $2\underline{Mg} + O_2 \rightarrow 2MgO$

C $2PbO + \underline{C} \rightarrow CO_2 + 2Pb$

D $\underline{Zn} + CuSO_4 \rightarrow Cu + ZnSO_4$

(2022 May/Jun · 0654/22 · Question 18 · Extended)

9. The ionic equation for the reaction between iron(II) chloride and chlorine is shown.

$$2Fe^{2+} + Cl_2 \rightarrow 2Fe^{3+} + 2Cl^-$$

Which row shows the substance that is reduced and the oxidising agent?

	substance reduced	oxidising agent
A	Cl_2	Cl_2
B	Cl_2	Fe^{2+}
C	Fe^{2+}	Cl_2
D	Fe^{2+}	Fe^{2+}

(2023 Oct/Nov · 0654/21 · Question 20 · Extended)

10. Which statements about the reduction of copper(II) oxide by heating with carbon are correct?

1 Copper(II) ions lose electrons.

2 Copper(II) oxide acts as an oxidising agent.

3 Copper(II) oxide loses oxygen.

4 Oxide ions are reduced.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

(2022 Feb/Mar · 0654/22 · Question 17 · Extended)

11. The equation for the reaction of iron(III) oxide and aluminium is shown.

$$2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$$

Which statements about this reaction are correct?

1 Iron(III) ions are reduced.

2 O atoms gain electrons.

3 Fe_2O_3 is a reducing agent.

4 Al atoms lose electrons.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

(2022 Oct/Nov · 0654/21 · Question 20 · Extended)

12. The equation for the reaction between sodium bromide and concentrated sulfuric acid is shown.

$$2NaBr + 2H_2SO_4 \rightarrow Na_2SO_4 + Br_2 + SO_2 + 2H_2O$$

What is oxidised in this reaction?

A sodium ions

B bromide ions

C hydrogen ions

D sulfate ions

（2024 Feb/Mar · 0654/22 · Question 20 · Extended）

题型 3：区分氧化还原与中和沉淀或分解（考频★★☆☆☆）

知识点 氧化还原反应中，电子由一种物质转移给另一种物质；失去电子的物质被_____，得到电子的物质被_____。

用氧转移判断时，得到氧是氧化，失去氧是还原，两者在同一反应中同时发生。

反应物或生成物中含氧元素、生成气体或生成水，都不能单独作为判据；须确认电子转移或氧转移。

答案：氧化；还原

怎么认 题目出现多组反应并询问是否为氧化还原反应时，先找是否有得失电子或氧转移。

例题 1

Which reaction is **not** a redox reaction?

A iron oxide + carbon → iron + carbon dioxide

B silver nitrate + sodium chloride → silver chloride + sodium nitrate

C copper oxide + hydrogen → copper + water

D magnesium + oxygen → magnesium oxide

（2022 Feb/Mar · 0654/12 · Question 18 · Core）

解：A 中氧由铁氧化物转移给碳，C 中氧由氧化铜转移给氢，D 中镁得到氧，三者均发生氧化还原反应。B 中硝酸银与氯化钠交换离子，生成氯化银沉淀，没有电子转移或氧转移。

故选 B。

针对练习

1. Which equation represents a redox reaction?

A $CaCO_3 \rightarrow CaO + CO_2$

B $CuSO_4 \cdot 5H_2O \rightarrow CuSO_4 + 5H_2O$

C $2Na + Cl_2 \rightarrow 2NaCl$

D $NaOH + HCl \rightarrow NaCl + H_2O$

（2022 Oct/Nov · 0654/23 · Question 20 · Extended）

2. Which word equation represents a redox reaction?

A calcium carbonate → calcium oxide + carbon dioxide

B calcium oxide + hydrochloric acid → calcium chloride + water

C copper oxide + carbon → copper + carbon dioxide

D sodium oxide + water → sodium hydroxide

(2023 Feb/Mar · 0654/12 · Question 20 · Core)

3. Which statements about redox reactions are correct?

1 A reaction where oxygen is transferred from one substance to another is a redox reaction.

2 The end-point of a redox reaction is when the pH equals 7.

3 Metals are always reduced and non-metals are always oxidised in a redox reaction.

A 1 and 2 **B** 1 only **C** 2 and 3 **D** 3 only

(2026 May/Jun · 0654/11 · Question 19 · Core)

1.9 酸、碱、氧化物与制盐

题型 1：按酸与金属碱或碳酸盐的反应判产物（考频★★★☆☆）

知识点 金属在活动性顺序中排在氢之前时，通常与稀盐酸或稀硫酸反应生成盐和_____。

酸与金属氢氧化物或金属氧化物反应，生成_____和水，这类反应属于中和反应。

酸与碳酸盐反应生成盐、水和_____；对应的离子关系为 $CO_3^{2-} + 2H^+ = H_2O + CO_2$。

氨气具有碱性，与酸反应生成铵盐；氨气与氢氧化钠不反应。

判断产物时，先将酸以外的反应物归为金属、碱、金属氧化物或碳酸盐，再写对应关系。

答案：氢气；盐；二氧化碳

怎么认 题目出现酸与金属、碱或碳酸盐反应并问产物时，先判断反应物类别，再配对应通式。

例题 1

What reacts with ammonia gas?

	hydrochloric acid	sodium hydroxide
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

key

✓ = reacts

✗ = does not react

（2024 Feb/Mar · 0654/12 · Question 21 · Core）

解：NH_3 具有碱性，与 HCl 反应：

$NH_3 + HCl = NH_4Cl$

NaOH 是碱，NH_3 与 NaOH 不反应。故选 B。

针对练习

1. Which gas is produced when zinc reacts with dilute hydrochloric acid?

A carbon dioxide

B hydrogen

C oxygen

D sulfur dioxide

（2022 Oct/Nov · 0654/13 · Question 20 · Core）

2. Which type of substance reacts with an acid to produce a salt, water and a gas?

A alkali

B base

C carbonate

D metal

（2025 Oct/Nov · 0654/11 · Question 21 · Core）

3. Copper carbonate is reacted with dilute hydrochloric acid.

Which gas is given off?

A carbon dioxide

B hydrogen

C nitrogen

D sulfur dioxide

（2022 Oct/Nov · 0654/11 · Question 20 · Core）

4. The word equation shown is incomplete.

$$\text{acid} + \text{alkali} \rightarrow \text{X} + \text{water}$$

What is X?

A base

B carbon dioxide

C hydrogen

D salt

（2025 Oct/Nov · 0654/22 · Question 25 · Extended）

5. A piece of magnesium ribbon is placed in dilute hydrochloric acid.

The magnesium reacts and bubbles of a colourless gas are formed.

What is the word equation for this reaction?

A magnesium + hydrochloric acid → magnesium chloride + hydrogen

B magnesium + hydrochloric acid → magnesium chloride + carbon dioxide + water

C magnesium + hydrochloric acid → magnesium chloride + carbon dioxide

D magnesium + hydrochloric acid → magnesium chloride + hydrogen + water

（2024 Oct/Nov · 0654/12 · Question 20 · Core；同题：2024 Oct/Nov · 0654/13 · Question 20 · Core）

6. Salts are made when four substances react separately with dilute hydrochloric acid.

1 magnesium

2 magnesium carbonate

3 magnesium hydroxide

4 magnesium oxide

Which substances produce a gas when reacted with dilute hydrochloric acid?

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2024 May/Jun · 0654/11 · Question 22 · Core）

7. Which statements about neutralisation are correct?

1 Acids and bases produce water when they neutralise each other.

2 During neutralisation, bases transfer protons to acids.

3 Neutral solutions turn universal indicator green.

4 During neutralisation, acids transfer hydroxide ions to bases.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2023 May/Jun · 0654/21 · Question 20 · Extended）

8. Which row describes chemical properties of dilute hydrochloric acid?

	effect on litmus paper	produces a gas when added to a metal carbonate
A	turns red litmus blue	no
B	turns blue litmus red	no
C	turns red litmus blue	yes
D	turns blue litmus red	yes

（2025 Feb/Mar · 0654/22 · Question 18 · Extended）

9. Limestone contains calcium carbonate, $CaCO_3$.

It is used to neutralise nitric acid, HNO_3.

What is the balanced ionic equation for the reaction between calcium carbonate and nitric acid?

A $Ca^{2+} + CO_3^{2-} + H^+ + NO_3^- \rightarrow CaNO_3 + H_2O + CO_2$

B $Ca^{2+} + CO_3^{2-} + 2H^+ + 2NO_3^- \rightarrow Ca(NO_3)_2 + H_2O + CO_2$

C $CO_3^{2-} + 2H^+ \rightarrow H_2O + CO_2$

D $CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O + CO_2$

（2025 May/Jun · 0654/23 · Question 17 · Extended）

题型 2：用 pH 和指示剂颜色判断酸碱变化（考频★★★☆☆）

知识点 水溶液的酸碱性可用pH表示；pH < 7为酸性，pH = 7为_____性，pH > 7为碱性，pH没有单位。

通用指示剂在酸性溶液中呈红、橙或黄色，在中性溶液中呈_____色，在碱性溶液中呈蓝或紫色。

加入能形成酸性溶液的物质，pH降低；加入碱性物质或能与水生成碱的物质，pH升高。

酸与碱反应生成盐和水，称为_____反应；溶液由碱性逐渐变为酸性时，甲基橙由黄变红。

答案：中；绿；中和

怎么认 题目出现pH升降、指示剂颜色或反应产物时，先判断溶液最终呈酸性、中性还是碱性。

例题 1

Substance Y is added to water containing universal indicator.

The pH of the mixture increases.

What is Y?

A HCl **B** K **C** $NaCl$ **D** SO_2

（2025 Oct/Nov · 0654/12 · Question 22 · Core；同题：2025 Oct/Nov · 0654/13 · Question 22 · Core）

解：由题意，混合液的pH升高，说明加入 Y 后碱性增强。
钾与水反应生成氢氧化钾，所得溶液呈碱性。
故选 B。

针对练习

1. Indigestion is caused by excess hydrochloric acid in the stomach.

Which substance can be used to neutralise the acid?

	substance	pH
A	vinegar	4
B	orange juice	6
C	water	7
D	baking powder	9

（2022 Oct/Nov · 0654/12 · Question 20 · Core）

2. A beaker contains dilute hydrochloric acid and universal indicator.

When substance X is added to the beaker, the indicator changes colour from red to blue.

What is X?

A calcium oxide

B carbon dioxide

C sulfur dioxide

D water

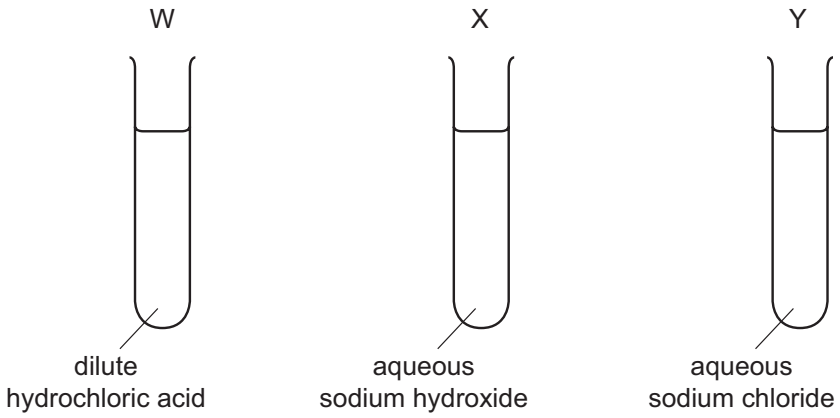
（2026 May/Jun · 0654/11 · Question 20 · Core）

3. Which row shows the colours observed when universal indicator is added to acidic, neutral and alkaline solutions?

	acidic solution	**neutral solution**	**alkaline solution**
A	red	yellow	blue
B	red	orange	yellow
C	yellow	green	purple
D	blue	green	red

（2026 May/Jun · 0654/13 · Question 20 · Core）

4. Universal indicator solution is added to test-tubes W, X and Y.



What are the colours of the universal indicator?

	in test-tube W	in test-tube X	in test-tube Y
A	green	red	purple
B	purple	green	red
C	red	green	purple
D	red	purple	green

(2024 May/Jun · 0654/22 · Question 20 · Extended)

5. Ammonia and sulfur dioxide are bubbled into separate samples of water.

What are the pH values of the resulting aqueous solutions?

	aqueous ammonia	**aqueous sulfur dioxide**
A	greater than 7	less than 7
B	greater than 7	greater than 7
C	less than 7	less than 7
D	less than 7	greater than 7

(2026 Feb/Mar · 0654/12 · Question 19 · Core)

6. 25.0 cm^3 of alkali and three drops of methyl orange indicator are added to a conical flask.

Acid is added to the conical flask from a burette.

A white tile is used.

Which colour change is observed and where should the white tile be placed?

	colour change	**white tile**
A	from red to yellow	behind the scale of the burette
B	from red to yellow	underneath the conical flask
C	from yellow to red	behind the scale of the burette
D	from yellow to red	underneath the conical flask

(2026 May/Jun · 0654/23 · Question 19 · Extended)

7. A metal oxide powder is added to a dilute acid.

The initial temperature of the acid is 21 °C. The pH of the acid is 2.

When all the acid has reacted, the temperature of the reaction mixture is 23 °C and the pH is 7.

Which statement describes this reaction?

A It is endothermic and neutralisation.

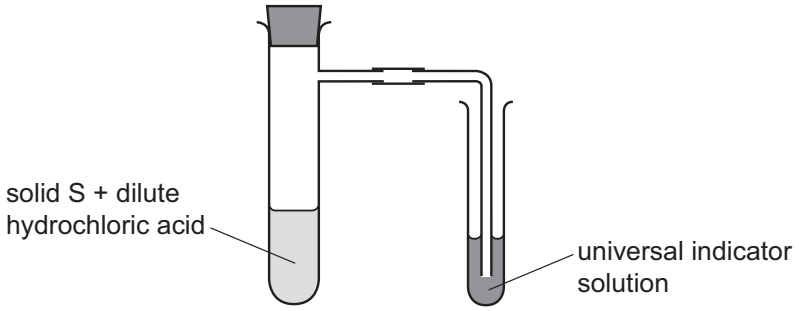
B It is endothermic and oxidation.

C It is exothermic and neutralisation

D It is exothermic and oxidation.

（2022 Oct/Nov · 0654/13 · Question 18 · Core）

8. Solid S is added to dilute hydrochloric acid in the apparatus shown.



The universal indicator solution shows the pH decreases.

What is solid S?

A zinc

B zinc carbonate

C zinc hydroxide

D zinc oxide

（2023 Oct/Nov · 0654/12 · Question 19 · Core；同题：2023 Oct/Nov · 0654/22 · Question 20 · Extended）

9. What happens when an acid reacts with an alkali?

A Neutralisation takes place and the temperature falls.

B Neutralisation takes place and the temperature rises.

C Reduction takes place and the temperature falls.

D Reduction takes place and the temperature rises.

（2024 Oct/Nov · 0654/22 · Question 19 · Extended）

题型 3：由元素类型和 pH 辨认酸性或碱性氧化物（考频★★★☆☆）

知识点 酸性氧化物能与碱反应生成盐和水，碱性氧化物能与酸反应生成盐和水。

一般情况下，金属氧化物呈_____性，非金属氧化物呈_____性。

当氧化物溶于水或与水反应形成溶液时，pH > 7 表明碱性，pH < 7 表明酸性；pH 没有单位。

答案：碱；酸

怎么认 题目出现元素类型、氧化物名称、溶液 pH 或与酸反应时，先判元素是金属还是非金属，再用 pH 或反应性质核验。

例题 1

Which substance is a basic oxide?

A calcium oxide

B carbon dioxide

C nitrogen dioxide

D sulfur dioxide

（2023 Oct/Nov · 0654/12 · Question 20 · Core）

解：钙是金属，氧化钙是金属氧化物，呈碱性。
故选 A。

针对练习

1. Which substance is classified as an acidic oxide?

A calcium oxide

B carbon dioxide

C lithium oxide

D sodium oxide

（2024 Oct/Nov · 0654/11 · Question 22 · Core）

2. Which row describes metallic oxides and non-metallic oxides?

	metallic oxides	non-metallic oxides
A	acidic	acidic
B	acidic	basic
C	basic	acidic
D	basic	basic

（2025 Feb/Mar · 0654/22 · Question 19 · Extended）

3. Which row describes an element on the left of the Periodic Table and its oxide?

	type of element	type of oxide
A	metallic	basic
B	non-metallic	acidic
C	metallic	acidic
D	non-metallic	basic

（2025 May/Jun · 0654/22 · Question 19 · Extended）

4. Element X burns in air to produce an oxide.

A solution of the oxide has a pH value of 10.

What is X?

A argon

B carbon

C magnesium

D phosphorus

（2023 Oct/Nov · 0654/13 · Question 21 · Core）

5. Which row shows the types of oxide formed by magnesium and sulfur?

	magnesium	sulfur
A	acidic	acidic
B	acidic	basic
C	basic	acidic
D	basic	basic

（2025 Feb/Mar · 0654/12 · Question 22 · Core）

6. A student makes lists of acidic oxides and basic oxides.

acidic oxides	basic oxides
carbon dioxide	calcium oxide
potassium oxide	magnesium oxide
nitrogen dioxide	sodium oxide
phosphorus oxide	sulfur dioxide

Which oxides are **not** in the correct list?

A carbon dioxide and sodium oxide

B potassium oxide and sulfur dioxide

C nitrogen dioxide and sulfur dioxide

D potassium oxide and calcium oxide

（2023 Feb/Mar · 0654/12 · Question 21 · Core；同题：2023 Feb/Mar · 0654/22 · Question 21 · Extended）

7. Sodium is a metal.

Silicon is a non-metal.

Both sodium and silicon form oxides.

Which statement is correct?

A Sodium oxide is acidic and silicon dioxide is basic.

B Sodium oxide is basic and silicon dioxide is acidic.

C Sodium oxide and silicon dioxide are both acidic.

D Sodium oxide and silicon dioxide are both basic.

（2025 Oct/Nov · 0654/21 · Question 18 · Extended）

8. Potassium oxide and sulfur dioxide are both soluble in water.

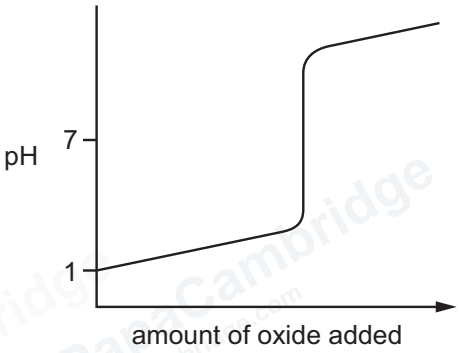
Which row describes properties of these oxides?

	oxide	pH in aqueous solution	effect on damp red litmus
A	potassium oxide	14	turns blue
B	potassium oxide	2	stays red
C	sulfur dioxide	14	stays red
D	sulfur dioxide	2	turns blue

（2023 May/Jun · 0654/12 · Question 21 · Core；同题：2023 May/Jun · 0654/13 · Question 21 · Core）

9. An excess of an oxide of element Q is added to hydrochloric acid.

The graph shows how the pH changes during the addition of the oxide.



Which row describes the type of oxide and element Q?

	type of oxide	**element Q**
A	acidic	metal
B	acidic	non-metal
C	basic	metal
D	basic	non-metal

（2026 May/Jun · 0654/21 · Question 20 · Extended）

题型 4：用过量不溶固体与酸制取可溶盐（考频★★★☆☆）

知识点 用不溶性固体与酸制取可溶盐时，应加入_____固体，使酸完全反应；反应物中的固体须不溶，生成的盐须可溶。

未反应的固体用_____除去，所得滤液中含有可溶盐。

滤液加热蒸发部分水至接近饱和，再_____使晶体析出；晶体经过滤并用干滤纸吸干。

答案：过量；过滤；冷却

怎么认 题目出现可溶盐、不溶性固体和稀酸，并要求制取晶体时，先使固体过量，再过滤、浓缩并冷却结晶。

例题 1

A student adds excess copper oxide powder to warm dilute sulfuric acid.

Aqueous copper sulfate is formed.

Which method is used to remove the unreacted copper oxide?

A chromatography

B crystallisation

C distillation

D filtration

（2023 Feb/Mar · 0654/12 · Question 14 · Core；同题：2023 Feb/Mar · 0654/22 · Question 14 · Extended）

解：由氧化铜不溶于水、硫酸铜可溶于水，得未反应的氧化铜为固体，硫酸铜留在溶液中。
过滤可将固体氧化铜与硫酸铜溶液分离。
故选 D。

针对练习

1.

Zinc sulfate is a soluble salt. Zinc sulfate is prepared by reacting zinc with dilute sulfuric acid.

Which statement about this preparation is correct?

A Excess dilute sulfuric acid is used and after the reaction has finished the unreacted acid is removed by evaporation.

B Excess dilute sulfuric acid is used and after the reaction has finished the unreacted acid is removed by adding an aqueous base.

C Excess zinc is used and after the reaction has finished the unreacted zinc is removed by filtration.

D Excess zinc is used and after the reaction has finished the zinc sulfate is purified by distillation.

（2025 Oct/Nov · 0654/21 · Question 19 · Extended）

2.

Crystals of copper(II) sulfate, a soluble salt, are made by reacting excess copper(II) oxide with dilute sulfuric acid.

After filtering off the unreacted copper(II) oxide, the solution is heated until it is saturated. It is then left to cool.

Which statements about this preparation are correct?

1 Excess copper(II) oxide is used in order to ensure a high yield is obtained.

2 After filtering, the solution is heated to evaporate some of the water.

3 When the saturated solution cools, crystals of copper(II) sulfate begin to appear.

4 After cooling, the water is rapidly removed by evaporation.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2023 May/Jun · 0654/23 · Question 20 · Extended）

3. Magnesium chloride is prepared by reacting an excess of insoluble magnesium oxide with dilute hydrochloric acid.

Which processes are used to obtain pure crystals of magnesium chloride from the reaction mixture?

1 distillation

2 evaporation

3 filtration

A 1 followed by 2

B 3 followed by 2

C 3 followed by 1

D 1 followed by 3, followed by 2

(2023 May/Jun · 0654/11 · Question 21 · Core)

4. Copper sulfate is made when copper carbonate is added to dilute sulfuric acid.

The copper carbonate is added until no more carbon dioxide is given off.

The mixture is 1 to remove excess copper carbonate.

The resulting solution is then 2 to decrease the volume.

This solution is then 3 to allow the formation of pure copper sulfate crystals.

Which words complete gaps 1, 2 and 3?

	1	2	3
A	boiled	heated	evaporated to dryness
B	filtered	cooled	left to cool
C	filtered	heated	evaporated to dryness
D	filtered	heated	left to cool

(2025 Feb/Mar · 0654/12 · Question 23 · Core)

5. Cobalt(II) chloride, cobalt(II) nitrate, and cobalt(II) sulfate are soluble in water.

Cobalt(II) oxide and cobalt(II) carbonate are insoluble in water.

Which method can be used to prepare a sample of solid cobalt(II) sulfate?

A Mix aqueous sodium sulfate and aqueous cobalt(II) nitrate, then filter.

B Mix excess aqueous sulfuric acid and aqueous cobalt(II) chloride, then filter and evaporate the filtrate.

C Mix dilute sulfuric acid and an excess of cobalt(II) oxide, then distil.

D Mix dilute sulfuric acid and an excess of cobalt(II) carbonate, then filter and evaporate the filtrate.

(2024 Oct/Nov · 0654/23 · Question 20 · Extended)

6. A dry sample of the soluble salt zinc chloride is prepared.

The equation for the reaction is shown.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

Which sets of apparatus are needed for this salt preparation?

1 burette and pipette

2 evaporating basin and Bunsen burner

3 filter funnel and filter paper

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

(2026 May/Jun · 0654/23 · Question 20 · Extended)

7. Copper(II) sulfate is produced by reacting copper(II) oxide with dilute sulfuric acid.

The stages in the process to produce pure dry crystals are listed.

1 Leave to crystallise in a cool place.

2 Filter the reaction mixture.

3 Press the crystals between dry filter papers.

4 Add copper(II) oxide until it is in excess.

5 Heat the filtrate to concentrate it.

6 Heat the dilute sulfuric acid.

What is the correct order for these stages?

A 6 → 4 → 2 → 5 → 3 → 1

B 6 → 4 → 1 → 2 → 5 → 3

C 6 → 4 → 2 → 5 → 1 → 3

D 4 → 6 → 2 → 1 → 5 → 3

(2023 May/Jun · 0654/22 · Question 20 · Extended)

8. Information about the solubility in water of some calcium compounds is listed.

- Calcium hydroxide is soluble.
- Calcium carbonate is insoluble.
- Calcium chloride is soluble.

Which method is used to prepare pure calcium chloride?

A Add excess calcium hydroxide to dilute hydrochloric acid, filter, then crystallise.

B Add excess calcium carbonate to dilute hydrochloric acid, filter, then crystallise.

C Add excess dilute hydrochloric acid to calcium hydroxide, filter, then crystallise.

D Add excess dilute hydrochloric acid to calcium carbonate, filter, then crystallise.

(2022 May/Jun · 0654/23 · Question 14 · Extended)

9. Zinc sulfate is made by adding zinc oxide to dilute sulfuric acid.

The steps used to obtain zinc sulfate crystals are listed.

1 Filter the solution to remove excess zinc oxide.

2 Warm the zinc sulfate solution.

3 Add excess zinc oxide and stir.

4 Filter and dry the crystals.

What is the correct order of the steps?

A 1 → 3 → 4 → 2

B 2 → 1 → 3 → 4

C 3 → 1 → 2 → 4

D 3 → 2 → 1 → 4

（2025 May/Jun · 0654/23 · Question 20 · Extended）

题型 5：由同时与酸碱反应辨认两性氧化物（考频★☆☆☆☆）

知识点 两性氧化物既能与酸反应，又能与碱反应，反应通常生成盐和水。

判定时，氧化物与酸、碱的反应须_____成立；若两者均能反应，则该氧化物属于_____氧化物。

答案：同时；两性

怎么认 题目出现同一氧化物既与酸反应又与碱反应时，先判定其为两性氧化物。

例题 1

Chromium(III) oxide reacts with dilute hydrochloric acid and with aqueous sodium hydroxide.

Which word describes chromium(III) oxide?

A acidic

B amphoteric

C basic

D neutral

（2024 May/Jun · 0654/23 · Question 19 · Extended）

解：由题意，氧化铬(III)能与稀盐酸和氢氧化钠溶液反应，符合两性氧化物的定义。
故选 B。

针对练习

1. Which statement describes an amphoteric oxide?

A It does not react with either sodium hydroxide or hydrochloric acid.

B It reacts with sodium hydroxide but not hydrochloric acid.

C It reacts with hydrochloric acid but not sodium hydroxide.

D It reacts with both sodium hydroxide and hydrochloric acid.

（2025 May/Jun · 0654/21 · Question 24 · Extended）

题型 6：写碳酸钙热分解制取生石灰（考频★☆☆☆☆）

知识点 石灰石的主要成分是碳酸钙，生石灰（lime）的主要成分是_____。
碳酸钙在_____条件下发生热分解，生成氧化钙和二氧化碳。

答案：氧化钙；高温

怎么认 题目出现 manufacture of lime 时，先判定反应物为碳酸钙，生成物为氧化钙和二氧化碳。

例题 1

What is the word equation for the manufacture of lime?

A calcium carbonate → calcium hydroxide + carbon dioxide

B calcium carbonate → calcium oxide + carbon dioxide

C calcium sulfate → calcium hydroxide + sulfur dioxide

D calcium sulfate → calcium oxide + sulfur dioxide

（2024 Oct/Nov · 0654/22 · Question 25 · Extended）

解： 由石灰石的主要成分为碳酸钙，得反应物为碳酸钙。
碳酸钙受强热发生热分解，生成氧化钙和二氧化碳。
故选 B。

题型 7：从盐溶液浓缩结晶过滤并干燥（考频★★☆☆☆）

知识点 可溶性盐的水溶液先加热，使部分水蒸发，得到热的浓溶液；冷却后，盐逐渐形成晶体。
晶体形成后用_____把晶体与母液分开，再将晶体_____。
制取水合盐晶体时，不能把盐溶液加热至干，以免晶体失去结晶水或盐受热分解。
若溶液中混有不溶性杂质，应在浓缩结晶前先_____除去杂质。

答案：过滤；干燥；过滤

怎么认 题目出现盐溶液、纯盐晶体或不溶性杂质时，先判断过滤应在结晶前还是结晶后。

例题 1

Pure copper(II) chloride crystals are made from aqueous copper(II) chloride using the processes listed.

1 cool

2 dry

3 filter

4 heat to reduce volume of water

What is the order of the processes?

A 1 → 4 → 2 → 3

B 1 → 2 → 4 → 3

C 4 → 2 → 1 → 3

D 4 → 1 → 3 → 2

（2026 May/Jun · 0654/12 · Question 21 · Core）

解： 由盐溶液制取晶体，先加热蒸发部分水，使溶液浓缩；再冷却，使晶体析出；过滤分离晶体和母液，最后干燥晶体。
故顺序依次为 4、1、3、2，故选 D。

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针对练习

1. Which statement about methods involved in preparing and purifying salts is correct?

A Crystals of a pure salt are formed when a hot saturated solution of the salt is cooled.

B Fractional distillation is used to separate different salts from a mixture of salts.

C Hydrated copper(II) sulfate is prepared by heating aqueous copper(II) sulfate to dryness.

D Pure copper(II) chloride is formed by reacting copper(II) oxide with excess dilute hydrochloric acid.

（2026 May/Jun · 0654/22 · Question 21 · Extended）

2. An acid reacts with an alkali to produce an aqueous solution of a salt.

Which procedure is used to obtain crystals of the salt from the solution?

A Distil the solution.

B Evaporate the solution to dryness.

C Filter the solution.

D Partially evaporate the solution and leave it to cool.

（2025 Oct/Nov · 0654/12 · Question 23 · Core；同题：2025 Oct/Nov · 0654/13 · Question 23 · Core）

3. An aqueous salt solution contains an insoluble impurity.

Which processes are used to obtain pure salt crystals?

A distillation then crystallisation

B distillation then chromatography

C filtration then crystallisation

D filtration then chromatography

（2023 May/Jun · 0654/11 · Question 14 · Core；同题：2023 May/Jun · 0654/21 · Question 14 · Extended）

题型 8：用可溶盐溶液沉淀制取不溶盐（考频★★☆☆☆）

知识点 沉淀法是将两种可溶盐溶液混合，使所需的阳离子与阴离子结合，生成不溶盐沉淀的制盐方法。

目标盐不溶时，应选择能分别提供所需阳离子和阴离子的两种_____；反应物均须能配成溶液。

生成的_____用_____与溶液分离，再用蒸馏水洗涤并干燥。

答案：可溶盐；沉淀；过滤

怎么认 题目出现目标盐不溶并要求选择制取方法时，先找能提供所需阳、阴离子的两种可溶盐。

例题 1

A student prepares an insoluble salt by neutralising an acid with an alkali.

Which method is used to separate the salt from the reaction mixture?

A chromatography

B distillation

C evaporation

D filtration

（2025 May/Jun · 0654/22 · Question 24 · Extended）

解：反应生成的盐不溶于水，故盐以固体沉淀存在。
过滤能将不溶固体与液体分离。故选 D。

针对练习

1. Copper carbonate is insoluble in water.

Which method can be used to make copper carbonate?

A adding aqueous sodium carbonate to aqueous copper sulfate and filtering off the product

B adding solid calcium carbonate to aqueous copper sulfate and filtering off the product

C adding solid copper oxide to solid calcium carbonate and heating the mixture

D heating copper metal in carbon dioxide

（2022 Feb/Mar · 0654/22 · Question 18 · Extended）

2. All Group I metal compounds and all Group II metal chlorides are soluble in water.

All Group II metal carbonates and barium sulfate are insoluble.

Which method is used to prepare barium sulfate using barium carbonate?

A direct combination of solid barium carbonate and dilute sulfuric acid

B reaction of solid barium carbonate and hydrogen chloride gas, followed by reaction with dilute sulfuric acid

C reaction of aqueous barium carbonate with dilute hydrochloric acid, followed by reaction with aqueous sodium sulfate

D reaction of solid barium carbonate with dilute hydrochloric acid, followed by reaction with aqueous sodium sulfate

（2024 Oct/Nov · 0654/21 · Question 21 · Extended）

化学 · 周期表与元素族趋势

1.10 周期表与元素族趋势

题型 1：用高熔点高密度彩色化合物辨认过渡金属（考频★★★★☆）

知识点 过渡元素是位于周期表中央过渡区的一类金属，能导电，通常具有_____熔点和高密度。过渡元素常形成_____的化合物或离子，也常用作_____，催化反应后本身不被消耗。
许多过渡元素形成碱性氧化物；辨认时应综合熔点、密度、导电性、化合物颜色和催化作用。
密度常用 g/cm³ 表示，熔点用 °C 表示。

答案：高；有颜色；催化剂

怎么认 题目出现高熔点、高密度、彩色化合物、导电或催化作用时，先对照过渡元素的典型性质。

例题 1

Which element causes a compound to be coloured?

A a Group I element

B a Group II element

C a Group VIII element

D a transition element

（2025 May/Jun · 0654/12 · Question 18 · Core；同题：2025 May/Jun · 0654/13 · Question 18 · Core）

解：过渡元素常形成有颜色的化合物，因此使化合物显色的元素应为过渡元素。故选 D。

针对练习

1. An element has a high melting point and forms coloured compounds.

Which row is correct?

	element	density
A	transition metal	high
B	transition metal	low
C	Group I metal	high
D	Group I metal	low

（2026 May/Jun · 0654/11 · Question 21 · Core）

2. The box lists four substances.

Br_2	CO	Cu	Na

Which substance is an element that forms a basic oxide and coloured compounds?

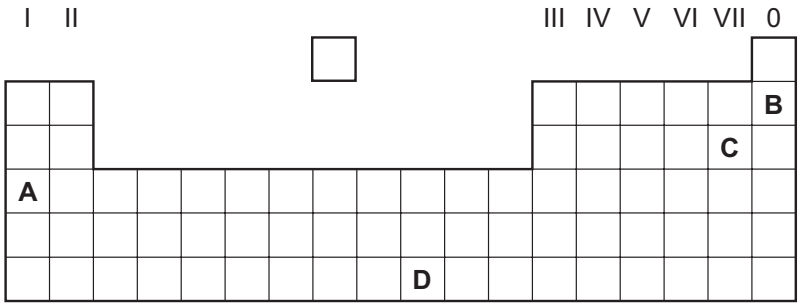
A Br_2 **B** CO **C** Cu **D** Na

（2023 May/Jun · 0654/12 · Question 22 · Core；同题：2023 May/Jun · 0654/13 · Question 22 · Core；同题：2023 May/Jun · 0654/22 · Question 21 · Extended）

3. Element X increases the rate of some reactions.

Element X is unchanged at the end of these reactions.

What is the position of element X in the Periodic Table?



（2024 Feb/Mar · 0654/12 · Question 23 · Core）

4. Which row describes a transition element?

	melting point / °C	electrical conductor
A	115	no
B	181	yes
C	1538	yes
D	4726	no

（2022 May/Jun · 0654/12 · Question 23 · Core；同题：2022 May/Jun · 0654/13 · Question 23 · Core）

5. What is **not** a property of transition elements?

A form coloured compounds

B good electrical conductivity

C high melting point

D low density

（2024 Oct/Nov · 0654/11 · Question 24 · Core）

6. What is **not** a property of transition elements?

A They often act as catalysts.

B They form coloured compounds.

C They have high densities.

D They have low melting points.

（2022 Oct/Nov · 0654/13 · Question 21 · Core；同题：2022 Oct/Nov · 0654/23 · Question 21 · Extended）

7. Manganese is a transition element.

What is a property of manganese?

A high melting point

B low density

C thermal insulator

D transparent

（2024 May/Jun · 0654/12 · Question 23 · Core；同题：2024 May/Jun · 0654/13 · Question 23 · Core）

8. What are properties of transition elements?

1 high melting point

2 form colourless compounds

3 high density

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 3 only

（2026 May/Jun · 0654/13 · Question 22 · Core）

9. The first row of the transition elements is shown.

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn

Which statement about transition elements is **not** correct?

A They are often used as catalysts.

B They always form colourless compounds.

C They have high densities.

D They have high melting points.

（2023 May/Jun · 0654/23 · Question 21 · Extended）

10. Which statement describes a typical transition element?

A It has a high melting point, high density and forms a coloured salt.

B It has a high melting point, low density and forms a white salt.

C It has a low melting point, low density and forms a coloured salt.

D It has a low melting point, high density and forms a white salt.

（2024 Oct/Nov · 0654/23 · Question 23 · Extended）

11. Lead has a high density of 11.3 g / cm^3. Lead(II) iodide is a bright yellow solid.

Which property of lead is **not** a property of a transition element?

A Lead conducts electricity.

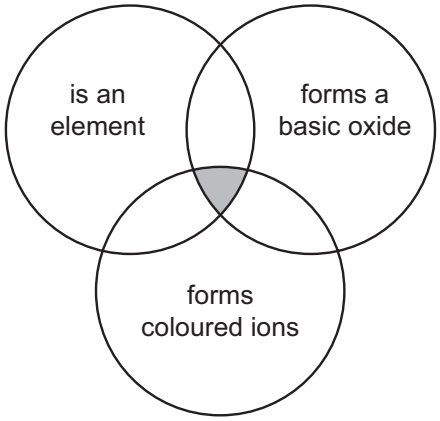
B Lead forms alloys.

C Lead has a relatively low melting point.

D Lead(II) oxide is basic.

（2024 May/Jun · 0654/11 · Question 23 · Core）

12. The diagram shows overlapping circles into which different chemical formulae can be placed.



Which formula can be placed in the shaded area because it has all three properties?

A Br_2 **B** CO **C** Cu **D** Na

（2023 Feb/Mar · 0654/12 · Question 22 · Core；同题：2023 Feb/Mar · 0654/22 · Question 22 · Extended）

13. Transition elements are metals with similar properties.

Which row shows properties typical of a transition element?

	density	melting point	colour of the sulfate
A	low	high	pink
B	low	low	white
C	high	high	pink
D	high	high	white

（2026 Feb/Mar · 0654/22 · Question 21 · Extended）

14. The properties of some substances are listed.

1 form acidic oxides
2 have high melting points
3 act as catalysts
4 form coloured compounds

What are the properties of transition metals?

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

（2023 May/Jun · 0654/11 · Question 22 · Core；同题：2023 May/Jun · 0654/21 · Question 21 · Extended）

15. Copper is a transition element.

Which row shows two properties of copper?

	property 1	property 2
A	high melting point	forms coloured compounds
B	high melting point	forms white compounds
C	low melting point	forms coloured compounds
D	low melting point	forms white compounds

（2024 May/Jun · 0654/22 · Question 21 · Extended）

16. Element E is a transition element. It reacts with oxygen to form an oxide with the formula EO.

A student suggests three properties for element E and its oxide.

1 Element E floats on water.

2 The oxide EO is a white solid.

3 The oxide EO is basic and reacts with dilute acid.

Which of the suggestions must be correct?

A 1 and 2 **B** 1 only **C** 2 and 3 **D** 3 only

（2024 Feb/Mar · 0654/22 · Question 23 · Extended）

题型 2：沿 I 族比较熔点密度与水反应（考频★★★★☆）

知识点 I 族元素锂、钠、钾等都是_____，且质地较软。

沿 I 族由上到下，熔点_____，密度总体增大，与水反应的剧烈程度增大，反应性_____。

比较同族元素时，按元素的上下位置应用趋势；熔点常用 °C，密度常用 g cm^{-3}。

I 族金属与冷水反应生成金属氢氧化物和氢气；形成的氧化物通常呈碱性。

答案：金属；降低；增强

怎么认 题目出现锂、钠、钾的位置，或问 I 族熔点、密度、水反应趋势时，先确定比较方向。

例题 1

Which row describes the trends shown by Group I elements down the group?

	melting point	reactivity with water
A	decreases	increases
B	decreases	decreases
C	increases	increases
D	increases	decreases

（2026 Feb/Mar · 0654/12 · Question 20 · Core）

解：由 I 族元素沿族向下的性质变化，熔点降低，与水反应的剧烈程度增大。

故选 A。

针对练习

1. Which description of the Group I elements is correct?

A relatively hard metals

B relatively soft metals

C low melting point non-metals

D unreactive gases

（2024 Feb/Mar · 0654/22 · Question 22 · Extended）

2. Which row describes the trends shown by the Group I elements lithium to potassium?

	trend in melting point	trend in reaction with water
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

（2025 Feb/Mar · 0654/22 · Question 20 · Extended）

3. The melting points of some Group I metals are shown.

element	melting point / °C
caesium	28
potassium	64
rubidium	–
sodium	98

What is the melting point of rubidium?

A 20 °C **B** 40 °C **C** 80 °C **D** 100 °C

（2025 Oct/Nov · 0654/23 · Question 18 · Extended）

4. Which row about the trends in the elements going down Group I of the Periodic Table is correct?

	reactivity	melting point
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

（2022 Feb/Mar · 0654/12 · Question 20 · Core；同题：2022 Feb/Mar · 0654/22 · Question 20 · Extended）

5. Which statement about elements in Group I of the Periodic Table is correct?

A They are metals and get less reactive going down the group.

B They are metals and get more reactive going down the group.

C They are non-metals and get less reactive going down the group.

D They are non-metals and get more reactive going down the group.

（2026 May/Jun · 0654/13 · Question 21 · Core）

6. Which row shows how the properties of the elements in Group I of the Periodic Table change going down the group?

	melting point	density
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

（2026 May/Jun · 0654/22 · Question 22 · Extended）

7. Sodium is below lithium in Group I of the Periodic Table.

Which row describes the properties of sodium in comparison with lithium?

	melting point of sodium	reaction of sodium with water
A	higher than lithium	less vigorous than lithium
B	higher than lithium	more vigorous than lithium
C	lower than lithium	less vigorous than lithium
D	lower than lithium	more vigorous than lithium

（2025 Feb/Mar · 0654/12 · Question 24 · Core）

8. The elements in Group I of the Periodic Table are metals.

What are the trends as the group is descended?

A decrease in melting point and less reactive with water

B decrease in melting point and more reactive with water

C increase in melting point and less reactive with water

D increase in melting point and more reactive with water

（2023 Oct/Nov · 0654/13 · Question 22 · Core；同题：2023 Oct/Nov · 0654/23 · Question 21 · Extended）

9. Potassium is in Group I of the Periodic Table.

Which statement about potassium is correct?

A It is a relatively hard metal.

B It is less dense than lithium.

C It has a higher melting point than sodium.

D It reacts more vigorously with water than sodium.

（2023 Oct/Nov · 0654/11 · Question 22 · Core；同题：2023 Oct/Nov · 0654/21 · Question 22 · Extended）

10. Which statements about the properties of Group I elements are correct?

1 Lithium is less dense than potassium.

2 Sodium has a higher melting point than lithium.

3 Potassium reacts more vigorously with water than sodium.

4 They are all hard metals.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

(2026 May/Jun · 0654/23 · Question 21 · Extended)

11. Substance Q is added to cold water. Q floats on the water and hydrogen gas is made.

What is Q?

A iodine

B lithium

C magnesium

D zinc

(2025 Oct/Nov · 0654/21 · Question 20 · Extended)

12. The element rubidium is in Group I of the Periodic Table.

It burns in oxygen to form an oxide.

Which row describes rubidium and its oxide?

	type of element	type of oxide
A	metal	acidic
B	metal	basic
C	non-metal	acidic
D	non-metal	basic

(2025 Oct/Nov · 0654/11 · Question 22 · Core)

13. Potassium reacts with water.

potassium + water → 1 + 2

Which words complete the equation?

	1	2
A	potassium hydroxide	hydrogen
B	potassium hydroxide	oxygen
C	potassium oxide	hydrogen
D	potassium oxide	oxygen

(2023 Feb/Mar · 0654/12 · Question 16 · Core)

题型 3：应用稀有气体满外层与低反应性（考频★★★★☆）

知识点 稀有气体位于周期表第 VIII 族，原子的最外电子层已经_____，所以通常不易得失电子，反应性很低。
稀有气体以_____形式存在；氦的最外层有 2 个电子，其他稀有气体通常有 8 个最外层电子。
在清洁空气中，每种稀有气体都只占少量。
灯泡和焊接需要低反应性的惰性气氛，常用氩；飞艇还要求气体密度比空气小，常用_____。

答案：充满；单原子；氦

怎么认 题目出现稀有气体性质、惰性气氛、灯泡或飞艇时，先判断满外层、低反应性或低密度。

例题 1

Which statements about the noble gas helium are correct?

1 It is unreactive.

2 Atoms of helium have two electrons in their outer electron shell.

3 Atoms of helium have incomplete outer electron shells.

4 The formula of helium gas is He_2.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2024 May/Jun · 0654/11 · Question 24 · Core）

解：氦的最外层是第一电子层，容纳 2 个电子时已经充满，因此氦不活泼，1、2 正确。
氦以单原子形式存在，化学式为 He，故 3、4 错误。
故选 A。

针对练习

1. Neon is in Group VIII of the Periodic Table.

Which row about neon is correct?

	unreactive	diatomic	full inner electron shell	incomplete outer electron shell
A	✓	✗	✓	✓
B	✗	✓	✗	✗
C	✓	✗	✓	✗
D	✗	✓	✗	✓

key
✓ = true
✗ = false

（2024 May/Jun · 0654/23 · Question 22 · Extended）

2. Which statement explains why argon is used to fill lamps?

A It is a gas.

B It is colourless.

C It is reactive.

D It is unreactive.

（2023 Oct/Nov · 0654/12 · Question 22 · Core；同题：2023 Oct/Nov · 0654/22 · Question 22 · Extended）

3. What is a use for argon?

A as a catalyst

B in alloys

C in lamps

D neutralising chemical waste

（2023 Oct/Nov · 0654/11 · Question 23 · Core；同题：2023 Oct/Nov · 0654/21 · Question 23 · Extended）

4. Why is argon used in lamps?

A It is heavier than air.

B It is lighter than air.

C It is reactive.

D It is unreactive.

（2023 Oct/Nov · 0654/13 · Question 23 · Core；同题：2023 Oct/Nov · 0654/23 · Question 22 · Extended）

5. Which statements about the noble gases are correct?

1 They are in Group VIII of the Periodic Table.

2 Their outer-electron shells are full.

3 They exist as diatomic molecules.

4 They are reactive.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2026 May/Jun · 0654/12 · Question 22 · Core）

6. Filament lamps require an inert atmosphere.

Which gas is used to fill these lamps?

A argon

B helium

C hydrogen

D oxygen

（2022 Oct/Nov · 0654/11 · Question 22 · Core；同题：2022 Oct/Nov · 0654/12 · Question 22 · Core；同题：2022 Oct/Nov · 0654/23 · Question 22 · Extended；同题：2022 Oct/Nov · 0654/13 · Question 22 · Core；同题：2022 Oct/Nov · 0654/21 · Question 22 · Extended；同题：2022 Oct/Nov · 0654/22 · Question 22 · Extended）

7. A gas is used in welding metals together at high temperatures.

The gas is used to provide an inert atmosphere.

What is the gas?

A argon

B carbon dioxide

C fluorine

D oxygen

（2022 May/Jun · 0654/11 · Question 21 · Core；同题：2022 May/Jun · 0654/22 · Question 20 · Extended；同题：2022 May/Jun · 0654/12 · Question 21 · Core；同题：2022 May/Jun · 0654/13 · Question 21 · Core、2022 May/Jun · 0654/21 · Question 20 · Extended；同题：2022 May/Jun · 0654/23 · Question 20 · Extended）

8. Which statement about noble gases is correct?

A All of the noble gas atoms have eight electrons in their outer shell.

B They all form diatomic molecules.

C Argon is used to fill weather balloons.

D They are all present in clean air in small amounts.

（2024 May/Jun · 0654/21 · Question 24 · Extended）

9. Which row describes and explains why helium is unreactive?

	description	explanation
A	diatomic gas	full outer-shell of electrons
B	diatomic gas	incomplete outer-shell of electrons
C	monatomic gas	full outer-shell of electrons
D	monatomic gas	incomplete outer-shell of electrons

（2026 May/Jun · 0654/23 · Question 22 · Extended）

10. Why are the elements in Group VIII of the Periodic Table unreactive?

A They are gaseous elements.

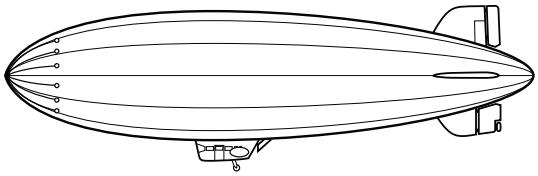
B They are monatomic elements.

C They have full inner shells of electrons.

D They have full outer shells of electrons.

（2023 Feb/Mar · 0654/12 · Question 23 · Core；同题：2023 Feb/Mar · 0654/22 · Question 23 · Extended）

11. An airship containing an unreactive gas floats in air, as shown.



Which gas is used to fill the airship?

A carbon dioxide

B helium

C hydrogen

D nitrogen

（2022 Feb/Mar · 0654/12 · Question 21 · Core；同题：2022 Feb/Mar · 0654/22 · Question 21 · Extended）

题型 4：沿 VII 族比较分子外观物态和沸点（考频★★★☆☆）

知识点 卤素是周期表第 VII 族非金属，原子最外层有_____个电子，单质以双原子分子存在。沿族向下，卤素的颜色逐渐_____，熔点和沸点逐渐_____；沸点通常用 °C 表示。

常温常压下，氟、氯为气体，溴为液体，碘为固体。

答案：七；加深；升高

怎么认 题目出现卤素的周期位置、颜色、物态或沸点时，先记向下颜色加深、熔沸点升高，再判断常温外观。

例题 1

Which statement describes the element chlorine?

A It is a diatomic metal.

B It is a diatomic non-metal.

C It is a monatomic metal.

D It is a monatomic non-metal.

（2026 Feb/Mar · 0654/12 · Question 21 · Core）

解：氯属于非金属，氯单质以双原子分子存在。
故选 B。

针对练习

1. Which statement about the halogens is **not** correct?

A Iodine has a darker colour than chlorine.

B They all exist as diatomic molecules.

C They are all gases at room temperature.

D They are all non-metals.

（2022 Oct/Nov · 0654/11 · Question 21 · Core；同题：2022 Oct/Nov · 0654/21 · Question 21 · Extended）

2. Which statement about the halogens is **not** correct?

A Bromine is darker in colour than iodine.

B Iodine is solid at room temperature.

C They all have seven electrons in their outer shell.

D They all form diatomic molecules.

（2024 Oct/Nov · 0654/23 · Question 22 · Extended）

3. Which statement about the halogens is correct?

A They become lighter in colour down the group.

B They are all gases at room temperature.

C They are members of the same period of the Periodic Table.

D They exist as diatomic molecules.

（2024 Oct/Nov · 0654/12 · Question 22 · Core；同题：2024 Oct/Nov · 0654/13 · Question 22 · Core）

4. Which statements about the elements in Group VII of the Periodic Table are correct?

1 Only one of them is a liquid at room temperature.

2 Their colours become darker down the group.

3 Their melting points and boiling points decrease down the group.

4 They are all metallic elements called halogens.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2022 Oct/Nov · 0654/12 · Question 21 · Core；同题：2022 Oct/Nov · 0654/22 · Question 21 · Extended）

5. Which statements about the halogens are correct?

1 They are diatomic metals.

2 Their atoms have seven outer-shell electrons.

3 Going down the group, they change from solid to liquid to gas.

4 Going down the group, they become darker in colour.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2023 Oct/Nov · 0654/12 · Question 21 · Core；同题：2023 Oct/Nov · 0654/22 · Question 21 · Extended）

6. The halogen in Period 4 of the Periodic Table is a red-brown liquid at room temperature and pressure.

Which row describes the appearance of the halogens in Period 3 and Period 5?

	halogen in Period 3	**halogen in Period 5**
A	pale yellow-green gas	grey-black solid
B	pale yellow-green solid	grey-black solid
C	grey-black solid	pale yellow-green solid
D	grey-black solid	pale yellow-green gas

（2026 May/Jun · 0654/21 · Question 21 · Extended）

7. The halogens are elements in Group VII of the Periodic Table.

They are 1 non-metals.

They become 2 in colour down the group.

Which words complete gaps 1 and 2?

	1	2
A	diatomic	darker
B	diatomic	lighter
C	monatomic	darker
D	monatomic	lighter

（2024 Feb/Mar · 0654/12 · Question 22 · Core）

8. Bromine has a boiling point of 59 °C. It reacts with hydrogen rapidly.

Iodine has a boiling point of 184 °C. It reacts with hydrogen slowly.

Which row about fluorine is correct?

	boiling point / °C	reaction with hydrogen
A	–188	explosive
B	–188	very slow
C	114	explosive
D	114	very slow

（2025 Feb/Mar · 0654/22 · Question 21 · Extended）

9. Elements in Group VI share similar chemical and physical trends as elements in Group VII.

Which statement about the elements of Group VI is correct?

A Atoms of Group VI elements form cations when they react with sodium.

B Sulfur has a lower boiling point than tellurium.

C Selenium displaces sulfur from metal sulfides.

D The elements become lighter in colour as Group VI is descended.

（2024 Oct/Nov · 0654/22 · Question 21 · Extended）

题型 5：由周期表位置和电子排布判元素类别（考频★★★☆☆）

知识点 周期表的横行称为周期，主族元素的周期数等于电子层数；竖列称为族，主族元素的族数通常等于_____。

同一周期从左到右，质子数依次增加，金属性_____，非金属性增强。

周期表左侧和中部多为金属，右侧多为非金属；过渡元素位于中部，通常密度大、熔点高，并能作催化剂。

第 Ⅰ 族元素的反应性向下增强，第 Ⅶ 族元素的反应性向下减弱。

第 Ⅱ 族原子通常失去两个电子形成二价阳离子；第 Ⅵ 族原子最外层有_____个电子，通常得到两个电子形成二价阴离子。

答案：最外层电子数；减弱；6

怎么认 题目出现周期表方格、族和周期或电子层排布时，先读横行和竖列或数电子层与最外层电子。

例题 1

Which statement about elements in the Periodic Table is correct?

A The density of the elements in Group I increases up the group.

B The metallic character of the elements increases across a period from left to right.

C The number of protons in the atoms of the elements increases across a period from left to right.

D The reactivity of the elements in Group VII increases down the group.

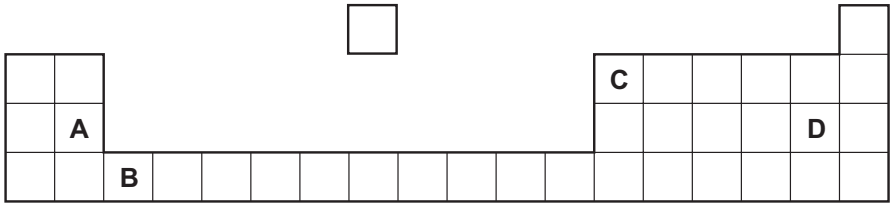
（2025 Oct/Nov · 0654/12 · Question 24 · Core；同题：2025 Oct/Nov · 0654/13 · Question 24 · Core）

解：A 错，第 Ⅰ 族元素的密度总体向下增大；B 错，同一周期从左到右金属性减弱；C 对，元素按质子数递增排列；D 错，第 Ⅶ 族元素的反应性向下减弱。故选 C。

针对练习

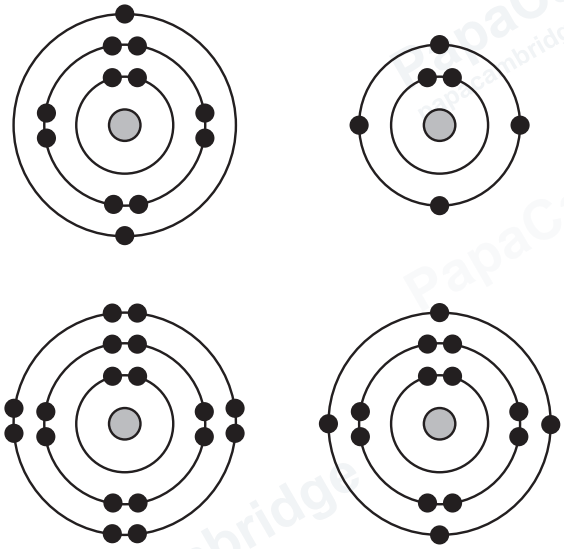
1. The diagram shows the positions of some elements in the Periodic Table.

Which element is in Group II and Period 3?



（2025 May/Jun · 0654/11 · Question 16 · Core）

2. How many of the electronic configurations shown represent elements in Group IV of the Periodic Table?



A 0 **B** 1 **C** 2 **D** 3

(2026 May/Jun · 0654/12 · Question 15 · Core)

3. Which electronic structure belongs to a non-metallic element?

A 2 **B** 2,2 **C** 2,8,2 **D** 2,8,8,2

(2024 Oct/Nov · 0654/21 · Question 22 · Extended)

4. Which element in Period 3 of the Periodic Table has the greatest metallic character?

A the element with the highest relative atomic mass

B the element with the lowest group number

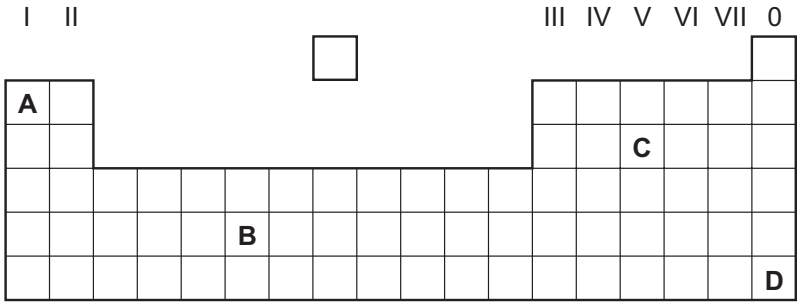
C the element with the most outer-shell electrons

D the element with the most protons

(2025 Oct/Nov · 0654/23 · Question 17 · Extended)

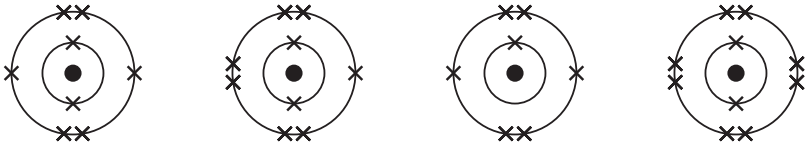
5. Element X is a dense solid with a high melting point.

Which letter shows the position of X in the Periodic Table?



(2024 May/Jun · 0654/21 · Question 23 · Extended)

6. The electronic configurations of four particles are shown.



1 2 3 4

Which diagrams represent the electronic configurations of a Group VI atom and its ion?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2025 May/Jun · 0654/21 · Question 16 · Extended）

7. P is in Group II of the Periodic Table.

Q is a non-metallic element.

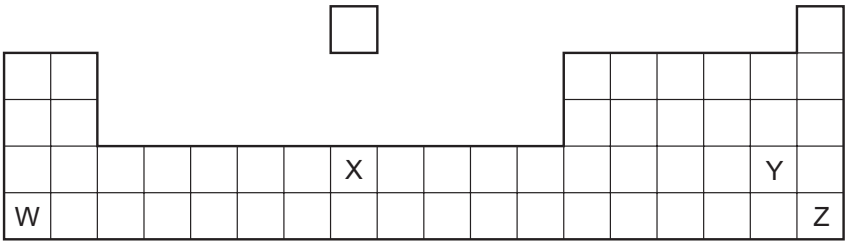
P reacts with Q to form an ionic compound, P_3Q_2.

What is the charge on the element Q ion in P_3Q_2?

A 1– **B** 2– **C** 3– **D** 4–

（2025 Oct/Nov · 0654/22 · Question 19 · Extended）

8. Part of the Periodic Table is shown.



Which description is correct?

A W is a soft solid at room temperature. It has a low melting point and it can act as a catalyst.

B X is a solid at room temperature. It has a high melting point and it can act as a catalyst.

C Y is a solid at room temperature. It forms a coloured vapour and it displaces iodide ions.

D Z is a gas at room temperature. It is very reactive and it has a low boiling point.

（2025 May/Jun · 0654/22 · Question 20 · Extended）

题型 6：用卤素反应性决定置换方向（考频★★☆☆☆）

知识点 第 Ⅶ 族卤素由上到下，反应性逐渐_____；氯、溴、碘的反应性依次减弱。

较活泼的卤素单质能从卤化物水溶液中置换出较不活泼的卤素，成立条件是前者在第 Ⅶ 族中位于后者的_____。

卤素由上到下颜色逐渐加深，熔点和沸点升高；常温下氯为气体、溴为液体，碘及其下方元素为固体。

答案：减弱；上方

怎么认 题目出现卤素单质加入卤化物水溶液时，先比较两种卤素在第 Ⅶ 族中的上下位置。

例题 1

Which statement about the halogens is correct?

A Chlorine is produced when aqueous iodine is added to aqueous sodium chloride.

B Iodine is produced when aqueous bromine is added to aqueous sodium iodide.

C The halogens become more reactive down the group.

D The halogens are coloured solid elements.

（2026 May/Jun · 0654/22 · Question 23 · Extended）

解：第 Ⅶ 族中，氯、溴、碘的反应性依次减弱。
溴位于碘的上方，能从碘化钠水溶液中置换出碘。
故选 B。

针对练习

1. Which statement about the elements in Group VII of the Periodic Table is correct?

A Chlorine is more reactive than bromine.

B The colour of the elements becomes darker up the group.

C The melting point of the elements decreases down the group.

D The reactivity of the elements increases down the group.

（2025 Oct/Nov · 0654/21 · Question 21 · Extended）

2. Which statements about the elements in Group VII of the Periodic Table are correct?

1 Bromine is lighter in colour than chlorine.

2 Chlorine is more reactive than bromine.

3 Chlorine displaces iodide ions from aqueous solution.

4 Iodine displaces bromide ions from aqueous solution.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2024 May/Jun · 0654/23 · Question 21 · Extended）

3. Tennessine is a newly discovered halogen and is below astatine in Group VII of the Periodic Table.

Which row predicts the appearance of tennessine and the effect of adding aqueous potassium iodide?

	appearance of tennessine	effect of adding aqueous potassium iodide to tennessine
A	black solid	iodine is formed
B	black solid	no reaction
C	brown liquid	iodine is formed
D	brown liquid	no reaction

（2024 Oct/Nov · 0654/21 · Question 23 · Extended）

化学 · 金属、活泼性、腐蚀与提取

1.11 金属、活泼性、腐蚀与提取

题型 1：用金属与碳的相对活泼性选择提取法（考频★★★★☆）

知识点 当较活泼的元素与较不活泼金属的氧化物反应时，较活泼的元素夺取氧，金属氧化物失氧的过程称为_____。

金属位于碳的下方时，可用碳加热还原；位于碳的上方时，碳不能将其还原，通常采用_____。

铝位于碳的上方，其矿石为铝土矿，铝由氧化铝经电解提取；金属矿石属于_____资源。

答案：还原；电解；有限

怎么认 题目出现活泼性顺序、碳与金属氧化物共热或提取方法时，先判断金属位于碳的上方还是下方。

例题 1

How is iron oxide converted to iron?

A oxidation using water

B reaction with hydrochloric acid

C reaction with sodium hydroxide

D reduction using carbon

（2024 Oct/Nov · 0654/12 · Question 23 · Core；同题：2024 Oct/Nov · 0654/13 · Question 23 · Core）

解：铁位于碳的下方，碳比铁活泼。

加热时，碳从氧化铁中夺取氧，氧化铁被还原为铁。

故选 D。

针对练习

1. Which metal is extracted from its ore by heating with carbon?

A copper

B magnesium

C potassium

D sodium

（2022 Feb/Mar · 0654/12 · Question 23 · Core）

2. Which metal **cannot** be extracted from its ore by heating with carbon?

A aluminium

B copper

C iron

D zinc

（2023 Feb/Mar · 0654/22 · Question 24 · Extended）

3. Which row identifies an ore of aluminium and the method of extraction of aluminium from its ore?

	ore	method of extraction
A	bauxite	electrolysis
B	bauxite	reduction using carbon
C	hematite	electrolysis
D	hematite	reduction using carbon

(2024 May/Jun · 0654/23 · Question 23 · Extended)

4. Which element is used to extract some metals from their ores?

A carbon

B copper

C iron

D nitrogen

(2025 May/Jun · 0654/23 · Question 22 · Extended)

5. Which statement about aluminium is correct?

A It is extracted from bauxite by heating with carbon.

B It is extracted from bauxite by electrolysis.

C It is extracted from hematite by heating with carbon.

D It is extracted from hematite by electrolysis.

(2024 Feb/Mar · 0654/12 · Question 24 · Core)

6. Aluminium is a 1 resource. It is found in the ore bauxite where it is present in aluminium oxide.

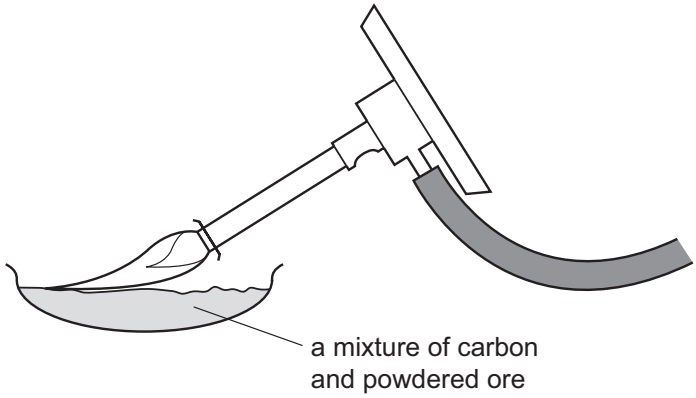
Pure aluminium is extracted from aluminium oxide by 2 .

Which words complete gaps 1 and 2?

	1	2
A	finite	electrolysis
B	finite	heating with carbon
C	renewable	electrolysis
D	renewable	heating with carbon

(2023 Oct/Nov · 0654/12 · Question 23 · Core)

7. The diagram shows a metal being extracted from its powdered ore using carbon.



What happens to the ore in this reaction?

A It burns.

B It decomposes.

C It is oxidised.

D It is reduced.

（2022 May/Jun · 0654/11 · Question 24 · Core；同题：2022 May/Jun · 0654/12 · Question 24 · Core、2022 May/Jun · 0654/13 · Question 24 · Core）

8. Which statement explains why carbon is used in the extraction of copper from its ore?

A It is in Group IV of the Periodic Table.

B It is more reactive than copper.

C It is a non-metal.

D It forms a giant covalent molecule.

（2023 Oct/Nov · 0654/13 · Question 24 · Core）

9. Metal X is extracted from its ore by heating the ore with carbon.

Which statement explains why carbon is used?

A Carbon is a non-metal.

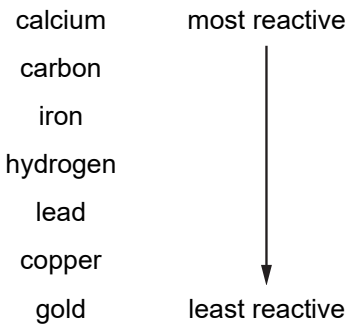
B Carbon is more reactive than X.

C Carbon reacts with oxygen in the air.

D Carbon is less reactive than X.

（2022 Oct/Nov · 0654/11 · Question 24 · Core；同题：2022 Oct/Nov · 0654/12 · Question 24 · Core；同题：2022 Oct/Nov · 0654/13 · Question 24 · Core）

10. Part of the reactivity series is shown.



Which statement is correct?

A Calcium can be extracted by heating its oxide with hydrogen.

B Copper forms an oxide that can be reduced by heating with gold.

C Gold forms an oxide that cannot be reduced by heating with carbon.

D Lead can be extracted by passing hydrogen over its heated oxide.

(2022 Oct/Nov · 0654/22 · Question 24 · Extended)

11. The ore cassiterite contains tin dioxide.

Tin is more reactive than copper but less reactive than iron.

Which row shows the industrial method used to extract tin based on tin's position in the reactivity series?

	using carbon in a blast furnace	electrolysis
A	yes	yes
B	yes	no
C	no	yes
D	no	no

(2025 Feb/Mar · 0654/22 · Question 23 · Extended)

12. Carbon is below aluminium but above zinc in the reactivity series.

Iron is below zinc in the reactivity series.

Which statements are correct?

1 Carbon can be used to extract aluminium and iron from their ores.

2 Aluminium can be used to extract zinc and iron from their ores.

3 Carbon can be used to extract zinc and iron from their ores.

4 Zinc can be used to extract aluminium and iron from their ores.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 3 and 4

(2022 May/Jun · 0654/22 · Question 22 · Extended)

题型 2：区分隔绝水氧与牺牲保护防锈（考频★★★☆☆）

知识点 铁生锈必须同时有_____和_____；隔绝其中任一种，铁便不能生锈。
涂漆和完整的金属镀层属于屏障法，作用是阻止铁与水、氧气接触。
镀锌是在铁或钢表面覆盖锌；锌比铁_____，镀层划破后锌先失去电子并被氧化，使铁继续受到保护。

答案：氧气；水；活泼

怎么认 题目出现防锈方法、镀层是否划破或镀层金属种类时，先判是否隔绝水氧，再比较该金属与铁的活泼性。

例题 1

Which metal is used to galvanise steel?

A aluminium

B copper

C iron

D zinc

（2026 May/Jun · 0654/21 · Question 22 · Extended）

解：由镀锌的定义，钢表面覆盖的金属是锌；锌比铁活泼，还能在镀层受损时先被氧化。
因此用于镀锌钢的金属是锌。故选 D。

针对练习

1. Which substances are needed for iron to rust?

A oxygen and water

B nitrogen and water

C oxygen only

D water only

（2023 Oct/Nov · 0654/13 · Question 25 · Core）

2. Which statements about rusting are correct?

1 Oxygen must be present for iron to rust.

2 Painting is a barrier method of rust prevention.

3 Barrier methods of rust prevention work by reacting with iron and making it less reactive.

4 Only water is required for iron to rust.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2026 May/Jun · 0654/13 · Question 23 · Core）

3. Which statements explain why zinc is used to galvanise steel?

1 It is less reactive than steel.

2 It forms an alloy with steel.

3 It prevents air and water coming into contact with steel.

4 It provides sacrificial protection for the steel.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

(2025 Feb/Mar · 0654/22 · Question 22 · Extended)

4. Four methods of preventing the rusting of iron are listed.

1 copper plating

2 galvanising

3 painting

4 sacrificial protection

Which methods involve the use of a more reactive metal?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

(2026 May/Jun · 0654/23 · Question 24 · Extended)

5. When iron is galvanised, it is coated with a layer of zinc.

Which statements about galvanising are correct?

1 Zinc has a greater tendency to form positive ions than iron.

2 Zinc prevents iron from rusting by sacrificial protection.

3 Iron is more reactive than zinc.

4 Zinc acts as a barrier method of rust prevention if scratched.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

(2024 Oct/Nov · 0654/23 · Question 24 · Extended)

6. Zinc is used to galvanise iron.

Which statements about galvanising are correct?

1 Iron is more reactive than zinc.

2 Zinc oxidises instead of iron.

3 Galvanised iron rusts if the zinc coating is scratched.

4 Galvanising iron is an example of sacrificial protection.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

(2022 May/Jun · 0654/23 · Question 23 · Extended)

7. A piece of iron is coated with a layer of zinc.

Which statement explains why zinc prevents iron from rusting, even when the layer of zinc is damaged?

A Iron is less reactive than zinc and zinc atoms lose electrons less easily than iron atoms.

B Iron is less reactive than zinc and zinc atoms lose electrons more easily than iron atoms.

C Iron is more reactive than zinc and zinc atoms lose electrons less easily than iron atoms.

D Iron is more reactive than zinc and zinc atoms lose electrons more easily than iron atoms.

(2022 May/Jun · 0654/21 · Question 23 · Extended)

题型 3：用金属物性和用途匹配材料（考频★★★☆☆）

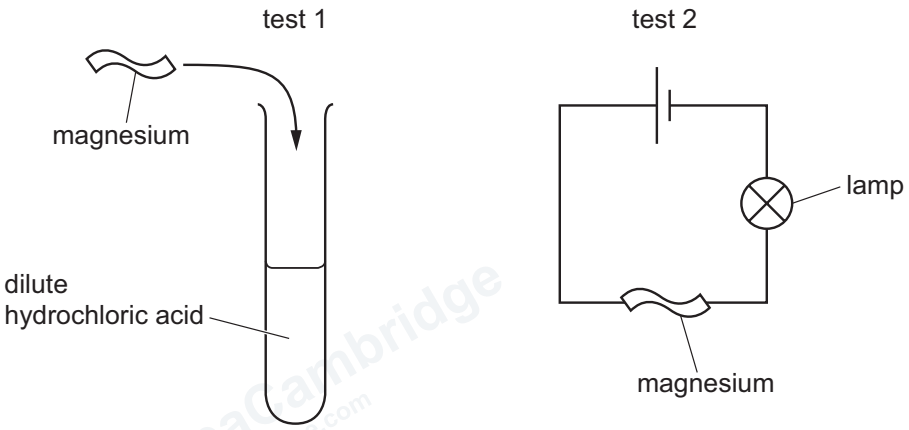
知识点 金属通常具有良好的_____，多数金属熔点较高，并能锻打成形。
材料的用途由工作条件决定：飞机部件要求低密度，食品容器要求耐腐蚀，架空电缆要求低密度和_____。
铝的密度低、导电性好且耐腐蚀；镁与稀盐酸反应产生_____，金属镁能导电。

答案：导电性和导热性；良好的导电性；氢气

怎么认 题目出现某种用途及备选金属性质时，先判断用途所需性能，再选与之对应的性质。

例题 1

Magnesium is tested as shown.



Which row shows the results of the tests?

	test 1	test 2
A	bubbles	lamp does **not** light
B	bubbles	lamp lights
C	no bubbles	lamp does **not** light
D	no bubbles	lamp lights

（2026 May/Jun · 0654/11 · Question 22 · Core）

解：镁与稀盐酸反应生成氯化镁和氢气，故实验 1 中有气泡。
镁是金属，能导电，接入电路后灯泡发光。故选 B。

针对练习

1. Which row describes the general properties of metals?

	melting point	electrical conductivity
A	high	good
B	high	poor
C	low	poor
D	low	good

（2025 Oct/Nov · 0654/11 · Question 23 · Core）

2. Which property of aluminium explains why it is used to manufacture parts for aircraft?

A high melting point

B ductile

C good electrical conductivity

D low density

（2025 May/Jun · 0654/23 · Question 21 · Extended）

3. Which property explains why aluminium is used to make food containers?

A low density

B high strength

C resistant to corrosion

D shiny

（2025 May/Jun · 0654/12 · Question 19 · Core；同题：2025 May/Jun · 0654/13 · Question 19 · Core）

4. Which statement describes **all** metals?

A They break when hit with a hammer.

B They have good electrical conductivity.

C They dissolve in water.

D They have high densities.

（2025 Oct/Nov · 0654/23 · Question 19 · Extended）

5. Which row does **not** link a general physical property to the type of element?

	type of element	general physical property
A	metal	malleable
B	metal	thermal conductor
C	non-metal	electrical conductor
D	non-metal	low melting point

（2022 May/Jun · 0654/11 · Question 22 · Core；同题：2022 May/Jun · 0654/12 · Question 22 · Core；同题：2022 May/Jun · 0654/13 · Question 22 · Core、2022 May/Jun · 0654/21 · Question 21 · Extended、2022 May/Jun · 0654/22 · Question 21 · Extended、2022 May/Jun · 0654/23 · Question 21 · Extended）

6. Which row shows the properties of aluminium that make it useful in the manufacture of overhead electrical cables?

	low density	good electrical conductivity
A	no	no
B	no	yes
C	yes	no
D	yes	yes

（2025 Oct/Nov · 0654/21 · Question 22 · Extended）

题型 4：从大小不同原子解释合金硬度和组成（考频★★★☆☆）

知识点 合金是金属与一种或多种其他元素形成的_____，由各元素的原子构成。

纯金属中大小相近的原子排列成层；混入大小不同的原子后，原子层较难滑动，所以合金通常比纯金属更_____。

黄铜是铜和锌的合金；不锈钢含铁和铬等元素，比纯铁更耐_____。

答案：混合物；硬；腐蚀

怎么认 题目出现合金组成、硬度或原子排列图时，先判断混合物，再看异种原子是否阻碍原子层滑动。

例题 1

What is an alloy?

A a compound

B a mixture

C a metallic element

D a non-metallic element

（2025 May/Jun · 0654/12 · Question 20 · Core；同题：2025 May/Jun · 0654/13 · Question 20 · Core）

解：合金由金属与一种或多种其他元素混合而成，属于混合物。

故选 B。

针对练习

1. What is brass?

A a mixture of a compound of copper and a compound of zinc

B a compound of copper and zinc

C a mixture of copper and a compound of zinc

D a mixture of copper and zinc

（2025 Oct/Nov · 0654/23 · Question 20 · Extended）

2. Which process is used to increase the hardness of a metal?

A Mix the metal with a gas.

B Mix the metal with another element.

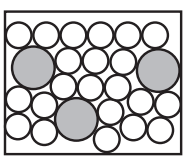
C Mix the metal with a polymer.

D Mix the metal with its ore.

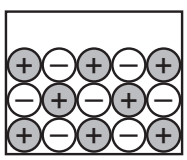
（2024 May/Jun · 0654/12 · Question 24 · Core；同题：2024 May/Jun · 0654/13 · Question 24 · Core）

3. Which diagram represents the structure of an alloy?

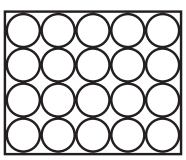
A



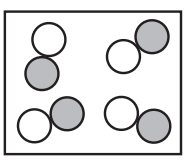
B



C



D



（2025 May/Jun · 0654/21 · Question 25 · Extended）

4. Which statement about alloys is correct?

A Brass is a compound that contains copper and zinc.

B Brass is a mixture of copper and iron.

C Stainless steel is a compound that contains iron.

D Stainless steel resists rusting.

（2026 Feb/Mar · 0654/12 · Question 22 · Core）

5. Duralumin and magnalium are alloys used in the manufacture of aircraft.

They both contain aluminium and another metallic element.

The alloys are made up of ……1…… of each element.

They are used because they are ……2…… than the pure metals.

Which words complete gaps 1 and 2?

	1	2
A	atoms	harder
B	atoms	softer
C	molecules	harder
D	molecules	softer

（2022 Feb/Mar · 0654/12 · Question 22 · Core；同题：2022 Feb/Mar · 0654/22 · Question 22 · Extended）

6. Which statements about stainless steel are correct?

1 It contains different sized atoms.

2 It is a compound of iron and chromium.

3 It is hard because its atoms slide over each other easily.

4 It is more resistant to corrosion than pure iron.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2026 Feb/Mar · 0654/22 · Question 22 · Extended）

题型 5：追踪高炉制 CO 还原铁矿的反应（考频★★★☆☆）

知识点 高炉用赤铁矿提取铁，赤铁矿的主要成分是氧化铁(III) Fe_2O_3；铝不在高炉中提取。

在高炉中，一氧化碳把 Fe_2O_3 还原为 Fe：$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$。

Fe_2O_3 失去氧而被_____，CO 得到氧而被_____，该反应属于氧化还原反应。

Fe_2O_3 是碱性氧化物，CO_2 是酸性氧化物。

石灰石受热生成 CaO，用于除去酸性杂质 SiO_2，并生成炉渣 $CaSiO_3$。

答案：还原；氧化

怎么认 题目出现高炉、赤铁矿或高炉反应式时，先判断铁氧化物和一氧化碳的得失氧。

例题 1

What happens in a blast furnace?

A Aluminium is extracted from bauxite.

B Aluminium is extracted from hematite.

C Iron is extracted from bauxite.

D Iron is extracted from hematite.

（2026 May/Jun · 0654/13 · Question 24 · Core）

解：高炉用于从赤铁矿中提取铁。
赤铁矿的主要成分为氧化铁(III) Fe_2O_3，其中的铁氧化物被还原为铁。
故选 D。

针对练习

1.

Hematite contains an oxide of iron.

Hematite is added to a blast furnace.

Which change happens in the blast furnace?

A FeO is reduced to Fe.

B FeO is reduced to Fe_2O_3.

C Fe_2O_3 is reduced to Fe.

D Fe_2O_3 is reduced to FeO.

（2026 May/Jun · 0654/22 · Question 24 · Extended）

2.

Which statement about the extraction of metals is correct?

A Aluminium ore is called hematite.

B Aluminium is extracted from its ore by heating with carbon.

C Iron oxide is reduced to iron by heating with carbon monoxide.

D Limestone is used to remove basic impurities in a blast furnace.

（2024 Oct/Nov · 0654/21 · Question 24 · Extended）

3.

The equations for reactions in the blast furnace are shown.

1 $C + O_2 \rightarrow CO_2$

2 $CO_2 + C \rightarrow 2CO$

3 $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

4 $CaO + SiO_2 \rightarrow CaSiO_3$

Which statement is correct?

A In reaction 1, carbon is reduced.

B In reaction 2, carbon dioxide is oxidised.

C In reaction 3, carbon monoxide is oxidised.

D In reaction 4, silicon dioxide is reduced.

（2022 Oct/Nov · 0654/22 · Question 20 · Extended）

4. Iron is extracted from its ore in the blast furnace.

One of the reactions involved is shown.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

Which statement is correct?

A Iron(III) oxide and carbon monoxide are both oxidised.

B Iron(III) oxide and carbon monoxide are both reduced.

C Iron(III) oxide is oxidised and carbon monoxide is reduced.

D Iron(III) oxide is reduced and carbon monoxide is oxidised.

（2023 May/Jun · 0654/12 · Question 20 · Core；同题：2023 May/Jun · 0654/13 · Question 20 · Core）

5. The equation for one reaction in the blast furnace is shown.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

Which row identifies the type of reaction and the type of each oxide?

	reaction	Fe_2O_3	CO_2
A	redox	basic	acidic
B	cracking	basic	basic
C	redox	acidic	acidic
D	cracking	acidic	basic

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（2026 Feb/Mar · 0654/22 · Question 24 · Extended）

题型 6：按水酸反应或标准序列比较金属活泼性（考频★★☆☆☆）

知识点 金属的活泼性表示金属发生化学反应的难易程度，是相对强弱，没有单位。

在金属种类和用量、酸的浓度、温度等条件相同时，先比较_____，再比较产生氢气的_____；反应越快，金属越活泼。

能与冷水反应的金属通常比只能与水蒸气反应的金属活泼；与稀盐酸反应能放出氢气的金属排在氢的_____。

常用顺序由强到弱为钾、钠、钙、镁、铝、锌、铁、氢、铜。

答案：是否反应；快慢；前面

怎么认 题目出现不同金属与水、水蒸气或稀盐酸的反应现象及活泼性排序时，先比较是否反应，再比较放气快慢。

例题 1

Pieces of four metals are added separately to test-tubes containing dilute hydrochloric acid.

The results are shown.

metal	results
1	bubbles produced slowly
2	no reaction
3	vigorous bubbling
4	steady bubbling

What is the order of reactivity of the metals from most to least reactive?

A 2 → 1 → 4 → 3

B 2 → 4 → 1 → 3

C 3 → 1 → 4 → 2

D 3 → 4 → 1 → 2

（2023 Feb/Mar · 0654/12 · Question 24 · Core）

解：在相同的稀盐酸中，放出氢气越快，金属越活泼。
金属 3 剧烈冒泡，金属 4 持续冒泡，金属 1 缓慢冒泡，金属 2 不反应，
∴ 活泼性顺序为 $3 > 4 > 1 > 2$。
故选 D。

针对练习

1. Metal X reacts rapidly with steam but only very slowly with cold water.

What is X?

A calcium

B copper

C magnesium

D sodium

（2025 Oct/Nov · 0654/23 · Question 21 · Extended）

2. What is the order of reactivity of metals, from highest to lowest?

A aluminium → calcium → copper → iron

B calcium → iron → copper → aluminium

C calcium → magnesium → iron → copper

D aluminium → magnesium → iron → copper

（2024 Oct/Nov · 0654/11 · Question 25 · Core）

3. Which row describes the order of reactivity of the metals?

	most reactive →			least reactive
A	copper	calcium	zinc	potassium
B	copper	zinc	calcium	potassium
C	potassium	calcium	zinc	copper
D	potassium	zinc	calcium	copper

（2025 May/Jun · 0654/12 · Question 21 · Core；同题：2025 May/Jun · 0654/13 · Question 21 · Core）

4. Three metals X, Y and Z are added separately to water and to dilute hydrochloric acid.

The results are shown.

metal	result with water	result with dilute hydrochloric acid
X	✗	✓
Y	✓	✓
Z	✗	✗

key

✓ = hydrogen is given off

✗ = hydrogen is not given off

What is the order of reactivity of X, Y and Z?

	most reactive →		least reactive
A	X	Z	Y
B	Y	X	Z
C	Y	Z	X
D	Z	X	Y

（2022 May/Jun · 0654/11 · Question 23 · Core）

题型 7：用更活泼者置换较不活泼金属（考频★★★☆☆）

知识点 金属越活泼，原子越容易_____电子形成正离子。

盐溶液中，加入的金属比盐中金属活泼时，前者置换后者；金属与另一金属的氧化物反应通常需要加热。

能发生置换时，单质金属的活泼性_____被置换金属；前者较不活泼时不反应。

金属活泼性表示相对次序，_____单位。

答案：失去；强于；没有

怎么认 题目出现单质金属与另一金属的盐溶液或氧化物反应时，先比较谁更容易失去电子。

例题 1

Metal X reacts with aqueous metal Y^{2+} ions.

The ionic equation for the reaction is shown.

$$X + Y^{2+} \rightarrow X^{2+} + Y$$

What are metals X and Y?

	X	Y
A	copper	iron
B	copper	zinc
C	zinc	copper
D	aluminium	iron

（2024 May/Jun · 0654/22 · Question 22 · Extended）

解：由 X 变为 X^{2+} 得，X 失去电子，说明 X 比 Y 活泼。
又因题中生成 X^{2+}，X 应形成二价离子；锌比铜活泼，且锌形成 Zn^{2+}。
故 X 为锌，Y 为铜。故选 C。

针对练习

1. Which metal oxide is reduced when heated with magnesium powder?

A calcium oxide

B copper oxide

C magnesium oxide

D sodium oxide

（2022 May/Jun · 0654/23 · Question 22 · Extended）

2. Which statement about the reactivity of metals is correct?

A Atoms of iron lose electrons more readily than atoms of zinc.

B Copper reacts with dilute hydrochloric acid.

C Magnesium reacts with heated copper oxide.

D Zinc reacts with aqueous magnesium sulfate.

（2026 May/Jun · 0654/23 · Question 23 · Extended）

3. Which statement about reactions of metals is correct?

A When copper is added to aqueous aluminium nitrate, the colourless solution turns blue.

B When magnesium oxide is heated with iron, solid iron(III) oxide is formed.

C When potassium oxide is heated with copper, an orange-brown solid is formed.

D When zinc is added to aqueous copper sulfate, the blue solution turns colourless.

（2022 Oct/Nov · 0654/21 · Question 24 · Extended）

4. W, X, Y and Z are metals.

Three statements about these metals are listed.

1 Metal W reduces the oxide of X.

2 Metal Z is **not** able to reduce the oxide of W, but it does reduce the oxides of X and Y.

3 Metal X displaces Y from its aqueous solution.

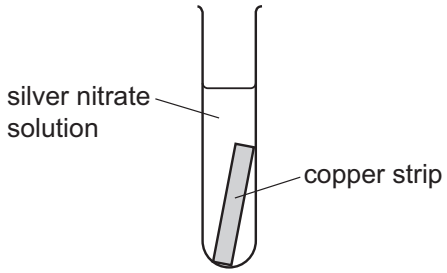
Which row shows the order of reactivity?

	most reactive →			least reactive
A	W	X	Z	Y
B	W	Z	X	Y
C	W	Z	Y	X
D	Z	W	X	Y

(2023 Oct/Nov · 0654/22 · Question 23 · Extended)

5. Silver oxide is reduced by heating with carbon more easily than copper oxide is reduced by heating with carbon.

A copper strip is placed into a solution of silver nitrate as shown.



Which row describes the reaction?

	the colourless solution slowly turns blue	the copper strip slowly dissolves	a silver-grey metal is formed
A	✗	✗	✗
B	✓	✓	✓
C	✓	✗	✓
D	✗	✓	✗

(2023 Oct/Nov · 0654/21 · Question 24 · Extended)

6. Elements Q, T, X and Z are metals.

The equations for three reactions between some of these metals and some oxides and chlorides of these metals are shown.

$$Q(s) + XO(s) \rightarrow QO(s) + X(s)$$

$$T(s) + ZCl_2(aq) \rightarrow TCl_2(aq) + Z(s)$$

$$X(s) + TCl_2(aq) \rightarrow XCl_2(aq) + T(s)$$

Which metal has the greatest tendency to form positive ions?

A Q **B** T **C** X **D** Z

(2024 Feb/Mar · 0654/22 · Question 24 · Extended)

7. The reactions of four different metals W, X, Y and Z with aqueous solutions of their ions are listed.

- W reacts with aqueous ions of X and of Z but not with aqueous ions of Y.
- X does not react with aqueous ions of W, Y or Z.
- Y reacts with aqueous ions of W, X and Z.
- Z reacts with aqueous ions of X but not with aqueous ions of Y or W.

Which row shows the tendency of the metals to form positive ions?

	least tendency →			greatest tendency
A	X	W	Z	Y
B	X	Z	W	Y
C	Y	W	Z	X
D	Y	Z	W	X

(2024 Oct/Nov · 0654/22 · Question 22 · Extended)

8. P, Q, R and S are four metals.

The oxide of metal R can be reduced by metal S, but not by metal P.

The oxide of metal Q can be reduced both by metal S and by metal P.

Which row shows the order of reactivity of these metals?

	least reactive →			most reactive
A	Q	R	P	S
B	Q	P	R	S
C	S	P	R	Q
D	S	R	P	Q

(2022 Oct/Nov · 0654/23 · Question 24 · Extended)

9. Which equation is balanced **and** represents a reaction in which a metal displaces another metal from an aqueous solution of its ion?

A $MgCl_2(aq) + Zn(s) \rightarrow ZnCl_2(aq) + Mg(s)$

B $Zn^{2+}(aq) + Cu(s) \rightarrow Zn(s) + Cu^{2+}(aq)$

C $Mg(s) + AgNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + Ag(s)$

D $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$

（2026 Feb/Mar · 0654/22 · Question 23 · Extended）

题型 8：追踪石灰石分解与成渣除杂（考频★★☆☆☆）

知识点 高炉炼铁时，加入的石灰石主要成分是_____，高温下先分解为氧化钙和二氧化碳。

$CaCO_3 \longrightarrow CaO + CO_2$

生成的_____与酸性杂质二氧化硅反应，生成炉渣硅酸钙。

$CaO + SiO_2 \longrightarrow CaSiO_3$

答案：碳酸钙；氧化钙

怎么认 题目出现高炉、石灰石、炉渣或酸性杂质时，先写碳酸钙分解，再写氧化钙与二氧化硅反应。

例题 1

In the blast furnace, which substance is added to make slag?

A calcium carbonate

B carbon dioxide

C carbon monoxide

D coke

（2023 May/Jun · 0654/22 · Question 23 · Extended）

解：高炉中加入石灰石，其主要成分为碳酸钙。

$CaCO_3 \longrightarrow CaO + CO_2$

$CaO + SiO_2 \longrightarrow CaSiO_3$

生成的硅酸钙为炉渣，因此加入的物质为碳酸钙。故选 A。

针对练习

1. Iron is extracted from hematite in the blast furnace.

Why is limestone added to the furnace?

A It decreases the melting point of the mixture.

B It increases the temperature inside the furnace.

C It produces calcium oxide which removes acidic impurities.

D It produces carbon dioxide which reduces the hematite.

（2022 May/Jun · 0654/21 · Question 22 · Extended）

2. Which statement describes what happens when calcium carbonate is added to the blast furnace during the extraction of iron?

A It burns and provides heat.

B It decomposes and calcium oxide is a product.

C It reacts with silicon dioxide.

D It reduces the iron ore.

(2025 May/Jun · 0654/22 · Question 21 · Extended)

3. Iron is extracted in the blast furnace.

Which reactions are involved in removing acidic impurities as slag?

1 $C + O_2 \rightarrow CO_2$

2 $C + CO_2 \rightarrow 2CO$

3 $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

4 $CaCO_3 \rightarrow CaO + CO_2$

5 $CaO + SiO_2 \rightarrow CaSiO_3$

A 1 and 2 only **B** 1, 2 and 3 **C** 3, 4 and 5 **D** 4 and 5 only

(2022 Feb/Mar · 0654/22 · Question 23 · Extended)

1.12 水、空气与环境化学

题型 1：按空气百分数组成读图或计算体积（考频★★★☆☆）

知识点 洁净、干燥空气按体积计，氮气约占 _____，氧气约占 _____，其他气体约占 _____。
其他气体主要包括稀有气体和二氧化碳；天然气的主要成分是甲烷。
在相同温度和压强下，体积百分数等于体积分数，$V_{成分} = pV_{空气}$，其中 p 为百分数化成的小数。
空气组成比例无单位；计算所得体积沿用题目给出的体积单位。

答案：78%；21%；1%

怎么认 题目出现洁净干燥空气的百分数、饼图或成分体积时，先写氮气、氧气、其他气体约为 78 : 21 : 1。

例题 1

Which gas is present in clean air?

A carbon dioxide

B carbon monoxide

C nitrogen dioxide

D sulfur dioxide

（2023 Oct/Nov · 0654/11 · Question 25 · Core）

解：洁净干燥空气中，氮气、氧气和其他气体的体积比约为 78 : 21 : 1，其他气体包括二氧化碳。
故选 A。

针对练习

1. What is the main constituent of clean air and of natural gas?

	clean air	natural gas
A	nitrogen	ethane
B	nitrogen	methane
C	oxygen	ethane
D	oxygen	methane

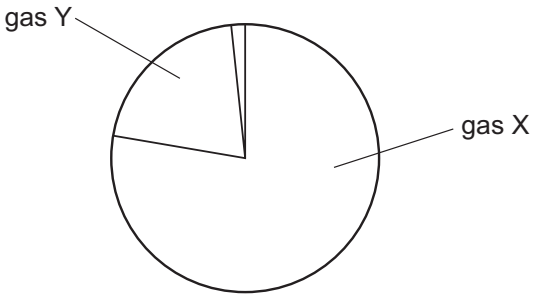
（2024 May/Jun · 0654/23 · Question 26 · Extended）

2. Which row shows the relative abundance of the gases in clean air?

	most abundant ⟶		least abundant
A	nitrogen	argon	oxygen
B	nitrogen	oxygen	argon
C	oxygen	carbon dioxide	nitrogen
D	oxygen	nitrogen	carbon dioxide

（2022 Oct/Nov · 0654/12 · Question 25 · Core）

3. The diagram represents the composition of clean, dry air.



Which row identifies gas X and gas Y?

	gas X	gas Y
A	nitrogen	oxygen
B	oxygen	nitrogen
C	oxygen	carbon dioxide
D	carbon dioxide	nitrogen

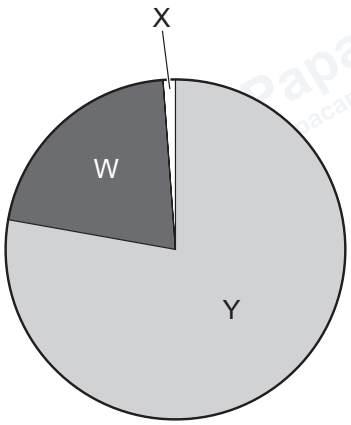
（2025 May/Jun · 0654/12 · Question 23 · Core；同题：2025 May/Jun · 0654/13 · Question 23 · Core）

4. What is the approximate composition of clean, dry air?

	78%	**21%**	**1%**
A	oxygen	nitrogen	noble gases and carbon dioxide
B	nitrogen	oxygen	methane
C	nitrogen	oxygen	noble gases and carbon dioxide
D	oxygen	nitrogen	methane

（2026 May/Jun · 0654/12 · Question 25 · Core）

5. The pie chart shows the composition of clean, dry air.



Which row identifies W, X and Y?

	W	X	Y
A	nitrogen	other gases	oxygen
B	nitrogen	oxygen	other gases
C	oxygen	other gases	nitrogen
D	oxygen	nitrogen	other gases

（2026 Feb/Mar · 0654/12 · Question 24 · Core）

6. Which volume of clean air contains 10.5 cm^3 of oxygen?

A 21 cm^3 **B** 42 cm^3 **C** 50 cm^3 **D** 100 cm^3

（2024 Oct/Nov · 0654/12 · Question 24 · Core；同题：2024 Oct/Nov · 0654/13 · Question 24 · Core）

7. Water vapour, carbon dioxide and the noble gases are removed from a 100 cm^3 sample of clean air.

What is the remaining volume?

A 1 cm^3 **B** 21 cm^3 **C** 78 cm^3 **D** 99 cm^3

（2024 May/Jun · 0654/11 · Question 25 · Core）

题型 2：按过滤吸附和氯化的功能排列净水步骤（考频★★★☆☆）

知识点 天然水源中，沉降使较大的不溶性颗粒沉下，_____除去较小的不溶性颗粒；二者均不能除去已溶解的物质。

活性炭用于_____使水产生异味和不良味道的物质，氯化用于杀死细菌等病原微生物。

处理河流或水库水时，常见次序为沉降、过滤、加入活性炭、_____。

答案：过滤；吸附；氯化

怎么认 题目出现净水步骤或颗粒、异味、微生物时，先将它们分别对应沉降或过滤、活性炭、氯化。

例题 1

Which statement about the treatment of the domestic water supply is correct?

A Sedimentation is used to remove microbes.

B Filtration is used to remove dissolved solids.

C Chlorination is used to kill pathogens.

D Carbon is used to change the pH.

（2026 Feb/Mar · 0654/12 · Question 23 · Core）

解：沉降和过滤除去不溶性颗粒，活性炭吸附使水产生异味和不良味道的物质。
氯化能杀死水中的病原微生物。
故选 C。

针对练习

1. Which statement about the treatment of the water supply is correct?

A Chlorination is used to improve the taste of the water.

B Chlorination is used to kill bacteria.

C Filtration is used to adjust the pH of the water.

D Filtration is used to remove soluble impurities.

（2022 May/Jun · 0654/11 · Question 25 · Core）

2. Which two processes are used to treat the domestic water supply?

A chlorination and evaporation

B chlorination and filtration

C crystallisation and evaporation

D crystallisation and filtration

（2025 May/Jun · 0654/23 · Question 24 · Extended）

3. Which statement about the treatment of the water supply is correct?

A Water from reservoirs and rivers is filtered to remove dissolved impurities.

B Chlorine is added to the water to kill bacteria.

C Sodium chloride is added to the water to make it pleasant to drink.

D Chlorine is added to make the water pure.

（2023 May/Jun · 0654/12 · Question 23 · Core；同题：2023 May/Jun · 0654/13 · Question 23 · Core）

4. Which row explains why filtration and chlorination are used in the treatment of the domestic water supply?

	filtration	chlorination
A	to remove soluble substances	to kill microbes
B	to remove insoluble substances	to kill microbes
C	to kill microbes	to remove insoluble substances
D	to remove insoluble substances	to remove soluble substances

（2025 Oct/Nov · 0654/23 · Question 23 · Extended）

5. Which row explains the use of chlorination and filtration in the treatment of the water supply?

	chlorination	filtration
A	to neutralise acids	to remove dissolved substances
B	to neutralise bases	to remove insoluble substances
C	to kill bacteria	to remove dissolved substances
D	to kill bacteria	to remove insoluble substances

（2024 Feb/Mar · 0654/22 · Question 25 · Extended）

6. Which row shows why filtration and chlorination are used in the treatment of the domestic water supply?

	filtration	**chlorination**
A	removes bacteria	removes solid particles
B	removes bacteria	removes smells and tastes
C	removes solid particles	removes bacteria
D	removes solid particles	removes smells and tastes

（2026 May/Jun · 0654/13 · Question 25 · Core）

7. What is the correct sequence for the stages in the treatment of the domestic water supply?

A addition of carbon → filtration → chlorination → sedimentation

B chlorination → addition of carbon → filtration → sedimentation

C filtration → sedimentation → addition of carbon → chlorination

D sedimentation → filtration → addition of carbon → chlorination

（2026 May/Jun · 0654/11 · Question 24 · Core）

题型 3：用温室气体和燃烧解释气候变化（考频★★☆☆☆）

知识点 二氧化碳和甲烷是_____，能吸收地球表面向外辐射的热能，减少热能向太空散失。
当大气中温室气体的浓度增加时，温室效应增强，全球平均温度升高，并可能导致气候变化。
燃烧汽油等化石燃料会增加大气中_____的浓度；二氧化碳浓度常用 ppm 表示，ppm 表示百万分之一。
酸雨主要由二氧化硫和氮氧化物引起；催化转化器不用于除去二氧化碳。

答案：温室气体；二氧化碳

怎么认 题目出现全球变暖、气候变化或二氧化碳浓度曲线时，先找二氧化碳或甲烷及其增加来源。

例题 1 Which statements about carbon dioxide are correct?

1 Carbon dioxide in the atmosphere reduces the loss of thermal energy to space.

2 Carbon dioxide gas in the atmosphere causes acid rain.

3 Carbon dioxide is removed from car engine emissions using a catalytic convertor.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 only **D** 2 and 3 only

（2026 May/Jun · 0654/21 · Question 24 · Extended）

解：二氧化碳是温室气体，能减少热能向太空散失，故陈述 1 正确。
酸雨主要由二氧化硫和氮氧化物引起，故陈述 2 错误；催化转化器不能除去二氧化碳，故陈述 3 错误。
正确的只有陈述 1，故选 C。

针对练习

1. Which row shows a greenhouse gas and its environmental effect?

	gas	environmental effect
A	methane	acid rain
B	methane	global warming
C	carbon monoxide	acid rain
D	carbon monoxide	global warming

（2025 May/Jun · 0654/22 · Question 22 · Extended）

2. Which statements about global warming are correct?

1 Global warming contributes to climate change.

2 Methane is a greenhouse gas.

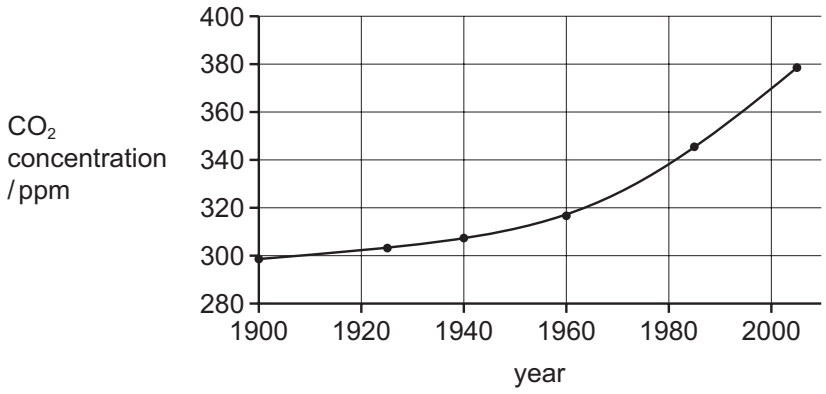
3 Decreasing concentrations of greenhouse gases in the atmosphere cause global warming.

4 Carbon is a greenhouse gas.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2025 Feb/Mar · 0654/22 · Question 24 · Extended）

3. The change in the concentration of carbon dioxide in the atmosphere over time is shown.



Which row identifies the cause of this change and an environmental problem caused by this change?

	cause	environmental problem
A	increased combustion of sulfur containing fossil fuels	acid rain
B	increased combustion of gasoline	climate change
C	increased fermentation of sugars	acid rain
D	increased cracking of crude oil	climate change

（2023 Oct/Nov · 0654/22 · Question 24 · Extended）

题型 4：把污染物来源对应到危害与去除法（考频★★★☆☆）

知识点 空气污染物是进入空气并对生物或环境造成危害的物质；一氧化碳、二氧化硫和氮氧化物属于常见空气污染物。

含碳燃料_____燃烧生成一氧化碳；燃料中的硫燃烧生成二氧化硫。

汽车发动机的高温使空气中的氮和氧反应生成氮氧化物；二氧化硫和氮氧化物可形成_____。

一氧化碳有毒；石灰能与_____反应，可用于除去该气体。

答案：不完全；酸雨；二氧化硫

怎么认 题目出现燃料燃烧、汽车发动机、酸雨或石灰除气时，先判定碳、硫或空气中的氮和氧参与反应。

例题 1

Which gas is an air pollutant?

A argon

B carbon dioxide

C nitrogen

D sulfur dioxide

（2023 Oct/Nov · 0654/12 · Question 24 · Core）

解：题目所列气体中，二氧化硫会形成酸雨并污染空气，属于空气污染物。

故选 D。

针对练习

1. Which atmospheric pollutant is removed from air by lime?

A ammonia

B carbon monoxide

C hydrocarbons

D sulfur dioxide

（2023 May/Jun · 0654/21 · Question 22 · Extended）

2. Which process leads to the formation of acid rain?

A incomplete combustion of methane

B reaction of nitrogen and oxygen in a car engine

C decay of vegetation

D digestion in animals

（2026 May/Jun · 0654/11 · Question 25 · Core）

3. Which air pollutants are produced by the combustion of fossil fuels in car engines?

A carbon monoxide, oxides of nitrogen and sulfur dioxide

B carbon monoxide and sulfur dioxide only

C carbon monoxide and oxides of nitrogen only

D oxides of nitrogen and sulfur dioxide only

(2025 Oct/Nov · 0654/11 · Question 24 · Core)

4. Which statements about air pollution are correct?

1 Carbon monoxide is a toxic gas that is formed by the incomplete combustion of carbon-based fuels.

2 Oxides of nitrogen damage buildings and are produced by impurities in carbon-based fuels.

3 Sulfur dioxide produces acid rain and is formed by the combustion of fossil fuels.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

(2025 Oct/Nov · 0654/23 · Question 24 · Extended)

5. Which statement explains how oxides of nitrogen are formed in a car engine?

A Nitrogen from the air reacts with the fuel.

B Oxygen and nitrogen from the air react together.

C Oxygen from the air reacts with sulfur impurities in the fuel.

D Oxygen from the air reacts with the fuel.

(2025 May/Jun · 0654/22 · Question 23 · Extended)

6. A sample of air is analysed before and after it is used in an experiment.

The percentage composition of the air before and after the experiment is recorded.

	nitrogen	oxygen	carbon dioxide	other gases
before	78	21	0.04	small amount
after	78	17	4	small amount

Which process does **not** produce this change in the composition of the air?

A combustion of coal

B combustion of natural gas

C combustion of sulfur

D respiration

(2024 Oct/Nov · 0654/22 · Question 23 · Extended)

7. Which processes add carbon dioxide to the air?

1 complete combustion of ethanol

2 displacement of copper from aqueous copper(II) sulfate

3 reaction of dilute hydrochloric acid with magnesium

4 reaction of dilute sulfuric acid with copper carbonate

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

(2025 May/Jun · 0654/23 · Question 25 · Extended)

题型 5：追踪催化转化器的进出气体及反应（考频★★★☆☆）

知识点 汽车催化转化器中的催化剂达到合适温度后，使尾气中的一氧化碳和一氧化氮反应，生成二氧化碳和氮气。

进入并被去除的污染气体是_____和_____；离开并增加的气体是二氧化碳和氮气。

反应中，一氧化碳被氧化，一氧化氮被_____；反应式为$2CO + 2NO \rightarrow N_2 + 2CO_2$。

答案：一氧化碳；一氧化氮；还原

怎么认 题目出现催化转化器的进出气体或反应时，先列一氧化碳、一氧化氮为去除物，再列二氧化碳、氮气为生成物。

例题 1

Which equation represents a reaction that takes place in the catalytic converter of a car?

A $N_2 + 2O_2 \rightarrow 2NO_2$

B $2NO \rightarrow N_2 + O_2$

C $N_2 + 3H_2 \rightarrow 2NH_3$

D $2SO_2 + O_2 \rightarrow 2SO_3$

（2023 May/Jun · 0654/23 · Question 22 · Extended）

解：催化转化器可使一氧化氮转化为氮气。

$2NO \rightarrow N_2 + O_2$

该反应能去除一氧化氮。

故选 B。

针对练习

1. Gases from a car engine travel through a catalytic converter and out through the exhaust.

Some of the gases going into the converter are listed.

1 carbon dioxide

2 carbon monoxide

3 nitrogen

4 nitrogen monoxide

Which gases increase in quantity in the catalytic converter?

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2022 May/Jun · 0654/22 · Question 23 · Extended）

2. Catalytic converters are fitted to cars to remove some gases from exhaust emissions.

Which gases are released by catalytic converters?

A carbon dioxide and nitrogen

B carbon dioxide and nitrogen monoxide

C carbon monoxide and nitrogen

D carbon monoxide and nitrogen monoxide

（2023 Oct/Nov · 0654/21 · Question 25 · Extended）

3. Which statements about the reactions in a catalytic converter are correct?

1 The catalyst needs to be hot for the reactions to work.

2 Carbon dioxide is converted to carbon monoxide.

3 It converts pollutant gases into gases present in clean air.

4 Nitrogen and oxygen combine to form nitrogen monoxide.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

(2022 Feb/Mar · 0654/22 · Question 24 · Extended)

4. Car engines produce pollutant gases.

Which gases are removed by catalytic converters?

A carbon monoxide, nitrogen monoxide and sulfur dioxide

B carbon monoxide and nitrogen monoxide only

C nitrogen monoxide and sulfur dioxide only

D carbon dioxide and sulfur dioxide

(2023 May/Jun · 0654/22 · Question 22 · Extended)

5. When petrol burns in a car engine, carbon monoxide, CO, and nitrogen monoxide, NO, are produced.

These gases pass through a catalytic converter where carbon monoxide reacts with nitrogen monoxide.

The equation for the reaction is shown.

carbon monoxide + nitrogen monoxide → nitrogen + carbon dioxide

Which statement is **not** correct?

A Carbon monoxide is oxidised in the catalytic converter.

B Carbon monoxide is produced by the complete combustion of petrol.

C Nitrogen from the air is oxidised in the car engine.

D Nitrogen monoxide is reduced in the catalytic converter.

(2023 Oct/Nov · 0654/11 · Question 19 · Core)

6. Nitrogen monoxide, NO, reacts with carbon monoxide, CO, in a catalytic converter.

The number of CO molecules that react with one NO molecule is 1 .

The substance reduced in this reaction is 2 .

Which row completes gaps 1 and 2?

	1	2
A	one	CO
B	one	NO
C	two	CO
D	two	NO

(2026 Feb/Mar · 0654/22 · Question 25 · Extended)

化学 · 有机化学、燃料与聚合物

1.13 有机化学、燃料与聚合物

题型 1：从碳链键型与官能团辨认名称和类别（考频★★★★☆）

知识点 只含碳、氢两种元素的化合物称为_____；烷烃是只含碳碳单键的饱和烃，名称以 -ane 结尾，并可用作燃料。

含有碳碳双键 $C=C$ 的烃是_____，属于不饱和化合物，名称以 -ene 结尾，并能使溴水褪色、发生加聚反应。

碳链连有 OH 基团的有机物是_____，名称以 -ol 结尾。

名称前缀 meth-、eth-、prop-、but- 分别表示碳链含 1、2、3、4 个碳原子；有多个可能位置时还要标明双键的位置。

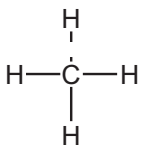
答案：烃；烯烃；醇

怎么认 题目出现有机物的名称、分子式或结构图时，先判是否只含碳、氢，再找 $C=C$ 或 OH 并数碳。

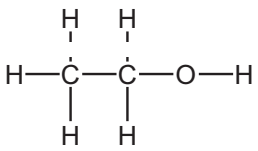
例题 1

Which structure represents a compound that has a chemical name ending in ‘ene’?

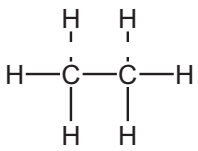
A



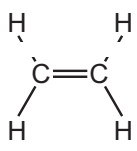
B



C



D



（2025 Feb/Mar · 0654/12 · Question 25 · Core）

解：名称以 -ene 结尾的是烯烃，结构中含 $C=C$。

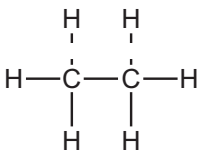
D 只含碳、氢两种元素，且两个碳原子之间为双键。

故选 D。

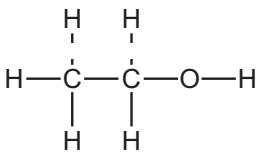
针对练习

1. Which compound is an alkene?

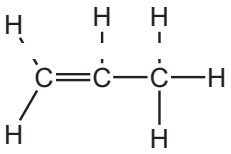
A



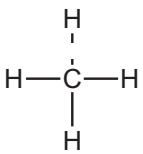
B



C



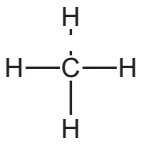
D



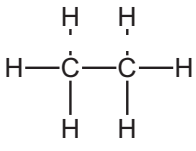
（2025 May/Jun · 0654/11 · Question 24 · Core）

2. Which diagram represents a molecule of ethane?

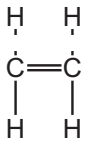
A



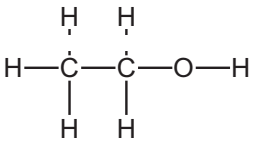
B



C

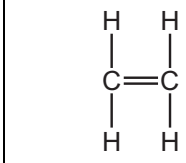
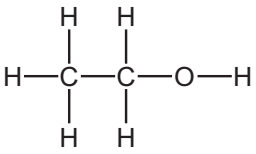
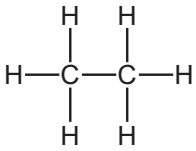
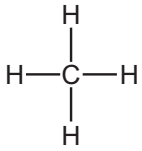


D



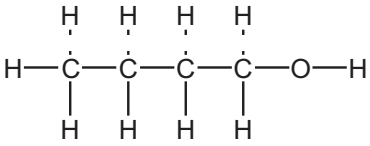
(2026 May/Jun · 0654/21 · Question 25 · Extended)

3. In which row is the name of the structure correct?

	structure	name
A		methane
B		ethene
C		ethane
D		ethanol

(2022 Oct/Nov · 0654/11 · Question 27 · Core)

4. The structure of compound P is shown.



Which type of compound is P?

A polymer

B alcohol

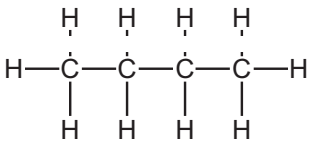
C alkane

D alkene

(2025 May/Jun · 0654/21 · Question 26 · Extended)

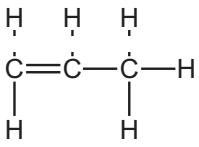
5. Which compound name matches the structure shown?

A



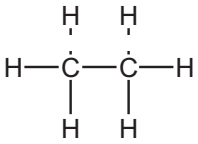
propane

B



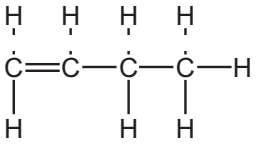
propene

C



methane

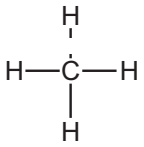
D



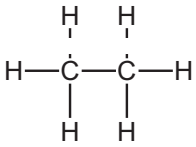
butane

（2024 Feb/Mar · 0654/22 · Question 27 · Extended）

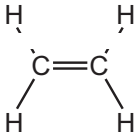
6. The displayed formulas of four compounds are shown.



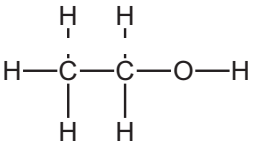
1



2



3



4

Which formulas represent ethanol and ethene?

	ethanol	ethene
A	4	2
B	1	3
C	4	3
D	2	1

（2025 Oct/Nov · 0654/12 · Question 25 · Core；同题：2025 Oct/Nov · 0654/13 · Question 25 · Core）

7. Which substance is an unsaturated compound?

A ethane

B ethanol

C ethene

D methane

（2023 Feb/Mar · 0654/12 · Question 27 · Core）

8. Which statement about alkanes is correct?

A They contain one double covalent bond.

B They contain only single covalent bonds.

C They form polymers.

D They react with aqueous bromine.

（2025 May/Jun · 0654/12 · Question 26 · Core；同题：2025 May/Jun · 0654/13 · Question 26 · Core）

9. Which molecules are hydrocarbons?

1 CH_4

2 CH_2O_2

3 C_2H_2

4 H_2CO_3

A 1, 2, 3 and 4 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 4 only

(2026 May/Jun · 0654/12 · Question 26 · Core)

10. Which statement about alkanes is correct?

A They rapidly decolourise aqueous bromine.

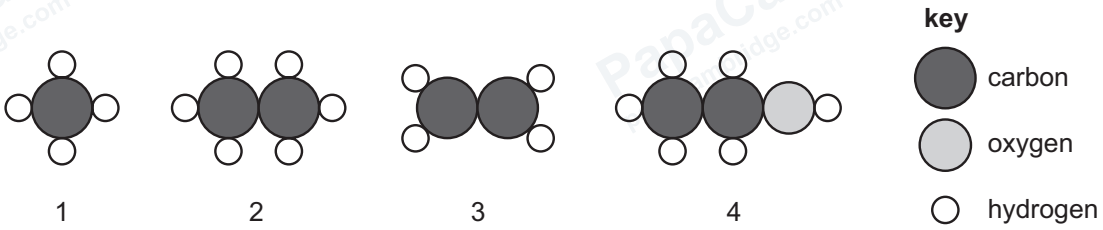
B They are unsaturated hydrocarbons.

C They are used to make polymers.

D They can be used as fuels.

(2022 Oct/Nov · 0654/13 · Question 27 · Core)

11. The structures of four organic molecules are shown.



Which row identifies the names of these molecules?

	1	2	3	4
A	ethane	ethanol	methane	ethene
B	ethanol	ethene	ethane	methane
C	ethene	methane	ethanol	ethane
D	methane	ethane	ethene	ethanol

(2026 May/Jun · 0654/11 · Question 14 · Core)

12. Which formula represents but-1-ene?

A $CH_3CH=CH_2$

B $CH_3CH_2CH_2CH_3$

C $CH_3CH_2CH=CH_2$

D $CH_3CH=CHCH_3$

(2023 Oct/Nov · 0654/23 · Question 26 · Extended)

13. What is the structure of but-2-ene?

A $CH_3–CH=CH_2$

B $CH_3–CH_2–CH_3$

C $CH_3–CH_2–CH=CH_2$

D $CH_3–CH=CH–CH_3$

（2025 Oct/Nov · 0654/23 · Question 26 · Extended）

题型 2：按石油分馏产物匹配用途和位置（考频★★★★☆）

知识点 石油是由多种_____组成的混合物，各组分的沸点范围不同，可用_____分成若干馏分；裂解不是分离石油的方法。

分馏塔下部温度高、上部温度低，沸点较低的馏分在较_____处收集，沥青留在塔底。

炼厂气用于烹饪和取暖，汽油作汽车燃料，石脑油作制造化学品的原料，柴油（gas oil）作柴油机燃料，沥青用于铺路。

答案：烃；分馏；高

怎么认 题目出现石油馏分、分馏塔位置或用途时，先确定馏分名称，再按沸点和用途配对。

例题 1

Which process is used to obtain gasoline from petroleum?

A crystallisation

B chromatography

C filtration

D fractional distillation

（2025 Oct/Nov · 0654/11 · Question 25 · Core）

解：汽油是石油的一个馏分，石油中各馏分的沸点范围不同，利用分馏将其分离。故选 D。

针对练习

1. Which fraction obtained from petroleum is **not** used as a fuel?

A bitumen

B gas oil

C gasoline

D refinery gas

（2026 Feb/Mar · 0654/12 · Question 26 · Core）

2. Which statement about petroleum is correct?

A It contains mostly alkene molecules.

B It is a mixture of hydrocarbons.

C It is separated into fractions by cracking.

D Its main constituent is methane.

（2023 Oct/Nov · 0654/11 · Question 26 · Core）

3. Which fraction obtained from petroleum is used as a feedstock for making chemicals?

A bitumen

B gasoline

C naphtha

D refinery gas

（2023 May/Jun · 0654/23 · Question 26 · Extended）

4. Naphtha is obtained from petroleum.

What is a use for naphtha?

A cooking

B heating

C making roads

D making chemicals

（2025 May/Jun · 0654/11 · Question 26 · Core）

5. What is a use of the naphtha fraction obtained by the fractional distillation of petroleum?

A bottled gas for heating

B feedstock for making chemicals

C fuel for diesel engines

D road surfaces

（2023 Feb/Mar · 0654/12 · Question 26 · Core）

6. Which fractions obtained by the fractional distillation of petroleum are used as fuels?

1 bitumen

2 diesel oil

3 gasoline

4 refinery gas

A 1 and 2 only **B** 3 and 4 only **C** 1, 2 and 3 **D** 2, 3 and 4

（2022 Oct/Nov · 0654/12 · Question 27 · Core）

7. Which statement about fossil fuels is correct?

A Ethane is the main constituent of natural gas.

B Gas oil is used as a fuel in diesel engines.

C Naphtha is used for heating and cooking.

D Petroleum is used as a fuel in car engines.

（2025 Oct/Nov · 0654/12 · Question 26 · Core；同题：2025 Oct/Nov · 0654/13 · Question 26 · Core）

8. Petroleum is separated into fractions by fractional distillation.

Which row shows a use for the named fraction?

	fraction	use
A	bitumen	feedstock for making chemicals
B	diesel oil / gas oil	road surfaces
C	naphtha	fuel in car engines
D	refinery gas	cooking and heating

（2024 Oct/Nov · 0654/12 · Question 26 · Core；同题：2024 Oct/Nov · 0654/13 · Question 26 · Core）

9. Petroleum is separated into useful fractions by fractional distillation.

Which row shows the uses of the named fractions?

	gasoline	naphtha	bitumen
A	fuel for cars	feedstock for making chemicals	fuel for cooking
B	fuel for cooking	fuel for heating	fuel for diesel engines
C	feedstock for making chemicals	fuel for heating	road surfaces
D	fuel for cars	feedstock for making chemicals	road surfaces

（2024 Oct/Nov · 0654/22 · Question 26 · Extended）

10. Naphtha is obtained by the fractional distillation of petroleum.

Which statements about naphtha are correct?

1 It burns to form carbon dioxide and water.

2 It is a mixture of hydrocarbons.

3 It is present in bottled gas.

4 The main component of naphtha is methane.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2023 May/Jun · 0654/12 · Question 26 · Core；同题：2023 May/Jun · 0654/13 · Question 26 · Core、2023 May/Jun · 0654/22 · Question 26 · Extended）

11. Petroleum is separated into fractions by fractional distillation.

Information about uses of some fractions and positions in the fractionating column where they are collected is shown.

	fraction	use	position
1	gasoline	making roads	below refinery gas
2	bitumen	petrol for car engines	bottom of column
3	naphtha	making chemicals	below gasoline
4	refinery gas	heating and cooking	top of column

Which rows are correct?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2023 May/Jun · 0654/11 · Question 26 · Core；同题：2023 May/Jun · 0654/21 · Question 26 · Extended）

题型 3：辨认单体聚合物与加成聚合过程（考频★★★☆☆）

知识点 由许多小分子连接形成的长链分子称为_____，这些小分子称为_____。

含碳碳双键的不饱和单体可发生_____：双键打开，许多单体连接成长链，反应中不生成其他小分子。

乙烯是单体，加成聚合生成聚乙烯；聚乙烯只含碳、氢元素。

答案：聚合物；单体；加成聚合

怎么认 题目出现许多小分子结合成长链或形成一个大分子时，先判定小分子为单体，生成物为聚合物。

例题 1

Polymers are long chain molecules made from smaller molecules.

What are these smaller molecules called?

A alkanes

B atoms

C components

D monomers

（2023 Oct/Nov · 0654/12 · Question 27 · Core）

解：聚合物是由许多较小分子连接形成的长链分子，形成聚合物的较小分子称为单体。

故选 D。

针对练习

1. Polymers are ……1…… chain molecules. They are formed when ……2…… join together.

Which words complete gaps 1 and 2?

	1	2
A	long	alkanes
B	long	monomers
C	short	alkanes
D	short	monomers

（2025 Oct/Nov · 0654/11 · Question 26 · Core）

2. Many molecules of T combine to form a single molecule U.

What are T and U?

	T	U
A	fraction	monomer
B	monomer	fraction
C	monomer	polymer
D	polymer	monomer

（2026 Feb/Mar · 0654/22 · Question 26 · Extended）

3. Molecules of ethene react together to form long chain molecules.

What is the name of this type of reaction?

A addition polymerisation

B cracking

C fermentation

D thermal decomposition

（2023 Oct/Nov · 0654/13 · Question 27 · Core）

4. Poly(ethene) is made from ethene by addition polymerisation.

Which word describes ethene in this process?

A fuel

B catalyst

C monomer

D solvent

（2024 May/Jun · 0654/12 · Question 27 · Core；同题：2024 May/Jun · 0654/13 · Question 27 · Core）

5. Which statement about poly(ethene) is correct?

A It always contains less than 12 carbon atoms.

B It is formed from ethane.

C It is formed from ethene.

D It occurs naturally.

（2023 Oct/Nov · 0654/11 · Question 27 · Core）

6. Which statement about addition polymerisation is correct?

A Large monomer units join to form small polymer molecules.

B Large polymer molecules join to form small monomer units.

C Small monomer units join to form large polymer molecules.

D Small polymer molecules join to form large monomer units.

（2024 Oct/Nov · 0654/12 · Question 27 · Core；同题：2024 Oct/Nov · 0654/13 · Question 27 · Core）

7. Which statement about poly(ethene) is correct?

A It is an alkene.

B It is formed in a reaction called cracking.

C It is obtained from the bitumen fraction of petroleum.

D It is made by an addition reaction.

（2022 Feb/Mar · 0654/12 · Question 27 · Core）

8. Which statement describes poly(ethene)?

A It is formed from monomer molecules which each contain two atoms.

B It is formed from a saturated hydrocarbon monomer.

C It is formed in an addition reaction.

D It is a polymer consisting of C, H and O atoms.

（2025 May/Jun · 0654/11 · Question 25 · Core）

题型 4：用通式与结构比较同系物（考频★★★☆☆）

知识点 同系物是官能团相同、通式相同的一系列有机物，化学性质_____；相邻成员的分子式相差 CH_2。

开链烷烃只含碳碳单键，通式为_____，其中 n 为正整数；不能使溴水褪色。

含一个碳碳双键的开链烯烃通式为_____，其中 $n \geq 2$；能使溴水褪色。

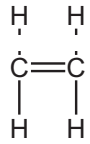
由碳原子数确定 n 后可求氢原子数；M_r 等于各原子的相对原子质量之和，没有单位。

答案：相似；C_nH_{2n+2}；C_nH_{2n}

怎么认 题目出现结构式、碳原子数或溴水现象，要求判断同系物时，先判定烷烃或烯烃，再用通式核算。

例题 1

The structure of a molecule of compound X is shown.



Which two formulas represent compounds that are in the same homologous series as X?

A C_5H_{10} and C_5H_{12}

B C_4H_{10} and C_6H_{14}

C C_3H_6 and C_5H_{10}

D C_3H_6 and C_4H_{10}

（2024 May/Jun · 0654/21 · Question 26 · Extended）

解： 结构式中含有 $C=C$，故 X 属于烯烃，通式为 C_nH_{2n}。

当 $n=3$ 时，分子式为 C_3H_6；当 $n=5$ 时，分子式为 C_5H_{10}。

两者均与 X 属于同一同系物，故选 C。

针对练习

1. Which row describes the hydrocarbon CH_3CHCH_2?

	homologous series	general formula
A	alkane	C_nH_{2n+2}
B	alkane	C_nH_{2n}
C	alkene	C_nH_{2n+2}
D	alkene	C_nH_{2n}

（2022 May/Jun · 0654/22 · Question 26 · Extended）

2. A molecule of methane contains one carbon atom and has the formula CH_4.

A molecule of octane contains eight carbon atoms.

How many hydrogen atoms are in a molecule of octane?

A 11 **B** 16 **C** 18 **D** 32

（2025 May/Jun · 0654/22 · Question 25 · Extended）

3. What is a general formula for unsaturated hydrocarbons?

A C_nH_{n+2} **B** $C_{2n}H_{2n+2}$ **C** C_nH_{2n} **D** C_nH_{2n+2}

（2024 Oct/Nov · 0654/21 · Question 26 · Extended）

4. Hydrocarbon X has two carbon atoms in each molecule. It does not decolourise bromine water.

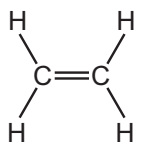
Hydrocarbon Y has three carbon atoms in each molecule. It does decolourise bromine water.

What is the difference in the number of hydrogen atoms in the molecules of X and Y?

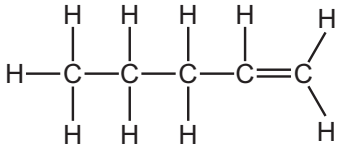
A 0 **B** 1 **C** 2 **D** 4

（2023 Feb/Mar · 0654/22 · Question 26 · Extended）

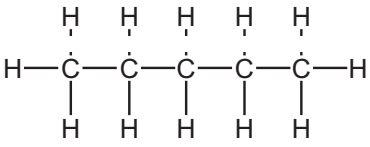
5. The structures of four organic compounds, P, Q, R and S, are shown.



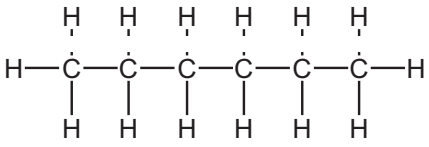
P



Q



R



S

Which statements about P, Q, R and S are correct?

1 P and Q have the same general formula.

2 Q and R have similar chemical properties.

3 R and S are members of the same homologous series.

4 R and Q have the same molecular mass, M_r.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2025 Oct/Nov · 0654/23 · Question 25 · Extended）

题型 5：按完全燃烧写烃或醇的产物（考频★★★☆☆）

知识点 只由碳、氢两种元素组成的有机物称为_____。
烃或乙醇在氧气充足时发生完全燃烧，碳生成_____，氢生成_____。
所以其完全燃烧的产物均为二氧化碳和水；燃烧反应放出热量。

答案：烃；二氧化碳；水

怎么认 题目出现完全燃烧并询问烃或醇的产物时，先判定氧气充足，再写二氧化碳和水。

例题 1

What is produced during the complete combustion of ethanol?

A carbon dioxide and water

B carbon dioxide only

C carbon monoxide

D water only

（2026 May/Jun · 0654/13 · Question 26 · Core）

解：乙醇中含有碳、氢元素，完全燃烧时氧气充足，碳生成二氧化碳，氢生成水。
故产物为二氧化碳和水。故选 A。

针对练习

1. What are the products of the complete combustion of ethanol?

A carbon dioxide + carbon monoxide + water

B carbon dioxide + hydrogen

C carbon dioxide + water

D carbon monoxide + water

（2026 May/Jun · 0654/22 · Question 26 · Extended）

2. What are the products of the complete combustion of ethanol?

A carbon dioxide and hydrogen

B carbon dioxide and water

C carbon monoxide and hydrogen

D carbon monoxide and water

（2022 May/Jun · 0654/12 · Question 27 · Core；同题：2022 May/Jun · 0654/13 · Question 27 · Core）

3. What are the products of the complete combustion of ethanol?

A carbon and hydrogen

B carbon dioxide and hydrogen

C carbon dioxide and water

D carbon monoxide and water

（2024 Oct/Nov · 0654/11 · Question 27 · Core）

4. Butane is a hydrocarbon.

What is the word equation for the complete combustion of butane?

A butane + oxygen → carbon + water

B butane + oxygen → carbon dioxide + carbon monoxide + water

C butane + oxygen → carbon dioxide + water

D butane + oxygen → carbon monoxide + water

（2022 Feb/Mar · 0654/12 · Question 26 · Core）

5. Which statement about methane is correct?

A Methane burns in air to form carbon dioxide.

B Methane decolourises aqueous bromine.

C Methane contains a carbon–carbon single bond.

D When methane burns, an endothermic reaction takes place.

（2026 May/Jun · 0654/23 · Question 25 · Extended）

题型 6：追踪烯烃加成反应的产物（考频★★☆☆☆）

知识点 烯烃是不饱和烃；含一个碳碳双键的链状烯烃通式为 C_nH_{2n}，加成反应发生在_____处，反应物结合成一种产物。

乙烯与氢气加成生成_____；乙烯与水蒸气加成生成_____；烯烃也能与溴水发生加成反应。

烷烃裂解可生成较小的烷烃和烯烃，乙烯、丁-1-烯均可由裂解得到。

许多乙烯分子在适当条件下加成聚合，双键变为单键，生成聚(乙烯)。

只含碳、氢且碳原子之间均为单键的物质属于饱和烃。

答案：碳碳双键；乙烷；乙醇

怎么认 题目出现烯烃与氢气、水蒸气反应或单体聚合时，先看加入物，再判断产物。

例题 1

Which substance reacts with ethene to produce ethanol?

A bromine

B hydrogen

C oxygen

D steam

（2024 Feb/Mar · 0654/12 · Question 27 · Core）

解：乙烯的双键是加成位点，水蒸气中的 H 和 OH 分别加到两个碳原子上，

$C_2H_4 + H_2O \rightarrow C_2H_5OH$

产物为乙醇，故选 D。

针对练习

1. Which type of reaction occurs when ethene reacts with steam?

A addition

B cracking

C displacement

D polymerisation

（2025 Oct/Nov · 0654/22 · Question 26 · Extended）

2. Which statements about the addition reactions of ethene are correct?

1 Ethene reacts with hydrogen to form ethane.

2 Ethene reacts with steam to form ethane.

3 Ethene undergoes addition reactions because it is a saturated hydrocarbon.

4 During addition reactions of ethene, only one product is produced.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2025 Oct/Nov · 0654/21 · Question 24 · Extended）

3. Which statements about ethene and but-1-ene are correct?

1 Only ethene reacts with bromine water.

2 They are both formed by cracking alkanes.

3 They both react with steam to form alcohols.

4 They have different general formulae.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2022 Feb/Mar · 0654/22 · Question 26 · Extended）

4. Reactants for three chemical processes are listed.

1 ethene + steam

2 ethene + hydrogen

3 ethene forming poly(ethene)

Which processes form saturated hydrocarbons?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

（2024 Oct/Nov · 0654/23 · Question 27 · Extended）

题型 7：用溴水褪色辨认碳碳双键（考频★★☆☆☆）

知识点 烯烃分子含有碳碳双键 $C=C$，英文名称通常以 _____ 结尾；烷烃中碳原子间均为单键，英文名称通常以 _____ 结尾。

在室温下，含有 $C=C$ 的化合物能与溴水反应，使溴水由橙色变为_____。

溴水检验属于定性判断，不涉及计量单位。

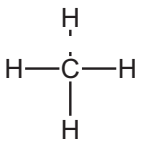
答案：-ene；-ane；无色

怎么认 题目出现溴水褪色、与溴水反应或给出结构式与名称时，先查分子中有无 $C=C$。

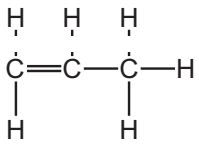
例题 1

Which molecule reacts with aqueous bromine?

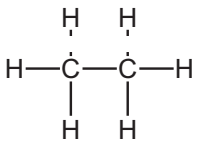
A



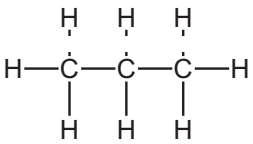
B



C



D



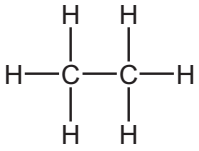
（2024 May/Jun · 0654/11 · Question 27 · Core）

解：由结构式可见，B 中碳原子之间有 $C=C$。
含有 $C=C$ 的分子能与溴水反应，使溴水褪色。
故选 B。

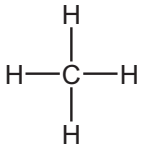
针对练习

1. Which substance decolourises aqueous bromine?

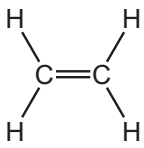
A



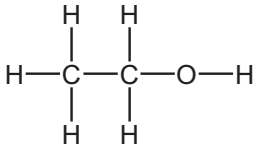
B



C



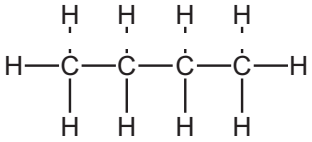
D



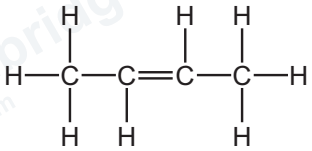
（2024 Oct/Nov · 0654/22 · Question 27 · Extended）

2. The structures or names of four compounds are listed.

1



2



3 hexane

4 hexene

Which compounds will decolourise aqueous bromine?

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2026 May/Jun · 0654/13 · Question 27 · Core）

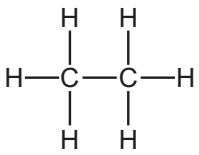
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3. Some information about a compound is listed.

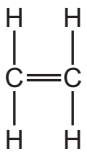
- It burns in air to form carbon dioxide and water.
- It decolourises aqueous bromine.
- It forms a polymer.

What is the displayed formula of the compound?

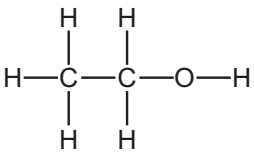
A



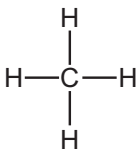
B



C



D



（2026 May/Jun · 0654/11 · Question 26 · Core）

题型 8：辨认化石燃料和天然气的主要成分（考频★★☆☆☆）

知识点 化石燃料是古代生物遗体经漫长地质作用形成的燃料，煤、石油和天然气属于_____燃料。
天然气的主要成分是_____，分子式为CH_4。
甲烷分子含1个碳原子和4个氢原子，碳原子分别与4个氢原子形成单键。

答案：化石；甲烷

怎么认 题目出现化石燃料或天然气主要成分的名称、分子式或结构式时，先找甲烷CH_4。

例题 1

Which energy source is an example of a fossil fuel?

A hydrogen

B methane

C the Sun

D wood

（2023 Oct/Nov · 0654/13 · Question 26 · Core）

解： 甲烷是天然气的主要成分，天然气属于化石燃料。
因此，甲烷是题给能源中属于化石燃料的一项。故选 B。

针对练习

1. What is the main constituent of natural gas?

A ethane

B ethene

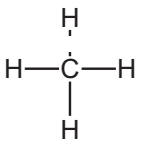
C methane

D nitrogen

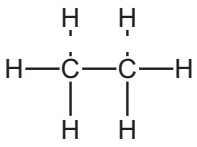
（2025 Feb/Mar · 0654/22 · Question 25 · Extended）

2. Which structure represents the main constituent of natural gas?

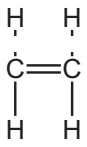
A



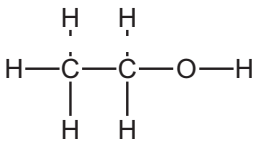
B



C



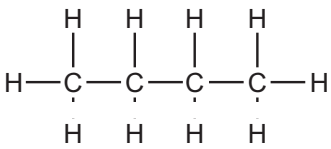
D



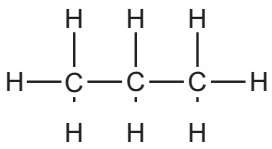
（2024 Feb/Mar · 0654/12 · Question 26 · Core）

3. Which compound is the main constituent of natural gas?

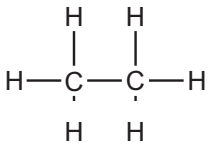
A



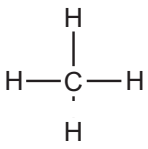
B



C



D



（2025 May/Jun · 0654/12 · Question 25 · Core；同题：2025 May/Jun · 0654/13 · Question 25 · Core）

题型 9：辨认葡萄糖发酵制乙醇及后续反应（考频★★☆☆☆）

知识点 发酵是葡萄糖在酵母作用下生成_____和二氧化碳的过程，需在缺氧和适宜温度条件下进行。

乙醇的分子式为 C_2H_5OH，两个碳原子以单键相连，分子末端含有羟基 $-OH$。

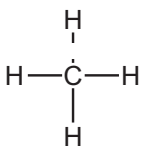
在氧气充足时，乙醇完全燃烧生成_____和水；蒸馏属于分离过程，不能生成乙醇。

答案：乙醇；二氧化碳

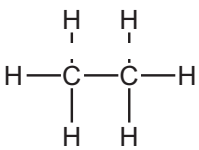
怎么认 题目出现发酵、酵母或葡萄糖溶液时，先确定产物为乙醇和二氧化碳。

例题 1 Which diagram represents a molecule that is formed by fermentation?

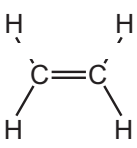
A



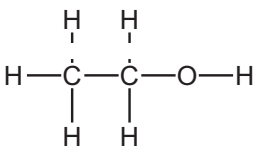
B



C



D



（2023 May/Jun · 0654/12 · Question 27 · Core；同题：2023 May/Jun · 0654/13 · Question 27 · Core）

解： 葡萄糖发酵生成乙醇和二氧化碳。

乙醇的分子式为 C_2H_5OH，含两个碳原子和末端羟基 $-OH$。

图 D 与此结构相符。故选 D。

针对练习

1. Which process forms ethanol?

A combustion

B cracking

C distillation

D fermentation

（2023 May/Jun · 0654/11 · Question 27 · Core）

2. Which method is used to make ethanol?

A fermentation of sugar by yeast

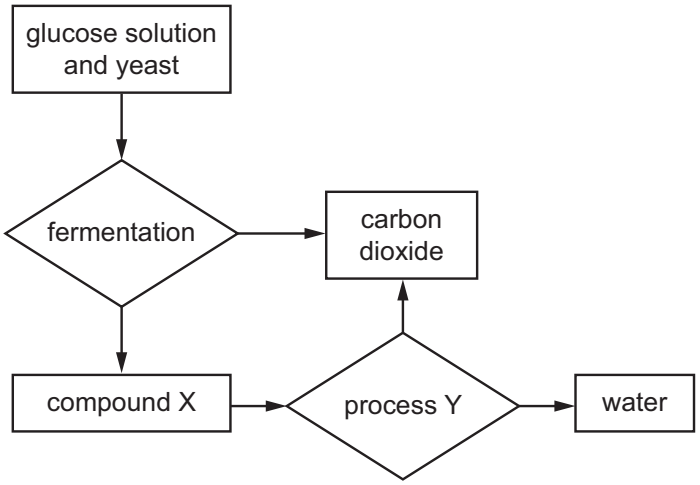
B reacting ethane with bromine

C reacting ethene with bromine

D reacting methane with steam

（2022 May/Jun · 0654/11 · Question 27 · Core）

3. The flow chart shows some chemical substances and processes.



Which row identifies compound X and process Y?

	compound X	process Y
A	ethanol	combustion
B	ethanol	cracking
C	ethene	combustion
D	ethene	cracking

（2022 Feb/Mar · 0654/22 · Question 27 · Extended）

题型 10：判裂解产物并核验原子守恒（考频★★☆☆☆）

知识点 长链烷烃在高温并有催化剂的条件下分解成较小分子的过程叫作_____，产物可含较短链烷烃、烯烃和氢气。
核验裂解反应式时，分别计算反应式两侧碳、氢原子总数；反应前后每种原子的总数必须_____。
裂解后的产物分子应小于原来的长链分子；能否生成某物质，以产物中是否出现该物质并符合原子守恒为准。

答案：裂解；相等

怎么认 题目出现长链烷烃分解、裂解反应式或所求产物时，先分别数反应前后的碳、氢原子总数。

例题 1

What is the name of the process that forms alkenes from long chain alkanes?

A addition polymerisation

B cracking

C fractional distillation

D reduction

（2026 May/Jun · 0654/23 · Question 26 · Extended）

解：长链烷烃受热分解，生成含烯烃的较小分子，这一过程称为裂解（cracking）。
故选 B。

针对练习

1. Large alkane molecules are cracked to form smaller molecules.

Which equations represent cracking reactions?

1 $C_{18}H_{38} \rightarrow 2C_6H_{14} + C_6H_{12}$

2 $C_{18}H_{38} \rightarrow H_2 + 3C_6H_{12}$

3 $C_{15}H_{32} \rightarrow C_5H_{10} + 2C_5H_{12}$

4 $C_{15}H_{32} \rightarrow C_6H_{14} + C_5H_{10} + C_4H_8$

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2025 May/Jun · 0654/22 · Question 26 · Extended）

2. Three processes are listed.

1 cracking of hydrocarbons

2 combustion of methane

3 reaction of magnesium with steam

Which processes produce hydrogen?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

（2025 May/Jun · 0654/23 · Question 27 · Extended）

题型 11：用产物和链接区分加成与缩合聚合（考频★★★☆☆）

知识点 加成聚合由含 C=C 的不饱和单体形成，双键打开并连接成长链，只生成_____。
缩合聚合的单体具有两个能继续反应的官能团，连接成长链时还生成水等_____。
聚乙烯由乙烯加成聚合形成；尼龙链中含_____链接，聚酯链中含 –COO– 链接。

答案：一种聚合物；小分子；–CONH–

怎么认 题目出现 C=C、–CONH–、–COO– 或小分子产物时，先认链接，再判断聚合类型。

例题 1

Which statements about addition polymers and condensation polymers are correct?

1 Alkanes and alkenes form addition polymers.

2 Addition polymerisation forms only one product.

3 Condensation polymerisation forms a polymer and a small molecule.

4 Poly(ethene) is a condensation polymer.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2026 May/Jun · 0654/21 · Question 26 · Extended）

解：1 错，烷烃不含 C=C，不能形成加成聚合物；2 对，加成聚合只生成聚合物；3 对，缩合聚合生成聚合物和小分子；4 错，聚乙烯是加成聚合物。
正确的是 2 和 3，故选 C。

针对练习

1. Which statements about monomers and polymers are correct?

1 Different polymers can have different linkages between monomers.

2 An addition polymerisation reaction produces more than one type of polymer.

3 Addition polymers are made from saturated monomer molecules.

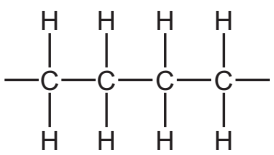
4 Nylon is a condensation polymer formed from two different monomers.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

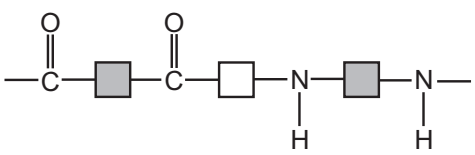
（2023 Oct/Nov · 0654/21 · Question 27 · Extended）

2. Which diagram represents the structure of nylon?

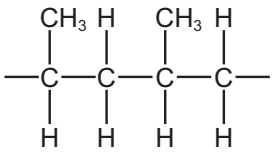
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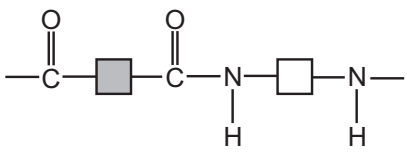
B



C



D



（2025 May/Jun · 0654/22 · Question 27 · Extended）

3. Which statement about polymerisation is correct?

A Addition polymerisation requires monomers from different homologous series.

B Condensation polymerisation produces a small molecule as well as a polymer.

C Polymerisation always produces polymers of the same chain length.

D The formation of poly(ethene) is by condensation polymerisation.

(2025 Oct/Nov · 0654/23 · Question 27 · Extended)

4. Poly(ethene) and nylon are two different types of polymer.

Which statement about these polymers is correct?

A Nylon is an addition polymer.

B The linkage between monomers in nylon is –CONH–.

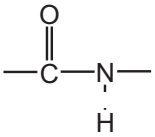
C Poly(ethene) and nylon are made from the same monomers.

D Poly(ethene) and nylon have the same linkages between their monomers.

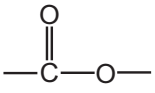
(2024 Oct/Nov · 0654/21 · Question 27 · Extended)

5. Which statement describes addition polymers?

A They contain long chains made from only one type of monomer.

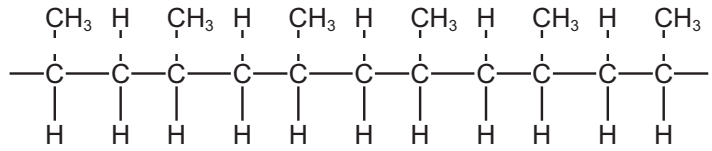
B They contain  links.

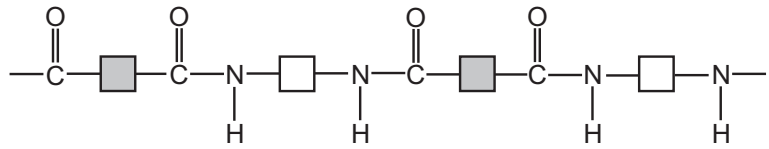
C They contain carbon-carbon double bonds.

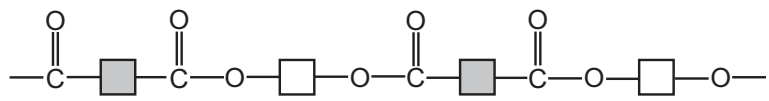
D They contain  links.

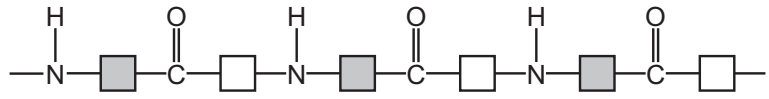
(2022 Oct/Nov · 0654/23 · Question 27 · Extended)

6. Which diagram represents the structure of nylon?

A 

B 

C 

D 

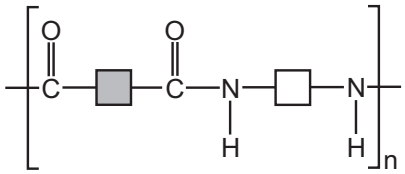
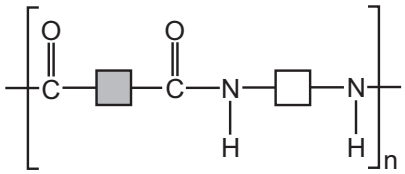
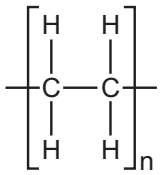
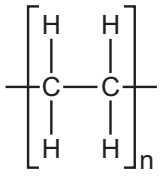
(2022 Oct/Nov · 0654/22 · Question 27 · Extended)

7. Which row about the formation of condensation polymers is correct?

	monomer description	product formation
A	contains C=C double bond	the condensation polymer only
B	contains C=C double bond	the condensation polymer and a small molecule
C	two different monomers used	the condensation polymer only
D	two different monomers used	the condensation polymer and a small molecule

(2023 Oct/Nov · 0654/22 · Question 27 · Extended)

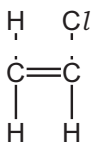
8. Which row shows the structure of poly(ethene) and the type of polymerisation used to make it?

	structure of polymer	type of polymerisation
A		addition
B		condensation
C		addition
D		condensation

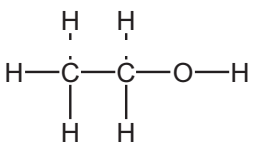
(2025 Feb/Mar · 0654/22 · Question 26 · Extended)

9. Which molecules can be used as monomers in polymerisation processes?

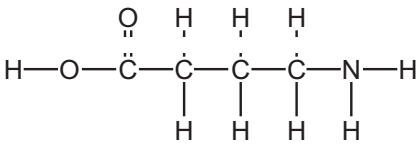
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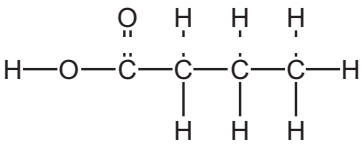
2



3



4



A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

(2024 May/Jun · 0654/21 · Question 27 · Extended)

题型 12：打开单体双键画加成聚合物链（考频★★★☆☆）

知识点 烯烃单体发生加成聚合时，$C=C$ 中的一条键打开，许多单体连接成长链，生成加成聚合物。画结构时，先圈出双键上的两个碳原子，将 $C=C$ 改为主链中的 _____，并使主链两端继续伸展。每个双键碳原子原有的氢原子和侧基均 _____；每个主链碳原子仍形成 _____ 条共价键。

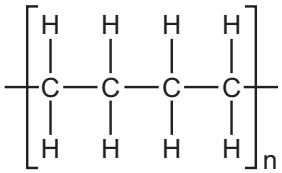
答案：碳碳单键；保留在原碳原子上；四

怎么认 题目出现含 $C=C$ 的单体结构并要求判断加成聚合物时，先圈出双键上的两个碳原子。

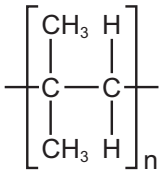
例题 1

What is the structure of the addition polymer formed from but-2-ene?

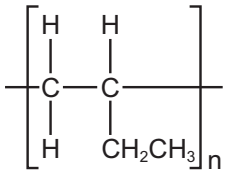
A



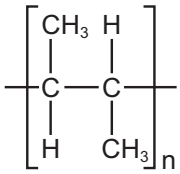
B



C



D



（2023 May/Jun · 0654/23 · Question 27 · Extended）

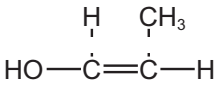
解：丁-2-烯可写为 $CH_3-CH=CH-CH_3$。

打开 $C=C$ 后，双键上的两个碳原子进入单键主链，两个 CH_3 分别保留在原碳原子上，重复单元为 $[-CH(CH_3)-CH(CH_3)-]_n$。

图中 D 的每个主链碳原子各连接一个 H 和一个 CH_3。故选 D。

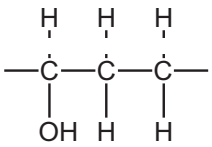
针对练习

1. The structure of a monomer is shown.

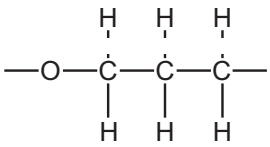


Which structure represents a section of the addition polymer that is formed from this monomer?

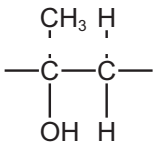
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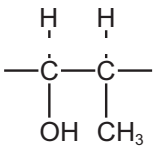
B



C

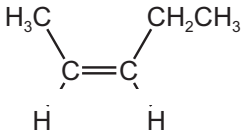


D



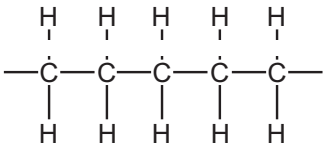
（2024 May/Jun · 0654/23 · Question 27 · Extended）

2. The structure of a monomer is shown.

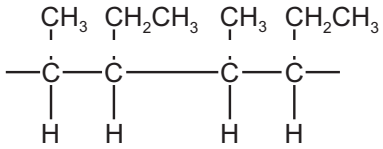


Which diagram represents the structure of the polymer formed from this monomer by addition polymerisation?

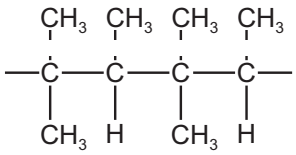
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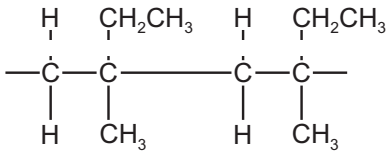
B



C

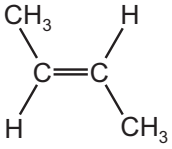


D



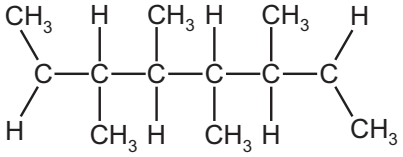
(2022 May/Jun · 0654/22 · Question 27 · Extended)

3. The structure of a monomer is shown.

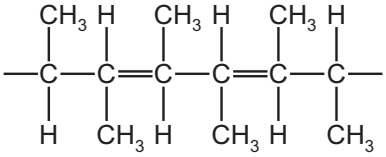


Which structure represents the addition polymer formed by this monomer?

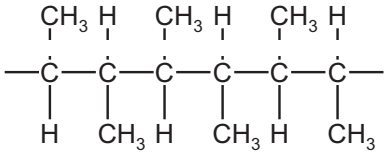
A



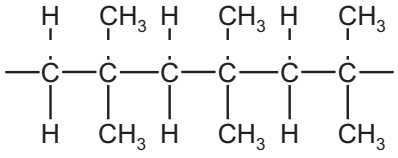
B



C



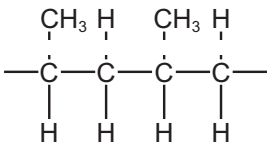
D



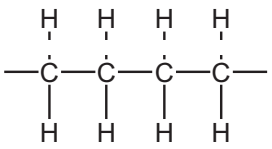
(2022 May/Jun · 0654/23 · Question 27 · Extended)

4. Which structure represents the addition polymer made from the monomer propene, C_3H_6?

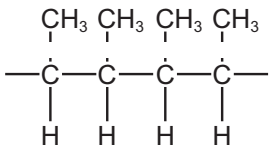
A



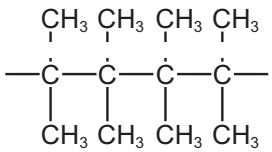
B



C

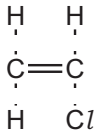


D



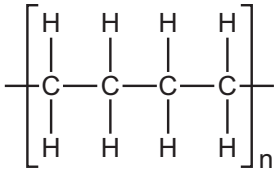
(2023 May/Jun · 0654/21 · Question 27 · Extended)

5. The structure of the monomer chloroethene is shown.

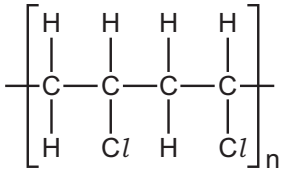


What is the structure of the polymer formed from this monomer?

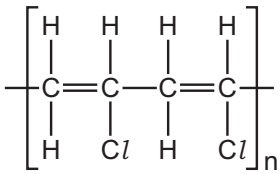
A



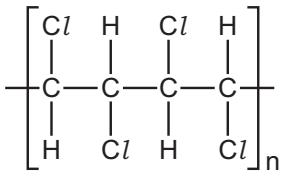
B



C

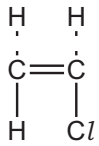


D



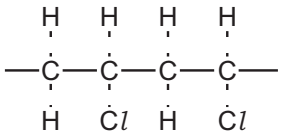
(2022 Oct/Nov · 0654/21 · Question 27 · Extended)

6. The structure of the monomer chloroethene is shown.

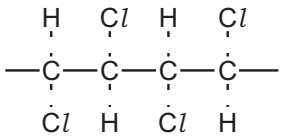


What is a part of the structure of the addition polymer formed from this monomer?

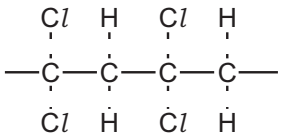
A



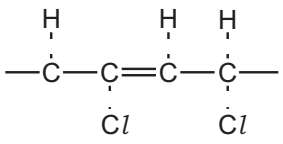
B



C



D



（2023 Oct/Nov · 0654/23 · Question 27 · Extended）

题型 13：由碳链长度比较馏分和烷烃物性（考频★★☆☆☆）

知识点 石油分馏按沸点范围分离各馏分；分馏塔底部温度较高，收集沸点较高的馏分。

同系列烷烃的碳链越长，分子越_____，相对分子质量越大，分子间作用力越_____。

因此碳链越长，沸点越高、挥发性越小、黏度越大、可燃性越低；相同条件下相同时间内蒸发损失的质量越_____。

烷烃的通式为 C_nH_{2n+2}；完全燃烧生成二氧化碳和水。

以上比较在同系列烃且条件相同时成立；相对分子质量没有单位，沸点常用 °C。

答案：大；强；少

怎么认 题目出现烷烃的碳原子数、不同石油馏分或沸点与蒸发比较时，先比较碳链长度。

例题 1

Petroleum is a mixture of hydrocarbons which is separated into fractions by fractional distillation.

Which statements describe the fraction collected at the bottom of the fractionating column?

1 It contains the smallest molecules.

2 It has the weakest forces between molecules.

3 It is the most viscous.

4 It is the least flammable.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

（2022 May/Jun · 0654/23 · Question 26 · Extended）

解：分馏塔底部温度最高，收集碳链较长、分子较大的高沸点馏分。

碳链较长，分子间作用力较强，故黏度最大、可燃性最低，3、4 正确。

故选 D。

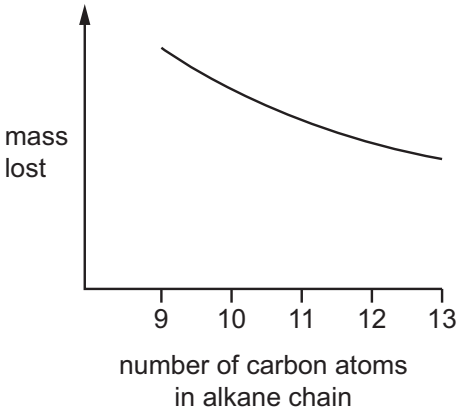
针对练习

1. The same mass of five different alkanes are left to evaporate under identical conditions.

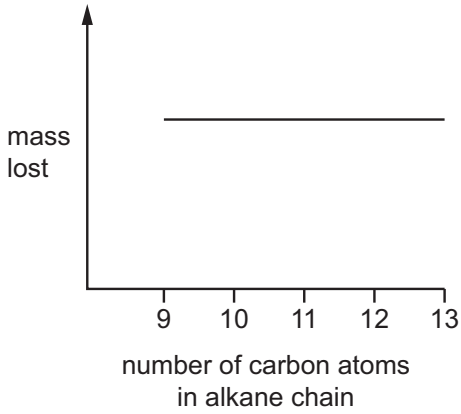
The mass lost by each alkane in one day is measured.

Which graph shows the mass lost against the number of carbon atoms in each alkane chain?

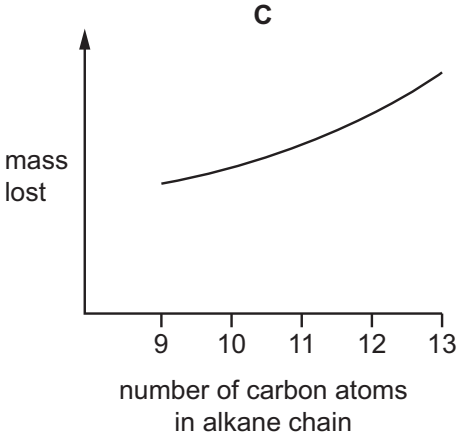
A



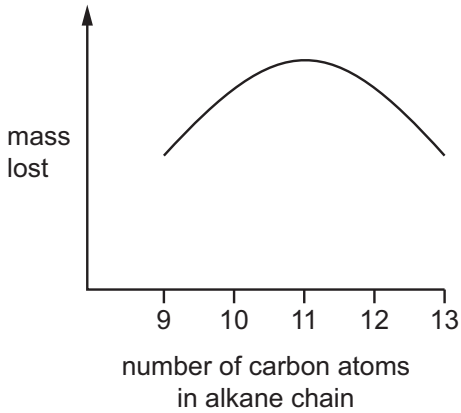
B



C



D



（2022 May/Jun · 0654/21 · Question 26 · Extended）

2. A gasoline fraction from the fractional distillation of petroleum includes compounds with the formulas C_6H_{14} and $C_{12}H_{26}$.

Which statements about these compounds are correct?

1 $C_{12}H_{26}$ has a higher boiling point than C_6H_{14}.

2 $C_{12}H_{26}$ has a lower relative molecular mass than C_6H_{14}.

3 C_6H_{14} and $C_{12}H_{26}$ are members of different homologous series.

4 C_6H_{14} and $C_{12}H_{26}$ both undergo complete combustion to form carbon dioxide and water.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2024 May/Jun · 0654/22 · Question 26 · Extended）

3. Gasoline and diesel oil are fractions obtained by the fractional distillation of petroleum.

Which row about gasoline and diesel oil is correct?

	temperature at which the fraction is collected	size of molecules in the fraction
A	gasoline higher than diesel oil	gasoline larger than diesel oil
B	gasoline higher than diesel oil	gasoline smaller than diesel oil
C	diesel oil higher than gasoline	diesel oil larger than gasoline
D	diesel oil higher than gasoline	diesel oil smaller than gasoline

（2025 Oct/Nov · 0654/21 · Question 23 · Extended）

题型 14：从加成重复单元反推烯烃单体（考频★☆☆☆☆）

知识点 烯烃发生加成聚合时，碳碳双键打开，相邻单体彼此连接，生成_____，反应中没有小分子脱去。

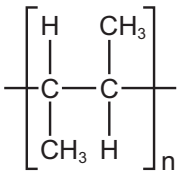
由重复单元反推单体时，保留两个主链碳原子上的_____，再把两碳原子之间的单键还原为_____。

此方法适用于碳主链由烯烃双键加成形成的聚合物；结构式无单位。

答案：加成聚合物；侧基；碳碳双键

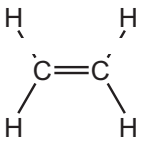
怎么认 题目出现加成聚合物的重复单元并要求单体时，先保留侧基，再把主链两碳间单键还原为双键。

例题 1 The structure of an addition polymer is shown.

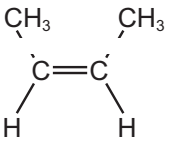


Which monomer is used to make this polymer?

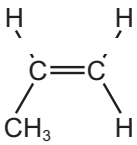
A



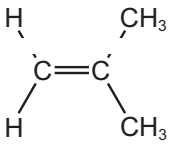
B



C



D



（2023 May/Jun · 0654/22 · Question 27 · Extended）

解： 重复单元中两个主链碳原子各连接一个 H 和一个 CH_3，保留这些侧基。

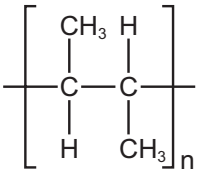
将两个主链碳原子之间的单键还原为双键，得单体

$CH_3-CH=CH-CH_3$

故选 B。

针对练习

1. A section of polymer X is shown.



Which statement about X is correct?

A It is a condensation polymer made from but-1-ene.

B It is an addition polymer made from but-1-ene.

C It is a condensation polymer made from but-2-ene.

D It is an addition polymer made from but-2-ene.

（2025 Oct/Nov · 0654/21 · Question 25 · Extended）

题型 15：在分子中逐个计数酰胺链接（考频★☆☆☆☆）

知识点 酰胺链接由羰基碳与氮原子相连构成，可写为 C(=O)-N。

每出现一处 _____，记作一处酰胺链接；同一组相连原子只计一次。

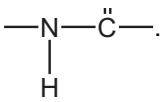
羧基中的 C=O 若没有连接氮，或氮没有连接羰基碳，均_____酰胺链接。

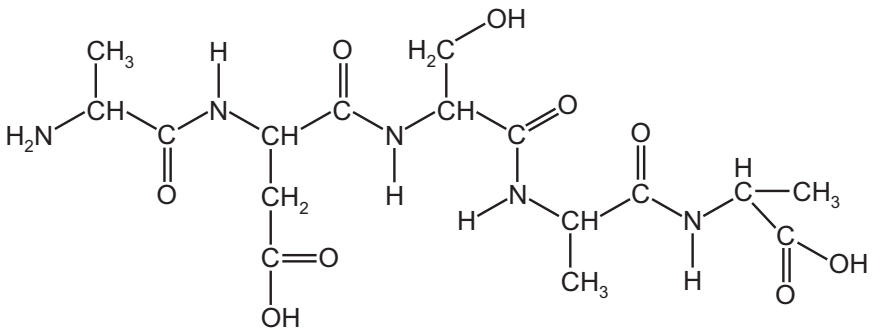
酰胺链接的个数为非负整数，没有单位。

答案：羰基碳以单键连接氮原子的结构；不属于

怎么认 题目出现含多个羰基和氮的结构式并求酰胺链接数时，先逐处圈出 C(=O)-N。

例题 1

The molecule shown contains some amide linkages, .



How many amide linkages are present in this molecule?

A 4 **B** 5 **C** 6 **D** 9

（2024 May/Jun · 0654/22 · Question 27 · Extended）

解： 酰胺链接要求羰基碳以单键连接氮原子。

沿分子主链从左向右，每遇到一处 C(=O)-N 记 1 个，共有

$1+1+1+1=4$

支链羧基和末端羧基中的 C=O 均没有连接氮，左端氨基中的氮也没有连接羰基碳，均不计入。

故选 A。

1.14 分离、色谱、滴定与定性分析

题型 1：用颜色变化检验水及水合状态（考频★★★★☆）

知识点 检验水时，硫酸铜或氯化钴必须处于无水状态，颜色变化才可作为检验依据。

无水硫酸铜为_____色，遇水变为_____色；无水氯化钴为蓝色，遇水变为_____色。

向白色无水硫酸铜中加水可使其变蓝，加热不能产生这一变化。

上述颜色变化证明样品中含水，不能据此判断其酸碱性或纯度。

答案：白；蓝；粉红

怎么认 题目出现白色硫酸铜、蓝色氯化钴或加水后的颜色时，先确认试剂是否无水，再写对应颜色变化。

例题 1

Which substance turns blue when it is added to pure water?

A anhydrous copper(II) sulfate

B anhydrous cobalt(II) chloride

C red litmus

D universal indicator

（2022 Oct/Nov · 0654/13 · Question 25 · Core）

解：无水硫酸铜为白色，加入纯水后形成水合硫酸铜，颜色由白色变为蓝色。

故选 A。

针对练习

1. Which statement describes a chemical test for water?

A Add blue cobalt(II) chloride.

B Add blue copper(II) sulfate.

C Measure the boiling point.

D Use universal indicator.

（2023 May/Jun · 0654/11 · Question 23 · Core）

2. Which colours are observed when water is added to white copper(II) sulfate and to blue cobalt(II) chloride?

	copper(II) sulfate	cobalt(II) chloride
A	white	pink
B	white	white
C	blue	pink
D	blue	white

（2024 Feb/Mar · 0654/12 · Question 25 · Core）

3. Which colour change is observed when water is added to anhydrous cobalt(II) chloride?

A blue to pink

B blue to white

C pink to blue

D white to blue

（2026 May/Jun · 0654/21 · Question 23 · Extended）

4. Which colour change is observed when water is tested using copper(II) sulfate?

A blue → pink

B blue → white

C white → blue

D white → pink

（2022 May/Jun · 0654/12 · Question 25 · Core；同题：2022 May/Jun · 0654/13 · Question 25 · Core）

5. Which row shows the colour of copper(II) sulfate and of cobalt(II) chloride when they are added to water?

	copper(II) sulfate	cobalt(II) chloride
A	blue	blue
B	blue	pink
C	white	blue
D	white	pink

（2025 May/Jun · 0654/12 · Question 22 · Core；同题：2025 May/Jun · 0654/13 · Question 22 · Core）

6. Which row shows the conditions that each turn a sample of white copper(II) sulfate blue?

	add water	heat
A	✗	✗
B	✗	✓
C	✓	✓
D	✓	✗

（2025 May/Jun · 0654/23 · Question 23 · Extended）

7. In a test for water, water turns anhydrous copper(II) 1 from 2 to 3 .

Which words complete gaps 1, 2 and 3?

	1	2	3
A	chloride	blue	white
B	chloride	white	blue
C	sulfate	blue	white
D	sulfate	white	blue

（2024 Oct/Nov · 0654/21 · Question 25 · Extended）

8. Anhydrous cobalt(II) chloride changes colour when water is added.

Which row shows the colour before and after water is added?

	before	after
A	blue	pink
B	blue	white
C	white	blue
D	white	pink

(2022 Feb/Mar · 0654/12 · Question 24 · Core)

9. A colourless liquid is tested with blue cobalt(II) chloride paper.

The blue paper turns pink.

What does this test prove that the liquid contains?

A an acid

B an alkali

C ethanol

D water

(2024 Oct/Nov · 0654/11 · Question 26 · Core)

10. Which row describes the colour changes when water is added to anhydrous copper(II) sulfate and to anhydrous cobalt(II) chloride?

	copper(II) sulfate	cobalt(II) chloride
A	blue → white	blue → pink
B	blue → white	pink → blue
C	white → blue	blue → pink
D	white → blue	pink → blue

(2025 Oct/Nov · 0654/23 · Question 22 · Extended)

11. Water is tested with white copper(II) sulfate powder and with blue cobalt(II) chloride paper.

Which row shows the results of the tests?

	copper(II) sulfate	cobalt(II) chloride
A	turns blue	stays blue
B	turns blue	turns pink
C	stays white	turns pink
D	stays white	stays blue

(2022 Oct/Nov · 0654/11 · Question 25 · Core)

12. Water is added separately to anhydrous cobalt(II) chloride and to anhydrous copper(II) sulfate.

Which row describes the colour changes?

	with anhydrous cobalt(II) chloride	with anhydrous copper(II) sulfate
A	blue to pink	white to blue
B	blue to pink	blue to white
C	pink to blue	white to blue
D	pink to blue	blue to white

(2026 May/Jun · 0654/11 · Question 23 · Core)

13. Which row shows a chemical test for the presence of water?

	substance	colour change
A	anhydrous cobalt(II) chloride	pink to blue
B	anhydrous cobalt(II) chloride	white to blue
C	anhydrous copper(II) sulfate	pink to blue
D	anhydrous copper(II) sulfate	white to blue

(2026 May/Jun · 0654/22 · Question 25 · Extended)

14. Copper(II) sulfate and cobalt(II) chloride are used to test for water.

Which rows show the colour changes for these two substances?

	substance	initial colour	final colour
1	cobalt(II) chloride	blue	pink
2	cobalt(II) chloride	pink	blue
3	copper(II) sulfate	blue	white
4	copper(II) sulfate	white	blue

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

(2024 May/Jun · 0654/23 · Question 24 · Extended)

15. Four liquids are tested with universal indicator and with anhydrous copper(II) sulfate.

Which row shows the observations for pure water?

	universal indicator	anhydrous copper(II) sulfate
A	turns blue	turns blue
B	turns blue	turns white
C	turns green	turns blue
D	turns green	turns white

(2025 May/Jun · 0654/11 · Question 23 · Core)

16. Four watch-glasses contain solid salts as shown.



blue copper(II) sulfate	white copper(II) sulfate	blue cobalt(II) chloride	pink cobalt(II) chloride

Water is added to each salt.

Which statement describes the salt solutions that form?

A They are blue or pink only.

B They are white or blue only.

C They are all pink.

D They are all blue.

（2023 Feb/Mar · 0654/12 · Question 25 · Core；同题：2023 Feb/Mar · 0654/22 · Question 25 · Extended）

题型 2：按挥发性与沸点选择简单或分馏（考频★★★☆☆）

知识点 蒸馏利用混合物中各成分_____不同，先使较易挥发的成分汽化，再冷凝并收集液体。从含不挥发性溶质的溶液中取得溶剂，用_____；把多种互溶液体按沸点范围分开，用_____。分馏柱使蒸气反复汽化和冷凝，适用于多种互溶液体或沸点较接近的液体；沸点常用 °C 表示。

答案：沸点；简单蒸馏；分馏

怎么认 题目出现回收溶剂、分开互溶液体或分馏装置时，先判断各成分的挥发性和沸点差异。

例题 1

Which process is used to obtain water from a salt solution?

A chromatography

B crystallisation

C distillation

D filtration

（2024 May/Jun · 0654/23 · Question 14 · Extended）

解： 盐是溶解在水中的不挥发性溶质，水受热后汽化。
水蒸气经冷凝成为液态水并被收集，盐留在烧瓶中，所用过程为蒸馏。
故选 C。

针对练习

1. Which method is used to separate a mixture of liquids?

A chromatography

B crystallisation

C fractional distillation

D filtration

（2026 May/Jun · 0654/11 · Question 27 · Core）

2. Which process is used to separate petroleum into useful substances?

A chromatography

B crystallisation

C filtration

D fractional distillation

（2026 May/Jun · 0654/12 · Question 27 · Core）

3. Which process is used to separate petroleum into useful products?

A cracking

B filtration

C fractional distillation

D thermal decomposition

（2023 Oct/Nov · 0654/12 · Question 26 · Core）

4. A mixture contains solid P dissolved in liquid Q.

Which process is used to obtain a pure sample of liquid Q from this mixture?

A crystallisation

B distillation

C evaporation

D paper chromatography

（2022 May/Jun · 0654/11 · Question 14 · Core；同题：2022 May/Jun · 0654/21 · Question 14 · Extended）

5. Which property allows petroleum to be separated by fractional distillation?

A boiling point

B colour

C density

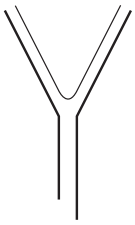
D melting point

（2025 May/Jun · 0654/12 · Question 24 · Core；同题：2025 May/Jun · 0654/13 · Question 24 · Core）

6. Hexane and octane are liquid hydrocarbons that mix together.

Which apparatus is used to separate a mixture of these two liquids?

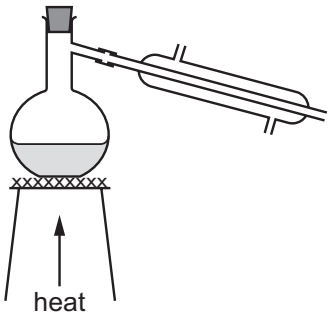
A



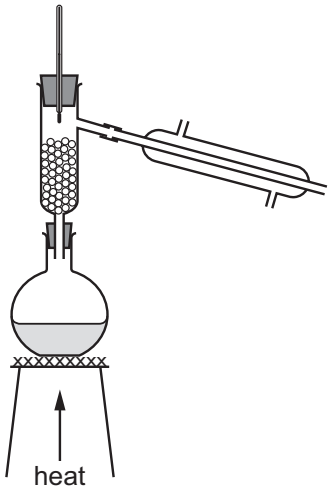
B



C

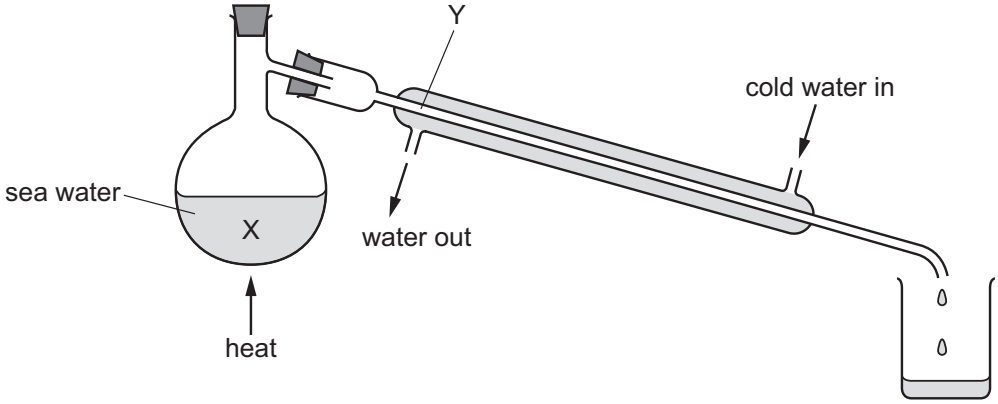


D



（2023 May/Jun · 0654/12 · Question 14 · Core；同题：2023 May/Jun · 0654/13 · Question 14 · Core、2023 May/Jun · 0654/22 · Question 14 · Extended）

7. Sea water is heated in the apparatus shown.



Which row describes changes at positions X and Y?

	at X	at Y
A	concentration of solution decreases	solvent condenses
B	concentration of solution decreases	solute condenses
C	concentration of solution increases	solvent condenses
D	concentration of solution increases	solute condenses

（2024 Oct/Nov · 0654/21 · Question 14 · Extended）

题型 3：按气体检验或受热生成气体识别气体（考频★★★☆☆）

知识点 气体检验是在规定条件下，根据气体与试纸、试剂或木条作用时的特征现象确定气体种类。

氨气使湿润红色石蕊试纸变_____色；氯气使湿润蓝色石蕊试纸先变红，随后漂白。

二氧化碳使石灰水变_____；氧气使带火星木条复燃，氢气遇燃着的木条发出爆鸣声。

葡萄糖发酵生成乙醇和二氧化碳，乙醇可作溶剂，二氧化碳可用石灰水检验。

绿色碳酸铜受热分解，生成黑色_____和二氧化碳。

答案：蓝；浑浊；氧化铜

怎么认 题目出现湿润石蕊试纸、石灰水、木条现象或受热产物时，先把现象与气体匹配，再核对反应来源。

例题 1

Which substance changes the colour of damp red litmus?

A CO_2　　**B** Cl_2　　**C** H_2　　**D** SO_2

（2022 May/Jun · 0654/23 · Question 19 · Extended）

解：氯气能漂白湿润的石蕊试纸，使红色变为白色。二氧化碳和二氧化硫显酸性，不改变红色石蕊试纸的颜色；氢气也不改变其颜色。

故选 B。

针对练习

1. Which gas turns damp red litmus paper blue?

A ammonia

B carbon dioxide

C chlorine

D hydrogen

（2025 Feb/Mar · 0654/12 · Question 27 · Core）

2. Gas X turns limewater milky.

What is X?

A carbon dioxide

B chlorine

C hydrogen

D oxygen

（2024 May/Jun · 0654/23 · Question 20 · Extended）

3. A piece of damp blue litmus paper is put in a test-tube of a gas. The litmus paper turns red and then changes to white.

What is the gas?

A ammonia

B carbon dioxide

C chlorine

D oxygen

（2023 Oct/Nov · 0654/13 · Question 20 · Core；同题：2023 Oct/Nov · 0654/23 · Question 20 · Extended）

4. What is used to test for ammonia gas?

A a lighted splint

B aqueous sodium hydroxide

C damp red litmus paper

D limewater

（2024 Feb/Mar · 0654/22 · Question 21 · Extended）

5. During fermentation, an organic liquid and a colourless gas are produced.

Which row identifies a use for the liquid and describes the result of a test on the colourless gas?

	use for the liquid	gas test result
A	monomer in addition polymerisation reactions	turns limewater milky
B	monomer in addition polymerisation reactions	relights glowing splint
C	solvent	turns limewater milky
D	solvent	relights glowing splint

（2023 Feb/Mar · 0654/22 · Question 27 · Extended）

6. Green copper(II) carbonate is heated. A black powder is formed and a gas is produced which turns limewater cloudy.

Which word equation is correct?

A copper(II) carbonate → copper + carbon + oxygen

B copper(II) carbonate → copper(II) oxide + carbon monoxide

C copper(II) carbonate → copper(II) oxide + carbon dioxide

D copper(II) carbonate → copper + carbon dioxide

（2026 May/Jun · 0654/11 · Question 15 · Core）

题型 4：用沉淀颜色与过量试剂辨认离子（考频★★★☆☆）

知识点 定性分析是根据加入试剂后的沉淀颜色、气体和沉淀在过量试剂中的变化，判断溶液中离子种类的方法。

加入氢氧化钠溶液时，Fe^{2+} 生成_____沉淀，Fe^{3+} 生成红棕色沉淀，Cu^{2+} 生成淡蓝色沉淀，Zn^{2+} 生成白色沉淀。

加入酸化硝酸银溶液时，Cl^- 生成白色沉淀，Br^- 生成_____沉淀；酸化后加入钡离子时，SO_4^{2-} 生成白色沉淀。

加入氨水时，Cu^{2+} 先生成淡蓝色沉淀，Zn^{2+} 先生成白色沉淀，两种沉淀均能在过量氨水中_____；碳酸根离子与稀盐酸反应只放出二氧化碳。

沉淀颜色、气体和溶解现象均为定性现象，不带单位。

答案：绿色；奶油色；溶解

怎么认 题目出现所加试剂、沉淀颜色或过量后的变化时，先看试剂，再对照颜色与溶解性。

例题 1

Substance X is mixed with aqueous sodium hydroxide.

A green precipitate is produced.

Which metal ion is present in X?

A Cu^{2+} **B** Fe^{2+} **C** Fe^{3+} **D** Zn^{2+}

（2023 Oct/Nov · 0654/11 · Question 21 · Core；同题：2023 Oct/Nov · 0654/21 · Question 21 · Extended）

解：由氢氧化钠溶液检验阳离子的现象，绿色沉淀为氢氧化亚铁，故 X 中含 Fe^{2+}。
故选 B。

针对练习

1. Acidified aqueous silver nitrate is added to a solution.

Which ion causes a white precipitate to form?

A chloride ions, Cl^-

B copper ions, Cu^{2+}

C hydroxide ions, OH^-

D sodium ions, Na^+

（2025 Oct/Nov · 0654/12 · Question 27 · Core；同题：2025 Oct/Nov · 0654/13 · Question 27 · Core）

2. A student tests an aqueous solution for the presence of sulfate ions.

What is the test and observation for sulfate ions?

A Acidify the solution and add aqueous barium ions to produce a white precipitate.

B Acidify the solution and add aqueous silver ions to produce a cream precipitate.

C Add aqueous iron(III) ions to produce a brown precipitate.

D Add aqueous copper(II) ions to produce a pale blue precipitate.

（2024 Oct/Nov · 0654/22 · Question 20 · Extended）

3. Which test and its result identifies aqueous bromide ions?

A adding acidified aqueous silver nitrate forming a cream precipitate

B adding acidified aqueous silver nitrate forming a white precipitate

C adding aluminium foil and heating with sodium hydroxide forming a gas that turns red litmus paper blue

D adding dilute acid forming a gas that produces a white precipitate when bubbled through limewater

（2022 Feb/Mar · 0654/12 · Question 19 · Core；同题：2022 Feb/Mar · 0654/22 · Question 19 · Extended）

4. Which chemical test does **not** produce a precipitate?

A carbon dioxide and limewater

B carbonate ions and dilute hydrochloric acid

C chloride ions and aqueous silver nitrate

D copper(II) ions and aqueous sodium hydroxide

（2024 Oct/Nov · 0654/12 · Question 21 · Core；同题：2024 Oct/Nov · 0654/13 · Question 21 · Core）

5. Aqueous ammonia is separately added dropwise and then in excess to four different aqueous cations.

Which cations give a precipitate that then dissolves?

1 Ca^{2+}

2 Cu^{2+}

3 Fe^{2+}

4 Zn^{2+}

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2025 May/Jun · 0654/11 · Question 27 · Core）

题型 5：用热碱释放氨检验铵根离子（考频★★☆☆☆）

知识点 铵根离子与强碱中的氢氧根离子反应，生成氨和水；离子反应为 $NH_4^+ + OH^- = NH_3 + H_2O$。

检验铵根离子时，将待测盐与_____混合并加热，逸出的氨使湿润的_____石蕊试纸变蓝。

氨溶于湿润试纸上的水后呈碱性；湿润的蓝色石蕊试纸保持蓝色。

答案：氢氧化钠溶液；红色

怎么认 题目出现铵盐与氢氧化钠或氢氧化钾加热、并检验所得气体时，先判断生成氨。

例题 1

What is warmed with a salt to test for ammonium ions?

A aqueous barium chloride

B aqueous litmus

C aqueous silver nitrate

D aqueous sodium hydroxide

（2024 Oct/Nov · 0654/23 · Question 21 · Extended）

解：检验铵根离子时，将待测盐与氢氧化钠溶液混合并加热：

$NH_4^+ + OH^- = NH_3 + H_2O$。

生成的氨能使湿润的红色石蕊试纸变蓝，故选 D。

针对练习

1. Ammonia is displaced from its salts by reaction with substance Z.

Which row identifies substance Z and the test for ammonia?

	substance Z	test for ammonia
A	hydrochloric acid	turns red litmus blue
B	hydrochloric acid	turns blue litmus red
C	sodium hydroxide	turns red litmus blue
D	sodium hydroxide	turns blue litmus red

（2024 May/Jun · 0654/22 · Question 23 · Extended）

2. When aqueous potassium hydroxide is warmed with ammonium chloride, a gas is given off.

Which test result identifies the gas?

A It bleaches pH paper.

B It turns anhydrous cobalt(II) chloride blue.

C It turns universal indicator red.

D It turns red litmus blue.

（2022 May/Jun · 0654/12 · Question 20 · Core；同题：2022 May/Jun · 0654/13 · Question 20 · Core、2022 May/Jun · 0654/22 · Question 19 · Extended）

3. Ammonium chloride is mixed with aqueous sodium hydroxide and heated. A gas is produced.

The gas is tested with damp blue and damp red litmus paper.

Which row shows the observations?

	blue litmus	red litmus
A	bleached	bleached
B	turns red	unchanged
C	unchanged	turns blue
D	unchanged	unchanged

（2026 Feb/Mar · 0654/12 · Question 27 · Core）

题型 6：用过滤与结晶分开不溶和可溶固体（考频★★☆☆☆）

知识点 过滤用于分离不溶性固体和液体；滤纸上留下的固体称为_____，通过滤纸的液体称为_____。

当一种固体不溶于水、另一种固体可溶于水时，加水搅拌后过滤，不溶性固体留在滤纸上，可溶性固体留在滤液中。

要取得滤液中的可溶性固体，应蒸发部分水使溶液浓缩，再冷却，使溶质_____析出。

答案：滤渣；滤液；结晶

怎么认 题目出现沉淀，或一种物质不溶而另一种物质溶于水时，先过滤，再从滤液中结晶。

例题 1

When aqueous copper(II) sulfate reacts with aqueous sodium hydroxide, a blue precipitate forms.

Which method is used to remove the precipitate from the reaction mixture?

A chromatography

B distillation

C filtration

D crystallisation

（2025 May/Jun · 0654/12 · Question 27 · Core；同题：2025 May/Jun · 0654/13 · Question 27 · Core）

解：由反应生成蓝色沉淀，得反应混合物中含有不溶性固体。

过滤可使沉淀留在滤纸上，并使液体通过滤纸。故选 C。

针对练习

1. A sample of water contains two useful substances, insoluble chalk and a soluble salt.

Which two processes are used to individually separate the insoluble chalk from the soluble salt and from the water?

A distillation and chromatography

B distillation and crystallisation

C filtration and chromatography

D filtration and crystallisation

（2023 Oct/Nov · 0654/12 · Question 14 · Core；同题：2023 Oct/Nov · 0654/22 · Question 14 · Extended）

2. A mixture of solid sulfur and solid sodium chloride is added to water and stirred.

Sulfur is insoluble in water.

Sodium chloride is soluble in water.

Which processes are used to obtain pure sodium chloride from the mixture?

A distillation then chromatography

B distillation then crystallisation

C filtration then chromatography

D filtration then crystallisation

（2023 May/Jun · 0654/23 · Question 14 · Extended）

题型 7：按读数需求选择量取液体或收集气体的仪器（考频★☆☆☆☆）

知识点 量取仪器的选择由测量对象和读数方式决定；液体和气体的体积通常以 cm^3 为单位。

测量液体体积的变化时，用有细密刻度和活塞的_____，由末读数减初读数得到放出液体的体积。

反应连续生成气体时，用能收集气体并带有刻度的_____；移液管用于量取固定体积，不能连续读数。

答案：滴定管；气体注射器

怎么认 题目出现液体体积变化或连续产气并要求测体积时，先判断测量对象，再看刻度与装置功能。

例题 1

Hydrogen gas is given off when zinc reacts with dilute sulfuric acid.

Which piece of apparatus is used to collect the hydrogen gas and measure its volume?

A balance

B gas syringe

C pipette

D test-tube

（2024 May/Jun · 0654/12 · Question 18 · Core；同题：2024 May/Jun · 0654/13 · Question 18 · Core）

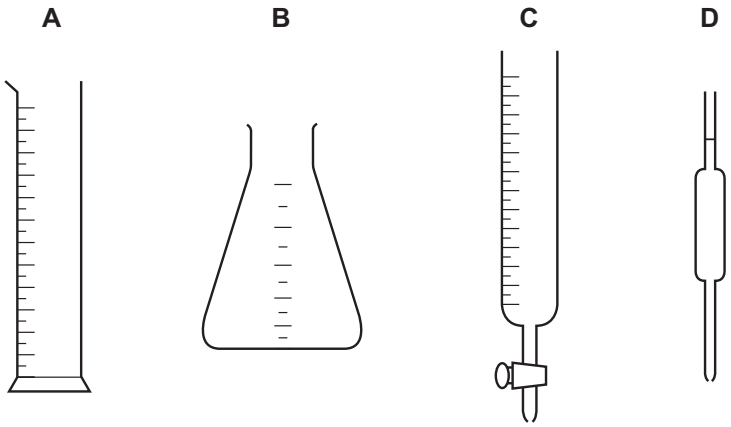
解：反应连续生成氢气，需要在收集气体的同时读出其体积。

气体注射器能收集气体，筒身刻度可读出气体体积。

故选 B。

针对练习

1. Which piece of apparatus is used to measure the change in the volume of a liquid most accurately?



（2022 May/Jun · 0654/12 · Question 14 · Core；同题：2022 May/Jun · 0654/13 · Question 14 · Core、2022 May/Jun · 0654/22 · Question 14 · Extended）

题型 8：用熔沸点范围或加热曲线判纯度（考频★☆☆☆☆）

知识点 纯净物在一定压强下有固定的_____和_____，温度常用单位为 °C。

混合物通常在一个温度范围内熔化或沸腾，不具有固定的相变温度。

加热曲线中，纯净物熔化时温度保持不变，形成水平平台；不纯固体熔化时温度仍会变化。

答案：熔点；沸点

怎么认 题目出现熔沸点数据或加热曲线并判断纯度时，先看相变温度是否固定或有无水平平台。

例题 1

A student measures the melting points and boiling points of samples of water.

The results are shown.

sample	temperature / °C
1	100
2	102
3	−6
4	0

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Which samples of water are impure?

A 1 and 4 **B** 2 and 3 **C** 2 only **D** 3 only

（2026 May/Jun · 0654/12 · Question 24 · Core）

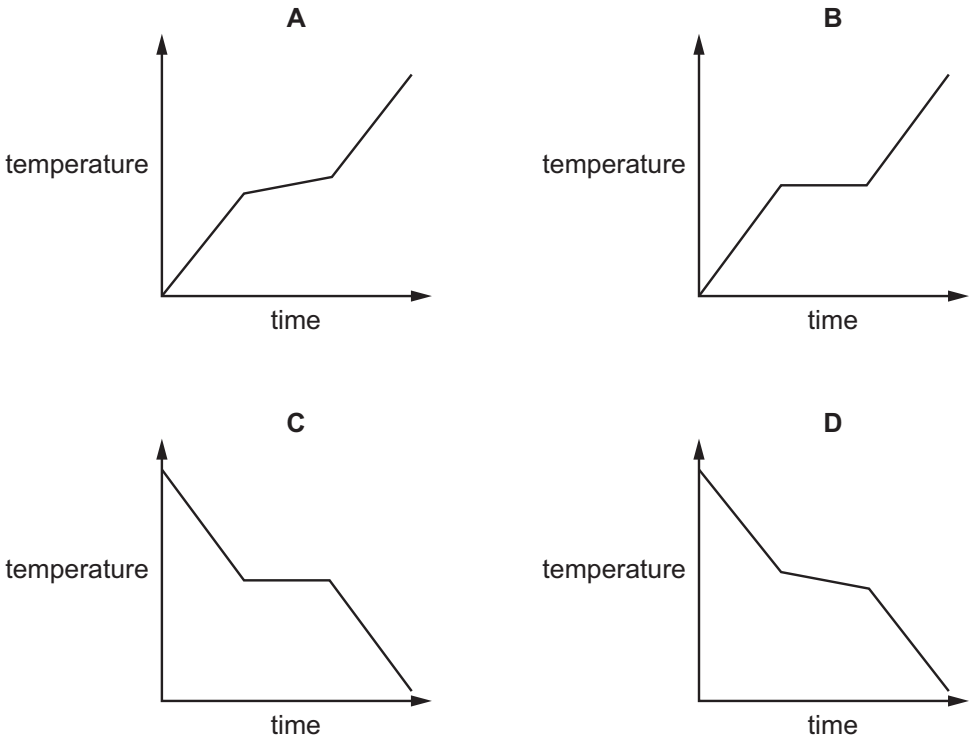
解：在一定压强下，纯水的沸点为 100 °C，熔点为 0 °C。

样品 1 和 4 的测量值分别符合纯水的沸点和熔点；样品 2 的沸点为 102 °C，样品 3 的熔点为 −6 °C，均不是纯水的固定相变温度。

所以不纯的水样品是 2 和 3。故选 B。

针对练习

1. Which graph shows the temperature change when an impure, solid substance is heated?



（2025 May/Jun · 0654/21 · Question 14 · Extended）

题型 9：根据碱性与指示剂颜色选择检验结果（考频★☆☆☆☆）

知识点 酸碱指示剂在不同酸碱性的溶液中显示不同颜色。

溶液呈碱性时，石蕊显_____色，甲基橙显_____色。

指示剂需分别检验；颜色没有单位。

答案：蓝；黄

怎么认 题目出现碱或氢氧化钠与石蕊、甲基橙的颜色表格时，先确认指示剂，再配碱性颜色。

例题 1

Which row describes the colour observed when sodium hydroxide is added separately to litmus and to methyl orange indicators?

	litmus	methyl orange
A	red	yellow
B	blue	yellow
C	red	red
D	blue	red

（2026 May/Jun · 0654/12 · Question 20 · Core）

解：由氢氧化钠为碱，得其水溶液呈碱性。

碱性溶液使石蕊显蓝色，使甲基橙显黄色。

表中符合的是 B 行，故选 B。

针对练习

1. An aqueous solution of an alkali is tested separately with litmus and methyl orange indicators.

Which row is correct?

	colour with litmus	colour with methyl orange
A	blue	red
B	red	yellow
C	blue	yellow
D	red	red

（2026 Feb/Mar · 0654/22 · Question 20 · Extended）

题型 10：按火焰颜色识别金属离子（考频★☆☆☆☆）

知识点 火焰检验利用某些金属离子在火焰中呈现的特征颜色进行鉴别。

进行火焰检验时，锂的焰色为_____，钠的焰色为_____，钾的焰色为_____。

答案：红色；黄色；淡紫色

怎么认 题目出现火焰检验及焰色或金属名称时，先按锂红、钠黄、钾淡紫对应。

例题 1

What is the colour of the flame produced by sodium in the flame test?

A blue-green

B red

C lilac

D yellow

（2025 Oct/Nov · 0654/11 · Question 27 · Core）

解：由火焰检验中钠的特征焰色为黄色，得火焰颜色为黄色。故选 D。

针对练习

1. Which row shows the flame test colours for lithium and sodium?

	lithium	sodium
A	lilac	blue-green
B	lilac	yellow
C	red	blue-green
D	red	yellow

（2022 May/Jun · 0654/11 · Question 20 · Core；同题：2022 May/Jun · 0654/21 · Question 19 · Extended）

题型 11：识别正确的纸色谱初始装置（考频★☆☆☆☆）

知识点 纸色谱利用混合物中各成分随溶剂在纸上移动速度不同进行分离。

组装时，色谱纸下端应_____溶剂，墨点应位于溶剂液面_____。

墨点若浸入溶剂，会溶入容器中的溶剂，不能在纸上形成分离后的色斑。

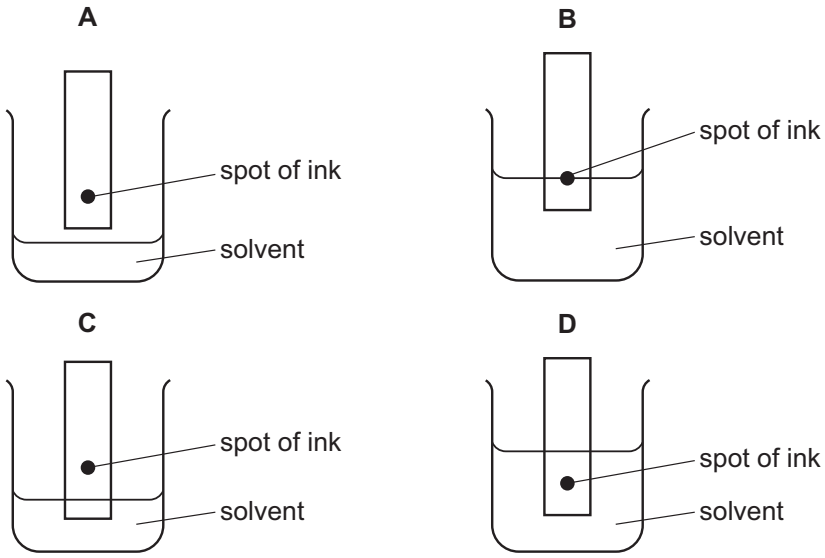
答案：浸入；上方

怎么认 题目出现纸条、墨点和溶剂液面的装置图时，先看纸底是否浸入溶剂，再看墨点是否高于液面。

例题 1

The colours in an ink are separated by chromatography.

Which diagram shows the assembled apparatus?



（2023 Oct/Nov · 0654/13 · Question 14 · Core；同题：2023 Oct/Nov · 0654/23 · Question 14 · Extended）

解：色谱纸下端应与溶剂接触，使溶剂沿纸向上移动；墨点应在溶剂液面上方，防止墨水溶入容器中的溶剂。

图 C 中纸的下端浸入溶剂，墨点位于液面上方。故选 C。

题型 12：用铝箔和热碱检验硝酸根离子（考频★☆☆☆☆）

知识点 硝酸根离子的定性检验利用其在强碱性条件下与铝反应生成氨气的性质。

检验时，向待测溶液中加入_____和氢氧化钠溶液，再加热。

若生成的气体使湿润的红色石蕊试纸变蓝，则该气体为_____，检验结果为阳性。

答案：铝箔；氨气

怎么认 题目出现硝酸根离子检验并询问所用金属时，先确定该金属为铝。

例题 1

Which metal is used in the test for nitrate ions?

A aluminium

B copper

C magnesium

D tin

（2024 May/Jun · 0654/21 · Question 22 · Extended）

解：检验硝酸根离子时，需加入铝箔和氢氧化钠溶液并加热。
题目所问的金属为铝，对应选项 A。故选 A。

题型 13：读取纸色谱的成分与纯混合状态（考频★★☆☆☆）

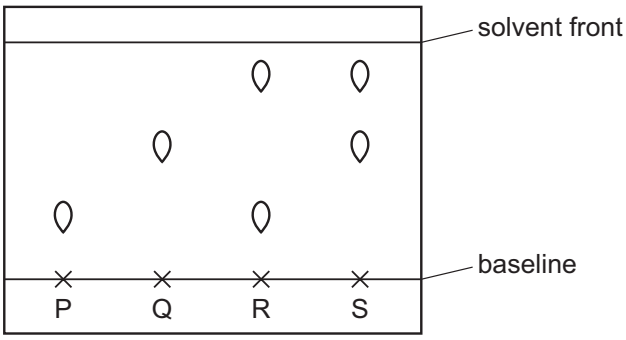
知识点 纸色谱把混合物中移动情况不同的物质分开；从同一基线出发且实验条件相同时，处在_____高度的斑点表示同一种物质。
一个样品形成一个斑点时，该样品为_____；形成两个或更多斑点时，该样品为混合物。
判断混合物是否含某种样品，应将该样品的全部斑点逐一比对；全部等高才表示含有该样品。
$R_f = \frac{\text{物质移动距离}}{\text{溶剂前沿移动距离}}$，两段距离均从基线量起，$R_f$ _____单位。

答案：相同；纯物质；没有

怎么认 题目出现同一基线上的色谱斑点图时，先按每列数斑点，再横向比较斑点高度。

例题 1

The chromatogram for substances P, Q, R and S is shown.



Which statement is correct?

A P and R are both pure substances.

B P has a higher R_f value than Q.

C R is a mixture of P and Q.

D S is a mixture of Q and one other substance.

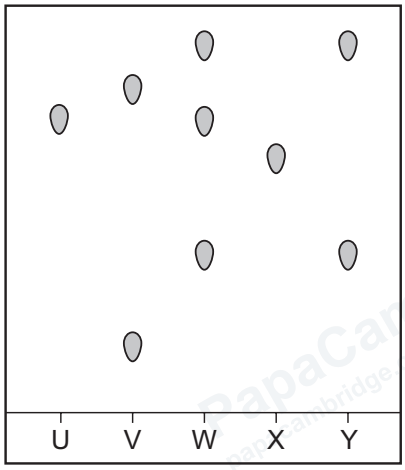
（2025 Oct/Nov · 0654/21 · Question 26 · Extended）

解：同一高度的斑点表示同一种物质。
S 有两个斑点，是混合物；其中较低的斑点与 Q 的斑点等高，另一个斑点与 Q 不同。
所以 S 是 Q 和另一种物质的混合物。故选 D。

针对练习

1. Paper chromatography is used to separate mixtures of soluble coloured substances using a suitable solvent.

The diagram shows the results of paper chromatography of five substances U, V, W, X and Y.



Which statement is correct?

A All five substances are mixtures.

B There are four pure substances.

C W and Y are the same substance.

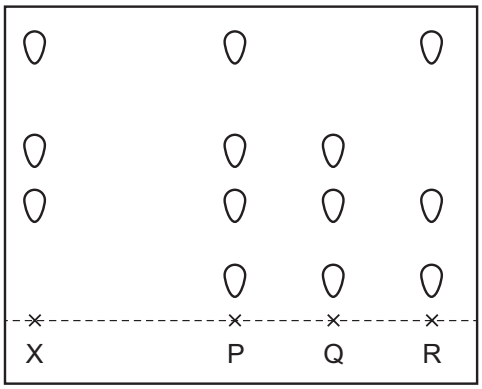
D W is a mixture of U and Y.

（2026 May/Jun · 0654/22 · Question 27 · Extended）

2. Dye X is a mixture of different coloured substances.

Chromatography is used to compare X with three other mixtures, P, Q and R.

The results are shown.



Which mixtures contain dye X?

A P, Q and R **B** P and Q only **C** P only **D** R only

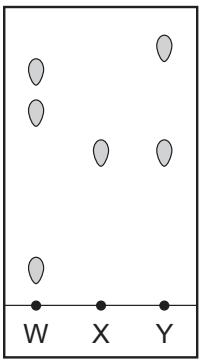
（2023 Oct/Nov · 0654/11 · Question 14 · Core；同题：2023 Oct/Nov · 0654/21 · Question 14 · Extended）

3. The boiling points of three substances, W, X and Y, are shown.

	W	X	Y
boiling point / °C	116–118	132	141–145

The substances are tested using chromatography.

The chromatogram is shown.



Which statement is correct?

A One of the components of Y has a boiling point of 132 °C.

B Substance Y has a smaller boiling point range than substance W.

C Substance W produces the largest R_f value.

D Substance X is an impure mixture.

（2025 Oct/Nov · 0654/22 · Question 27 · Extended）

题型 14：从同一基线计算 Rf 或反求距离（考频★★☆☆☆）

知识点 纸上色谱中，R_f 表示某组分相对溶剂前沿的移动程度，$R_f =$ ＿＿＿＿。

分子、分母的距离都从同一基线量起，并使用相同单位；比较不同物质的 R_f 时，展开条件应相同。

R_f 没有单位；斑点未越过溶剂前沿时，$0 \le R_f \le 1$。

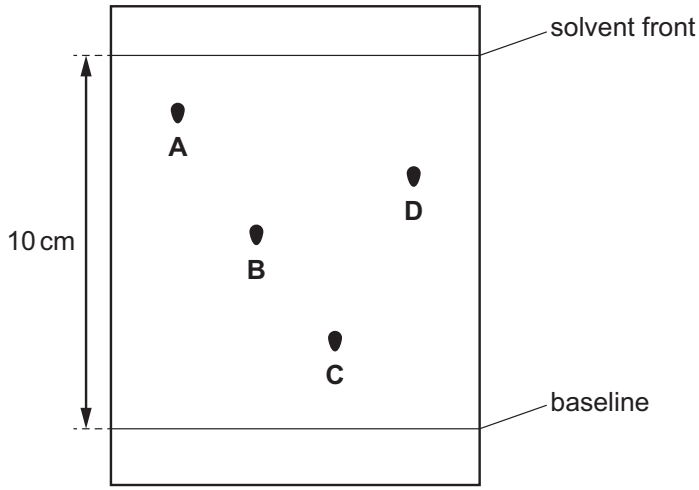
答案：组分斑点中心到基线的距离；溶剂前沿到基线的距离

怎么认 题目出现色谱图、基线、溶剂前沿及 R_f 或距离所求时，先从同一基线确定两段距离。

例题 1

The chromatogram of four different inks is shown.

Which ink has an R_f value of 0.53?



（2025 Feb/Mar · 0654/22 · Question 27 · Extended）

解： 溶剂前沿到基线的距离为 10 cm，从同一基线量得 B 斑点中心的距离约为 5.3 cm。

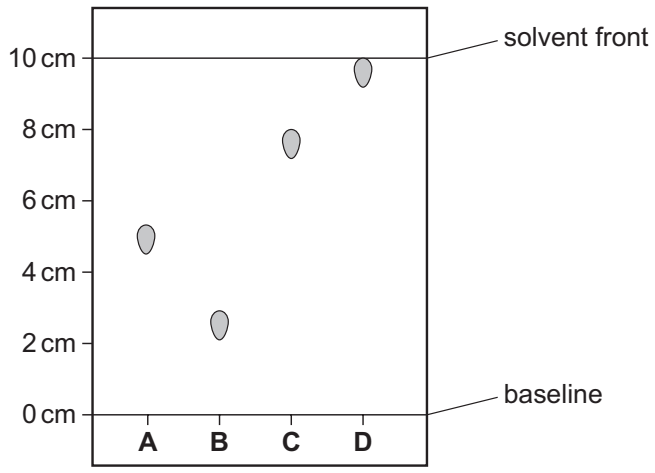
$R_f = \frac{5.3\ \text{cm}}{10\ \text{cm}} = 0.53$。

故选 B。

针对练习

1. The chromatogram of four substances is shown.

Which substance has an R_f value of 0.25?

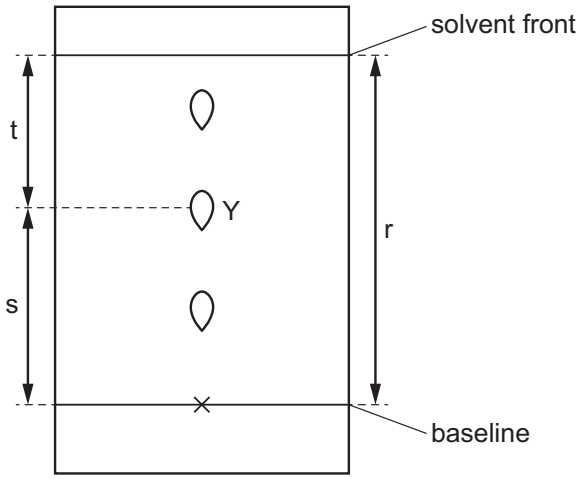


（2025 May/Jun · 0654/21 · Question 27 · Extended）

2. A chromatography experiment is performed on a coloured solution.

The solution contains substance Y.

The chromatogram is shown.



How is the R_f value of substance Y calculated?

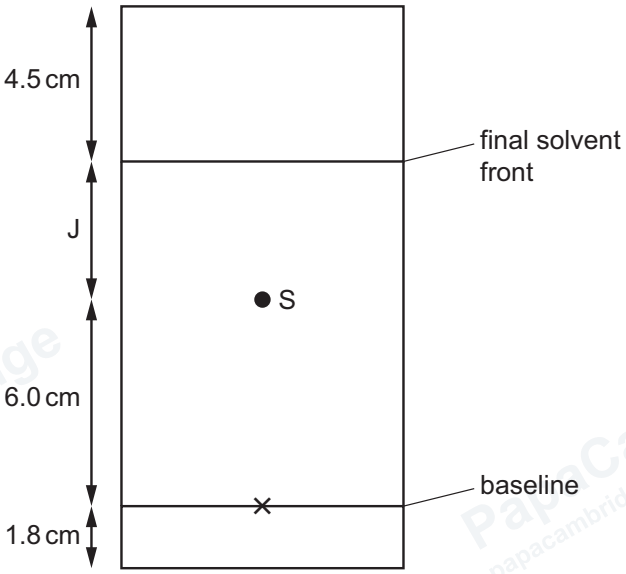
A r ÷ s **B** s ÷ r **C** s ÷ t **D** t ÷ s

(2025 May/Jun · 0654/23 · Question 26 · Extended)

3. Substance S is analysed by paper chromatography.

The chromatogram obtained is shown. The chromatogram is **not** drawn to scale.

The R_f value of S is 0.60.



What is distance J?

A 4.0 cm **B** 5.2 cm **C** 6.0 cm **D** 7.8 cm

(2026 Feb/Mar · 0654/22 · Question 27 · Extended)

题型 15：合并两项定性检验确定完整盐（考频★★☆☆☆）

知识点 盐由阳离子和阴离子组成；确定完整盐时，两项检验应分别得到_____证据和_____证据，并同时符合一个选项。

焰色为红色说明含锂离子；加氢氧化钠后，铁(III)离子生成红棕色沉淀，钙离子生成不溶于过量试剂的白色沉淀，锌离子的白色沉淀溶于过量试剂。

加酸化硝酸银后，氯离子生成白色沉淀，溴离子生成浅黄色沉淀；加酸化硝酸钡后，硫酸根离子生成白色沉淀。

与氢氧化钠和铝箔共热，生成使湿润红色石蕊试纸变蓝的气体，说明含硝酸根离子；钡离子与硫酸根离子生成白色沉淀。

碳酸盐与稀盐酸反应，放出的气体能使石灰水变浑浊；本类结论为离子或盐的种类，不写单位。

答案：阳离子；阴离子

怎么认 题目出现同一物质的两项检验现象并求盐的名称时，先分别判定阳离子和阴离子，再合并匹配选项。

例题 1

The results of two tests on compound P are shown.

test	observation
flame test	red flame
addition of acidified silver nitrate	white precipitate

What is P?

A lithium bromide

B lithium chloride

C sodium bromide

D sodium chloride

（2024 Oct/Nov · 0654/11 · Question 23 · Core）

解：焰色为红色，说明 P 含锂离子。

加酸化硝酸银产生白色沉淀，说明 P 含氯离子。

两项检验共同确定 P 为氯化锂。故选 B。

针对练习

1. The results of two tests on aqueous M are shown.

- When aqueous sodium hydroxide is added to M, a red-brown precipitate is produced.
- When acidified aqueous barium nitrate is added to M, a white precipitate is produced.

What is M?

A copper(II) chloride

B copper(II) sulfate

C iron(III) chloride

D iron(III) sulfate

（2026 May/Jun · 0654/21 · Question 27 · Extended）

2. The results of tests on aqueous G are listed.

1 Adding aqueous sodium hydroxide produces a white precipitate that is insoluble in excess.

2 Adding acidified aqueous silver nitrate produces a cream precipitate.

What is G?

A calcium bromide

B calcium chloride

C zinc bromide

D zinc chloride

（2025 Oct/Nov · 0654/21 · Question 27 · Extended）

3. Aqueous Z is warmed with aqueous sodium hydroxide and a piece of aluminium foil.

A gas is produced which turns damp red litmus paper blue.

A second sample of aqueous Z is mixed with dilute sulfuric acid. A white precipitate is observed.

What is Z?

A ammonium chloride

B ammonium nitrate

C barium chloride

D barium nitrate

（2026 May/Jun · 0654/23 · Question 27 · Extended）

4. White solid X reacts with dilute hydrochloric acid. A gas is produced which turns limewater milky.

A flame test is done on solid X and produces a red coloured flame.

What is X?

A lithium carbonate

B lithium chloride

C potassium carbonate

D potassium chloride

（2024 May/Jun · 0654/12 · Question 21 · Core；同题：2024 May/Jun · 0654/13 · Question 21 · Core）

1.15 旧纲工业过程与碳酸盐

题型 1：沿接触法原料中间体和可逆步骤追踪（考频★★★★☆）

知识点 接触法以硫为原料，物质转化顺序为硫、二氧化硫、三氧化硫、发烟硫酸和硫酸。

各步反应为 $S + O_2 \rightarrow SO_2$；$2SO_2 + O_2 \leftrightarrow 2SO_3$；$H_2SO_4 + SO_3 \rightarrow H_2S_2O_7$；$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$。

其中二氧化硫转化为三氧化硫的一步是_____反应，以_____为催化剂，温度约为 450 °C。

三氧化硫先被浓硫酸吸收生成发烟硫酸，再将发烟硫酸加入水中制得硫酸。

答案：可逆；五氧化二钒

怎么认 题目出现接触法、硫酸制造或反应方程式时，先按硫、二氧化硫、三氧化硫、发烟硫酸、硫酸的顺序核验。

例题 1

Sulfuric acid is produced in the Contact process.

Which substances react together in a reversible reaction in the Contact process?

A S and O_2

B SO_2 and O_2

C H_2SO_4 and SO_3

D $H_2S_2O_7$ and H_2O

（2022 May/Jun · 0654/21 · Question 24 · Extended）

解：接触法中二氧化硫生成三氧化硫的反应为 $2SO_2 + O_2 \leftrightarrow 2SO_3$。

反应物为 SO_2 和 O_2，且该反应可逆。故选 B。

针对练习

1. Which element is used in the manufacture of sulfuric acid?

A carbon

B hydrogen

C nitrogen

D sulfur

（2023 May/Jun · 0654/12 · Question 24 · Core；同题：2023 May/Jun · 0654/13 · Question 24 · Core）

2. Which statement about sulfur is correct?

A It is a metallic element.

B It is used to make sulfuric acid.

C It is in Group VII of the Periodic Table.

D An atom of sulfur contains 32 electrons.

（2023 May/Jun · 0654/11 · Question 24 · Core）

3. Which statement about manufacturing processes is correct?

A Limestone is manufactured from calcium oxide.

B Limestone is manufactured from acidic waste products.

C Ethene is manufactured by addition polymerisation.

D Sulfuric acid is manufactured from sulfur.

(2024 May/Jun · 0654/11 · Question 26 · Core)

4. The Contact process is used to manufacture sulfuric acid.

Which step in the Contact process is reversible?

A sulfur reacting with oxygen

B sulfur dioxide reacting with oxygen

C sulfuric acid reacting with sulfur trioxide

D oleum, $H_2S_2O_7$, reacting with water

(2024 Feb/Mar · 0654/22 · Question 26 · Extended)

5. Four different reactions occur in the manufacture of sulfuric acid by the Contact process.

Which substance is a reactant in one of these reactions and a product in another?

A H_2O **B** O_2 **C** S **D** SO_3

(2023 May/Jun · 0654/23 · Question 24 · Extended)

6. Which equation does **not** represent a reaction that occurs in the Contact process?

A $2S + 3O_2 \rightarrow 2SO_3$

B $2SO_2 + O_2 \rightleftharpoons 2SO_3$

C $H_2SO_4 + SO_3 \rightarrow H_2S_2O_7$

D $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

(2022 May/Jun · 0654/23 · Question 24 · Extended)

7. Which equation does **not** represent a reaction that occurs in the Contact process?

A $CaO + SO_2 \rightarrow CaSO_3$

B $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

C $2SO_2 + O_2 \rightarrow 2SO_3$

D $S + O_2 \rightarrow SO_2$

(2023 Oct/Nov · 0654/22 · Question 25 · Extended)

8. Four equations are listed.

1 $H_2S_2O_7 + H_2O \rightarrow H_2SO_4 + SO_3 + H_2O$

2 $2S + 3O_2 \rightarrow 2SO_3$

3 $H_2SO_4 + SO_3 \rightarrow H_2S_2O_7$

4 $2SO_2 + O_2 \rightarrow 2SO_3$

Which equations represent reactions that are involved in the Contact process?

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

(2024 May/Jun · 0654/22 · Question 24 · Extended)

9. Which statements about the Contact process are correct?

1 An iron catalyst is used.

2 Oleum is added to water.

3 Sulfur dioxide is converted to sulfur trioxide.

4 Sulfur trioxide is reacted with water.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2022 Oct/Nov · 0654/23 · Question 25 · Extended）

10. Four reaction equations involving sulfur and its compounds are shown.

1 $S + O_2 \rightarrow SO_2$

2 $SO_2 + H_2O \rightarrow H_2SO_3$

3 $2H_2SO_3 + O_2 \rightarrow 2H_2SO_4$

4 $H_2SO_4 + SO_3 \rightarrow H_2S_2O_7$

Which reactions take place in the manufacture of sulfuric acid by the Contact process?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2023 Oct/Nov · 0654/23 · Question 25 · Extended）

题型 2：配接触法反应步骤与操作条件（考频★★★☆☆）

知识点 接触法制造硫酸时，二氧化硫的催化氧化反应为 $2\ SO_2 + O_2 \rightleftharpoons 2\ SO_3$。

该反应使用 _____ 作催化剂，温度约为 _____ °C，压强约为 _____ atm。

催化剂改变反应速率，不改变平衡组成；温度单位为 °C，压强单位为 atm。

答案：五氧化二钒（V_2O_5）；450；1 – 2

怎么认 题目出现接触法及 SO_2 转化为 SO_3 时，先确定五氧化二钒、450 °C 和约 1 – 2 atm。

例题 1

Sulfur dioxide is oxidised to sulfur trioxide in the Contact process.

The equation for this reaction is shown.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

Which row describes the conditions for this reaction?

	catalyst	temperature / °C	pressure / atm
A	Fe	200	2
B	Fe	450	250
C	V_2O_5	200	250
D	V_2O_5	450	2

（2022 Oct/Nov · 0654/22 · Question 25 · Extended）

解： 由接触法的催化氧化条件，催化剂为五氧化二钒 V_2O_5，温度约为 450 °C，压强约为 1 – 2 atm。表中与这些条件相符的是 D。故选 D。

针对练习

1. Which row describes conditions for the conversion of sulfur dioxide to sulfur trioxide in the Contact process?

	temperature / °C	catalyst
A	200	iron
B	200	vanadium(V) oxide
C	450	iron
D	450	vanadium(V) oxide

（2022 Oct/Nov · 0654/21 · Question 25 · Extended）

2. Which catalyst is used in the Contact process?

A iron

B phosphoric(V) acid

C nickel

D vanadium(V) oxide

（2023 May/Jun · 0654/22 · Question 24 · Extended）

3. What is the catalyst used in the Contact process?

A yeast

B iron

C nickel

D vanadium(V) oxide

（2024 Oct/Nov · 0654/22 · Question 24 · Extended）

4. Sulfuric acid is manufactured by the Contact process.

One of the reactions in this process converts sulfur dioxide to sulfur trioxide.

Which statements about the conditions for this reaction are correct?

1 A nickel catalyst is used.

2 A pressure of about 1–2 atmospheres is used.

3 A temperature of about 450 °C is used.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

（2023 Oct/Nov · 0654/21 · Question 26 · Extended）

5. Sulfuric acid is manufactured by the Contact process.

Which reaction in this process uses a catalyst?

A $S + O_2 \rightarrow SO_2$

B $2SO_2 + O_2 \rightarrow 2SO_3$

C $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$

D $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

（2024 May/Jun · 0654/23 · Question 25 · Extended）

6. Which reaction that occurs in the Contact process requires the use of a vanadium(V) oxide catalyst?

A $S + O_2 \rightarrow SO_2$

B $2SO_2 + O_2 \rightarrow 2SO_3$

C $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$

D $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

（2024 Oct/Nov · 0654/23 · Question 26 · Extended）

7. Equations representing reactions in the Contact process are listed.

reaction 1 $S + O_2 \rightarrow SO_2$

reaction 2 $2SO_2 + O_2 \rightleftharpoons 2SO_3$

reaction 3 $H_2SO_4 + SO_3 \rightarrow H_2S_2O_7$

reaction 4 $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

Which row identifies the reactions that use the stated conditions?

	requires a vanadium(V) oxide catalyst	requires a temperature of 450 °C	requires a pressure of 2 atmospheres
A	reaction 2	reaction 1	reaction 4
B	reaction 2	reaction 2	reaction 2
C	reaction 3	reaction 1	reaction 2
D	reaction 3	reaction 2	reaction 4

（2023 May/Jun · 0654/21 · Question 24 · Extended）

题型 3：把石灰石用途与中和酸性联系（考频★★★☆☆）

知识点 酸与碱、金属氧化物或碳酸盐反应，使酸性减弱的过程称为_____。

石灰石的主要成分是_____，受热可制得石灰；石灰石、石灰和氢氧化钙都能中和酸。

处理酸性工业废物或酸性土壤时，pH 向 7 增大；pH 是没有单位的数值。

答案：中和；碳酸钙

怎么认 题目出现石灰石处理酸性废物或土壤、比较处理前后 pH 时，先判断中和使 pH 向7增大。

例题 1

What is **not** a use of limestone?

A manufacture of calcium oxide

B neutralising industrial waste products

C purifying water

D treating acidic soil

（2022 Oct/Nov · 0654/11 · Question 26 · Core；同题：2022 Oct/Nov · 0654/12 · Question 26 · Core；同题：2022 Oct/Nov · 0654/13 · Question 26 · Core、2022 Oct/Nov · 0654/21 · Question 26 · Extended；同题：2022 Oct/Nov · 0654/22 · Question 26 · Extended、2022 Oct/Nov · 0654/23 · Question 26 · Extended）

解：石灰石受热分解生成氧化钙，因此可用于制造氧化钙；石灰石还能中和酸性工业废物和酸性土壤。净化水不是石灰石的用途，故选 C。

针对练习

1. What are two uses of limestone?

1 as a fertiliser

2 to decrease the pH of soil

3 making lime

4 neutralising some industrial waste products

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2024 Oct/Nov · 0654/12 · Question 25 · Core；同题：2024 Oct/Nov · 0654/13 · Question 25 · Core）

2. Which substances neutralise acids?

1 lime

2 limestone

3 calcium hydroxide

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

（2022 Feb/Mar · 0654/12 · Question 25 · Core；同题：2022 Feb/Mar · 0654/22 · Question 25 · Extended）

3. The waste from a factory is acidic. The factory treats the waste with limestone.

Which row shows the pH of the waste before and after treatment?

	before	after
A	6	5
B	6	7
C	8	7
D	8	9

（2024 May/Jun · 0654/12 · Question 20 · Core；同题：2024 May/Jun · 0654/13 · Question 20 · Core）

4. Why do farmers add limestone to soil?

A It acts as a fertiliser.

B It adds nitrogen to the soil.

C It decreases the pH of the soil.

D It increases the pH of the soil.

（2022 May/Jun · 0654/11 · Question 26 · Core；同题：2022 May/Jun · 0654/12 · Question 26 · Core；同题：2022 May/Jun · 0654/13 · Question 26 · Core、2022 May/Jun · 0654/21 · Question 25 · Extended；同题：2022 May/Jun · 0654/22 · Question 25 · Extended、2022 May/Jun · 0654/23 · Question 25 · Extended）

5. Which statements about limestone are correct?

1 It contains calcium oxide.

2 It is used to manufacture lime.

3 It neutralises acidic industrial waste products.

4 It neutralises alkaline soil.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

（2023 May/Jun · 0654/12 · Question 25 · Core；同题：2023 May/Jun · 0654/13 · Question 25 · Core、2023 May/Jun · 0654/22 · Question 25 · Extended）

题型 4：写石灰石热分解制生石灰与二氧化碳（考频★★☆☆☆）

知识点 石灰石的主要成分是碳酸钙，化学式为_____；石灰又称生石灰，是氧化钙，化学式为_____。

碳酸钙在加热条件下发生_____，生成氧化钙和二氧化碳。

本反应的条件是加热；化学式表示物质组成，不带单位。

答案：$CaCO_3$；CaO；热分解

怎么认 题目出现石灰石受热、制石灰或判断分解产物时，先确定碳酸钙生成氧化钙和二氧化碳。

例题 1

Which type of reaction is used to manufacture lime from limestone?

A addition polymerisation

B cracking

C neutralisation

D thermal decomposition

（2024 May/Jun · 0654/12 · Question 26 · Core；同题：2024 May/Jun · 0654/13 · Question 26 · Core）

解：石灰石的主要成分是碳酸钙，石灰是氧化钙。

碳酸钙受热生成氧化钙和二氧化碳，反应物由一种变为两种，属于热分解。

故选 D。

针对练习

1. Which substance is produced by the thermal decomposition of limestone?

A calcium

B calcium carbonate

C calcium hydroxide

D calcium oxide

（2024 May/Jun · 0654/22 · Question 25 · Extended）

2. Which statements about limestone are correct?

1 Its main constituent is calcium oxide.

2 It can be used to manufacture lime.

3 It thermally decomposes to release carbon dioxide.

4 It is used to neutralise alkaline soils.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2023 May/Jun · 0654/11 · Question 25 · Core；同题：2023 May/Jun · 0654/21 · Question 25 · Extended）

3. Which word equation describes the manufacture of lime from limestone?

A calcium carbonate → calcium hydroxide + carbon dioxide

B calcium carbonate → calcium oxide + carbon dioxide

C calcium hydroxide → calcium oxide + water

D calcium oxide + carbon dioxide → calcium carbonate

（2023 Oct/Nov · 0654/12 · Question 25 · Core；同题：2023 Oct/Nov · 0654/22 · Question 26 · Extended）

4. When limestone is heated, it decomposes.

Which row about limestone and the decomposition is correct?

	chemical name for limestone	decomposition products
A	calcium carbonate	calcium oxide only
B	calcium carbonate	calcium oxide and carbon dioxide
C	calcium oxide	calcium carbonate only
D	calcium oxide	calcium carbonate and carbon dioxide

（2023 May/Jun · 0654/23 · Question 25 · Extended）

题型 5：配哈伯法制氨的催化剂温度压力（考频★★☆☆☆）

知识点 哈伯法用氮气和氢气制取氨，氮气取自空气，氢气不取自空气。

工业条件通常为较高压力，约 200 atm 至 250 atm，温度约 _____ °C。

催化剂为 _____，不是钒(V)氧化物。

答案：450；铁

怎么认 题目出现 Haber process、温度、压力或催化剂时，先对应铁、约 450 °C 和较高压力。

例题 1

Which row shows the conditions used for making ammonia by the Haber process?

	pressure / atm	temperature / °C	catalyst
A	250	450	iron
B	250	200	vanadium pentoxide
C	2	200	iron
D	2	450	vanadium pentoxide

（2023 Oct/Nov · 0654/23 · Question 24 · Extended）

解：由哈伯法工业条件得，催化剂为铁，温度约 450 °C，压力通常为 200 atm 至 250 atm。

表中 A 行为 250 atm、450 °C、铁。故选 A。

针对练习

1. The Haber process is used to make ammonia.

Which statement about the Haber process is **not** correct?

A A vanadium(V) oxide catalyst is used.

B The nitrogen used is obtained from the air.

C The pressure used is 200 atmospheres.

D The temperature used is 450 °C.

（2023 May/Jun · 0654/23 · Question 23 · Extended）

2. Which statements about the Haber process are correct?

1 The hydrogen used is obtained from the air.

2 The pressure used is about twice atmospheric pressure.

3 The catalyst used is iron.

4 The process takes place at a temperature of about 450 °C.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

（2024 May/Jun · 0654/21 · Question 25 · Extended）

题型 6：按 NPK 元素核验肥料成分（考频★☆☆☆☆）

知识点 多数肥料含有的三种主要元素是_____、_____和_____，元素符号依次为 N、P、K。

按 NPK 元素核验物质成分时，只统计名称或化学式中出现的 N、P、K；C、Na、S 等不计入这三种元素。

答案：氮；磷；钾

怎么认 题目出现肥料所含元素或给出化合物名称时，先核验 N、P、K 是否出现。

例题 1

Which compound contains two of the three elements needed in a fertiliser used for plant growth?

A potassium carbonate

B potassium chloride

C potassium nitrate

D potassium sulfate

（2024 May/Jun · 0654/12 · Question 25 · Core；同题：2024 May/Jun · 0654/13 · Question 25 · Core）

解：肥料的三种主要元素为 N、P、K。

potassium nitrate（硝酸钾）含 K 和 N，共含其中两种元素。

故选 C。

针对练习

1. Which three elements do most fertilisers contain?

A Na, C, P **B** Na, P, K **C** K, C, N **D** K, P, N

（2024 Oct/Nov · 0654/23 · Question 25 · Extended）

题型 7：辨认工业制氨原料氢氮来源（考频★☆☆☆☆）

知识点 哈伯法合成氨需要氮气和氢气两种原料气体。

工业上，氮气由空气液化后_____获得，氢气由_____制得。

前者依据各组分沸点不同，后者需在高温条件下进行。

答案：分馏；甲烷和水蒸气反应

怎么认 题目出现哈伯法原料气体来源的表格时，先把氮气对应空气分馏、氢气对应甲烷与水蒸气反应。

例题 1 Which row describes how hydrogen and nitrogen are obtained for use in the Haber process?

	hydrogen	nitrogen
A	electrolysis of sulfuric acid	catalytic reduction of nitrogen oxides
B	electrolysis of sulfuric acid	distillation of air
C	reaction of methane and steam	catalytic reduction of nitrogen oxides
D	reaction of methane and steam	distillation of air

（2023 May/Jun · 0654/21 · Question 23 · Extended）

解： 工业上，甲烷与水蒸气反应制得氢气，空气经液化、分馏得到氮气。D 行中两种气体的来源均符合。故选 D。