学生手册 2026

实验计划与生物观察

Cambridge IGCSE Co-ordinated Sciences · 0654 · Papers 5 / 6 · 2022–2026 真题

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第 1 章 生物观察与测量

1.1 生物观察、检测与探究

题型 1：观察轮廓与内部结构，作生物绘图（考频★★★☆☆）

知识点 生物绘图是依据照片、标本或显微图像，用清晰单线准确记录可见轮廓及结构位置关系。

图形应_____、比例合理，线条应_____，不得涂阴影、填色或反复描线。

题目限定对象、数量或范围时，仅画指定部分；要求内部结构时，应画出图中可辨认的内部结构。

照片背景、字母、引线和明暗不属于标本结构，除题目要求外不画。

未要求测量或比例尺时，不标长度和单位；若要求标尺或长度，应按题目给定单位标注。

答案：足够大；清晰、连续

怎么认 题目出现生物照片或显微图并要求大型详细铅笔绘图时，先圈定作图对象和范围。

例题 1

Fig. 1.1 shows a flower with some of the petals removed.



Fig. 1.1

(a) (i) In the box, make a large, detailed, pencil drawing of the flower.

Include the internal parts of the flower.

（2022 Feb/Mar 0654/62 第1题(a)(i)）

解：由题意，作图对象为整朵花，并须包括内部结构。

由图可见两片保留的花瓣和花基部，内部有中央雌蕊及多枚雄蕊；按各部分的相对形状、大小和位置放大，以清晰连续的单线画出，不加明暗，不画字母、黑点和图注。

答：得到与图中花的轮廓、比例和内部结构相符的大型铅笔绘图。

针对练习

1. Fig. 1.1 shows a photograph of a flower.



Fig. 1.1

(a) In the box, make a large and detailed pencil drawing of the flower.

Include the internal parts of the flower.

（2023 May/Jun 0654/63 第1题(a)）

2. **(a)** Fig. 1.1 is a photograph of a flower.



Fig. 1.1

(i) In the box, make a large, detailed pencil drawing of the flower shown in Fig. 1.1.

Include the internal parts of the flower.

（2025 May/Jun 0654/62 第1题(a)(i)）

3. Fig. 1.1 is a photograph of a slice of an orange shown actual size.



Fig. 1.1

(a) In the box, make a large, detailed, pencil drawing of the slice of the orange shown in Fig. 1.1.

（2024 May/Jun 0654/61 第1题(a)）

4. Fig. 2.1 is a photograph of a leaf, **C**.



leaf **C**

Fig. 2.1

(a) In the box make a large, detailed pencil drawing of leaf **C**.

（2025 Oct/Nov 0654/61 第2题(a)）

5. Fig. 2.1 shows a photomicrograph of a single-celled organism called *Euglena*.

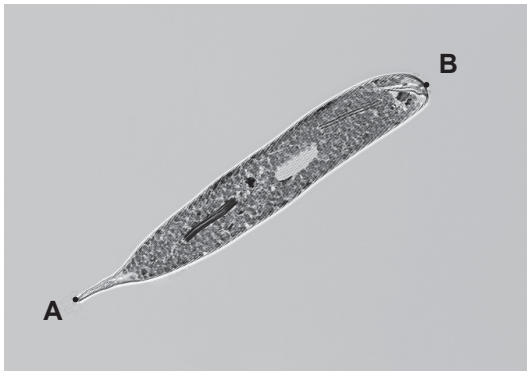


Fig. 2.1

(a) In the box below, make a large, detailed pencil drawing of the *Euglena* cell in Fig. 2.1.

（2023 Oct/Nov 0654/61 第2题(a)）

6. Fig. 2.1 shows a photomicrograph of some blood cells.

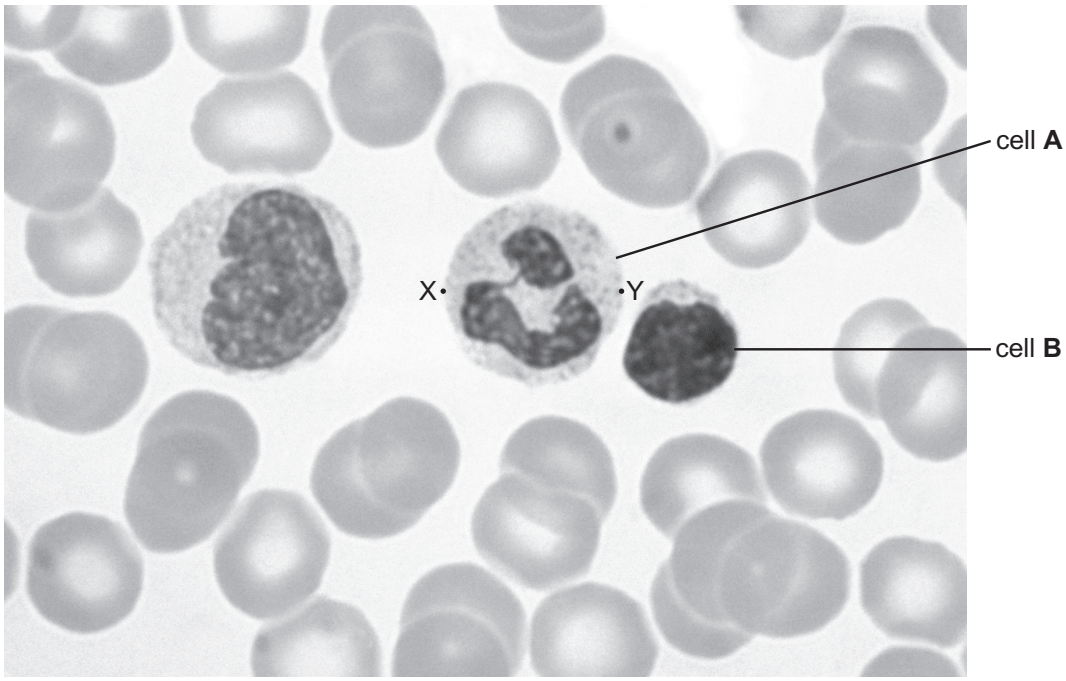


Fig. 2.1

(a) Make a large detailed pencil drawing of blood cell **A** in the box below.

（2022 Oct/Nov 0654/63 第2题(a)）

7. A student investigates okra and star fruit.

Figure 1.1 shows a photograph of a slice of okra at its actual size.



Figure 1.1

(a) In the box, make a large, detailed, pencil drawing of the slice of okra shown in Figure 1.1.

（2026 Feb/Mar 0654/62 第1题(a)）

8. Fig. 2.1 shows a magnified section through part of a leaf.

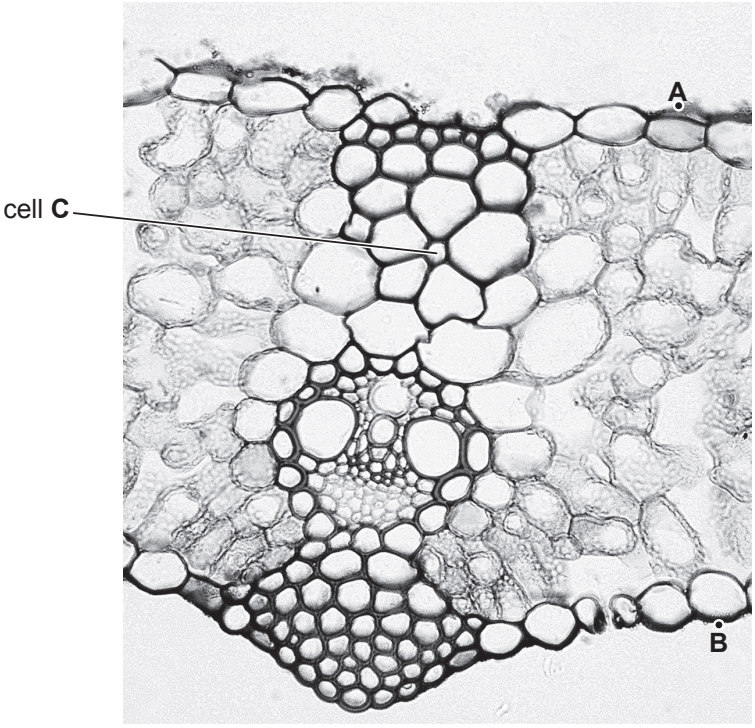


Fig. 2.1

(a) In the box, make a large pencil drawing of only the cell labelled **C** and the **5** cells touching it.

Do **not** draw any other cells.

（2022 May/Jun 0654/62 第2题(a)）

题型 2：在原图标记端点并量取长度（考频★★★☆☆）

知识点 图中线段的长度，是两个标记点中心之间的直线距离；连线时，细直线的两端应落在_____。量取时，直尺刻度边沿线段放置，分别读取两端刻度，线段长度等于_____；长度单位为 mm。题目要求精确到最接近的毫米时，将量得的毫米数按_____取整。

答案：两个标记点的中心；较大读数与较小读数之差；四舍五入

怎么认 题目出现图中标出的两个端点，并要求连线或量取毫米长度时，先连接两点中心。

例题 1 Fig. 1.1 shows a flower with some of the petals removed.



Fig. 1.1

(b) (i) **On Fig. 1.1**, draw a line to join points **A** and **B**. This shows the width of one petal.

Record this width, **AB**, in millimetres to the nearest millimetre.

（2022 Feb/Mar 0654/62 第1题(b)(i)）

解：用细直线连接 A、B 两点中心，沿线段量取。
由图量得 $AB \approx 48.2$ mm。
精确到最接近的毫米，得 $AB = 48$ mm。
答：48 mm。

针对练习

1. Fig. 1.1 shows a photograph of a flower.

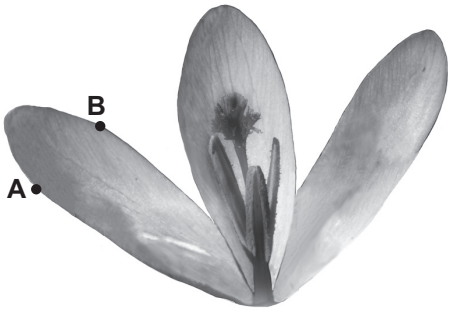


Fig. 1.1

(b) (i) Draw a line to join points **A** and **B** on Fig. 1.1.

Measure the length of this line **AB** in millimetres to the nearest millimetre.

（2023 May/Jun 0654/63 第1题(b)(i)）

2. Fig. 2.1 shows a photomicrograph of some blood cells.

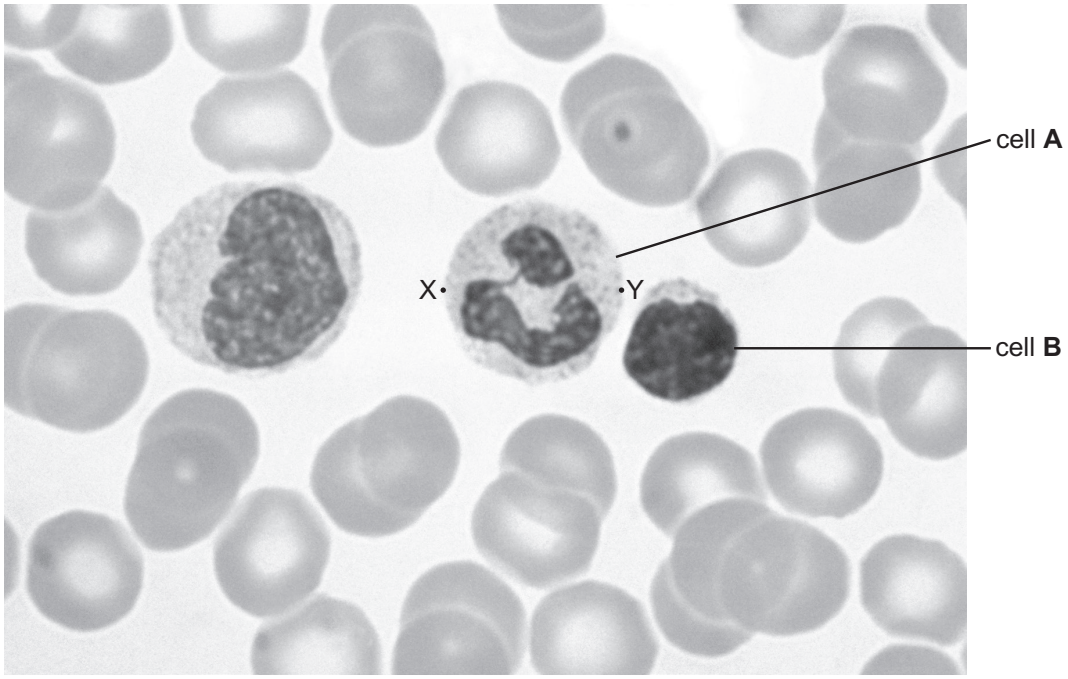


Fig. 2.1

(b) (i) Measure the diameter XY of cell **A** in Fig. 2.1 in millimetres to the nearest millimetre.

（2022 Oct/Nov 0654/63 第2题(b)(i)）

3. Fig. 2.1 shows a photomicrograph of a single-celled organism called *Euglena*.

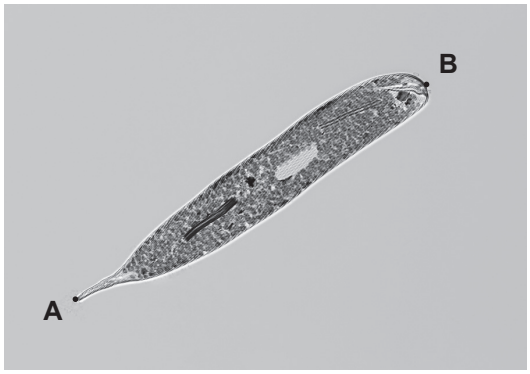


Fig. 2.1

(b) (i) Measure the length **AB** of the *Euglena* cell in Fig. 2.1 in millimetres to the nearest millimetre.

（2023 Oct/Nov 0654/61 第2题(b)(i)）

4. **(a)** Fig. 1.1 is a photograph of a flower.



Fig. 1.1

(b) **(i)** On Fig. 1.1, draw a line to join points **A** and **B**, which shows the width of **one** petal.

Record this width, **AB**, in millimetres to the nearest millimetre.

（2025 May/Jun 0654/62 第1题(b)(i)）

5. Fig. 2.1 shows a magnified section through part of a leaf.

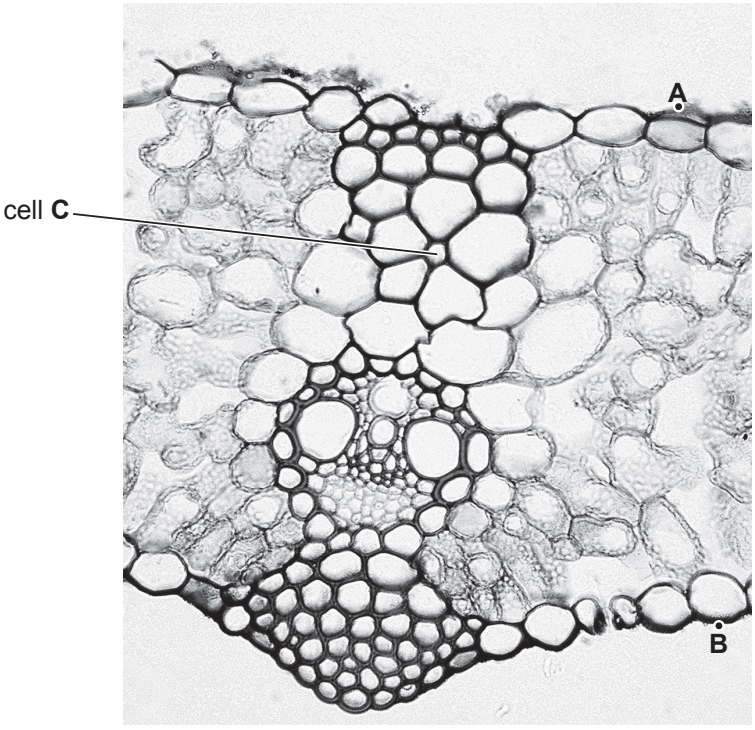


Fig. 2.1

(b) **(i)** The distance between the points **A** and **B** in Fig. 2.1 shows the thickness of the leaf.

Draw a line between points **A** and **B** in Fig. 2.1.

Measure the length of line **AB** in Fig. 2.1.

Record this length in millimetres to the nearest millimetre.

（2022 May/Jun 0654/62 第2题(b)(i)）

6. A student investigates okra and star fruit.

Figure 1.1 shows a photograph of a slice of okra at its actual size.



Figure 1.1

(b) (i) Draw a line to join points **A** and **B** on Figure 1.1.

Record the length of this line **AB** in millimetres to the nearest millimetre.

（2026 Feb/Mar 0654/62 第1题(b)(i)）

7. Fig. 1.1 is a photograph of a slice of an orange shown actual size.



Fig. 1.1

(b) (i) Draw a line to join points **A** and **B** on Fig. 1.1.

Record the length of this line **AB** in millimetres to the nearest millimetre.

（2024 May/Jun 0654/61 第1题(b)(i)）

题型 3：在同倍率图中比较可见形态（考频★★★☆☆）

知识点 可见形态比较，是在相同观察条件下，按同一特征分别描述两个对象。

差异必须写成_____，相似点必须写出二者共有且图中可见的特征。

大小或长度仅在_____或实际大小的图中才可比较；测量值应写单位，常用 mm。

答案：同一特征下的成对对照；同倍率

怎么认 题目出现两幅同倍率或实际大小的图并要求比较可见特征时，先按同一维度成对观察。

例题 1

Fig. 2.1 shows a photomicrograph of some blood cells.

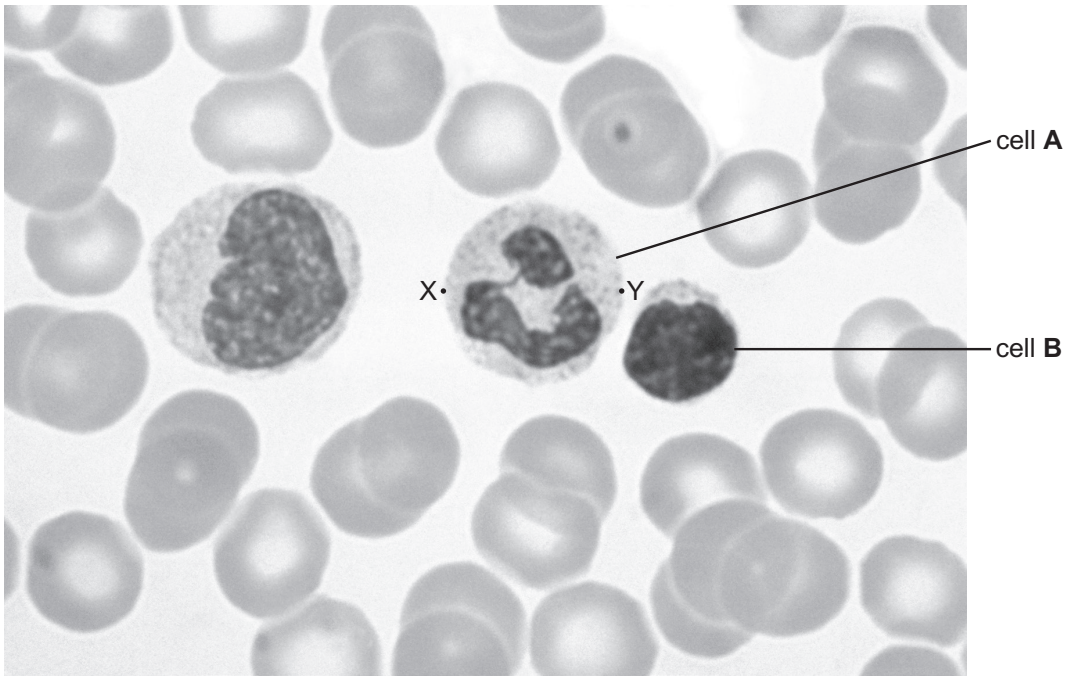


Fig. 2.1

(c) Describe **one** difference and **one** similarity between cell **A** and cell **B**.

（2022 Oct/Nov 0654/63 第2题(c)）

解：按细胞核形状比较，细胞 A 的细胞核分叶，细胞 B 的细胞核近圆形；按共有结构比较，二者均有细胞核。

答：细胞 A 的细胞核分叶而细胞 B 的近圆形；二者均有细胞核。

针对练习

1. Fig. 2.1 shows a photomicrograph of a single-celled organism called *Euglena*.

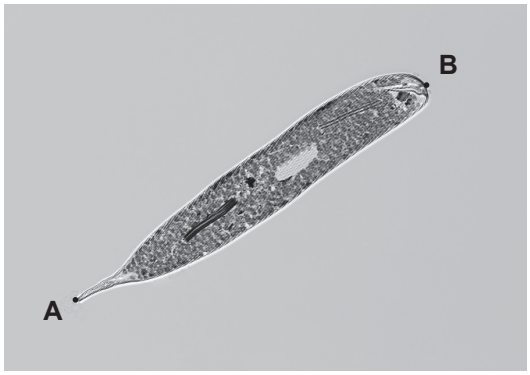


Fig. 2.1

(c) Fig. 2.2 shows a photomicrograph of a single-celled organism called *Chlamydomonas*.

Fig. 2.1 and Fig. 2.2 are shown at the same magnification.

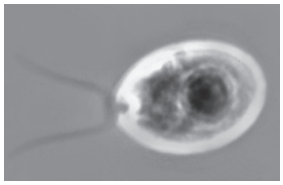


Fig. 2.2

Describe **two** visible differences and **one** visible similarity between the *Euglena* cell and the *Chlamydomonas* cell.

（2023 Oct/Nov 0654/61 第2题(c)）

2. Fig. 1.1 is a photograph of a slice of an orange shown actual size.



Fig. 1.1

(c) Fig. 1.2 is a photograph of a slice of a kiwi fruit shown actual size.

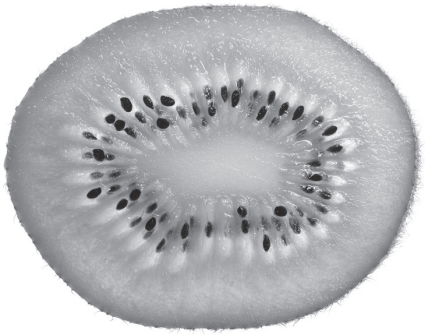


Fig. 1.2

State **two visible** differences between the slice of orange shown in Fig. 1.1 and the slice of kiwi fruit shown in Fig. 1.2.

（2024 May/Jun 0654/61 第1题(c)）

3. Fig. 1.1 shows a photograph of a flower.



Fig. 1.1

(c) Fig. 1.2 shows a flower at the same magnification as the flower in Fig. 1.1.



Fig. 1.2

(i) Describe three **visible** differences between the flower in Fig. 1.1 and the flower in Fig. 1.2.

（2023 May/Jun 0654/63 第1题(c)(i)）

4. A student investigates okra and star fruit.

Figure 1.1 shows a photograph of a slice of okra at its actual size.



Figure 1.1

(c) Figure 1.2 is a photograph of a slice of star fruit shown actual size.

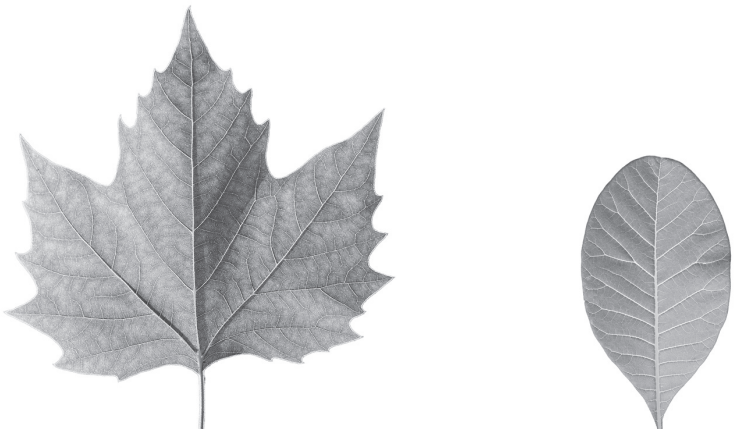


Figure 1.2

Describe **two** visible differences and **one** visible similarity between the slice of okra in Figure 1.1 and the slice of star fruit in Figure 1.2.

（2026 Feb/Mar 0654/62 第1题(c)）

5. **(b)** Fig. 2.2 shows photographs of leaves, **C** and **D**, from two different trees. The photographs are at the same magnification.



leaf **C** leaf **D**

Fig. 2.2

State **one** similarity and **two** differences between leaf **C** and leaf **D** visible in Fig. 2.2.

（2025 Oct/Nov 0654/61 第2题(b)）

题型 4：把图上长度除以参照长度，求放大倍数（考频★★★☆☆）

知识点 放大倍数是图像长度与参照对象对应长度的比，$m = \frac{L_1}{L_0}$，其中 L_1 为图像长度，L_0 为参照长度。

两段长度必须表示_____，并换成_____后再相除。

放大倍数是比值，_____；线段长度通常以 mm 记录。

答案：同一部位、同一方向；相同单位；没有单位

怎么认 题目出现图中标线、绘图对应线段和放大倍数所求时，先用两段对应长度作比。

例题 1

Fig. 1.1 shows a flower with some of the petals removed.



Fig. 1.1

(a) (i) In the box, make a large, detailed, pencil drawing of the flower.

Include the internal parts of the flower.

(b) (i) **On Fig. 1.1**, draw a line to join points **A** and **B**. This shows the width of one petal.

Record this width, **AB**, in millimetres to the nearest millimetre.

(ii) Draw a line to show the same width **AB** of the petal on your drawing.

Record this width in millimetres to the nearest millimetre.

(iii) Use your measurements in **(b)(i)** and **(b)(ii)** to calculate the magnification ***M*** of your drawing.

Use the equation shown.

$$M = \frac{\text{width of petal on your drawing}}{\text{width AB of petal on Fig. 1.1}}$$

（2022 Feb/Mar 0654/62 第1题(b)(iii)）

解：连接图中 A、B，量得花瓣宽度约为 48 mm；设绘图中同一宽度为 d mm。

由放大倍数定义得

$M = \frac{d}{48}$

答：$M = \frac{d}{48}$，数值由绘图实测宽度决定。

针对练习

1. **(a)** Fig. 1.1 is a photograph of a flower.



Fig. 1.1

(i) In the box, make a large, detailed pencil drawing of the flower shown in Fig. 1.1.

Include the internal parts of the flower.

(b) **(i)** On Fig. 1.1, draw a line to join points **A** and **B**, which shows the width of **one** petal.

Record this width, **AB**, in millimetres to the nearest millimetre.

(ii) Draw a line to show the same width **AB** of the petal on your drawing.

Record this width in millimetres to the nearest millimetre.

(iii) Use your measurements in **(b)(i)** and **(b)(ii)** to calculate the magnification M of your drawing.

Use the equation shown.

$$M = \frac{\text{width of petal on drawing}}{\text{width } \mathbf{AB} \text{ of petal on Fig. 1.1}}$$

Give your answer to **two** significant figures.

（2025 May/Jun 0654/62 第1题(b)(iii)）

2. Fig. 1.1 shows a photograph of a flower.



Fig. 1.1

(a) In the box, make a large and detailed pencil drawing of the flower.

Include the internal parts of the flower.

(b) **(i)** Draw a line to join points **A** and **B** on Fig. 1.1.

Measure the length of this line **AB** in millimetres to the nearest millimetre.

(ii) Draw a line on your drawing in **(a)** in the same place as **AB** on Fig. 1.1.

Measure the length of this line in millimetres to the nearest millimetre.

(iii) Use your measurements in **(b)(i)** and **(b)(ii)** to calculate the magnification m of your drawing.

Use the equation shown.

$$m = \frac{\text{length of line } \mathbf{AB} \text{ on your drawing}}{\text{length of line } \mathbf{AB} \text{ on Fig. 1.1}}$$

Record your value to **two** significant figures.

（2023 May/Jun 0654/63 第1题(b)(iii)）

3. Fig. 1.1 is a photograph of a slice of an orange shown actual size.



Fig. 1.1

(a) In the box, make a large, detailed, pencil drawing of the slice of the orange shown in Fig. 1.1.

(b) **(i)** Draw a line to join points **A** and **B** on Fig. 1.1.

Record the length of this line **AB** in millimetres to the nearest millimetre.

(ii) Draw the line **AB** on your drawing in **(a)**.

Record the length of this line in millimetres to the nearest millimetre.

(iii) Calculate the magnification m of your drawing.

Use your measurements in **(b)(i)** and **(b)(ii)** and the equation shown.

$$m = \frac{\text{length of line } \mathbf{AB} \text{ on your drawing}}{\text{length of line } \mathbf{AB} \text{ on Fig. 1.1}}$$

Record your value to **two** significant figures.

（2024 May/Jun 0654/61 第1题(b)(iii)）

4. A student investigates okra and star fruit.

Figure 1.1 shows a photograph of a slice of okra at its actual size.



Figure 1.1

(a) In the box, make a large, detailed, pencil drawing of the slice of okra shown in Figure 1.1.

(b) **(i)** Draw a line to join points **A** and **B** on Figure 1.1.

Record the length of this line **AB** in millimetres to the nearest millimetre.

(ii) Draw the line **AB** on your drawing in **1(a)**.

Record the length of this line in millimetres to the nearest millimetre.

(iii) Calculate the magnification *m* of your drawing.

Use your measurements in **1(b)(i)** and **1(b)(ii)** and the equation shown.

$$m = \frac{\text{length of line } \mathbf{AB} \text{ on your drawing}}{\text{length of line } \mathbf{AB} \text{ on Figure 1.1}}$$

Record your value to **two** significant figures.

（2026 Feb/Mar 0654/62 第1题(b)(iii)）

5. Fig. 2.1 shows a magnified section through part of a leaf.

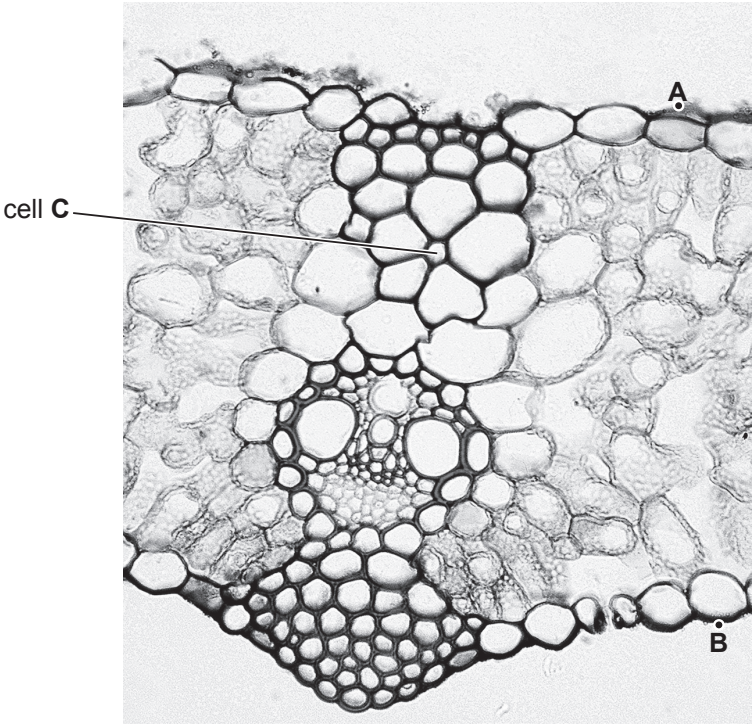


Fig. 2.1

(b) (i) The distance between the points **A** and **B** in Fig. 2.1 shows the thickness of the leaf.

Draw a line between points **A** and **B** in Fig. 2.1.

Measure the length of line **AB** in Fig. 2.1.

Record this length in millimetres to the nearest millimetre.

(ii) The thickness of the actual leaf at **AB** is 0.75 mm.

Calculate the magnification *m* of the photograph.

Use the equation shown.

$$m = \frac{\text{length of line } \mathbf{AB} \text{ in Fig. 2.1}}{\text{thickness of the actual leaf at } \mathbf{AB}}$$

（2022 May/Jun 0654/62 第2题(b)(ii)）

6. Fig. 2.1 shows a photomicrograph of some blood cells.

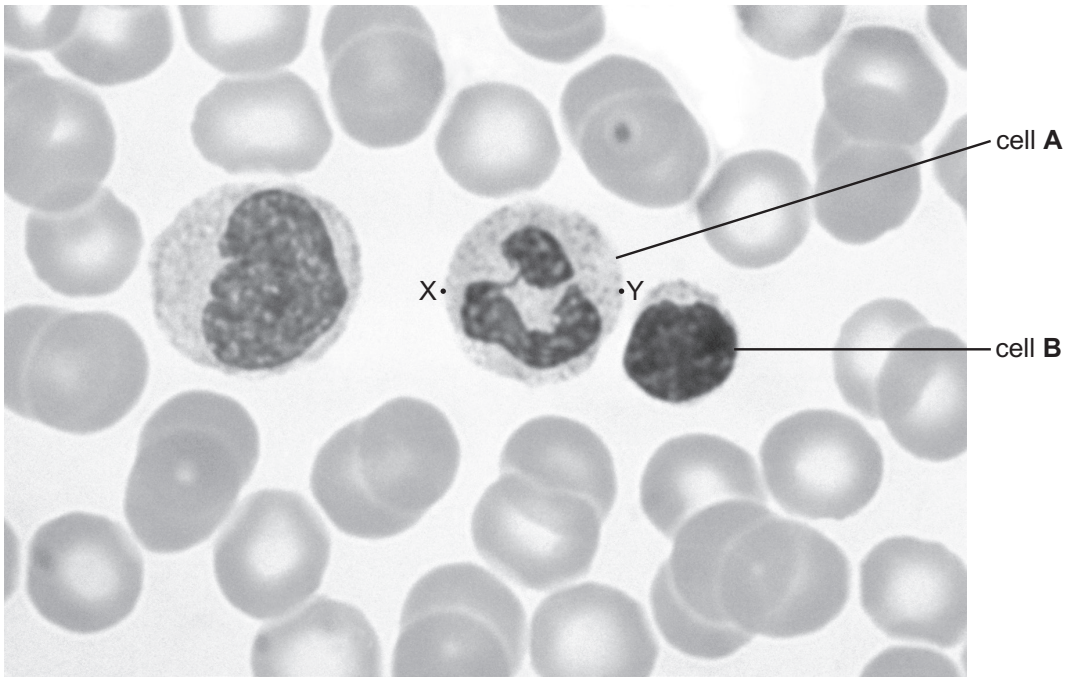


Fig. 2.1

(a) Make a large detailed pencil drawing of blood cell **A** in the box below.

(b) **(i)** Measure the diameter XY of cell **A** in Fig. 2.1 in millimetres to the nearest millimetre.

(ii) Draw a line to show this diameter XY on your drawing in **(a)**.

Measure the length of this line in millimetres to the nearest millimetre.

(iii) Use your measurements in **(b)(i)** and **(b)(ii)** to calculate the magnification *m* of your drawing .

Use the equation shown.

$$m = \frac{\text{diameter of cell in drawing}}{\text{diameter of cell in Fig. 2.1}}$$

Record your value to **two** significant figures.

（2022 Oct/Nov 0654/63 第2题(b)(iii)）

7. Fig. 2.1 shows a photomicrograph of a single-celled organism called *Euglena*.

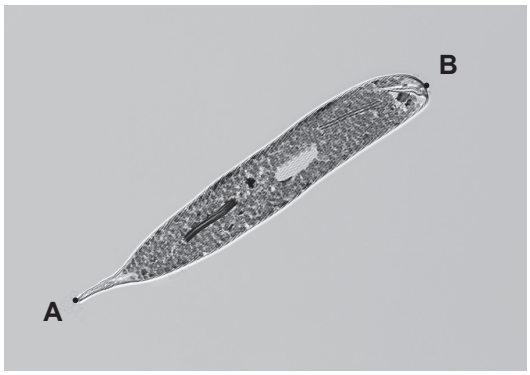


Fig. 2.1

(a) In the box below, make a large, detailed pencil drawing of the *Euglena* cell in Fig. 2.1.

(b) **(i)** Measure the length **AB** of the *Euglena* cell in Fig. 2.1 in millimetres to the nearest millimetre.

(ii) Draw a line to show this length on your drawing in **(a)**.

Measure the length of this line in millimetres to the nearest millimetre.

(iii) Use your measurements in **(b)(i)** and **(b)(ii)** to calculate the magnification *m* of your drawing.

Use the equation shown.

$$m = \frac{\text{length of } \textit{Euglena} \text{ cell on your drawing}}{\text{length of } \textit{Euglena} \text{ cell in Fig. 2.1}}$$

Record your value to **two** significant figures.

（2023 Oct/Nov 0654/61 第2题(b)(iii)）

题型 5：在自己的绘图上对应标记并量取长度（考频★★★☆☆）

知识点 对应长度是绘图中与原图同一结构、同一方向的线段；两端应落在对应轮廓处。

用_____沿所画线段量取，读数单位为_____，按题意取至最接近的 1 mm。

绘图放大或缩小时，记录的是_____的长度，不照抄原图读数。

答案：直尺；毫米；所画线段

怎么认 题目出现题图中的 AB 或 XY，并要求在自己的绘图上画线并量取时，先确定两端的对应位置。

例题 1

Fig. 1.1 shows a flower with some of the petals removed.



Fig. 1.1

(a) (i) In the box, make a large, detailed, pencil drawing of the flower.

Include the internal parts of the flower.

(ii) Draw a line to show the same width **AB** of the petal on your drawing.

Record this width in millimetres to the nearest millimetre.

（2022 Feb/Mar 0654/62 第1题(b)(ii)）

解：由题图中 A、B 的位置，AB 表示左侧花瓣在两侧轮廓之间的宽度。
在绘图的同一花瓣上确定两侧对应点，连接两点并标出 AB。
用直尺沿所画线段量取，读数取至最接近的 1 mm。
答：AB 的长度以所画线段的实际毫米读数为准。

针对练习

1. **(a)** Fig. 1.1 is a photograph of a flower.



Fig. 1.1

(i) In the box, make a large, detailed pencil drawing of the flower shown in Fig. 1.1.

Include the internal parts of the flower.

(ii) Draw a line to show the same width **AB** of the petal on your drawing.

Record this width in millimetres to the nearest millimetre.

（2025 May/Jun 0654/62 第1题(b)(ii)）

2. Fig. 1.1 shows a photograph of a flower.

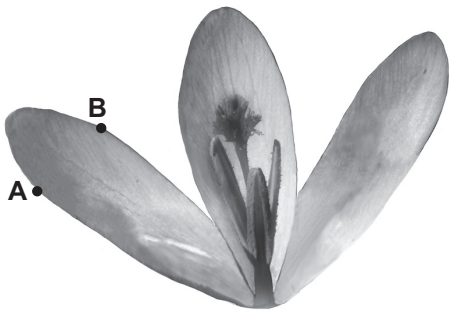


Fig. 1.1

(a) In the box, make a large and detailed pencil drawing of the flower.

Include the internal parts of the flower.

(ii) Draw a line on your drawing in **(a)** in the same place as **AB** on Fig. 1.1.

Measure the length of this line in millimetres to the nearest millimetre.

（2023 May/Jun 0654/63 第1题(b)(ii)）

3. A student investigates okra and star fruit.

Figure 1.1 shows a photograph of a slice of okra at its actual size.



Figure 1.1

(a) In the box, make a large, detailed, pencil drawing of the slice of okra shown in Figure 1.1.

(ii) Draw the line **AB** on your drawing in **1(a)**.

Record the length of this line in millimetres to the nearest millimetre.

（2026 Feb/Mar 0654/62 第1题(b)(ii)）

4. Fig. 1.1 is a photograph of a slice of an orange shown actual size.

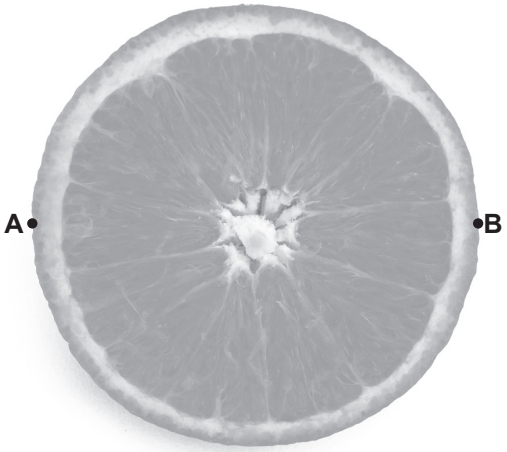


Fig. 1.1

(a) In the box, make a large, detailed, pencil drawing of the slice of the orange shown in Fig. 1.1.

(ii) Draw the line **AB** on your drawing in **(a)**.

Record the length of this line in millimetres to the nearest millimetre.

（2024 May/Jun 0654/61 第1题(b)(ii)）

5. Fig. 2.1 shows a photomicrograph of some blood cells.

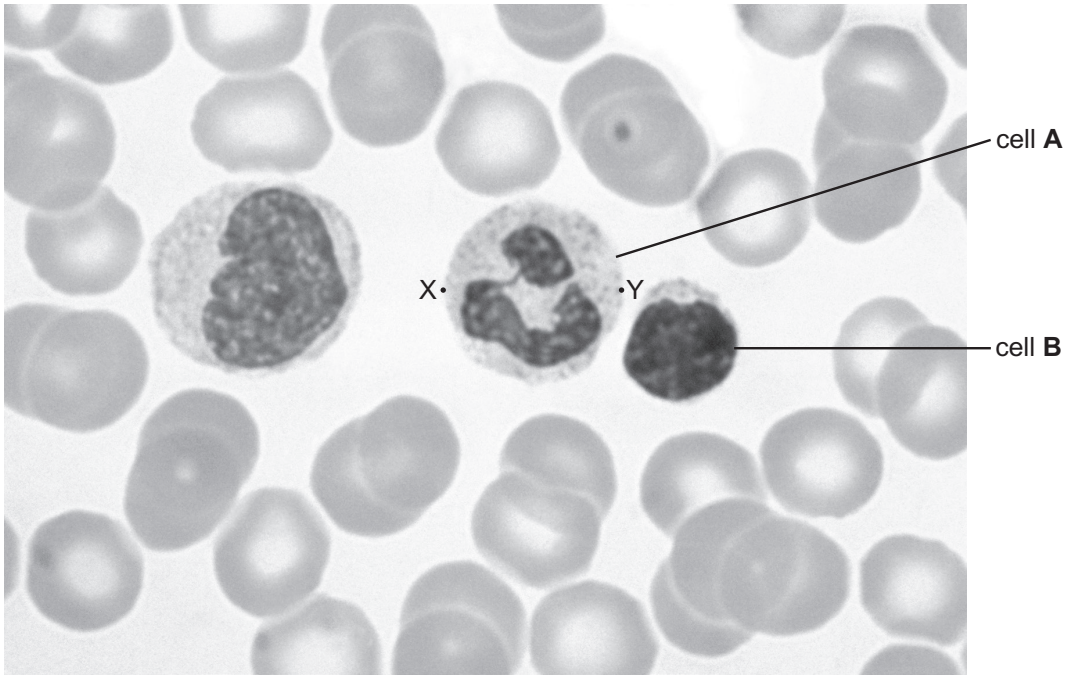


Fig. 2.1

(a) Make a large detailed pencil drawing of blood cell **A** in the box below.

(ii) Draw a line to show this diameter XY on your drawing in **(a)**.

Measure the length of this line in millimetres to the nearest millimetre.

（2022 Oct/Nov 0654/63 第2题(b)(ii)）

6. Fig. 2.1 shows a photomicrograph of a single-celled organism called *Euglena*.

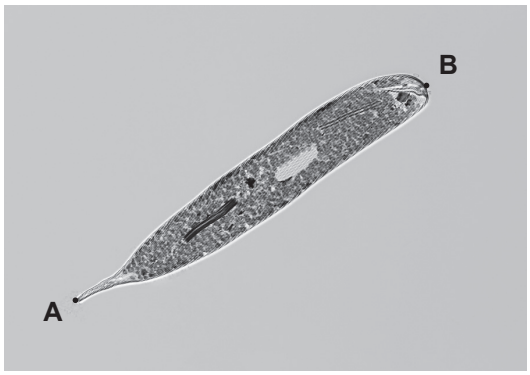


Fig. 2.1

(a) In the box below, make a large, detailed pencil drawing of the *Euglena* cell in Fig. 2.1.

(b) **(i)** Measure the length **AB** of the *Euglena* cell in Fig. 2.1 in millimetres to the nearest millimetre.

(ii) Draw a line to show this length on your drawing in **(a)**.

Measure the length of this line in millimetres to the nearest millimetre.

（2023 Oct/Nov 0654/61 第2题(b)(ii)）

题型 6：尺寸随位置改变：多处测量再求平均（考频★★☆☆☆）

知识点 同一生物结构的尺寸常随测量位置或方向改变，单次测量值不能代表整体。

应在_____个有代表性的位置或方向按相同方法测量，取_____作为整体尺寸的估计值。

各次读数须使用相同单位；图中长度通常以_____记录。

答案：多；算术平均值；毫米

怎么认 题目出现某处尺寸不能代表整体或求平均尺寸时，先在多处或多方向测量再求平均。

例题 1 Fig. 2.1 shows a magnified section through part of a leaf.

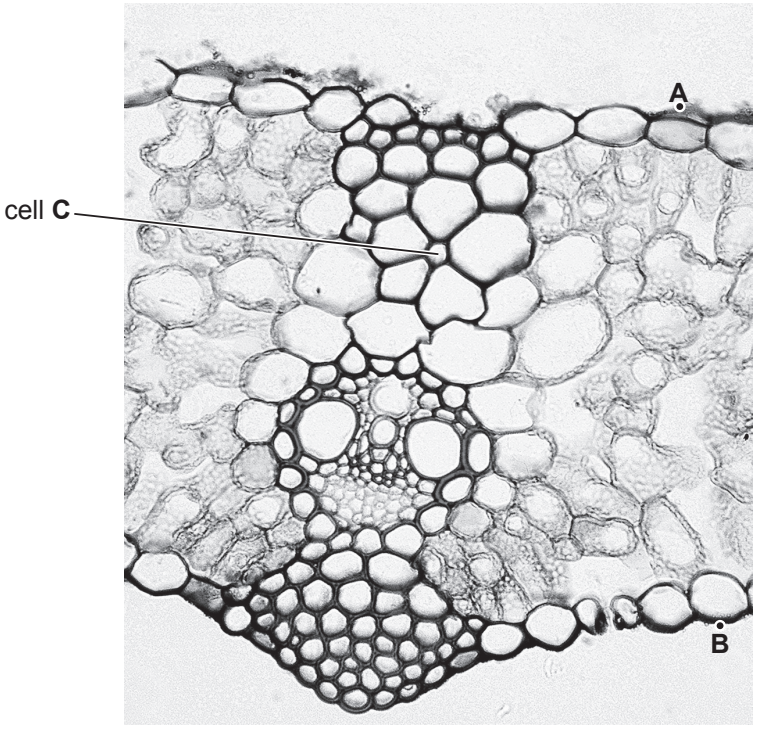


Fig. 2.1

(c) A teacher states that the thickness of the actual leaf measured between points **A** and **B** does **not** show the thickness of the **whole** leaf.

Suggest why the teacher is correct.

State how you can improve confidence in the measurement of the thickness of the **whole** leaf.

improvement

（2022 May/Jun 0654/62 第2题(c)）

解：∵叶片不同位置的厚度不同，A、B 间的测量只反映一个位置，∴该值不能代表整片叶的厚度。
在叶片多个有代表性的位置测量厚度，计算所得数值的平均值。
答：叶片各处厚度不同；应多处测量并求平均。

针对练习

1. **(c)** Fig. 1.2 is a photograph of a slice of a kiwi fruit shown actual size.

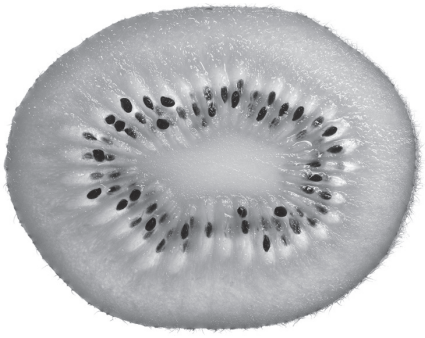


Fig. 1.2

(d) Suggest how the mean diameter of the kiwi fruit is determined.

（2024 May/Jun 0654/61 第1题(d)）

2. **(a)** Fig. 1.1 is a photograph of a flower.



Fig. 1.1

(b) **(i)** On Fig. 1.1, draw a line to join points **A** and **B**, which shows the width of **one** petal.

Record this width, **AB**, in millimetres to the nearest millimetre.

(iv) A teacher states that the width of the petal in **(b)(i)** does **not** represent the width of all of the petals on the flower.

Suggest how to improve confidence in the value of the width of all the petals on the flower.

（2025 May/Jun 0654/62 第1题(b)(iv)）

题型 7：在花的图中标记生殖结构（考频★★☆☆☆）

知识点 花的生殖结构包括雄蕊和心皮。雄蕊由_____和花丝组成，花药通常位于花丝顶端；心皮由_____、花柱和子房组成，柱头通常位于花柱顶端。

标记线的末端应准确接触所指结构；同类结构有多个时，可指向其中任意一个清晰实例。

答案：花药；柱头

怎么认 题目出现花的照片或观察图并要求标记花药、柱头或心皮时，先按位置和形态确定目标结构。

例题 1

Fig. 1.1 shows a flower with some of the petals removed.



Fig. 1.1

(a) (i) In the box, make a large, detailed, pencil drawing of the flower.

Include the internal parts of the flower.

(ii) On your drawing, add a line labelled **C** to identify a carpel.

（2022 Feb/Mar 0654/62 第1题(a)(ii)）

解：心皮由柱头、花柱和子房组成，图中花中央顶端膨大的柱头向下连接花柱和基部子房，故该中央结构为心皮。
在铅笔图上画一条标签线，线端接触该结构，并在线旁标 C。
答：C 指向花中央的心皮。

针对练习

1. **(c)** Fig. 1.2 shows a flower at the same magnification as the flower in Fig. 1.1.



Fig. 1.2

(ii) Add a line labelled anther to identify an anther on Fig. 1.2.

（2023 May/Jun 0654/63 第1题(c)(ii)）

2. **(a)** Fig. 1.1 is a photograph of a flower.



Fig. 1.1

(i) In the box, make a large, detailed pencil drawing of the flower shown in Fig. 1.1.

Include the internal parts of the flower.

(ii) On your drawing, add a line labelled **S** to identify a stigma.

（2025 May/Jun 0654/62 第1题(a)(ii)）

题型 8：取生物样本时说明防止感染的措施（考频★☆☆☆☆）

知识点 交叉感染是病原体在患者与医护人员之间传播而引起的感染。

血液可能含有病原体；采集血样时，手术手套形成_____，减少皮肤与血液的接触。

手套应在接触血液前戴好，并在使用后更换或弃置，以降低病原体_____的风险。

答案：物理屏障；传播

怎么认 题目出现采集血液等生物样本并问防护原因时，先写隔离接触，再写防止病原体传播。

例题 1 **(d)** Suggest why a nurse wears surgical gloves when obtaining a sample of blood from a patient.

（2022 Oct/Nov 0654/63 第2题(d)）

解：患者的血液可能含有病原体，手术手套可隔离皮肤与血液，减少病原体进入护士体内的机会。

答：防止护士接触患者血液中的病原体，降低感染风险。

题型 9：写出营养物质检验的试剂与阳性现象（考频★☆☆☆☆）

知识点 淀粉检验使用_____作为检测试剂。

待测样品中含有淀粉时，加入试剂后出现_____；该反应不需要加热。

答案：碘液；蓝黑色

怎么认 题目出现检测淀粉并要求写试剂和阳性现象时，先写碘液，再写样品变为蓝黑色。

例题 1 **(c)** A student tests the carpel for the presence of starch.

State the reagent used to test for the presence of starch.

Give the observation for a positive result.

（2022 Feb/Mar 0654/62 第1题(c)）

解：由淀粉的特征检验反应，所用试剂为碘液。
若心皮中含有淀粉，加入碘液后心皮变为蓝黑色。
答：试剂为碘液；阳性现象为心皮变为蓝黑色。

题型 10：由燃烧产物的检验结果反推样品中的元素（考频★☆☆☆☆）

知识点 干燥样品在氧气中燃烧，生成的二氧化碳使石灰水_____，生成的水使白色无水硫酸铜_____。
燃烧所用的氧气可提供氧元素，因此二氧化碳和水分别确认原样品含_____元素和氢元素，不能据此确认原样品含氧元素。

答案：变浑浊；变蓝；碳

怎么认 题目出现燃烧产物使石灰水变浑浊、无水硫酸铜变蓝时，先判定产物，再反推样品中的元素。

例题 1

(c) A student investigates the elements present in a dried plant sample, a sample where all of the water has been removed from the plant.

The student burns the dried plant sample in oxygen.

The student tests the products formed.

The gas product formed turns limewater milky.

The liquid product formed turns white anhydrous copper sulfate blue.

Name the **two** products identified by these tests.

State which elements these tests **confirm** are present in the dried plant sample.

（2025 May/Jun 0654/62 第1题(c)）

解：石灰水变浑浊，表明气体产物为二氧化碳。
白色无水硫酸铜变蓝，表明液体产物为水。
二氧化碳中的碳来自干燥植物样品，水中的氢来自干燥植物样品；氧还可来自燃烧所用的氧气。
答：两种产物为二氧化碳和水；确认样品中含碳元素和氢元素。

第 2 章 实验计划

2.1 观察、变量、重复测量与作图

题型 1：改变释放高度，测量回弹高度（考频★☆☆☆☆）

知识点 自变量是实验中有计划改变的量，因变量是随自变量变化而测量的量；其余可能影响测量结果的量应作为_____变量。

同一条件下重复测量并取_____，可减小随机误差；读数时视线应与刻度面垂直。

本实验以 $\frac{H}{\text{cm}}$ 为横轴、$\frac{h}{\text{cm}}$ 为纵轴；若最佳拟合线为过原点的直线，则 h 与 H 成_____。

答案：控制；平均值；正比

怎么认 题目出现改变释放高度并测量回弹高度时，先确定自变量、因变量和控制变量。

例题 1

A ball is dropped from rest at a height *H* above the ground. The ball rebounds and bounces back up to a height *h*.

Plan an experiment to investigate the relationship between the bounce height *h* and the height *H* from which the ball is dropped.

You are provided with a selection of balls of different sizes and different materials.

You may use any other apparatus normally found in a school laboratory.

Include in your answer:

- the apparatus you will use
- a brief description of the method, including how you will ensure your results are accurate
- the variables you will control
- a table with column headings to show how you will present your results (you are not required to enter any readings in the table)
- how you will process your results to reach a conclusion.

You may include a labelled diagram if it helps to explain your plan.

（2022 Oct/Nov 0654/63 第6题）

解： 选用一个球、米尺、铁架台和夹具、硬质水平地面及慢动作摄像设备。

将米尺竖直固定，零刻度与地面相平，使球在米尺旁竖直运动；摄像设备正对刻度面并保持位置不变。

使球的最低点与释放高度 H 的刻度对齐，松手使球由静止落下，不施加推力；由录像确定第一次回弹的最高位置，按球的最低点读取回弹高度 h。

改变 H，在较大范围内取至少五个数值；每个 H 重复三次，求平均回弹高度。

$|h| = \frac{h_1+h_2+h_3}{3}$

实验中保持球、地面材料、落点、释放方式、米尺位置和摄像位置不变。

记录表如下：

$\frac{H}{\text{cm}}$	$\frac{h_1}{\text{cm}}$	$\frac{h_2}{\text{cm}}$	$\frac{h_3}{\text{cm}}$	$\frac{\lvert h\rvert}{\text{cm}}$

以 $\frac{H}{\text{cm}}$ 为横轴、$\frac{|h|}{\text{cm}}$ 为纵轴作图，画最佳拟合线，并由图线形状判断 h 与 H 的关系。

$k=\frac{|h|}{H}$

若最佳拟合线为过原点的直线，且各组 k 在实验误差范围内近似相等，则 $|h|=kH$，故 h 与 H 成正比；k 为图线斜率。

答：改变释放高度 H，测量并比较平均回弹高度 $|h|$，由图线与比值判定二者关系。

2.2 生物观察、检测与探究

题型 1：改变生长条件，比较植物增长或失水（考频★★☆☆☆）

知识点 生长条件是影响植物生长或失水速率的环境或物质因素；探究时只改变_____，其余条件保持相同。

植物生长速率为 $\text{生长速率}=\frac{h_2-h_1}{\Delta}t$，常用单位为 cm d^{-1}；失水速率为 $\text{失水速率}=\frac{m_1-m_2}{\Delta}t$，常用单位为 g h^{-1}。

每组设置多株状态相近的植物并取平均值，以各组的_____判断生长条件的影响。

答案：自变量；平均速率

怎么认 题目出现改变肥料、光色或风力并比较生长或失水时，先确定自变量、因变量和控制变量。

例题 1

Fertilisers contain nutrients that are added to crops to help them grow.

A farmer has a choice of three fertilisers, **A**, **B** and **C** for use on his rice crop.

Plan an investigation to find out which fertiliser produces the highest rate of growth of the rice plants.

You are provided with:

- rice plant seedlings
- fertilisers **A**, **B** and **C**.

You may also use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- a brief description of the method
- the measurements you will make
- the variables you will control
- how you will process your results to draw a conclusion.

You may include a results table if you wish, you are not required to enter any readings in the table.

You may include a labelled diagram if you wish.

（2024 Feb/Mar 0654/62 第2题；同题：2024 Feb/Mar 0654/52 第2题）

解：准备花盆、同种土壤、直尺、天平、量筒、烧杯、标签和水，将同品种、同龄且初始高度相近的水稻幼苗随机分成 A、B、C 三组，每组设置多株幼苗。

各盆加入等质量的同种土壤并各栽一株幼苗，测量从土面到植株最高点的初始高度；将等质量的三种肥料分别配成等体积溶液，每组加入等体积对应肥料溶液。

各组使用相同大小的花盆，控制土壤种类和质量、施肥量、浇水量、光照、温度及生长时间相同，并随机排列花盆位置。

在相同时间间隔内测量各株高度，直尺竖直且每次均从土面量至植株最高点。

$\text{生长速率}=\frac{\text{末高度}-\text{初高度}}{\text{生长时间}}$

$\text{各组平均生长速率}=\frac{\text{组内各株生长速率之和}}{\text{组内植株数}}$

比较三组的平均生长速率，平均值最大的组所用肥料产生的生长速率最高。
答：控制其他条件相同，比较施用 A、B、C 三种肥料后水稻幼苗的平均生长速率。

针对练习

1. Plant seedlings need light to grow.

Plan an investigation to determine if the **colour** of the light affects the rate of growth of plant seedlings.

You are provided with plant seedlings.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- a brief description of the method
- what you will measure
- the variables you will control
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

You may include a results table if you wish. You are **not** required to include any results.

（2024 May/Jun 0654/63 第2题；同题：2024 May/Jun 0654/53 第2题）

2. Water from the soil enters a plant through its roots, travels up the plant in xylem vessels and exits through holes in the leaves.

Plan an investigation to show that the mass of water lost from the leaves of a plant is greater when it is windy compared to when it is not windy.

You are provided with several plants in pots.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- a brief description of the method
- the measurements you will make including how to make them as accurate as possible
- the variables you will control
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

You may include a results table if you wish. You are **not** required to include any results.

（2022 May/Jun 0654/61 第2题；同题：2022 May/Jun 0654/51 第2题）

题型 2：改变酶或细胞反应条件，计时到达变色终点（考频★★☆☆☆）

知识点 变色终点法是在其余条件相同时，改变一种反应条件，测量指示剂达到规定颜色所需的时间 t；t 越小，反应速率越_____。

各组反应物用量及颜色终点相同时，可用 $r=\frac{1}{t}$ 表示相对速率；t 的单位为 s，r 的单位为 s^{-1}。

研究温度时，反应物应先在恒温水浴中达到设定温度；研究浓度时，用水稀释原液，并使溶液总体积_____。

同一条件至少重复测量三次，排除明显异常值后计算_____，再用表格或图像比较自变量与平均时间或相对速率的关系。

答案：大；相同；平均值

怎么认 题目出现改变温度或浓度、用指示剂判断变色终点并计时时，先确定自变量、统一终点和受控变量。

例题 1

Yeast is a unicellular organism that respires.

DCPIP is an indicator that turns from blue to colourless when respiration takes place.

When DCPIP is added to yeast cells the rate of colour change is an indication of the rate of respiration.

Plan an investigation to determine the effect of temperature on the rate of respiration in a suspension of yeast cells.

You are provided with:

- a suspension of yeast cells (yeast cells in water)
- DCPIP solution.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus you will need
- a brief description of the method
- what you will measure
- the variables you will control
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

You may include a results table if you wish. You do not need to enter any readings into the table.

（2025 Oct/Nov 0654/62 第2题）

解： 选用恒温水浴、温度计、试管和试管架、量筒或移液管、滴管、计时器及白色背景；设置不少于五个有规律间隔的温度。

把等体积的酵母悬液和 DCPIP 分装在两支试管中，置于对应水浴，待温度稳定后混合并开始计时；轻轻振荡，以蓝色恰好褪为无色作为终点，记录时间 t，各温度重复至少三次。

各组控制酵母悬液与 DCPIP 的体积和浓度、溶液总量、酵母批次、混合方式、终点判断和水浴时间相同，并用温度计监测实际温度。

由平均时间 t 计算相对呼吸速率

$r=\frac{1}{t}$

以温度为横轴、平均相对呼吸速率为纵轴作图；图中速率随温度的变化表示温度对酵母呼吸速率的影响，曲线最高点对应所测范围内的最适温度。答：按上述方法比较温度和呼吸作用的平均相对速率之间的关系。

针对练习

1. Amylase is a digestive enzyme that breaks down starch into sugars.

The presence of starch in a solution is confirmed by adding iodine solution.

When starch is present, the iodine solution turns from brown to blue-black.

Plan an investigation to determine the relationship between temperature and the time taken for the starch to be completely broken down by the enzyme.

You are provided with:

- starch solution
- amylase solution
- iodine solution.

You may also use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- a brief description of the method, explaining any safety precautions
- the measurements you will take
- the variables you will control
- how you will process your results to reach a conclusion.

You may include a results table in your answer. You are **not** required to enter any readings in the table.

You may include a labelled diagram in your answer.

（2023 Oct/Nov 0654/63 第2题；同题：2023 Oct/Nov 0654/53 第2题）

2. Amylase is a digestive enzyme that breaks down starch into reducing sugar.

The presence of starch in a solution can be confirmed by adding iodine solution. If starch is present the iodine solution will turn from brown to blue-black.

Plan an investigation to find out if the time taken for starch to break down is affected by the concentration of amylase enzyme.

You are provided with:

- starch solution
- 10% amylase solution
- iodine solution.

You may also use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- a brief description of the method explaining any safety precautions
- the measurements you will make
- the variables you will control
- how you will process your results to draw a conclusion.

You may include a results table if you wish, you are not required to enter any readings in the table.

You may include a labelled diagram if you wish.

（2022 Oct/Nov 0654/62 第3题）

题型 3：记录人体特征，比较运动后的恢复时间（考频★☆☆☆☆）

知识点 恢复时间是运动停止后，脉搏率恢复至运动前_____脉搏率所需的时间，单位为 s。

研究身高与恢复时间的关系时，身高是_____变量，恢复时间是_____变量；其余影响恢复时间的条件应保持相同。

在相同条件下重复测量并求平均值，以身高为横轴、平均恢复时间为纵轴作图，由总体趋势判断两者的关系。

答案：静息；自；因

怎么认 题目出现身高、运动后脉搏率和恢复时间时，先统一运动条件，再比较不同身高者的恢复时间。

例题 1

When a person exercises, their pulse rate increases from their resting pulse rate.

The time it takes for the pulse rate to return to the resting pulse rate after exercise is called the recovery time.

Plan an investigation to determine the relationship between the height of a person and their recovery time.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus you will need
- a brief description of the method
- what you will measure
- the variables you will control
- how you will process your results to reach a conclusion.

You may include a labelled diagram in your answer.

You may include a results table in your answer. You are **not** required to enter any readings in the table.

（2026 May/Jun 0654/62 第2题；同题：2026 May/Jun 0654/52 第2题、2026 May/Jun 0654/53 第2题）

解：备身高尺、固定高度的踏板、节拍器、计时器、脉搏传感器、数据记录器和记录表。

选取数量足够且身高分布较广的健康参与者，使年龄范围、性别和体能水平相近。

每人脱鞋直立，用身高尺测量身高 h，单位为 cm；在同一室温下静坐相同时间，用脉搏传感器测量静息脉搏率，单位为次/min。

每人按相同节拍在同一踏板上运动相同时间；运动停止时开始计时，并连续记录脉搏率。脉搏率首次恢复至该次试验的静息值时停止计时，所得时间为恢复时间，单位为 s。

每人在不同日期的相同时段重复测量三次，每次运动前均充分休息；保持踏板高度、运动方式、运动时间、运动节拍、测量装置、室温及运动前饮食条件相同。

设三次恢复时间分别为 t_1、t_2、t_3，则

$\bar{t}=\frac{t_1+t_2+t_3}{3}$

以身高 h 为横轴、平均恢复时间 $\bar{t}$ 为纵轴作散点图并画最佳拟合线。拟合线总体向上表明身高越大，恢复时间越长；总体向下表明身高越大，恢复时间越短；散点无明显趋势表明两者没有明确关系。答：由散点图和最佳拟合线的总体趋势确定身高与恢复时间的关系。

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题型 4：改变释放高度，测量种子水平移动距离（考频★☆☆☆☆）

知识点 释放高度 h 是种子释放点到着地点平面的竖直距离，水平移动距离 d 是释放点正下方到首次着地点的水平距离。

在风速、风向、种子和释放方式相同的条件下，改变 h，测量 d；两者均属于长度，可用 _____ 测量，单位取 _____。

同一高度重复测量后取 d 的 _____，再由图像判断 h 与 d 的关系。

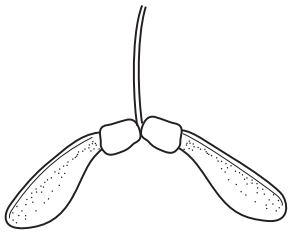
答案：米尺或卷尺；m 或 cm；平均值

怎么认 题目出现改变种子释放高度并测量水平距离 d 时，先确定测量基准和控制变量。

例题 1

The seeds of a sycamore tree are shown in Fig. 3.1.

They have “wings” to help carry them in the wind.



sycamore seeds

Fig. 3.1

Fig. 3.2 shows sycamore seeds fallen from the parent tree.

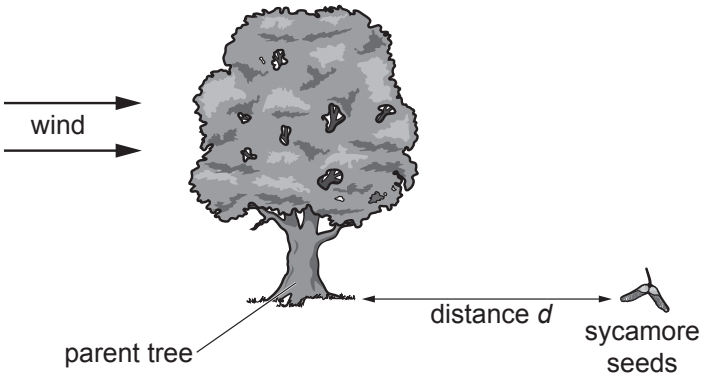


Fig. 3.2

Plan an investigation to determine the relationship between the vertical height the seeds fall from and the horizontal distance *d* the seeds travel from the height they were dropped.

You are provided with several sycamore seeds.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- a brief description of the method
- what you will measure
- the variables you will control
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

You may include a results table if you wish. You are **not** required to include any results.

（2023 May/Jun 0654/62 第3题；同题：2023 May/Jun 0654/52 第3题）

解： 器材取电风扇、铁架台和夹子、米尺或卷尺、铅垂线、胶带、白纸及若干形态相近的种子。

关闭门窗，将电风扇固定在释放点一侧，保持风向水平；用铅垂线在地面标出释放点的正下方，并将卷尺零点固定在此处。

用米尺量出释放点到地面的竖直高度 h，在同一朝向用夹子无初速度释放种子；标记种子首次接触地面的位置，测量该位置到铅垂点的水平距离 d。

设置不少于五个不同的释放高度，各高度重复三次，记录 h 和各次 d，求同一高度下 d 的平均值。

保持电风扇的档位、风向、风扇与释放点的距离、种子、种子初始朝向、释放方式、地面和室内环境相同。以 h 为横坐标、平均 d 为纵坐标描点并画最佳拟合线，由图线的变化趋势判断释放高度与水平移动距离的关系。若图线随 h 增大而上升，则释放高度越大，种子的水平移动距离越大。

2.3 反应观察、化学检测与定量探究

题型 1：改变加入量，测量酸碱性（考频★★☆☆☆）

知识点 改变加入量、测量酸碱性的探究中，加入物质的体积或质量是_____，所得样品的 pH 是_____。

在同一温度的水溶液中，pH 越小，酸性越强；pH 没有单位，液体体积常用 cm^3，固体质量常用 g。比较各组结果时，除加入量外，其余影响 pH 的条件应作为_____保持相同；各组应重复测量并求平均值。

答案：自变量；因变量；控制变量

怎么认 题目出现改变某物质加入量并测量 pH 时，先确定自变量、因变量和控制变量。

例题 1

The pH of saliva in the mouth is approximately 7.

Eating and drinking lowers the pH of saliva in the mouth. This can cause tooth decay.

Mouthwash is sometimes used to raise the pH of saliva in the mouth.

Plan an investigation to determine the relationship between the volume of mouthwash used and the pH of saliva.

You are provided with:

- mouthwash
- a solution of saliva at pH 3.

You may use any laboratory apparatus.

In your plan include:

- the apparatus needed
- a brief description of the method
- the measurements you will make
- the variables you will control
- how you process your results to draw a conclusion.

（2024 Oct/Nov 0654/61 第2题；同题：2024 Oct/Nov 0654/51 第2题、2024 Oct/Nov 0654/52 第2题、2024 Oct/Nov 0654/53 第2题）

解： 所需器材为量筒、刻度移液管、相同烧杯、玻璃棒、pH 计、温度计、蒸馏水和标准缓冲液。

用标准缓冲液校准 pH 计，向各烧杯分别加入 $20cm^3$、pH 为 3 的唾液溶液，再分别加入 $0cm^3$、$2cm^3$、$4cm^3$、$6cm^3$、$8cm^3$ 和 $10cm^3$ 漱口水。以相同方式搅拌，待读数稳定后记录 pH；每次测量后用蒸馏水清洗探头。

保持唾液溶液的体积和来源、漱口水的来源、温度、搅拌时间、静置时间及所用容器相同。每种漱口水体积用新配样品重复测量 3 次。

$|\mathrm{pH}| = \frac{\mathrm{pH}_1+\mathrm{pH}_2+\mathrm{pH}_3}{3}$

以漱口水体积为横轴、平均 pH 为纵轴作图并画趋势线，由图线的升降方向和形状判断二者的关系。答：改变漱口水体积，测量并比较唾液的平均 pH。

针对练习

1. Solid **X** dissolves in water and the solution it forms is acidic.

Plan an experiment to find the relationship between the mass of **X** dissolved in water and the pH of the solution formed.

You are provided with solid **X**.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus you will need
- a brief description of the method
- the measurements you will make
- the variables you will control
- how you will process your results to draw a conclusion.

You may include a results table if you wish, you are not required to enter any readings in the table.

You may include a labelled diagram if you wish.

（2025 Oct/Nov 0654/63 第4题）

2. The pH of urine in a healthy person is approximately 6.5.

A student suggests that the pH of urine changes as the amount of water a person drinks during the day changes.

Plan an investigation to determine the relationship between the volume of water a person drinks and the pH of their urine three hours later.

You may use any common laboratory apparatus in your plan.

In your plan, include:

- the apparatus and chemicals you will need
- a brief description of the method
- the measurements you will make and how you make them as valid as possible
- the variables you will control
- how you will process your results to reach a conclusion.

You may include a results table if you wish. You are **not** required to enter any readings in the table.

（2025 May/Jun 0654/63 第2题；同题：2025 May/Jun 0654/53 第2题）

题型 2：改变反应物或电压，测量产物的量（考频★★☆☆☆）

知识点 定量探究是改变_____，测量因变量，并研究二者的关系；其余可能影响结果的条件均保持不变。

每个自变量值至少重复三次，排除异常值后求_____，以减小随机误差。

以自变量为横轴、因变量为纵轴作图，根据图线趋势判断二者的关系。

质量、气体体积、电压、时间和高度的单位可分别写作 g、cm^3、V、s 和 cm。

答案：自变量；平均值

怎么认 题目出现改变反应物质量或电压并测量产物体积、高度或质量时，先确定自变量、因变量和控制变量。

例题 1

When ammonium sulfate is heated with sodium hydroxide, it reacts to form ammonia gas.

Ammonia gas is **not** collected over water because it is soluble in water.

Plan an investigation to find the relationship between the mass of ammonium sulfate used and the volume of ammonia gas made.

You are provided with:

- aqueous sodium hydroxide
- ammonium sulfate powder.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus you will need and an explanation of any safety precautions
- a brief description of the method
- the measurements you will make and how you make them as valid as possible
- the variables you will control
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

You may include a results table if you wish, you are not required to enter any readings in the table.

（2025 Feb/Mar 0654/62 第4题；同题：2025 Feb/Mar 0654/52 第4题）

解：用电子天平称取至少五份质量不同的硫酸铵，记录质量；把其中一份置于耐热烧瓶中，装上盛有固定体积、固定浓度且过量氢氧化钠溶液的滴液漏斗，并连接干燥、气密的气体注射器。

密闭装置后加入氢氧化钠并缓慢加热，至气体注射器读数不再增加；停止加热，待装置恢复至室温，视线与刻度垂直，记录氨气体积。

依次换用其余质量的硫酸铵；保持氢氧化钠的体积、浓度和过量程度、加热条件、装置气密性、气体温度及气压相同，每个质量重复三次并求平均体积。

氢氧化钠有腐蚀性，氨有刺激性，实验应在通风橱内进行并佩戴护目镜；烧瓶用铁夹固定，瓶口不得朝向人员。

以硫酸铵质量为横轴、氨气平均体积为纵轴作图；图线为通过原点的直线时，二者在所测范围内成正比。

答：由图线趋势判断硫酸铵质量与氨气体积的关系。

针对练习

1. When sodium carbonate solid reacts with dilute hydrochloric acid it makes carbon dioxide gas.

When the carbon dioxide gas made is bubbled into a detergent the bubbles make a foam.

The more carbon dioxide that is bubbled into the detergent the more foam is made.

You are provided with:

- detergent (washing up liquid)
- sodium carbonate
- dilute hydrochloric acid
- any common laboratory apparatus.

Plan an investigation to find the relationship between the mass of sodium carbonate added to dilute hydrochloric acid and the height of foam made.

Include in your plan:

- the apparatus needed, including a labelled diagram if you wish
- a brief description of the method, including any safety precautions
- the measurements you will make, including how to make them as accurate as possible
- the variables you will control
- how you will process your results to draw a conclusion.

Include a results table if you wish. You are **not** required to add any results into the table.

（2023 Oct/Nov 0654/62 第4题）

2. An iron key is electroplated with copper metal using the apparatus shown in Fig. 4.1.

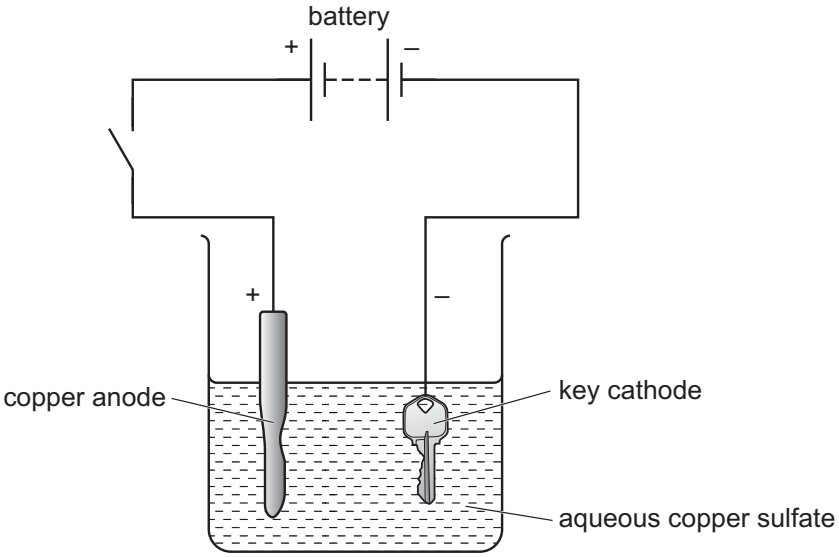


Fig. 4.1

When the switch is closed, the copper dissolves from the anode, moves through the aqueous copper sulfate and coats (plates) onto the key at the cathode.

Plan an investigation to find the relationship between the number of volts supplied by the batteries and the mass of copper coated onto the key.

You are provided with:

- several 1.5 V batteries
- the apparatus and chemicals shown in Fig. 4.1.

You may use any common laboratory apparatus in your plan.

In your plan, include:

- any other apparatus you will need
- a brief description of the method
- the measurements you will make and how you make them as valid as possible
- the variables you will control
- how you will process your results to reach a conclusion.

（2025 May/Jun 0654/61 第4题；同题：2025 May/Jun 0654/51 第4题）

3. Copper is an unreactive metal. It is a pink-orange colour.

In an experiment a grey coloured iron key is attached to the negative terminal of a power supply. A piece of copper is attached to the positive terminal of the power supply.

The iron key and the piece of copper are both dipped in aqueous copper sulfate.

A diagram of the apparatus is shown in Fig. 4.1.

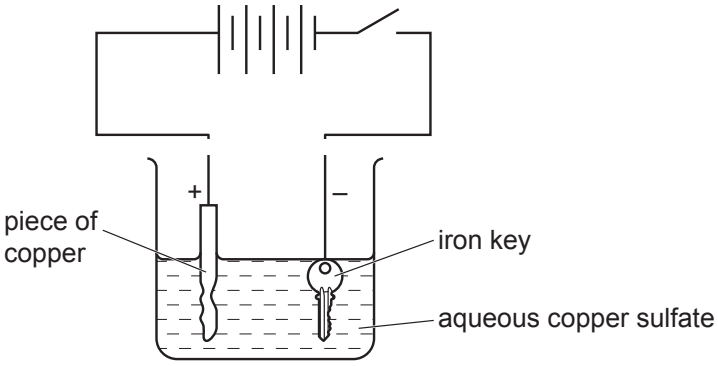


Fig. 4.1

The power supply is turned on. The voltage on the power supply must not be higher than 20 V for safety reasons.

The iron key becomes covered in copper metal. The piece of copper becomes smaller.

Plan an experiment to find out the relationship between the voltage of the power supply and the mass of copper plated onto the iron key.

You will **not** be doing this experiment.

Include in your plan:

- the apparatus needed, you do **not** need to include what is shown in Fig. 4.1
- a brief description of the method, explaining any safety precautions
- the measurements you will make including how to make them as accurate as possible
- the variables you will control
- how you will process your results to reach a conclusion.

You may include a table that can be used to record results if you wish. You are not required to include any results.

（2022 Oct/Nov 0654/51 第4题；同题：2022 Oct/Nov 0654/61 第4题）

题型 3：改变反应条件，用时间和可观测结果比较速率（考频★★☆☆☆）

知识点 化学反应速率表示反应物消耗或生成物生成的快慢；比较速率时，反应体系与观测终点必须一致。

产生气体时，若体积 V 以 $\mathrm{cm^3}$ 记录、时间 t 以 s 记录，则平均速率的单位为 $\mathrm{cm^3 s^{-1}}$；测定固定体积时，速率与 _____ 成正比。

改变一种反应条件时，该条件是 _____，测得的时间或体积是因变量，其余影响速率的条件均应控制。

用颜色变化表示反应开始时，应规定统一的 _____，每组重复测量并取平均值。

答案：时间的倒数 $\frac{1}{t}$；自变量；显色终点

怎么认 题目出现改变一种反应条件并要求比较速率时，先确定唯一自变量和同一观测终点。

例题 1

When manganese(IV) oxide powder is added to aqueous hydrogen peroxide, the hydrogen peroxide decomposes and forms oxygen gas.

$$\text{hydrogen peroxide} \rightarrow \text{oxygen} + \text{water}$$

Plan an investigation to determine the relationship between the **rate** of this reaction and the initial temperature of the aqueous hydrogen peroxide.

You are provided with an unlimited supply of:

- aqueous hydrogen peroxide
- manganese(IV) oxide powder.

You may use any common laboratory apparatus.

In your plan, include:

- the apparatus you will need
- a brief description of the method
- the measurements you will make, including how you will make them as accurate as possible
- the variables you will control
- how you will use your results to reach a conclusion.

You may include a labelled diagram in your answer.

You may include a results table in your answer. You are **not** required to enter any readings in the table.

（2026 May/Jun 0654/63 第4题）

解：所需器材有锥形瓶、带导管的双孔塞、气体注射器、温度计、水浴、移液管、电子天平、称量纸、药匙、小试管和计时器。

用移液管量取相同体积、同浓度的过氧化氢溶液放入锥形瓶，将相同质量、粒度相同的二氧化锰装在瓶内的小试管中，使两者暂不接触；连接气体注射器并检验装置气密性。

设置至少五个不同的初始温度。每次将装置放入相应温度的水浴，待温度计示数稳定后记录初始温度；倾斜锥形瓶使二氧化锰与溶液混合，同时开始计时。

记录气体注射器达到同一氧气体积 V 时的时间 t，所选 V 应在量程内并使计时长度足够；读数时视线与活塞刻度垂直。

由固定体积法得

$r = \frac{V}{t}$

过氧化氢溶液的体积和浓度、二氧化锰的质量和粒度、氧气体积 V、装置及混合方式均保持相同。每个温度重复至少三次，分别计算 r 后取平均值。

以初始温度 T 为横轴、平均速率 $|r|$ 为纵轴作图，由图线的变化方向和形状得出两者的关系。实验时戴护目镜，避免过氧化氢接触皮肤，水浴不用明火加热。

答：用固定体积法求各初始温度下的平均速率，并由 $|r|$ 与 T 的图像确定关系。

针对练习

1. Aqueous hydrogen peroxide is a solution that breaks down slowly into water and oxygen gas.

hydrogen peroxide → water + oxygen

A catalyst is a substance that increases the rate of a chemical reaction.

Manganese(IV) oxide is a catalyst for this reaction.

The reaction is too fast to count the bubbles of gas formed.

Plan an investigation to find the relationship between the mass of manganese(IV) oxide added and the rate of this reaction.

You are provided with:

- aqueous hydrogen peroxide
- manganese(IV) oxide solid.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- a brief description of the method, with an explanation of any safety precautions
- the measurements you will make, including how to make them as accurate as possible
- the variables you will control
- how you will use your results to draw a conclusion.

You may include a diagram if it helps to explain your plan.

You may include a results table. You are **not** required to include any results.

（2023 May/Jun 0654/61 第4题；同题：2023 May/Jun 0654/51 第4题）

2. Rust is a brown solid that forms on the surface of iron.

At first, the brown solid cannot be seen with the eye.

The rusting of iron in salt water is detected using indicator **X**.

Indicator **X**:

- dissolves in water
- turns blue as soon as iron starts to rust in water
- is poisonous.

Plan an investigation to find the relationship between the mass of salt added to water and the time it takes for rust to start forming.

You are given:

- water
- salt
- iron pieces
- indicator **X**.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus you will use
- a brief description of the method explaining any safety precautions you will take
- what you will measure and how you will make these measurements as accurate as possible
- which variables you will control
- how you will process your results and use them to draw a conclusion.

You may include a labelled diagram if you wish.

You may also include a table that can be used to record results. You are **not** required to include any results.

（2024 Oct/Nov 0654/63 第4题）

题型 4：取等体积溶液，蒸干后比较固体质量（考频★☆☆☆☆）

知识点 当溶剂能被蒸发、溶解固体受热不分解且不挥发时，蒸干后残留物的质量等于该体积中溶解固体的质量。

取各样品_____的体积，在相同条件下蒸干、冷却并称量，$m_{\text{固体}} = m_{\text{皿和残留物}} - m_{\text{空皿}}$。

体积用 cm^3，质量用 g；蒸干后重复加热、冷却和称量，直至质量_____。

等体积时，残留固体质量越大，溶液中溶解固体的质量越_____。

答案：相等；恒定；大

怎么认 题目出现多份溶液，要求比较溶解固体质量，且不许用化学品或固体受热不分解时，先取等体积样品蒸干称量。

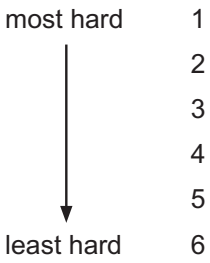
例题 1

Hard water contains many dissolved solids.

Plan an experiment to find out how hardness is affected by the **mass** of solid dissolved in water.

You are provided with six water samples, numbered 1 to 6.

The order of hardness of the water samples 1 to 6 is shown.



You must not use any chemicals or any soap.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- a brief description of the method, explaining any safety precautions
- the measurements you will make including how to make them as accurate as possible
- the variables you will control
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

You may include a results table if you wish. You are **not** required to include any results.

（2022 Feb/Mar 0654/62 第4题）

解：用六只清洁干燥的蒸发皿、容量移液管和吸球、电子天平、加热装置、坩埚钳、隔热垫及护目镜。分别称量各空蒸发皿的质量；用待测水样润洗移液管，再量取相同体积的各号水样，例如 20.0cm^3，分别加入对应蒸发皿，读数时视线与弯月面最低处相平。

缓慢加热使水蒸发，近干时减弱加热以防液滴飞溅；佩戴护目镜，用坩埚钳将热蒸发皿移至隔热垫，冷却至室温后称量。重复加热、冷却和称量，直至质量恒定。

由残留物质量等于两次称量之差，$m_{\text{固体}} = m_{\text{皿和残留物}} - m_{\text{空皿}}$。

每种水样平行测定三次，计算 $m_{\text{固体}}$ 的平均值；控制水样体积、量取器具、加热方式、干燥终点、冷却温度和所用天平相同。

按题给硬度由强到弱排列各平均值，或以水样编号为横轴、平均 $m_{\text{固体}}$ 为纵轴作图；若平均 $m_{\text{固体}}$ 随硬度降低而减小，则水中溶解固体质量越大，硬度越大。

答：取等体积水样蒸干，以恒重残留物的质量表示溶解固体质量，并与已知硬度次序比较得出关系。

针对练习

1. Solid sodium carbonate does not decompose when it is heated.

Sodium carbonate solid dissolves in water to form sodium carbonate solution.

Sodium carbonate **solution** does not decompose when it is heated.

Sodium carbonate solution reacts with acid to give carbon dioxide gas.

You are going to plan an experiment to find out which sodium carbonate solution, **A**, **B** or **C**, contains the most dissolved solid sodium carbonate.

You are provided with three different sodium carbonate solutions, **A**, **B** and **C**.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- a brief description of the method, explaining any safety precautions
- the measurements you will make including how to make them as accurate as possible
- the variables you will control
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

You may include a results table if you wish. You are **not** required to include any results.

（2022 May/Jun 0654/63 第4题；同题：2022 May/Jun 0654/53 第4题）

2.4 长度、密度、弹簧、力矩与压强

题型 1：改变摆长，计时多次摆动再求周期（考频★☆☆☆☆）

知识点 单摆的周期 T 是摆球完成一次完整摆动所用的时间，单位为_____；摆长 l 是从悬点到摆球_____的距离，单位为 m。

保持摆球和释放角度不变，测量 N 次完整摆动的总时间 t，则 $T=\frac{t}{N}$；增加计时的摆动次数并重复取平均可减小反应时间造成的误差。

在同一地点且摆角较小时，T^2 与 l 成_____，等价于 T 与 $\sqrt{l}$ 成正比。

答案：s；中心；正比

怎么认 题目出现摆长可调的单摆图并要求研究摆长与周期的关系时，先计时多次完整摆动再求周期。

例题 1 A student investigates the time taken for one swing of a pendulum (period).

Plan an experiment to determine the relationship between the time for one swing of a pendulum (period) and the length of the string, l.

You are provided with the assembled apparatus shown in Fig. 6.1.

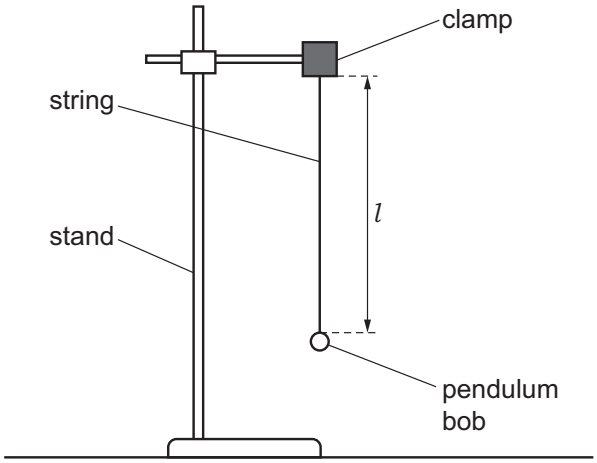


Fig. 6.1

You may use any common laboratory apparatus in your plan.

In your plan, include:

- any additional apparatus
- what you will measure including how you make sure your results are accurate
- the variables you will control
- a results table to record your measurements (you are **not** required to enter any readings into the table)
- how you will process your results to form a conclusion.

（2025 Oct/Nov 0654/61 第6题；同题：2025 Oct/Nov 0654/51 第6题、2025 Oct/Nov 0654/52 第6题、2025 Oct/Nov 0654/53 第6题）

解： 另取米尺、计时器、量角器，并在摆球的平衡位置旁设置标志物。

用米尺测量悬点到摆球中心的距离 l，米尺靠近细线并与细线平行，读数时视线与刻度垂直；改变细线长度，取至少五个分布较宽的 l 值。

每次用量角器将同一摆球拉到相同的小角度，静止释放且不施加推力；摆球沿选定方向经过标志物时开始计时，完成相同的 N 次完整摆动后停止，记录总时间 t。

每个 l 重复计时至少三次，求平均总时间 $t_{平均}$。

$T = \frac{t_{平均}}{N}$

保持摆球、释放角度、释放方法、摆动方向和悬点不变。

结果表可写为

$\frac{l}{\text{m}}$	$\frac{t_1}{\text{s}}$	$\frac{t_2}{\text{s}}$	$\frac{t_3}{\text{s}}$	$\frac{t_{平均}}{\text{s}}$	$\frac{T}{\text{s}}$	$\frac{T^2}{\text{s}^2}$

。

计算各组 T^2，以 l 为横轴、T^2 为纵轴作图。若各点形成通过原点的直线，则 $T^2 \propto l$，所以 $T \propto \sqrt{l}$。

答：摆角较小时，摆长越大，周期越大，且 $T \propto \sqrt{l}$。

针对练习

1. A student investigates the oscillations (swings) of a pendulum.

A pendulum consists of a bob supported by thin thread or string.

The period *T* of a pendulum is the time taken for one oscillation of the pendulum.

Plan an experiment to investigate the relationship between the length l of a pendulum and its period *T*.

The pendulum is assembled as shown in Fig. 6.1.

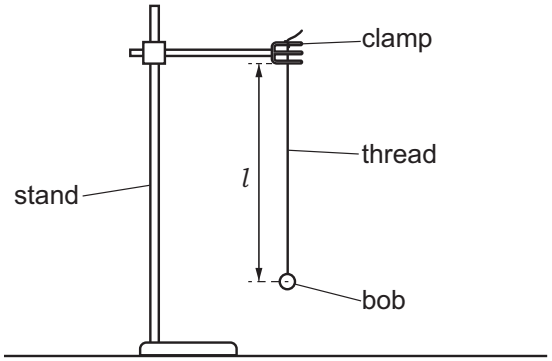


Fig. 6.1

You may use any other common laboratory apparatus.

In your plan include:

- any **other** apparatus needed
- a brief description of the method **after** the apparatus in Fig. 6.1 is assembled. Include what you will measure and how you will make sure your measurements are accurate
- the variables you will control
- a results table to record your measurements (you are not required to enter any readings in the table)
- how you will process your results to draw a conclusion.

（2024 Oct/Nov 0654/62 第6题）

题型 2：改变材料，在相同负载下比较形变或断裂（考频★☆☆☆☆）

知识点 弹簧的伸长量是加载后长度与原长之差。

$\Delta x = l - l_0$

在弹性限度内，同一弹簧满足 $F = k\Delta x$，其中 k 的单位是_____。

研究材料的影响时，自变量是_____；弹簧实验的因变量是_____。

比较金属丝的断裂质量时，金属丝的有效长度和直径应相同，断裂总质量包括挂钩和所加砝码。

答案：N/m；材料；弹簧的伸长量

怎么认 题目出现不同材料的弹簧或金属丝，并要求比较形变或断裂质量时，先固定尺寸和加载条件。

例题 1

Plan an investigation to find out if the material from which a spring is made affects the extension of the spring when it is stretched by a load.

You are provided with:

- springs made from aluminium, steel, iron and nickel
- a set of 100 g masses, together with a hanger
- boss, stand and clamp.

You may use any other common laboratory apparatus.

In your plan include:

- any other apparatus needed
- a brief description of the method, including what you will measure and how you will make sure your measurements are accurate
- the variables you will control
- a results table to record your measurements (you are **not** required to enter any readings in the table)
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

（2023 May/Jun 0654/63 第6题；同题：2023 May/Jun 0654/53 第6题）

解：另取米尺和直角三角板。选用原长、线径、线圈直径和匝数相同的四种弹簧，把米尺竖直固定在弹簧旁。依次悬挂铝、钢、铁、镍弹簧，记录未加载时两固定标记间的长度 l_0。对每种弹簧挂上相同的固定总质量，待弹簧停止振动后，用直角三角板把弹簧下端位置水平移至刻度尺，视线与刻度垂直，记录长度 l_1。卸载后确认弹簧恢复原长，再重复测得 l_2 和 l_3。

保持弹簧原长、线径、线圈直径、匝数、悬挂方式、测量标记和总悬挂质量相同，并使负载处于各弹簧的弹性限度内。

$\Delta x_{平均} = \frac{l_1+l_2+l_3}{3} - l_0$

记录表如下。

材料	总悬挂质量/g	原长 l_0/cm	l_1/cm	l_2/cm	l_3/cm	平均加载后长度/cm	平均伸长量/cm
铝							
钢							
铁							
镍							

答：若四种材料的平均伸长量存在超出重复测量离散范围的差异，则材料影响弹簧的伸长；同一负载下平均伸长量较大的材料使弹簧伸长较大。

针对练习

1. Plan an experiment to investigate whether the material a wire is made from affects the mass required to break the wire.

One end of the wire is securely held by a clamp and masses can be attached to the other end as shown in Fig. 6.1. Masses are added until the wire breaks.

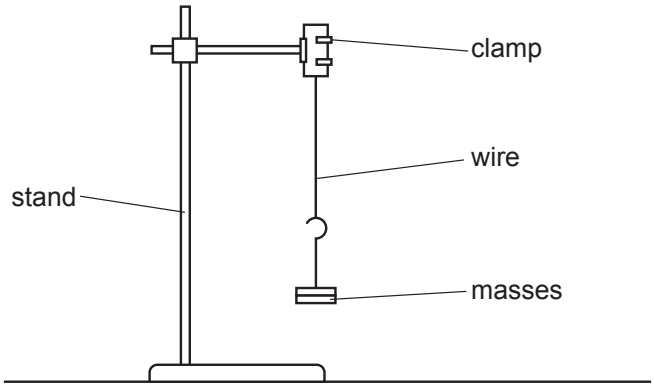


Fig. 6.1

You are provided with:

- wires of different lengths and diameters made from different metals
- a set of masses, together with a hanger
- a boss, stand and clamp.

You may use any other common laboratory apparatus.

In your plan include:

- a brief description of the method, including what you will measure and how you will make sure your measurements are accurate
- any safety precautions you will take
- the variables you will control
- a results table to record your measurements (you are not required to enter any readings in the table)
- how you will process your results to draw a conclusion.

（2023 Oct/Nov 0654/61 第6题；同题：2023 Oct/Nov 0654/51 第6题、2023 Oct/Nov 0654/52 第6题）

2.5 温度、传热与冷却

题型 1：改变溶质质量，比较沸腾温度的增量（考频★☆☆☆☆）

知识点 沸腾温度升高量定义为盐水沸腾温度与同条件下纯水沸腾温度之差：$\Delta T = T_b - T_0$，本题中 $T_0 = 100\ ^\circ\mathrm{C}$。

在水的初始质量与大气压相同时，加入盐的质量是_____，ΔT 是_____。

盐的质量用 g 表示，温度与温度升高量用 °C 表示；盐完全溶解后，取持续沸腾时的稳定温度。

答案：自变量；因变量

怎么认 题目出现改变溶质质量并研究沸腾温度升高量时，先确定自变量、因变量和控制变量。

例题 1

Pure water boils at a temperature of 100 °C.

When salt is dissolved in the water, the boiling temperature increases.

Plan an experiment to find the relationship between the mass of salt added to water and the increase in boiling temperature.

You are provided with:

- pure water
- salt.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus you will use
- a brief description of the method and explain any safety precautions you will take
- what you will measure and how you will make these as accurate as possible
- which variables you will control
- how you will process your results and use them to draw a conclusion.

You may include a labelled diagram if you wish.

You may also include a table that can be used to record results. You are **not** required to include any results.

（2024 May/Jun 0654/62 第4题；同题：2024 May/Jun 0654/52 第4题）

解： 器材为电子天平、若干相同烧杯、量程超过 100 °C 且分度较小的温度计、铁架台、热板、玻璃棒、护目镜和隔热垫。

用电子天平称取至少 5 份质量相同的纯水，分别装入相同烧杯；再称取递增且间隔相同的盐，其中一份为 0 g。将盐加入对应水样并搅拌至完全溶解。

用铁架台固定温度计，使感温泡浸入液体的深度相同且不接触杯底或杯壁；用同一热板以相同功率加热并缓慢搅拌。液体持续沸腾且温度示数稳定时记录沸腾温度，随后停止加热。

天平使用前调零，温度读数时视线与液柱顶端水平；每个盐质量用新配制的水样重复至少三次，取沸腾温度的平均值。戴护目镜防止热液飞溅，热板和烧杯冷却后再接触。

控制水的初始质量、盐的种类、烧杯、加热功率、温度计及其浸入深度、搅拌方式和大气压相同；在刚达到稳定沸腾时读数，减小蒸发改变浓度的影响。

将 0 g 盐样品的平均沸腾温度记为 T_0，其他样品的平均沸腾温度记为 T_b，计算

$\Delta T = T_b - T_0$

记录盐质量 m、各次沸腾温度、平均沸腾温度和 ΔT；以 m 为横轴、ΔT 为纵轴描点并作最佳拟合线。由图线走势判断两者的关系；若图线为过原点的直线，则 ΔT 与 m 成正比，斜率表示单位盐质量引起的沸腾温度升高量。

答：由 ΔT 对 m 的图线确定加入盐的质量与沸腾温度升高量的关系。

题型 2：改变传热条件，记录温度与经过时间（考频★★☆☆☆）

知识点 物体在一段时间内的平均温度变化率为 $r = \frac{|\Delta T|}{\Delta} t$，单位为 °C/s 或 °C/min。

研究传热条件的影响时，只改变_____，水量、初温及其他散热条件保持不变。

可测量相同时间内的_____，或相同温度变化所需的时间；重复测量取平均值，可减小_____误差。

答案：自变量；温度变化量；随机

怎么认 题目出现改变容器材料、保温层或水面面积并记录温度和时间时，先确定自变量与温度变化率。

例题 1

Water is heated from room temperature to its boiling point in a metal cooking pot.

Plan an experiment to investigate if the time taken for water to reach its boiling point depends on the metal from which the cooking pot is made.

You are provided with:

- a supply of cold water
- a set of three cooking pots of the same size, one made of aluminium, one made of copper and one made of steel
- a Bunsen burner, a tripod and gauze
- a measuring cylinder.

You may use any other common laboratory apparatus.

In your plan include:

- any other apparatus needed
- a brief description of the method, including what you will measure and how you will make sure your measurements are accurate
- the variables you will control
- a results table to record the measurements (you do not need to make any measurements or record any results in the table)
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

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解： 还需温度计、秒表、铁架台、夹具、隔热垫和护目镜。

用量筒量取相同体积的冷水，读数时视线与凹液面最低处相平；使水和锅均处于相同初温 T_0。

将水倒入铝锅，用夹具固定温度计，使温包浸入水中且不接触锅底和锅壁。用同一本生灯以固定火焰加热，点燃时启动秒表；温度首次达到沸点并保持不变时停止计时。

换用铜锅和钢锅重复实验，每次使用相同体积、相同初温的水；每种金属测量 3 次，锅冷却至 T_0 后再测。

保持锅的大小、水的体积和初温、火焰大小、锅底与火焰的距离、温度计位置及周围环境相同。

金属	初温/°C	时间 t_1/s	时间 t_2/s	时间 t_3/s	平均时间 $\lvert t\rvert$/s
铝					
铜					
钢					

由 $\lvert t\rvert = \frac{t_1+t_2+t_3}{3}$ 计算各金属锅的平均时间并比较；若平均时间明显不同，则所需时间与金属种类有关，$\lvert t\rvert$ 最小的金属锅升温最快。

答：在其他条件相同时，比较三种金属锅使水达到沸点的平均时间。

针对练习

1. The rate of cooling of hot water in a beaker depends upon the number of layers of insulating newspaper wrapped around the beaker.

Plan an investigation to find the relationship between the rate of cooling of hot water and the number of layers of newspaper wrapped around the beaker.

You are provided with:

- a stop-watch
- a beaker
- a supply of hot water
- several pages from a newspaper.

In your plan, include:

- any other apparatus you will need
- a brief description of the method
- the measurements you will make and how you make them as valid as possible
- the variables you will control
- how you will process your results to reach a conclusion.

You may include a table that can be used to record results. You are **not** required to include any results.

（2025 May/Jun 0654/62 第6题；同题：2025 May/Jun 0654/52 第6题）

2. A student investigates the cooling of hot water in a beaker.

Plan an experiment to investigate the relationship between the thickness of the cardboard insulation wrapped around a beaker and the rate of cooling of hot water in the beaker.

You are provided with:

- a supply of hot water
- a beaker
- a measuring cylinder
- thin sheets of cardboard.

You may use any other common laboratory apparatus.

In your plan include:

- any other apparatus needed
- a brief description of the method, including what you will measure and how you will make sure your measurements are accurate
- the variables you will control
- a results table to record your measurements (you are **not** required to enter any readings in the table)
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

（2024 May/Jun 0654/61 第6题；同题：2024 May/Jun 0654/51 第6题）

3. Plan an experiment to investigate how the area of the water surface in a beaker affects the rate of cooling of hot water in the beaker.

Fig. 6.1 shows the area of the water surface.

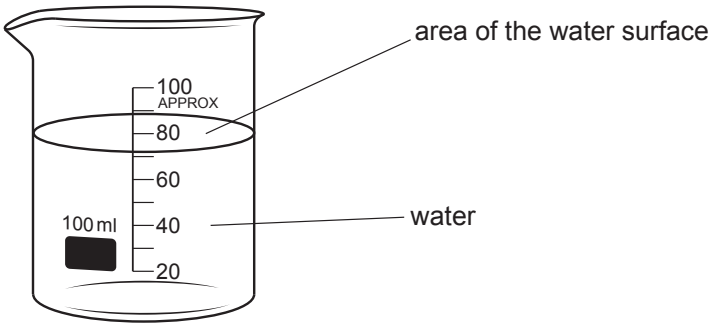


Fig. 6.1

You are provided with:

- a supply of hot water
- a set of different sized beakers made from the same material, but with different areas of water surface. The beakers are lagged with insulation on their sides and bases.

You may use any other common laboratory apparatus.

Include in your plan:

- any other apparatus needed
- a brief description of the method, including what you will measure and how you will make sure your measurements are accurate
- the variables you will control
- a results table to record your measurements (you are **not** required to enter any readings in the table)
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

（2022 May/Jun 0654/62 第6题；同题：2022 May/Jun 0654/52 第6题）

2.6 电路、电流、电压与电阻

题型 1：改变电路条件，测量电流或电压（考频★☆☆☆☆）

知识点 电流是单位时间内通过导体横截面的电荷量，$I = \frac{Q}{t}$，单位为安培（A）。

电压是电路两点间的电势差，单位为伏特（V）。

实验中主动改变的量称为_____，随其变化而测量的量称为_____，其余影响结果的量应保持不变。

电流表应与待测电路_____，电压表应并联在待测元件两端。

电源电压不变且灯泡规格相同时，串联灯泡数增加，总电阻增大，电流减小。

答案：自变量；因变量；串联

怎么认 题目出现改变电路条件并测量电流或电压时，先确定自变量、因变量和控制变量。

例题 1

A student investigates how the current in a series circuit changes with the number of lamps connected in the circuit.

Plan an investigation to determine the relationship between the current in a series circuit and the number of lamps connected in the circuit.

You are provided with:

- a number of identical lamps
- connecting wires.

You may use any common laboratory apparatus in your plan.

In your plan, include:

- the apparatus you will use
- a brief description of the method
- the variables you will control and how you will ensure your results are valid
- a results table for your measurements (you are **not** required to enter any readings into the table)
- how you will process your results to form a conclusion.

（2026 Feb/Mar 0654/62 第6题；同题：2026 Feb/Mar 0654/52 第6题）

解：取低压直流电源、开关、电流表和电压表。将一只灯泡、电流表、开关与电源串联，电压表并联在电源两端。

设定并保持电源电压不变。闭合开关，在相同通电时间后读取电流 I，随即断开开关；每次增加一只相同灯泡，使全部灯泡保持串联，测量至少五组灯泡数 n 对应的电流。

控制电源电压、灯泡规格、电流表及量程相同；每组测量前使灯泡恢复至相同起始温度，并保持通电时间相同。每个 n 重复测量三次。

灯泡数 n	$\frac{I_1}{\text{A}}$	$\frac{I_2}{\text{A}}$	$\frac{I_3}{\text{A}}$	$\frac{\overline{I}}{\text{A}}$

由 $\overline{I}=\frac{I_1+I_2+I_3}{3}$ 求各组平均电流，以 n 为横轴、$\overline{I}$ 为纵轴描点并作拟合曲线。

答：若图线随 n 增大而下降，则串联灯泡数越多，电流越小。

针对练习

1. A student investigates the voltage output from a solar cell.

Plan an investigation to determine the relationship between the distance of a lamp from a solar cell and the voltage produced by the solar cell.

You are provided with:

- a small solar cell
- a desk lamp.

You may use any common laboratory apparatus in your plan.

In your plan, include:

- any other apparatus you will use
- a brief description of the method
- the measurements you will take and how you will ensure they are valid
- the variables you will control
- how you will process your results to reach a conclusion.

You may include a results table in your answer. You are **not** required to enter any readings in the table.

You may include a labelled diagram in your answer.

（2026 May/Jun 0654/61 第6题；同题：2026 May/Jun 0654/51 第6题）