详解手册 2026–2028

CIE IGCSE Physics 全基础题型

0625 · Core & Extended · 实验技能

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[P] 专题 P 实验技能

P.1 仪器与安全

题型 1：规范仪表读数（考频★★★★☆）

知识点 温度计与被测液体达到热平衡后，示数表示球泡附近液体的温度，温度常用单位为 _____。测量液体温度时，球泡应完全浸没且不接触容器侧壁或底部；必要时轻轻搅拌，待示数 _____ 后读数。读数时视线应与液柱顶端同高，并垂直于刻度面，以避免 _____。

答案：摄氏度（°C）；稳定；视差误差

怎么认 题目出现温度计或要求说明准确读数方法时，先平视液柱顶端并垂直刻度面读数。

一. 温度计平视并均温

例题 1 In this experiment, you will investigate the cooling of water.

Carry out the following instructions, referring to Fig. 2.1.

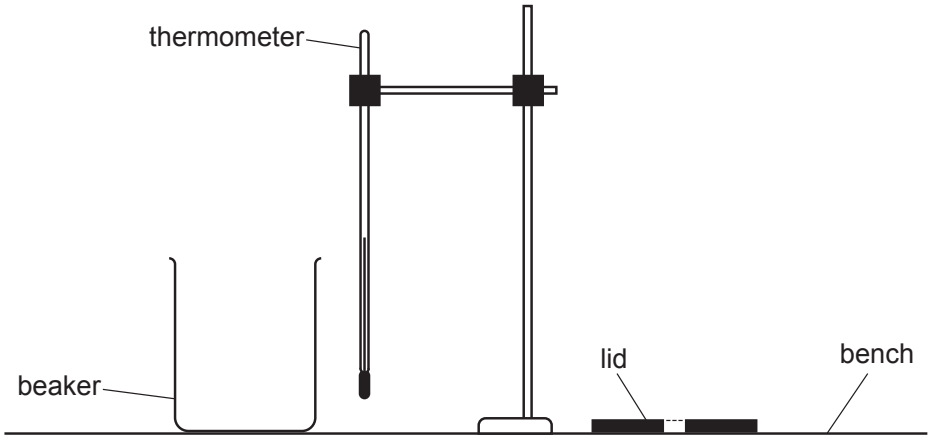


Fig. 2.1

(e) State **one** precaution that you take to obtain accurate temperature readings.

Explain briefly the reason for this precaution.

（2023 夏季 0625/52 第2题(e)）

解：读数时使视线与液柱顶端同高，并垂直于温度计刻度面，可避免观察方向倾斜造成的视差误差。
答：平视并垂直刻度面读数，防止视差误差。

针对练习

1. In this experiment, you will investigate the cooling of water in a metal can.

Refer to Fig. 2.1.

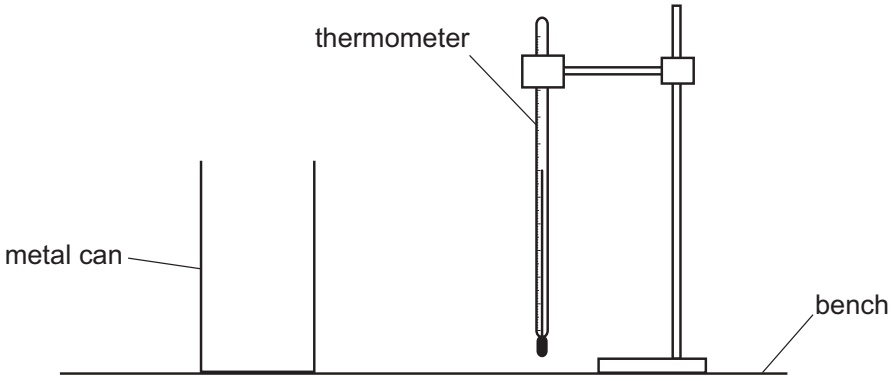


Fig. 2.1

(e) Explain why it is good practice to read the thermometer scale at right angles to the reading.

（2024 冬季 0625/51 第2题(e)）

【答案】避免视差误差。
【解析】从斜向观察液柱顶端，液柱位置相对刻度会发生偏移。垂直于刻度面读数可避免视差误差。
答：避免视差误差。

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

She uses the apparatus shown in Fig. 2.1.

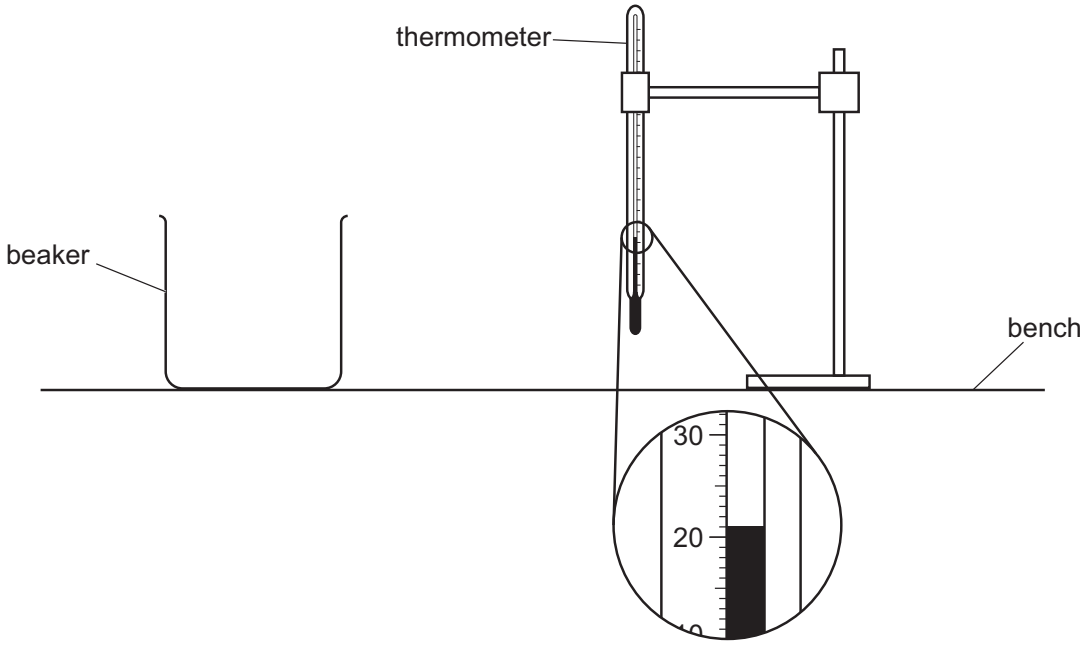


Fig. 2.1

(b) The student pours hot water into the beaker and records the initial temperature θ in Table 2.1. She then records the temperature θ every 30 s. Her values are shown in Table 2.1.

Describe **one** technique that you use to ensure that temperature readings in this type of experiment are as accurate as possible.

（2025 夏季 0625/63 第2题(b)）

【答案】读数时使视线与液柱顶端同高，并垂直于温度计刻度面。
【解析】视线与液柱顶端同高并垂直于刻度面，可避免观察方向倾斜造成的视差误差。
答：平视并垂直刻度面读数。

二. 量筒读凹液面

知识点　量筒用于测量液体的体积，体积常用单位为 $\mathrm{cm^3}$ 或 mL，且 $1\mathrm{cm^3} = 1$ mL。

读数时量筒应放在_____面上，视线与液面_____，并与刻度面垂直。

水在量筒中形成凹液面，应读取凹液面_____所对的刻度。

答案：水平；同高；最低点

怎么认　题目出现量筒、水的液面图或要求避免视差时，先使视线与液面同高，再读凹液面最低点。

例题 2　A student investigates the cooling of water under different conditions.

Fig. 2.1 shows the set-up.

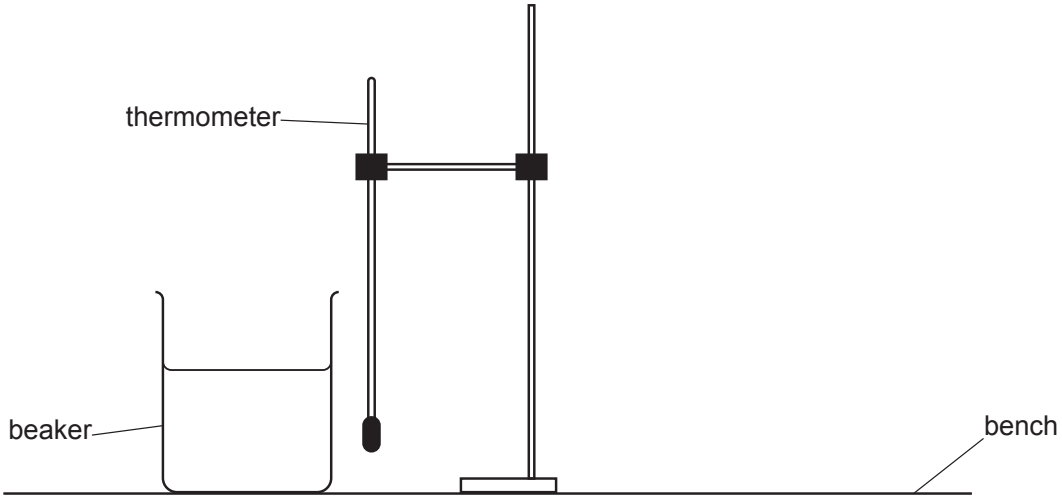


Fig. 2.1

(f) The student uses a measuring cylinder to measure 200 cm^3 of hot water. She reads the scale at right angles.

Suggest another precaution to obtain an accurate reading of the volume of the water.

（2023 夏季 0625/61 第2题(f)）

解：水在量筒中形成凹液面，读数取凹液面最低点所对的刻度。
答：读取凹液面最低点所对的刻度。

针对练习

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

The apparatus is shown in Fig. 2.1.

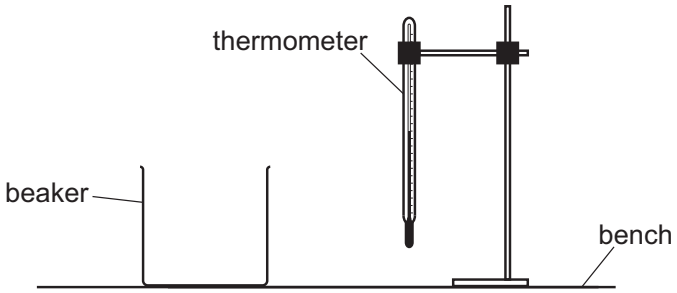


Fig. 2.1

(f) Name the apparatus that the student uses to measure the volume of water.

（2025 夏季 0625/61 第2题(f)）

【答案】量筒
【解析】测量液体体积所用的仪器是量筒。
答：量筒。

4. In this experiment, you will determine the internal diameter *d* of a boiling tube.

You are provided with an empty boiling tube held vertically in the clamp of a retort stand.

The apparatus is assembled as shown in Fig. 1.1.

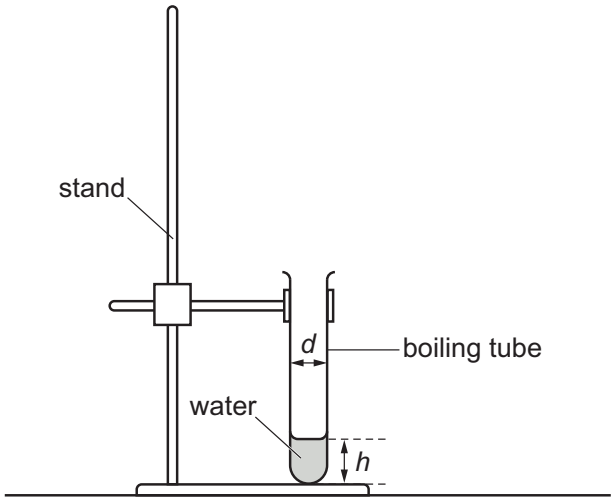


Fig. 1.1

(g) It is important to avoid line-of-sight (parallax) errors when reading the scale of the measuring cylinder.

Describe how such errors are avoided. You may draw a diagram.

（2025 夏季 0625/52 第1题(g)）

【答案】视线与液面同高，并与量筒刻度面垂直。
【解析】视线高于或低于液面会产生视差，故读数时视线应与液面同高，并与量筒刻度面垂直。
答：视线与液面同高，并与量筒刻度面垂直。

5. A student investigates the cooling of water in a metal container.

(f) Draw a measuring cylinder containing water. On your diagram show the line of sight you use to obtain an accurate reading of the volume of water.

（2024 冬季 0625/61 第2题(f)）

【答案】量筒内画有水；视线通过凹液面最低点，并与量筒刻度面垂直。
【解析】量筒内画出水的凹液面，在凹液面最低点的高度处画视线，视线与量筒刻度面垂直。
答：量筒内有水，视线与凹液面最低点同高且与刻度面垂直。

三. 等稳或准时读数

知识点 规范读数要求在预先规定的状态或时刻读取仪表，使各次记录具有相同的比较条件。

测量变化较慢的量时，待示数_____后读数；定时记录时，将计时器置于仪表附近，报时后_____读数。

测量周期运动时，以物体沿_____经过同一固定标记作为计时起止；时间的单位为 s。

答案：稳定；立即；同一方向

怎么认 题目出现等示数稳定、每隔固定时间读数或计时振动时，先确定统一的读数或计时标志。

例题 3 A student investigates the effect of insulation on the cooling of water.

He uses the apparatus shown in Fig. 2.1.

Beaker A is covered with material that is a thermal insulator.

Beaker B is identical to beaker A but has no insulation.

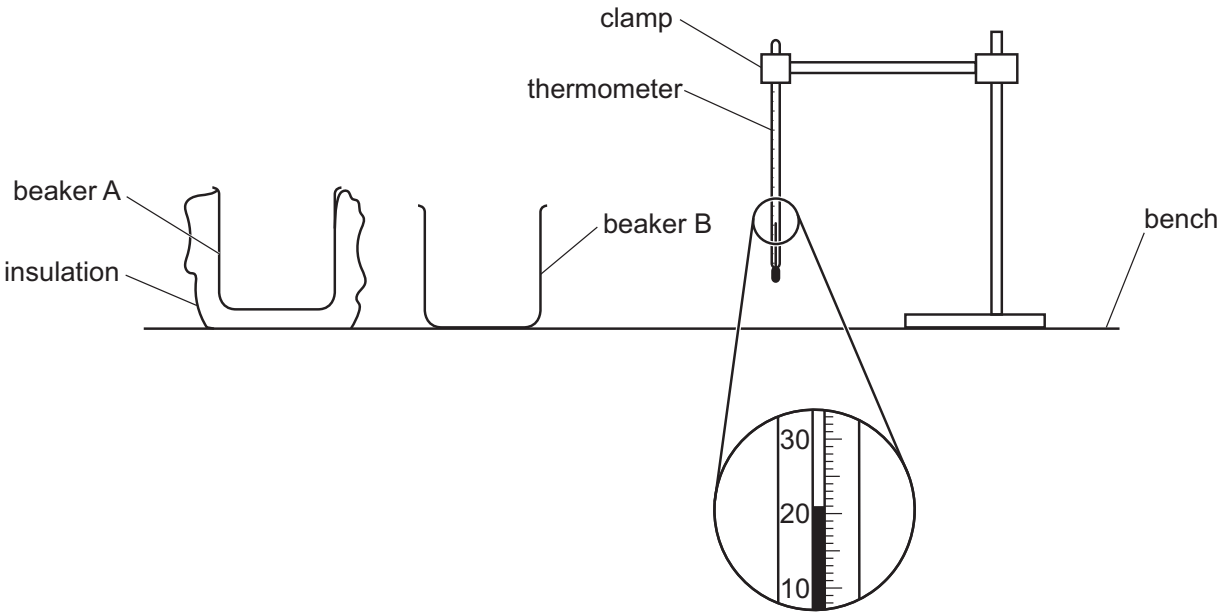


Fig. 2.1

(b) The student pours 200 cm^3 of hot water into beaker A and records the temperature θ at time t = 0.

He records, in Table 2.1, the temperature of the water in the beaker every 30 s.

The student repeats the procedure for beaker B.

It is important that the temperatures are recorded at exactly every 30 s.

Describe a technique which will make it easier for the student to do that.

（2025 春季 0625/62 第2题(b)）

解：将计时器设置为每隔 30 s 报时一次，报时后立即读取温度计示数，使各次读数均在规定时刻取得。

答：使用每隔 30 s 报时一次的计时器，报时后立即读数。

针对练习

6. In this experiment, you will investigate the period of a pendulum.

Refer to Fig. 1.1 and Fig. 1.2.

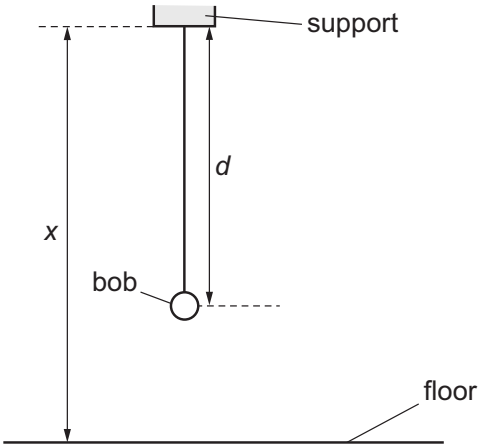


Fig. 1.1

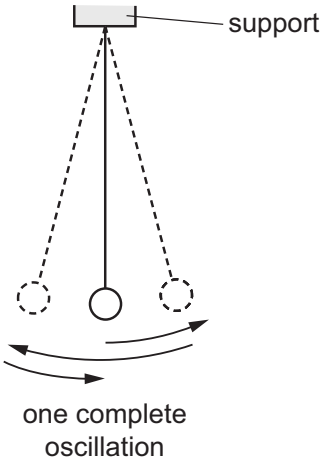


Fig. 1.2

A pendulum has been set up for you as shown in Fig. 1.1. Do **not** change the height of the support.

(e) Describe **one** technique that you use to improve accuracy when measuring the time *t* for 10 oscillations.

（2024 冬季 0625/51 第1题(e)）

【答案】在平衡位置设置固定标记，以摆球沿同一方向经过标记作为 10 次振动计时的起止。
【解析】在平衡位置设置固定标记，摆球沿某一方向经过标记时开始计时。
完成 10 次振动后，摆球再次沿该方向经过标记时停止计时。
答：以摆球同向经过平衡位置固定标记作为计时起止。

7. A student investigates the cooling of water.
The student sets up the apparatus shown in Fig. 3.1.

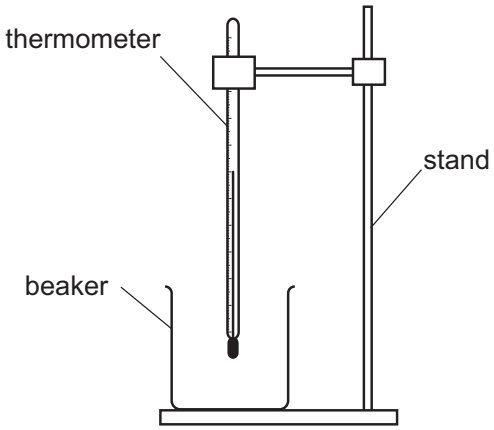


Fig. 3.1

(b) **(i)** Suggest why the student waits for 30 s before measuring the initial temperature of the hot water.

(ii) State how the student ensures that the temperature readings are as accurate as possible.

（2025 冬季 0625/62 第3题(b)）

【答案】（i）让温度计充分响应并达到热水温度，待示数停止上升。
（ii）把秒表放在温度计旁，在规定时刻读取温度。
【解析】（i）温度计中的液体膨胀需要时间，等待 30 s 后，温度计达到热水温度，示数停止上升。
（ii）把秒表放在温度计旁，规定时刻一到便读取温度，减小读数时刻的偏差。
答：（i）待温度计充分响应，示数停止上升；（ii）把秒表放在温度计旁，按时读数。

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

The apparatus is shown in Fig. 2.1.

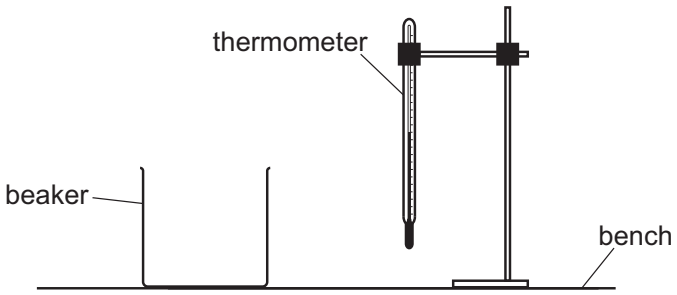


Fig. 2.1

(d) In the experiment, the student aims to investigate the effect on the temperature of the hot water as cold water is added.

(i) Complete the sentence to explain why it is important to add the cold water without delay at each stage.

(ii) Complete the sentence to explain the reason for stirring the water at each stage.

（2025 夏季 0625/61 第2题(d)）

【答案】（i）使温度变化由加入冷水引起，而不是由等待时向环境散热引起。
（ii）使液体各处温度均匀。
【解析】（i）若加入冷水有延迟，热水会继续向环境散热，温度变化便不全由加入的冷水引起。
（ii）搅拌使液体各处温度均匀，温度计读数能代表整杯水的温度。
答：（i）减小等待时向环境散失的热量；（ii）使液体温度均匀。

题型 2：用标尺准确定位（考频★★★☆☆）

知识点 用直尺测量端点或中心之间的距离时，直尺应贴近被测物并与被测方向_____，视线应与刻度面_____。
端点不便对准刻度时，可用直角尺、挡块或铅垂线把位置投到刻度上；两投影读数之差为所测长度。
对称物体的中心读数等于两侧边缘读数的_____；也可使两边缘到目标刻度的距离相等。
长度常用单位为 mm 或 cm；改变测量位置或方向并重复测量，取平均值可减小随机误差。

答案：平行；垂直；平均值

怎么认 题目出现端点或中心难以对准直尺刻度时，先用直角尺、挡块或铅垂线把位置投到刻度上。

一. 投影端点或中心读尺

例题 1 A student determines the diameter of a marble by two methods and calculates the density of the material from which the marble is made.

Some marbles are shown full size in Fig. 1.1.

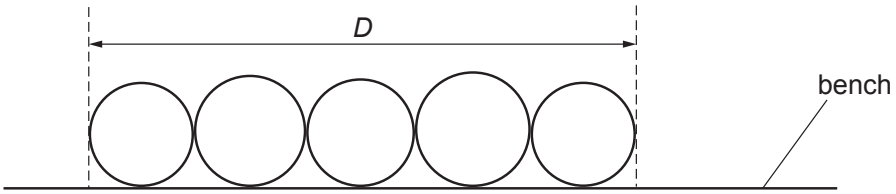


Fig. 1.1

Method 1

Method 2

(b) Fig. 1.2 shows two wooden blocks and one of the marbles.

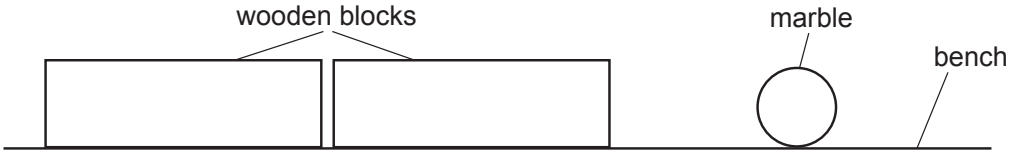


Fig. 1.2

Describe how the student uses the two blocks and the marble to determine a new accurate value for the diameter of a marble.
Draw a diagram to show the arrangement.
Describe clearly how the student ensures that the value for the diameter of a marble is as accurate as possible.

（2023 春季 0625/62 第1题(b)）

解：将两木块和弹珠放在同一水平桌面上，使两木块的内侧面分别与弹珠相切。

木块 | ○ | 木块

保持木块不动，移出弹珠，把直尺贴近桌面并沿两内侧面间的距离方向放置。测得两内侧面之间的间距为 d，则弹珠直径为 d。

在木块前后两处测量间距，两次读数相等时两内侧面相互平行；转动弹珠，沿不同方向重复测量，取各次 d 的平均值。

答：两木块内侧面的间距为弹珠直径。

针对练习

1. In this experiment, you will investigate the behaviour of a spring and use it to determine the mass of an object.

A stand and spring have been set up for you.

Refer to Fig. 1.1.

(b) Describe a technique you used when measuring the length of the spring, to ensure an accurate reading. You may draw a diagram.

（2025 春季 0625/52 第1题(b)）

【答案】将直尺贴近弹簧并与弹簧平行，用直角尺把弹簧端点投到刻度上，视线垂直刻度面读数。
【解析】把直尺贴近弹簧并与弹簧平行，用直角尺把弹簧端点水平投到刻度上，读数时视线垂直刻度面。
答：用直角尺投影弹簧端点的位置后读数。

2. A student investigates the balancing of a metre ruler.

Fig. 1.1 shows the apparatus.

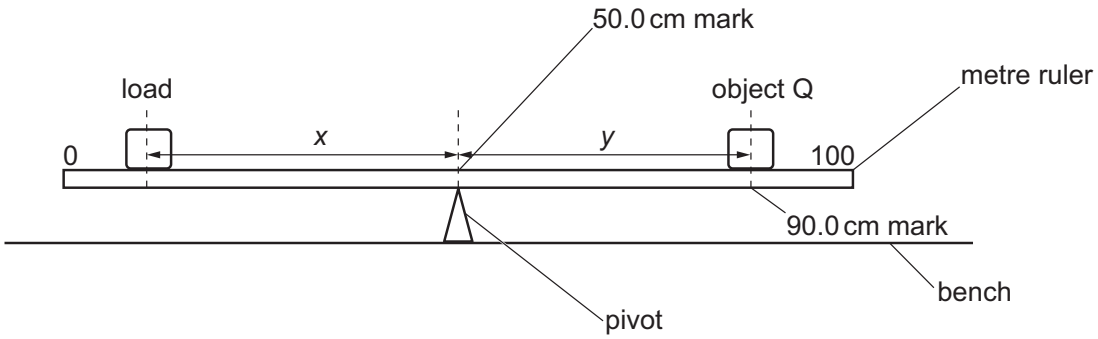


Fig. 1.1

(d) Explain how you ensure that the centre of object Q is directly over the 90.0 cm mark of the metre ruler. You may draw a diagram.

（2025 冬季 0625/61 第1题(d)）

【答案】使物体 Q 的两侧边缘位于 90.0 cm 刻度两侧，且到该刻度的距离相等。
【解析】观察物体 Q 左右边缘在米尺上的位置，调整物体 Q，使两边缘分别位于 90.0 cm 刻度两侧且到该刻度的距离相等。
答：此时物体 Q 的中心在 90.0 cm 刻度正上方。

3. In this experiment, you will investigate the period of a pendulum.

Refer to Fig. 1.1 and Fig. 1.2.

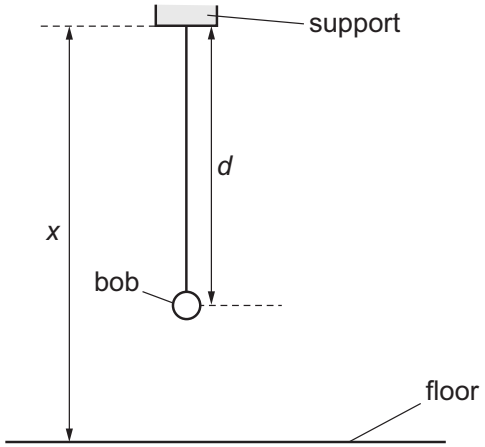


Fig. 1.1

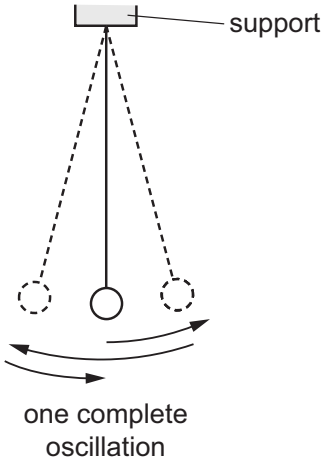


Fig. 1.2

A pendulum has been set up for you as shown in Fig. 1.1. Do **not** change the height of the support.

(d) Describe **one** technique that you use to improve accuracy when measuring the distance *d*.

You may draw a diagram to help your description.

（2024 冬季 0625/51 第1题(d)）

【答案】把米尺竖直放在摆球旁，用直角尺分别把支架底部和摆球中心投到刻度上。
【解析】把米尺竖直放在摆球旁并与摆线平行，用直角尺分别把支架底部和摆球中心水平投到米尺刻度上。
两投影读数之差为距离 d。
答：用贴近摆球的米尺和直角尺测量 d。

4. A student investigates the stretching of a spring.

Fig. 1.1 shows the set-up.

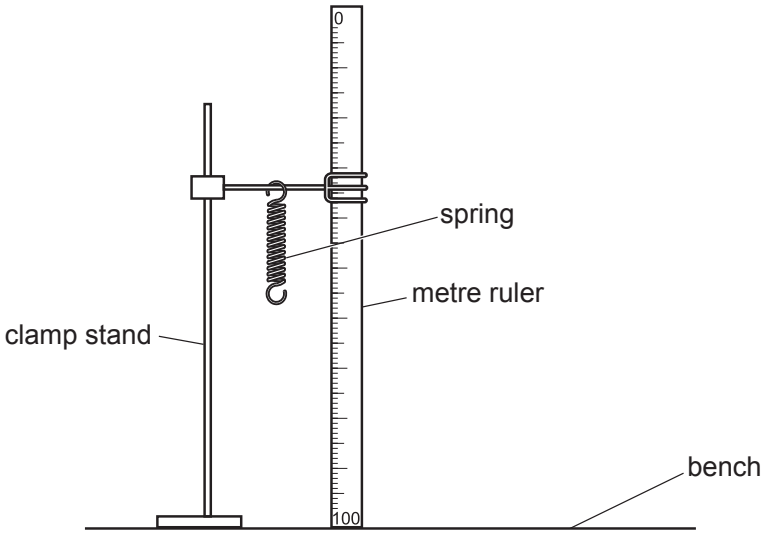


Fig. 1.1

(a) The student measures, and records in Table 1.1, the unstretched length l_0 of the spring. He does **not** include the loops at the ends of the spring in the measurement. The value l_0 is the length of the spring when the load *L* on the spring is 0.00 N.

Describe **one** technique you would use to obtain an accurate value for l_0. Draw a diagram to illustrate your answer.

（2024 夏季 0625/61 第1题(a)）

【答案】把米尺贴近弹簧并与弹簧平行，用直角尺把不含端环的弹簧两端投到刻度上，两读数之差为 l_0。

【解析】把米尺贴近弹簧并与弹簧平行，用直角尺把不含端环的弹簧上端和下端水平投到刻度上。

弹簧上端 ●┄┄ | 米尺

弹簧下端 ●┄┄ |

设两处读数分别为 r_1 和 r_2，则 $l_0 = |r_2 - r_1|$。

答：两投影读数之差为弹簧的原长 l_0。

二. 校水平、共轴或基准

知识点 精确测量长度前，应使装置保持稳定，并使各部件处于规定的位置关系。

光学装置中，发光物体与透镜的中心应处于同一_____，透镜和光屏应与实验台_____。

标尺应固定在实验台上，距离应从透镜中心所对应的_____量起；长度单位为 cm 或 m。

答案：水平高度；垂直；基准线

怎么认 题目出现装置图并要求保证位置测量准确时，先检查水平、等高、竖直及测量基准。

例题 2

A student determines the focal length of a converging lens by two methods.

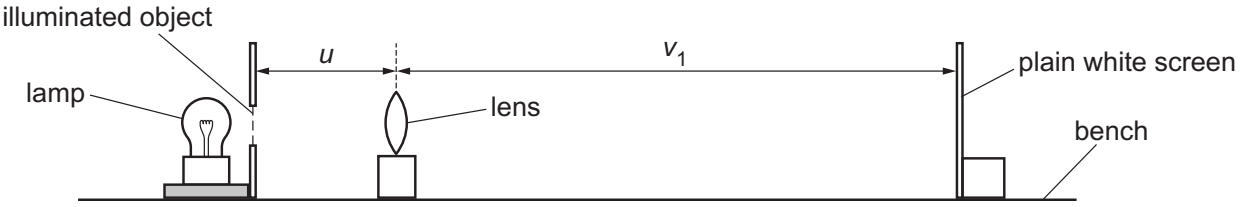


Fig. 3.1

(a) The student sets up the apparatus as shown in Fig. 3.1.

Suggest **one** precaution that must be taken when setting up the apparatus to ensure accurate measurements.

（2024 春季 0625/62 第3题(a)）

解：物距 u 应沿透镜主光轴测量，故调节发光物体和透镜，使二者的中心处于同一高度。
答：发光物体和透镜的中心应处于同一高度。

针对练习

5. A student determines the focal length of a converging lens.

She uses the apparatus shown in Fig. 3.1.

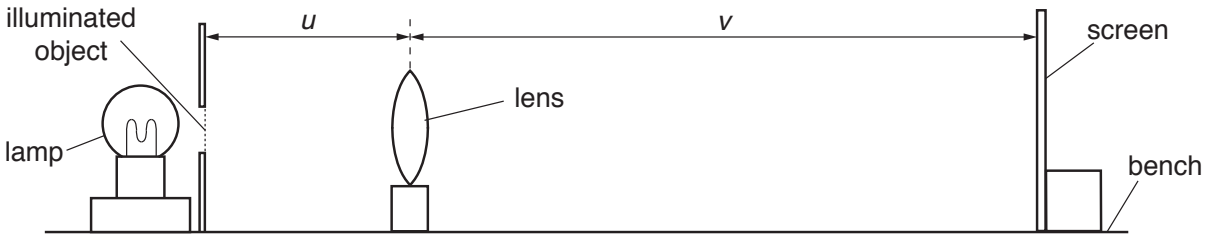


Fig. 3.1

(e) Suggest **one** precaution that can be taken to ensure measurements are accurate in this experiment.

（2023 冬季 0625/63 第3题(e)）

【答案】将标尺固定在实验台上。
【解析】实验中需测量透镜与物体、光屏之间的距离，故将标尺固定在实验台上，使测量基准保持不变。
答：将标尺固定在实验台上。

6. A student investigates the forces supporting a metre ruler to determine the weight of the metre ruler.

He uses the apparatus shown in Fig. 1.1. The scale of the metre ruler faces upwards.

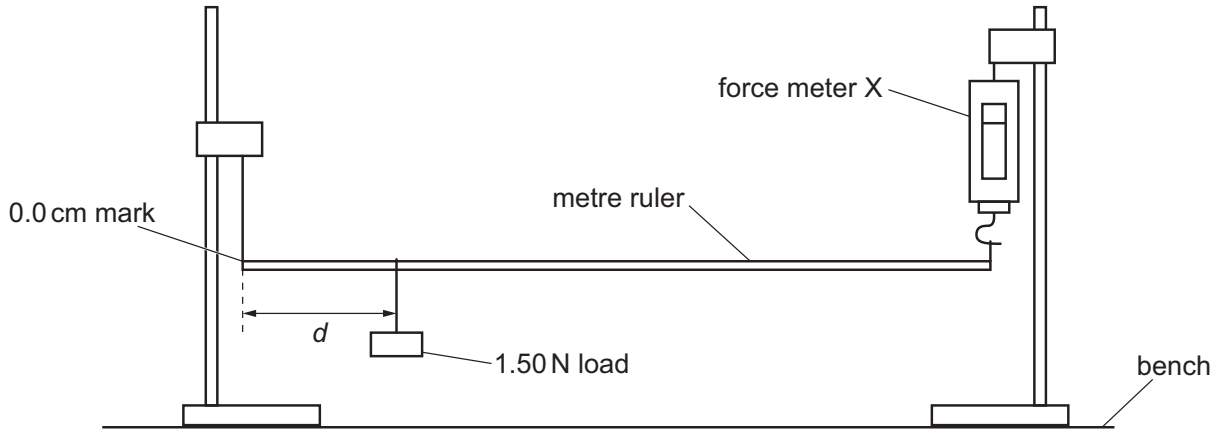


Fig. 1.1

(a) The student ensures that the metre ruler is horizontal.

Briefly describe how to check that the ruler is horizontal. You may draw a diagram.

（2025 夏季 0625/63 第1题(a)）

【答案】测量米尺上两处到实验台面的高度，调节至两高度相等。
【解析】在米尺上选取两处，分别测量它们到实验台面的竖直高度。
两处高度相等时，米尺水平。
答：测量米尺上两处到实验台面的高度，调节至两高度相等。

题型 3：补全并保护电路（考频★★★☆☆）

知识点 电压表测量两点间的电势差，单位为_____，符号为 V。
测量某元件或某段导线两端的电势差时，电压表应与被测部分_____联。
连接时先确定被测部分的两个端点，再将电压表的两个接线端分别接到这两点。

答案：伏特；并

怎么认 题目出现测量某元件或某段导线两端电势差的要求时，先找出被测部分的两个端点。

一. 电压表并联或按图改接

例题 1 A student investigates the properties of a resistance wire.

He uses the circuit shown in Fig. 3.1.

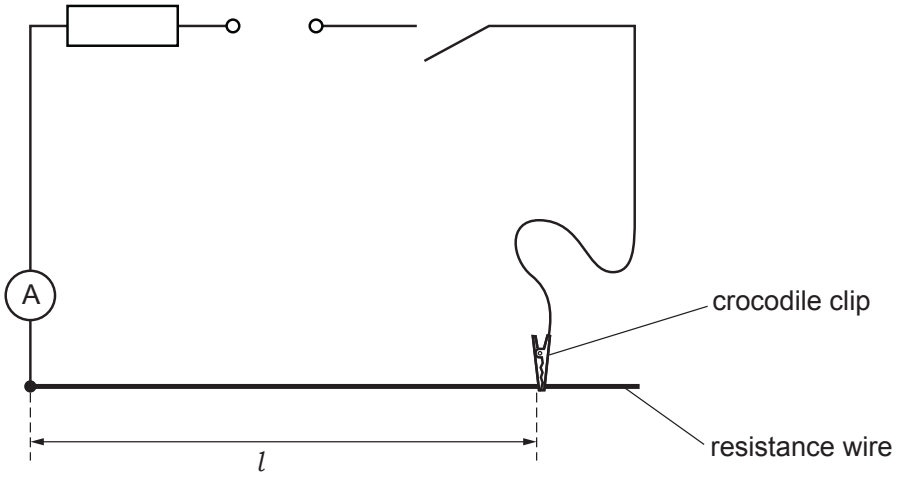


Fig. 3.1

(a) On Fig. 3.1, draw a voltmeter connected to measure the potential difference (p.d.) across length l of the resistance wire.

（2023 春季 0625/62 第3题(a)）

解：由电压表测量两点间的电势差，应与被测部分并联。
长度 l 的两端为电流表下方的接点和鳄鱼夹接触点，故将带 V 的电压表符号跨接在这两点之间。
答：电压表并联在长度 l 的电阻丝两端。

针对练习

1. A student investigates a circuit containing different combinations of resistors.

She uses **circuit A**, shown in Fig. 2.1.
Circuit A is not yet complete.

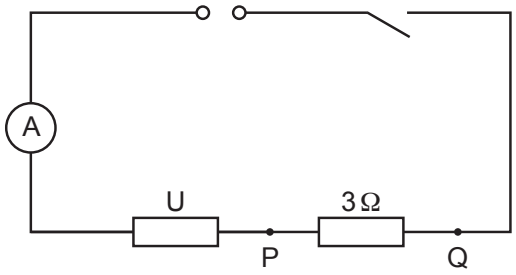


Fig. 2.1

(a) On Fig. 2.1, complete the circuit to show a voltmeter connected to measure the potential difference (p.d.) across resistor U.

（2023 夏季 0625/63 第2题(a)）

【答案】电压表并联在电阻 U 两端。
【解析】电阻 U 的两端分别为其左侧接点和连接 P 的右侧接点。

由电压表应与被测电阻并联，将带 V 的电压表符号跨接在这两点之间。
答：电压表并联在电阻 U 两端。

二. 限流并短时通电

知识点 保护电阻串联在电路中，使电路总电阻增大；电源电压不变时，由 $I=\frac{V}{R}$ 可知，电流将_____。
电流过大会使导线发热，并可能超过电流表的满量程值；电流的单位是_____。
开关应在读数时闭合，读数后断开，以缩短通电时间并减少发热。
答案：减小；安培（A）

怎么认 题目出现保护电阻、导线发热或电流表量程时，先串联限流并缩短通电时间。

例题 2 A student determines the resistance of a resistor.

She uses the apparatus shown in Fig. 2.1.

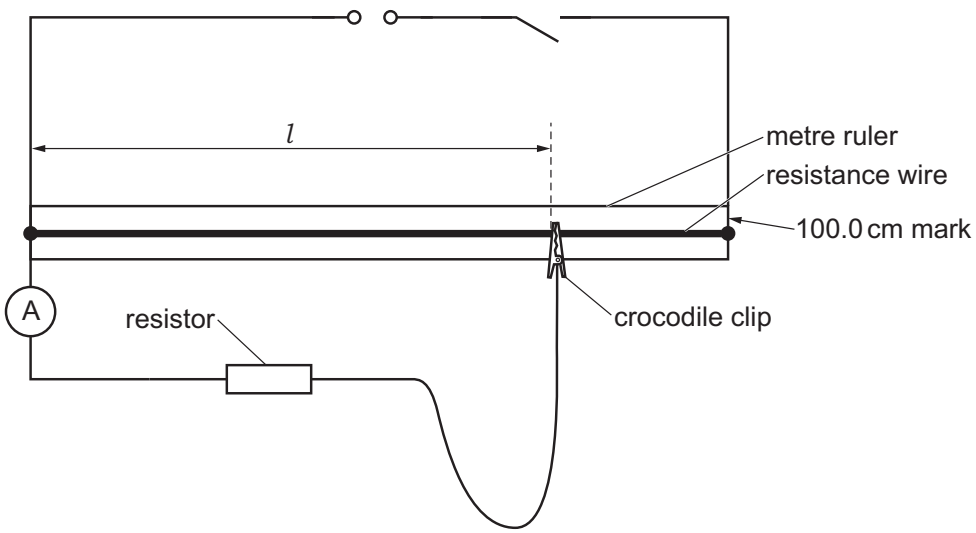


Fig. 2.1

(g) The resistance wire can become very hot during this type of experiment.
Suggest **one** change to the apparatus that prevents this.

（2024 冬季 0625/63 第2题(g)）

解：串联保护电阻后，电路总电阻增大。
由 $I=\frac{V}{R}$ 得，电源电压不变时电流减小，电阻丝的发热减弱。
答：在电路中串联一个保护电阻。

题型 4：搭建插针光路（考频★★★★☆）

知识点 透明块边缘或镜面所在直线称为界面；法线是通过指定点并与界面_____的直线。
直角大小为_____，角度单位为°；入射角或反射角均从法线量起。
描绘透明块时，器材定位后沿外缘描线，移去器材后再定位作图点；作指定角度的光线时，以_____为起始边量角。
插针光路中，两枚针应在同一直线上，间距至少为5.0 cm。
答案：垂直；90 °；法线

怎么认 题目出现透明块或镜面边界、指定点及法线或角度时，先描出界面并定位作图点。

一. 描轮廓并作法线角线

例题 1 In this experiment, you will investigate the refraction of light using a semicircular transparent block.

Carry out the following instructions using the separate ray-trace sheet provided. You may refer to Fig. 3.1 and Fig. 3.2 for guidance.

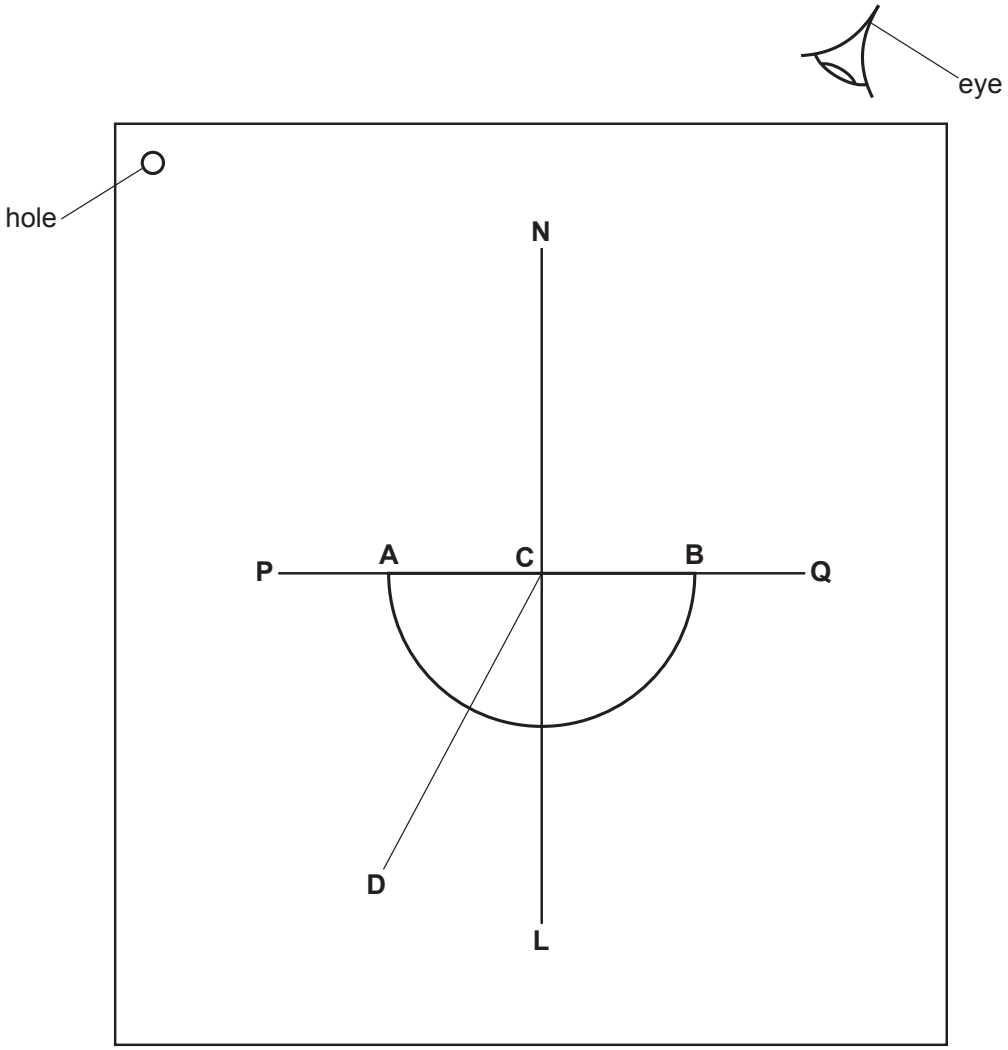


Fig. 3.1

(a)
- Draw a line across the ray-trace sheet supplied, approximately in the middle. Label the line **PQ**.
- Place the transparent block, largest face down, with the straight side on the line **PQ** and the curved side below the line.
- Draw round the outline of the block. Label the ends of the straight side of the block **A** and **B**.
- Remove the block and draw the normal **NL** through the centre of **AB**. Continue the normal so that it passes through the curved side of the block.
- Label the point **C** where the normal **NL** crosses **AB**.

（2023 夏季 0625/51 第3题(a)）

解：在纸面中部画直线PQ，使透明块的直边与PQ重合，曲边位于其下方，沿外缘描出轮廓，并将直边两端标为A、B。

由C是AB的中点，过C作AB的垂线NL，并延长至穿过透明块的曲边。
答：法线NL与AB垂直，且通过AB的中点C。

针对练习

1. In this experiment, you will investigate the reflection of light by a plane mirror.

Use the separate ray-trace sheet provided. You may refer to Fig. 1.1 for guidance.

(a)
- Draw a line **LN** 12 cm long across the ray-trace sheet supplied, near to the top of the sheet.
- Label the mid-point of the line with the letter **M**.
- Draw a line **PR** parallel to line **LN** at a distance 12.0 cm below it across the full width of the page.
- Draw a normal to **LN** at the point **M**.
- Extend the normal downwards to the bottom of the page and label the end of the line **S**.
- Label the point where the normal line crosses **PR** with the letter **Q**.

（2025 冬季 0625/52 第1题(a)）

【答案】法线过M且垂直于LN，向下延长至纸面底端S；PR在LN下方12.0 cm且与其平行；交点标为Q。
【解析】画长12 cm的直线LN，标出中点M；在其下方12.0 cm处画与其平行、横贯纸面的直线PR。
过M作LN的垂线并向下延长至纸面底端，底端标为S，与PR的交点标为Q。
答：法线过M且垂直于LN，并延长至S。

2. In this experiment, you will investigate the refraction of light by a transparent block.
You will determine a quantity known as the refractive index of the material of the block.

Use the separate ray-trace sheet provided.

You may refer to Fig. 3.1 for guidance.

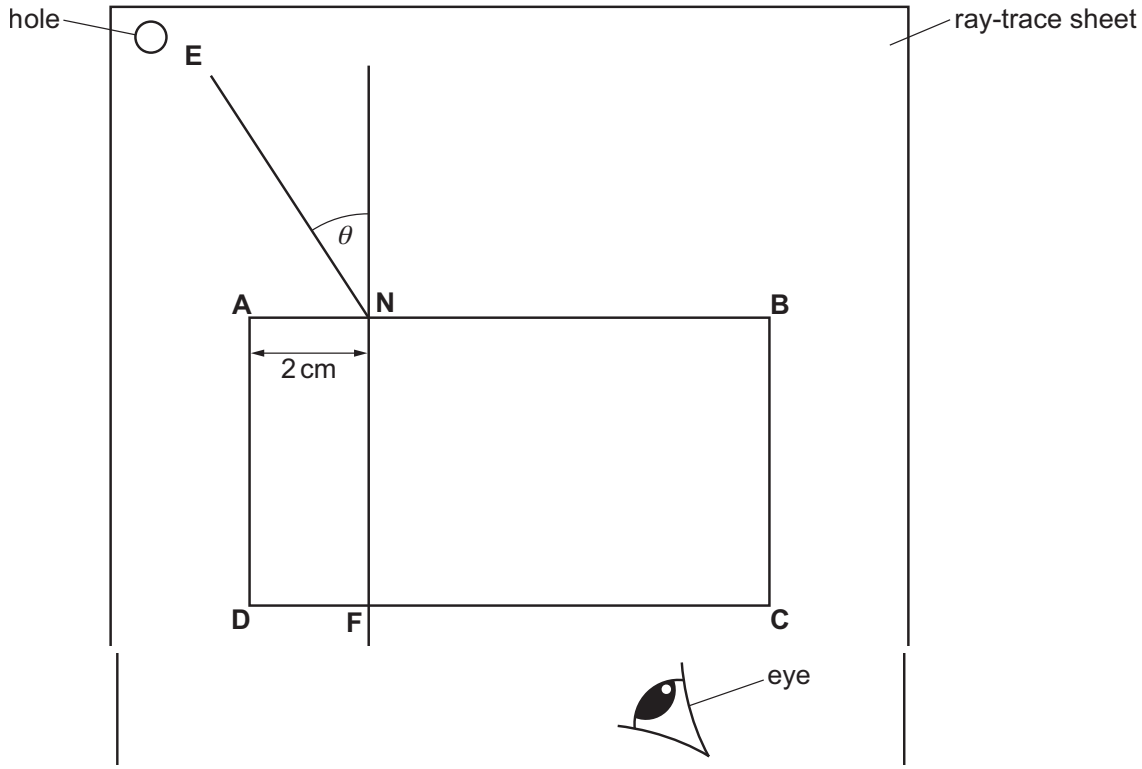


Fig. 3.1

(a) Place the transparent block approximately in the centre of the ray-trace sheet. Carefully draw round the block and label the corners **A**, **B**, **C** and **D** as indicated by Fig. 3.1.
Remove the block from the ray-trace sheet.

Draw a normal to line **AB** at a point **N**, 2 cm from **A**. Extend the normal downwards until it crosses the line **CD**. Label the point at which it crosses **CD** with the letter **F**.

Draw a line **NE**, as indicated by Fig. 3.1, 7 cm long and at an angle θ_1 = 15° to the normal.

（2024 冬季 0625/53 第3题(a)）

【答案】N在AB上且AN = 2 cm，法线过N并交CD于F；NE = 7 cm，且与法线成15 °。
【解析】将透明块置于纸面中部，沿外缘描出轮廓，按图标出A、B、C、D，移去透明块。
在AB上取N，使AN = 2 cm；过N作AB的垂线，向下延长交CD于F。
以N为顶点、法线为起始边，在图示一侧量出15 °，沿刻度点画长7 cm的线段NE。
答：NE = 7 cm，且θ_1 = 15 °。

3. A student investigates the reflection of light by a plane mirror.
The student's ray-trace is shown full-size in Fig. 1.1.

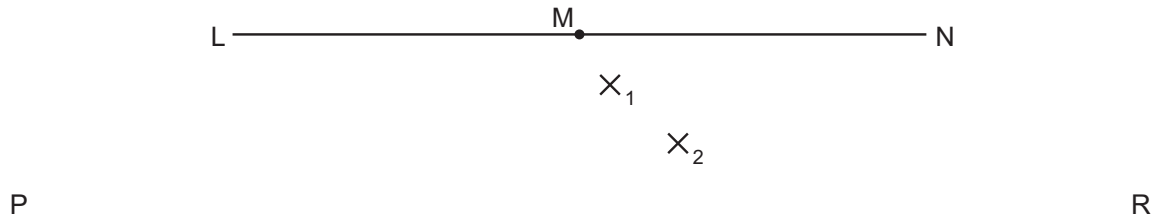


Fig. 1.1

(a) The student:

- draws line **LN**
- labels the mid-point of **LN** with the letter **M**
- draws a line **PR** parallel to **LN** and 10.0 cm below it

On Fig. 1.1, draw a normal to **LN** at the point **M**. Extend the normal downwards until it crosses the line **PR**. Label the point at which the normal crosses **PR** with the letter **Q**.

（2025 冬季 0625/62 第1题(a)）

【答案】法线过M且垂直于LN，向下延长交PR于Q。
【解析】过M作LN的垂线，向下延长至与PR相交。
将交点标为Q。
答：法线过M且垂直于LN，并交PR于Q。

二. 四针共线还原光线

知识点 插针法用针孔中心的位置记录光线经过的点；在已知光线上竖直插入两针，两针间距应不小于 _____ cm。
从透明块另一侧观察，后插两针与前两针的像看起来完全重合时，后两针和两个像位于同一_____上。
移去透明块和大头针，连接后两针的针孔中心并延长，所得直线表示透明块外的光线方向；长度用 cm，角度用 ° 表示。

答案：5.0；视线

怎么认 题目出现透明块、四枚大头针及前后两针或针像重合时，先连接后两针的针孔中心并延长。

例题 2 A student investigates the refraction of light by a transparent block.

The student's ray-trace sheet is shown full-size in Fig. 3.1.

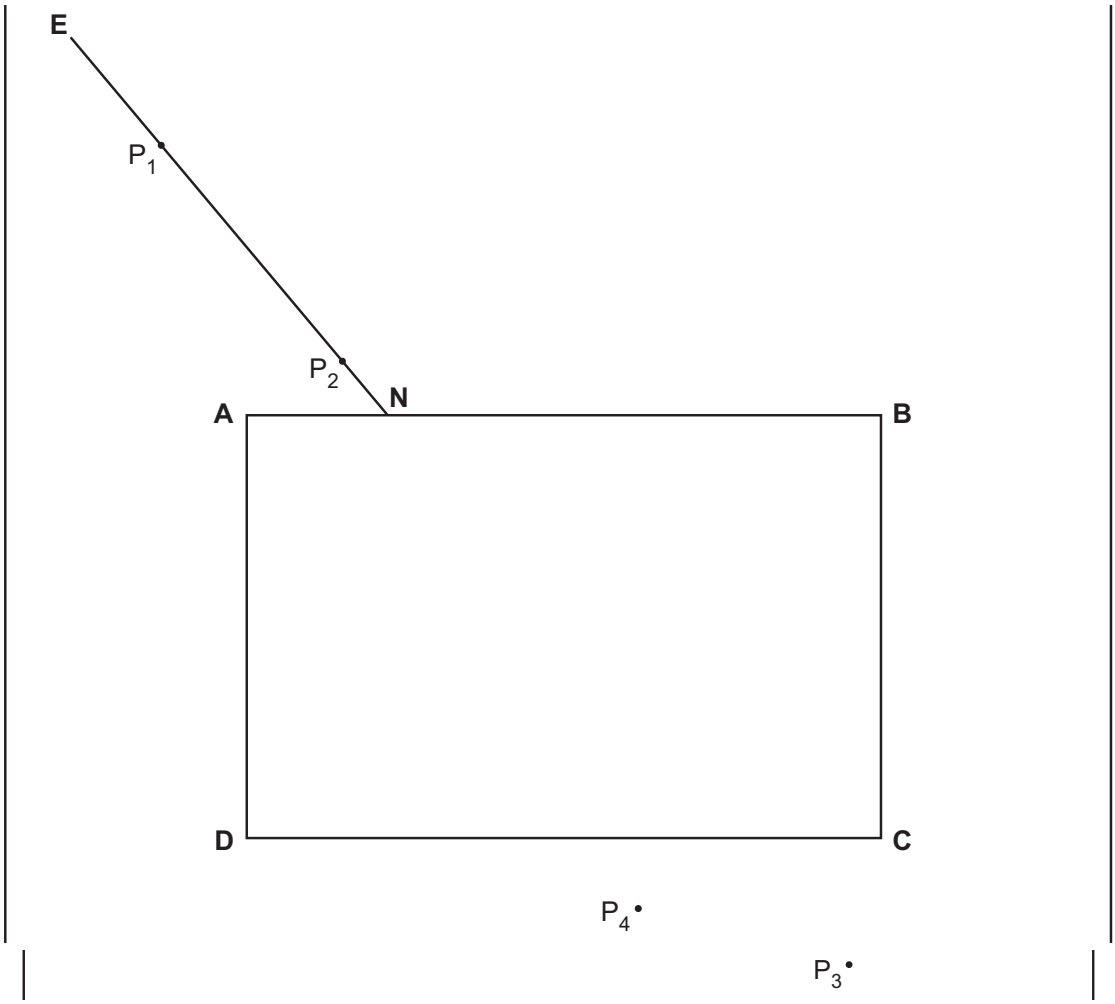


Fig. 3.1

(c) The student views the images of P_1 and P_2 through the block.
He places two pins P_3 and P_4 so that pins P_3 and P_4 and the images of P_1 and P_2 all appear exactly one behind the other.

Draw a line through P_3 and P_4. Extend this line to meet **CD**.

Label the point at which this line meets **CD** with the letter **F**. Label the lower end of this line with the letter **G**.

Extend line **EN** to approximately 5 cm below line **CD**.
Label the point at which this line crosses **CD** with the letter **H**. Label the lower end of this line with the letter **J**.

（2025 春季 0625/62 第3题(c)）

解：由 P_3、P_4 与 P_1、P_2 的像重合，过 P_3、P_4 的针孔中心作直线，向上延长至 CD，交点标为 F，下端标为 G。
过 E、N 作一直线并向下延长至 CD 下方约 5 cm，与 CD 的交点标为 H，下端标为 J。
答：直线 FG 经过 P_3、P_4，直线 EJ 经过 E、N 并延长至 CD 下方约 5 cm。

4. A student investigates reflections in a plane mirror.

A ray-trace sheet is shown in Fig. 3.1.

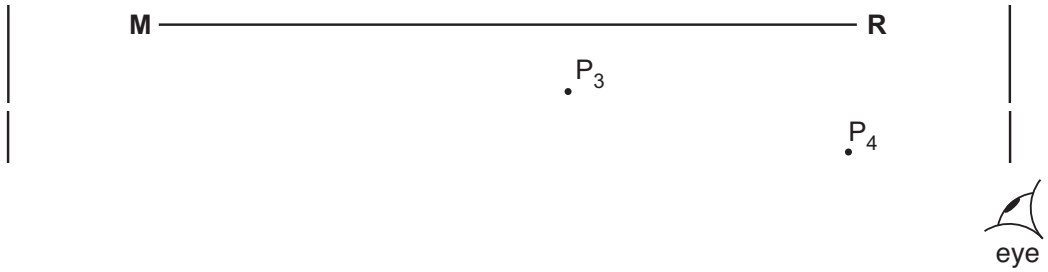


Fig. 3.1

(b) The student places the reflecting face of the mirror vertically on the line **MR**.

He places **two** pins, P_1 and P_2, on line **AB**.

Mark the positions of P_1 and P_2 with crosses (X) on line **AB** at a suitable distance apart for this type of ray-trace experiment. Label the positions of P_1 and P_2.

（2025 夏季 0625/61 第3题(b)）

【答案】P_1、P_2 位于 AB 上，间距不小于 5.0 cm。
【解析】在直线 AB 上用两个整齐的叉号标出 P_1、P_2，使两点间距不小于 5.0 cm。
答：P_1、P_2 位于 AB 上，间距不小于 5.0 cm。

5. A student investigates the refraction of light using a semicircular transparent block.

Fig. 3.1 shows her ray-trace sheet.

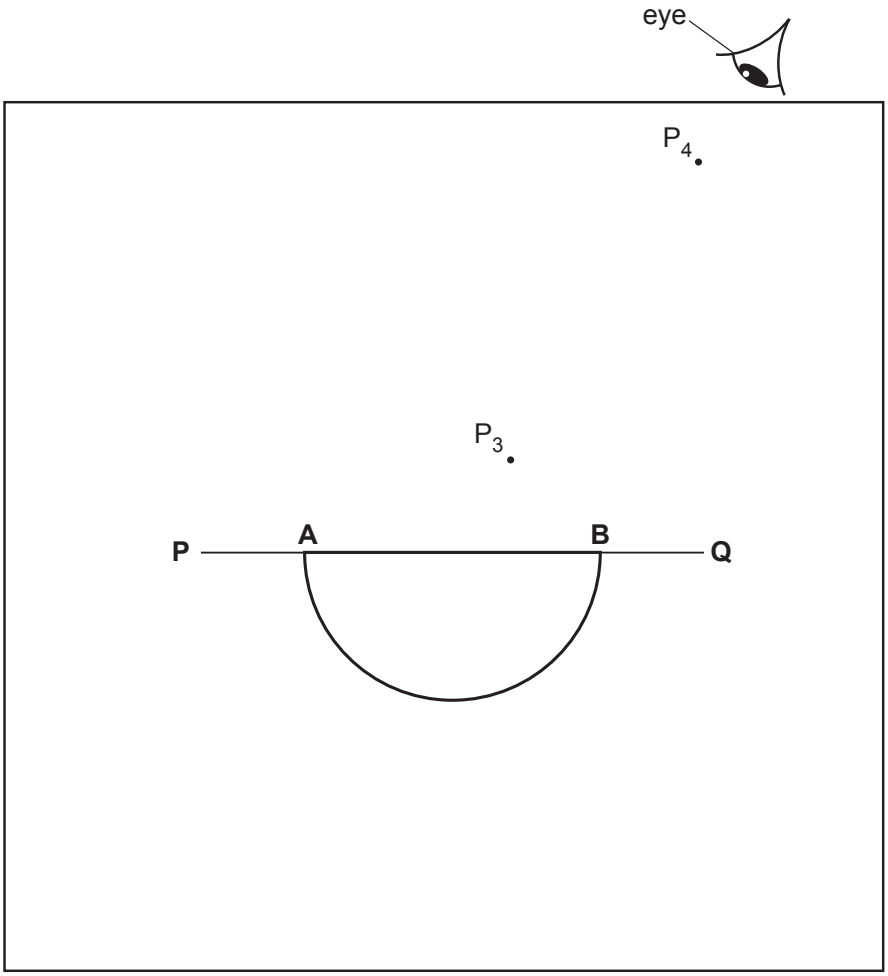


Fig. 3.1

(a) (i)
- Draw a normal **NL** through the centre of **AB**.
- Continue the normal so that it passes through the curved side of the block.
- Label the normal **NL**.
- Label the point **C** where the normal **NL** crosses **AB**.

(ii)
- Draw a line **DC**, below line **PC**, at an angle *i* = 20° to the normal and to the left of normal.

(iii)
- Mark with neat crosses (X) the positions for two pins on line **DC** at a suitable distance apart for this type of ray-trace experiment.
- Label the positions P_1 and P_2.

（2023 夏季 0625/62 第3题(a)）

【答案】法线 NL 垂直平分 AB；$i = 20°$；P_1、P_2 间距不小于 5.0 cm。

【解析】过 AB 的中点作垂线，向曲面延长并标为 NL，与 AB 的交点标为 C。

在法线左侧、PC 下方作 DC，使 $i = 20°$。

在 DC 上用叉号标出 P_1、P_2，使两点间距不小于 5.0 cm。

答：法线 NL 垂直平分 AB，$i = 20°$，P_1、P_2 间距不小于 5.0 cm。

三. 拉开针距并竖直插针

知识点 插针法用两枚针确定一条光线；同一直线上的两针间距越大，针位偏差造成的方向偏差越小，针距应大于 _____。

插针应与纸面 _____，观察时以针脚根部为准进行对齐。

选用细针，并用尖铅笔画 _____，可减小光线路径的位置误差。

答案：5 cm；垂直；细线

怎么认 题目出现插针光路图并要求提高描迹准确性时，先写两针相距大于 5 cm 并保持竖直。

例题 3 In this experiment, you will investigate the refraction of light by a transparent block.

Use the separate ray-trace sheet provided.
You may refer to Fig. 3.1 for guidance.

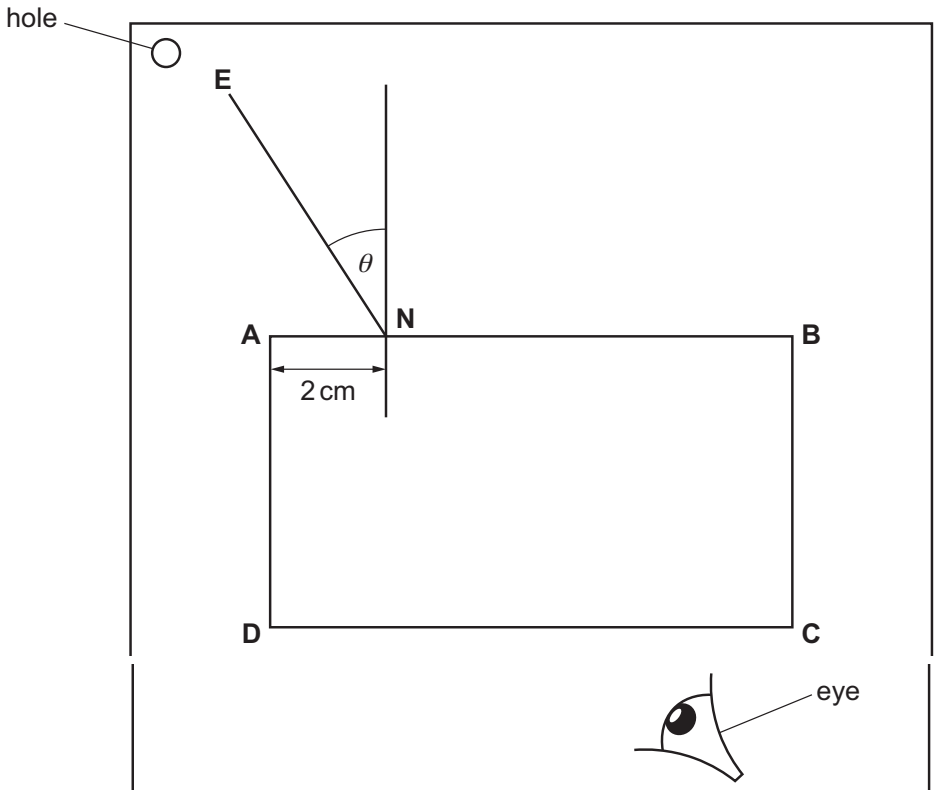


Fig. 3.1

(e) Describe **one** technique to use in this type of experiment to ensure accurate results.

（2025 春季 0625/52 第3题(e)）

解：答：将同一直线上的两枚针尽可能拉开，使针距大于约 5 cm；针距增大后，同样的针位偏差造成的光线方向偏差较小。

6. A student investigates the refraction of light using a semicircular transparent block.

Fig. 3.1 shows her ray-trace sheet.

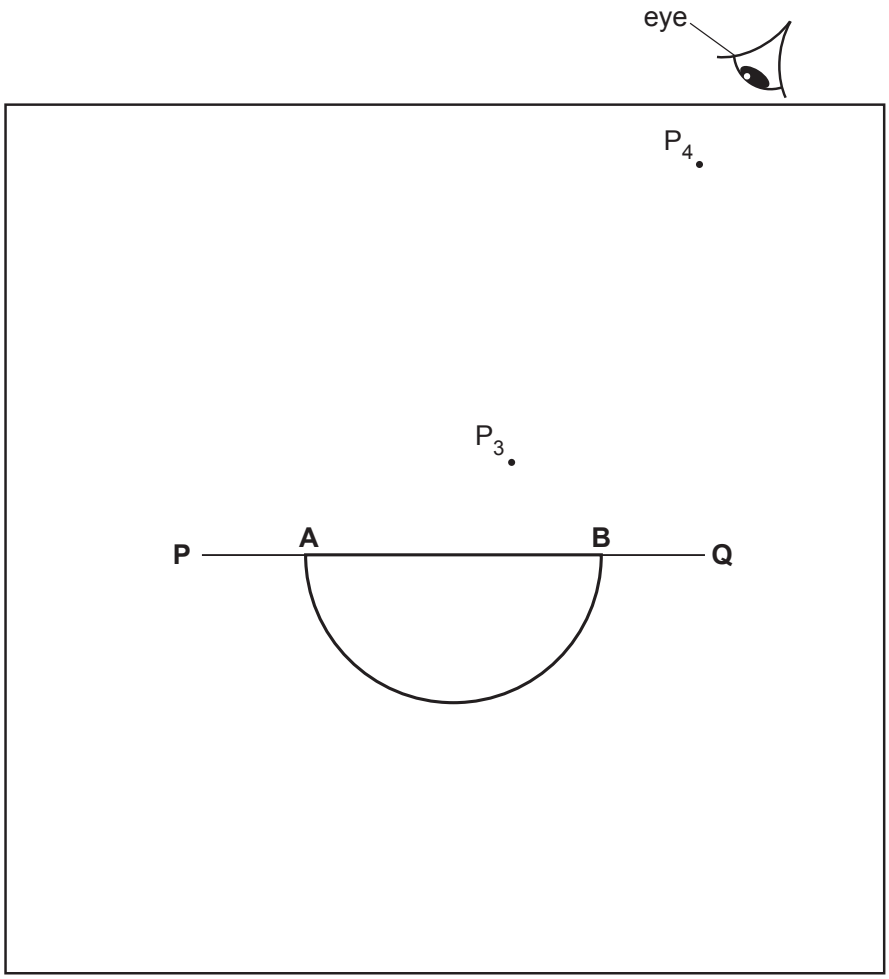


Fig. 3.1

(c) State **one** precaution that the student takes to produce an accurate ray trace.

（2023 夏季 0625/62 第3题(c)）

【答案】使同一直线上的两枚针相距大于 5 cm。
【解析】答：将同一直线上的两枚针尽可能拉开，使针距大于 5 cm，可减小光线方向的误差。

7. In this experiment, you will investigate the refraction of light using a semicircular transparent block.

Carry out the following instructions using the separate ray-trace sheet provided. You may refer to Fig. 3.1 and Fig. 3.2 for guidance.

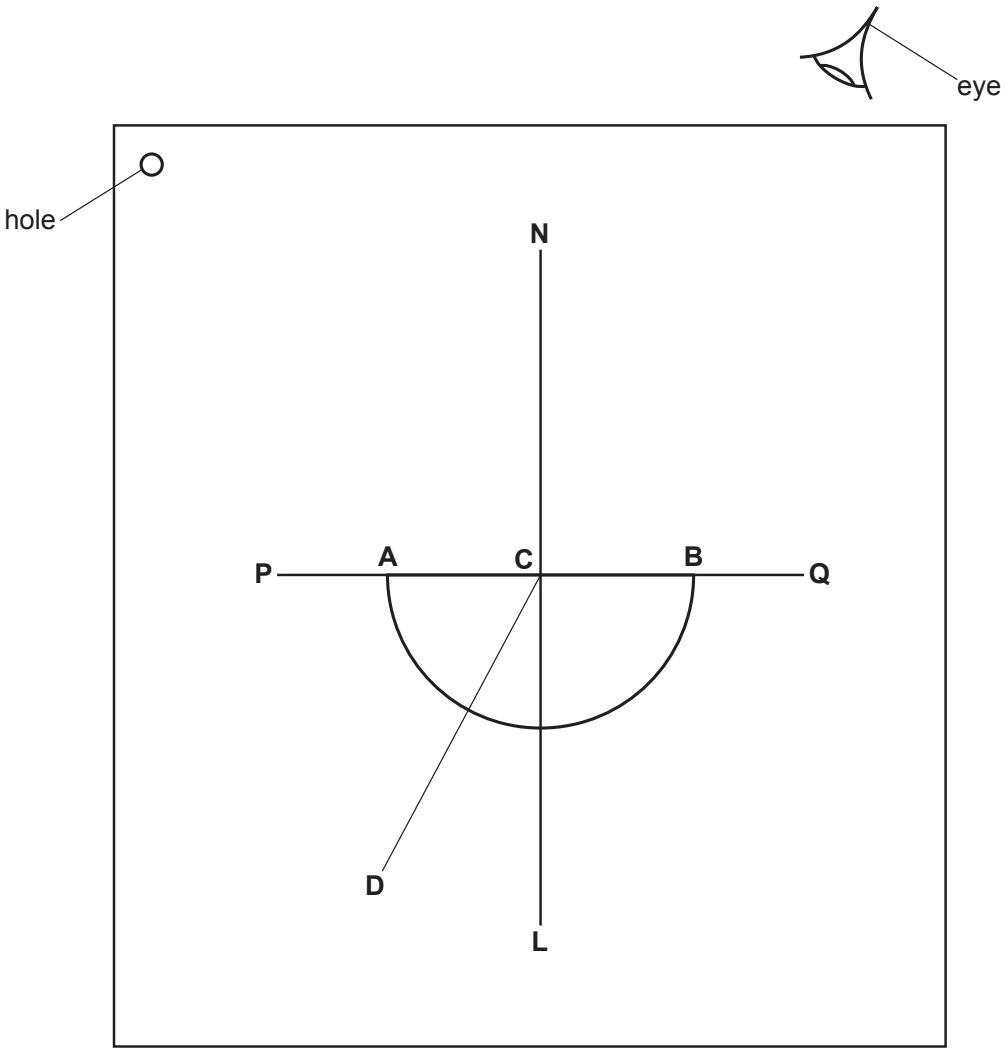


Fig. 3.1

(d) State **one** precaution that you take to produce an accurate ray trace.

（2023 夏季 0625/51 第3题(d)）

【答案】保持插针与纸面垂直。

【解析】答：使插针与纸面垂直，观察时以针脚根部为准进行对齐，可减小针倾斜造成的位置误差。

8. A student investigates the refraction of light in the material of a transparent block.

Fig. 3.1 shows the ray-trace sheet. The student places a transparent block on the sheet and labels the block **ABCD**.

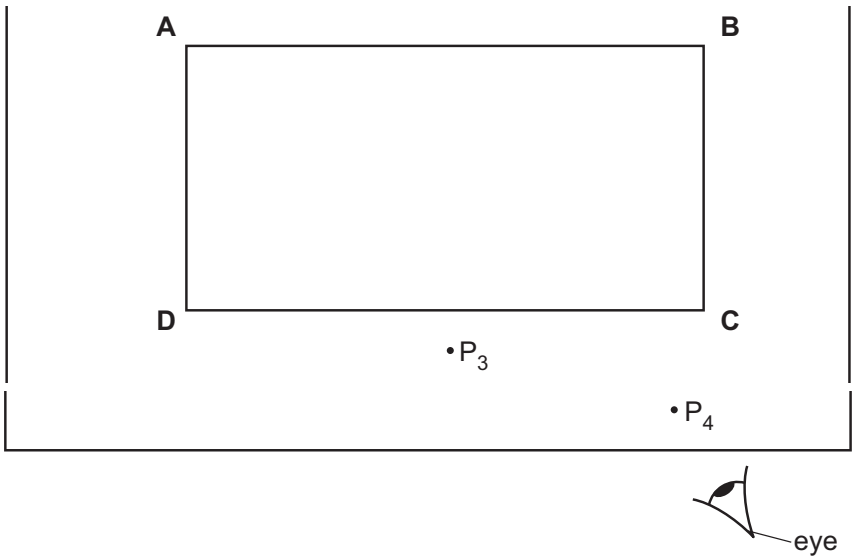


Fig. 3.1

(d) (i) Tick **one** box to complete the sentence.

To produce the most accurate ray-trace, a student places the pins P_1 and P_2

☐ exactly 5.0 cm apart.

☐ less than 5.0 cm apart.

☐ more than 5.0 cm apart.

(ii) Suggest **two** other techniques that the student can use to produce an accurate ray-trace.

（2025 冬季 0625/61 第3题(d)）

【答案】（i）大于 5.0 cm；（ii）保持插针竖直；用尖铅笔画细线。

【解析】答：（i）勾选大于 5.0 cm。

（ii）保持插针与纸面垂直；用尖铅笔画细线。

针距较大可减小方向误差，竖直插针和细线可减小位置误差。

9. A student investigates reflections in a plane mirror.

A ray-trace sheet is shown in Fig. 3.1.

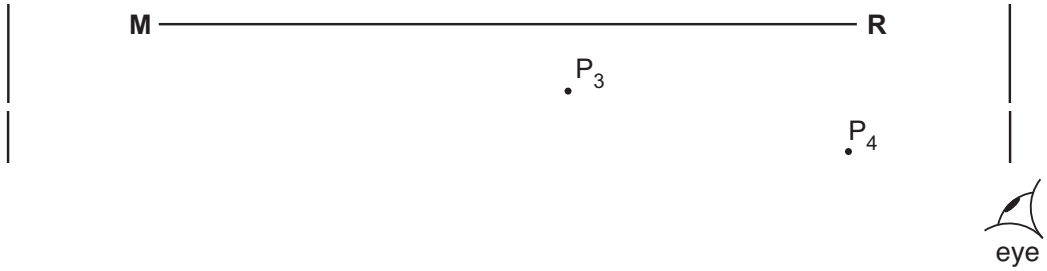


Fig. 3.1

(f) State **two** techniques that you use in this type of experiment to obtain an accurate ray trace.

（2025 夏季 0625/61 第3题(f)）

【答案】使两针相距至少 5 cm；保持插针与纸面垂直。
【解析】答：使同一直线上的两枚针相距至少 5 cm，并保持插针与纸面垂直。
针距增大可减小光线方向误差，竖直插针便于以针脚根部为准进行对齐。

题型 5：移动光屏判焦（考频★★☆☆☆）

知识点 光屏上图像最清晰的位置，是图像边缘最分明、细节最容易辨认时光屏或透镜所在的位置。
判焦时，使光屏或透镜_____移动，越过最清晰位置后，再在该位置两侧_____微调。
较暗的环境或较亮的物体可增大图像与屏幕其余部分的对比度。

答案：缓慢；小幅往返

怎么认 题目出现会聚透镜、光屏和最清晰像的要求时，先缓慢越过清晰位置，再往返微调。

例题 1 A student determines the focal length of a converging lens.

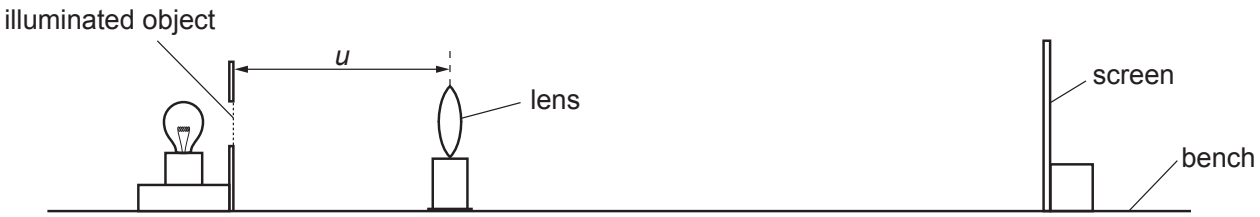


Fig. 3.1

(a) The student sets up the apparatus as shown in Fig. 3.1.

He sets the distance *u* between the illuminated object and the lens to 25.0 cm.

He places the screen near the lens and moves the screen until a focused image of the illuminated object is seen on the screen.

Describe a technique for obtaining an image that is as sharp as possible.

（2024 夏季 0625/63 第3题(a)）

解：将光屏放在透镜附近，沿光具座缓慢移动，使光屏越过图像最清晰的位置。
再在该位置两侧前后小幅移动，比较图像边缘，直至轮廓最分明。
答：缓慢前后移动光屏，在最清晰位置附近往返微调。

针对练习

1. A student investigates the image formed by a converging lens.

The apparatus is set up as shown in Fig. 3.1.

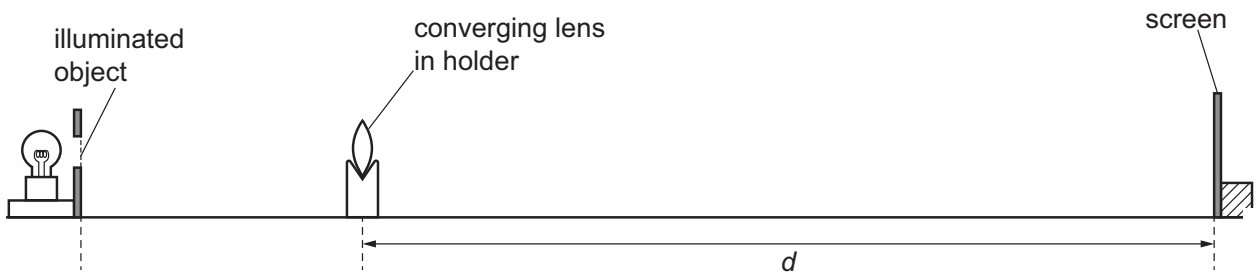


Fig. 3.1

(f) State **one** technique you use when doing the experiment to ensure that the image on the screen is as clearly focussed as possible.

（2024 冬季 0625/62 第3题(f)）

【答案】缓慢前后移动光屏。
【解析】沿光具座缓慢移动光屏，使光屏越过最清晰位置，再前后小幅微调。
答：缓慢前后移动光屏。

2. A student determines the focal length of a converging lens.

She uses the apparatus shown in Fig. 3.1.

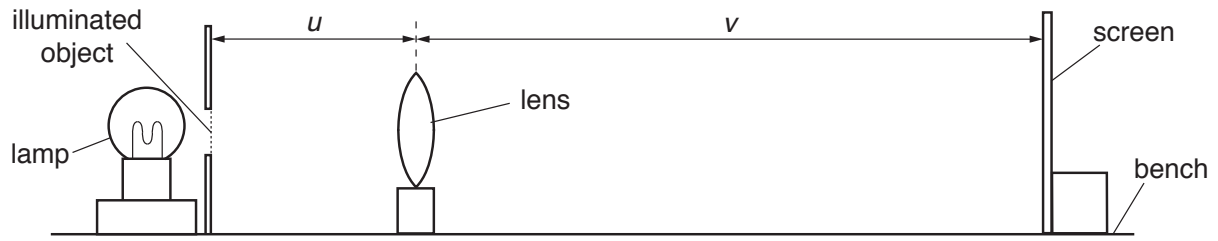


Fig. 3.1

(a) The student sets the distance *u* between the illuminated object and the lens to 20.0 cm. She moves the screen until a sharp image of the illuminated object is seen on the screen. She then measures, and records in Table 3.1, the distance *v* between the lens and the screen.

Describe a technique to obtain an image on the screen that is as sharp as possible in this experiment.

Include in your description:

- where the screen should be placed initially
- how an accurate position for the sharp image is obtained.

（2023 冬季 0625/63 第3题(a)）

【答案】先将光屏放在透镜附近，缓慢向远离透镜的方向移动；越过最清晰位置后，在其两侧前后小幅移动。
【解析】先将光屏放在透镜附近，沿光具座缓慢向远离透镜的方向移动。
越过图像最清晰的位置后，前后小幅移动光屏，直至图像边缘最分明。
答：将光屏放在透镜附近，缓慢前后移动并微调位置。

3. In this experiment, you will investigate the image formed by a converging lens.

Refer to Fig. 3.1.

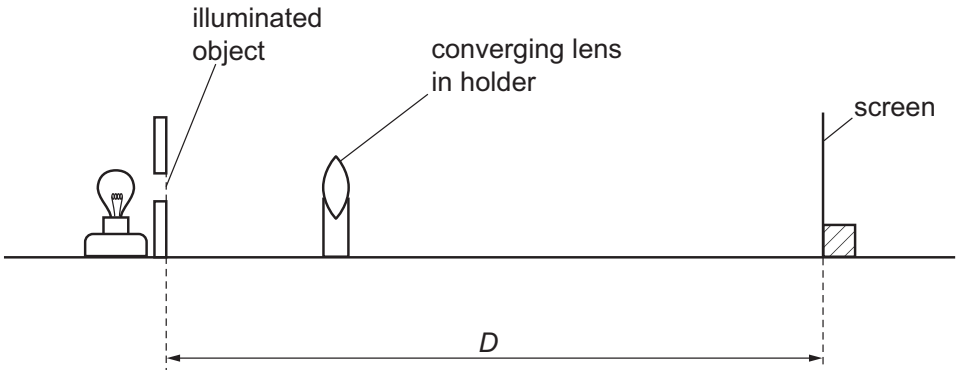


Fig. 3.1

(e) (i) State **one** technique you use when doing the experiment to ensure that the image on the screen is focused as clearly as possible.

(ii) This experiment is usually done in a darkened room.

Explain how this makes it easier to see when the image is in focus.

（2025 夏季 0625/52 第3题(e)）

【答案】(i) 缓慢前后移动透镜。 (ii) 图像与屏幕其余部分的对比度增大，图像边缘更容易辨认。
【解析】缓慢前后移动透镜，直至图像边缘最分明。
暗室中的环境光较弱，图像与屏幕其余部分的对比度较大，图像边缘更容易辨认。
答：(i) 缓慢前后移动透镜；(ii) 图像与屏幕其余部分的对比度增大。

4. A student investigates the image produced by a lens.

Fig. 3.1 shows the set up.

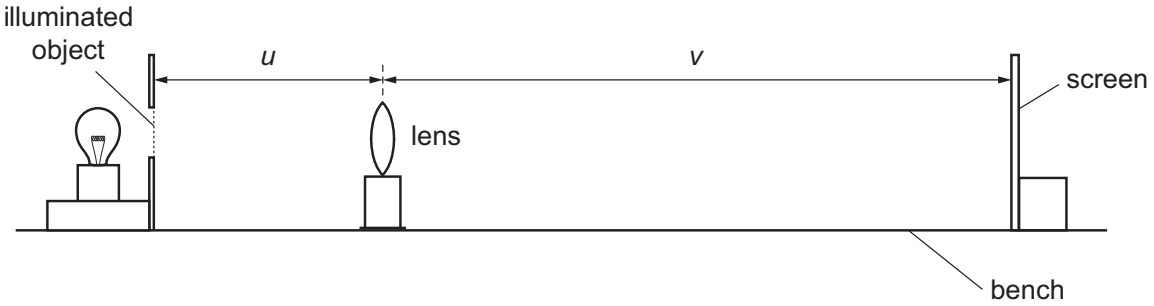


Fig. 3.1

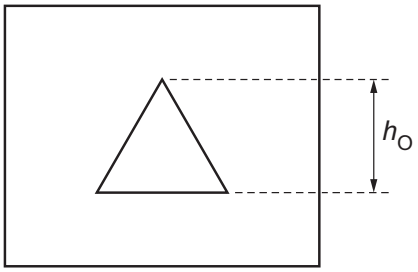


Fig. 3.2

(b) The student places the lens at a distance u = 25.0 cm from the illuminated object.

He moves the screen until a clearly focused image is formed on the screen.

He measures the distance v between the centre of the lens and the screen.

Describe **two** techniques that you use to obtain a clearly focused image.

[2]

（2024 冬季 0625/61 第3题(b)）

【答案】缓慢前后移动光屏；在较暗的环境中进行实验。
【解析】缓慢前后移动光屏，可从最清晰位置的两侧比较图像清晰程度；减弱环境光可增大图像与屏幕其余部分的对比度。
答：缓慢前后移动光屏，并在较暗的环境中进行实验。

P.2 实验规划

题型 1：补齐公平实验要素（考频★★★☆☆）

知识点 公平实验中，自变量是主动改变的量，因变量是测量或计算的结果；其余会影响因变量的量称为_____。

比较各组结果时，各次实验应使用_____的装置、相同用量和相同起始条件，使因变量的差异能归因于自变量。

控制量要写成可执行的条件，如水的体积相同、烧杯材料相同或室温相同；体积可用 cm^3、温度用 °C 表示。

答案：控制变量；相同

怎么认 题目出现控制变量或公平比较并要求列举条件时，先找除自变量外会影响因变量的量。

一. 固定控制量保证公平

例题 1 In this experiment, you will investigate the cooling of hot water from different initial temperatures.

Carry out the following instructions, referring to Fig. 2.1.

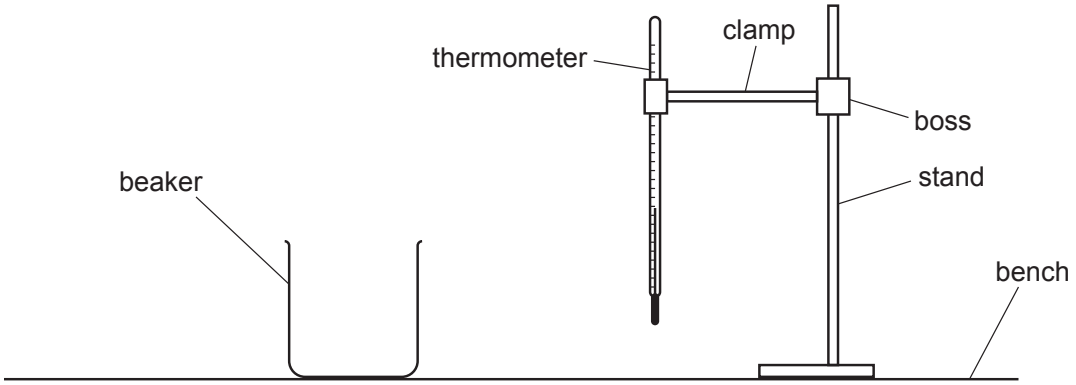


Fig. 2.1

(e) State **one** variable which must be controlled so that the comparison of x_1 and x_2 is valid.

（2023 春季 0625/52 第2题(e)）

解：本实验改变水的初始温度，而水的体积也会影响冷却速率，故各次实验中水的体积应相同。

答：各次实验使用相同体积的水。

针对练习

1. In this experiment, you will investigate the cooling of water in different sized beakers.

Refer to Fig. 1.1.

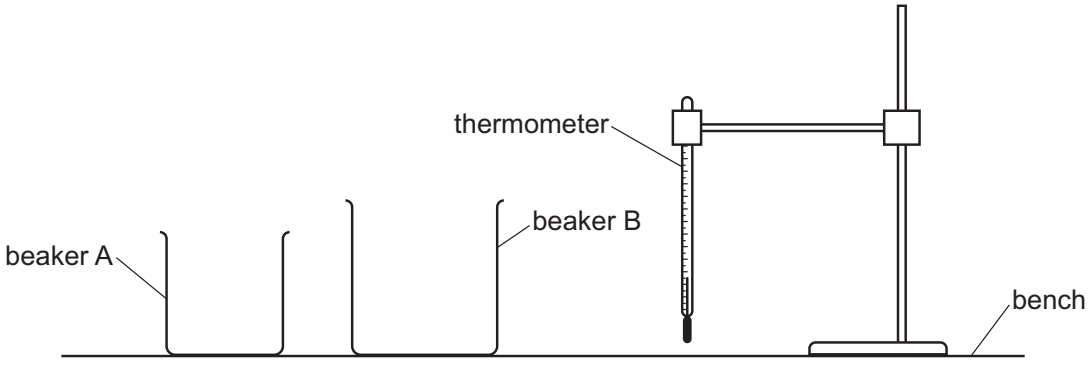


Fig. 1.1

(d) Calculate the average cooling rate x for beaker B.
Use your readings **for beaker B** in Table 1.1 and the equation

$$\frac{_0 - \theta_{180}}{T}$$

where T = 180 s and θ_0 and θ_{180} are the temperatures of the water in beaker B at t = 0 and t = 180 s.

Include the unit for the cooling rate.

(e) **(i)** A student thinks that more thermal energy is lost from the surface of the water in beaker B than from the sides of beaker B.
Suggest an additional experiment that she can do with beaker B to test her idea.
You are **not** required to do this additional experiment.

(ii) Suggest how the cooling rate of the water in beaker B in this additional experiment compares with the value of x in **(d)** if her idea is correct.

（2024 冬季 0625/53 第1题(e)）

【答案】(i) 给烧杯 B 加盖，在其余条件相同下重复实验；(ii) 冷却速率小于 $\frac{x}{2}$。
【解析】给烧杯 B 加盖后，水面散热受到抑制，而侧面散热条件不变。若水面损失的热能多于侧面，加盖后减少的散热超过原总散热的一半，故新的冷却速率小于 $\frac{x}{2}$。
答：给烧杯 B 加盖后重复实验；新的冷却速率小于 $\frac{x}{2}$。

2. A student investigates how the volume of water affects the rate at which water in a beaker cools.

She uses the apparatus shown in Fig. 2.1.

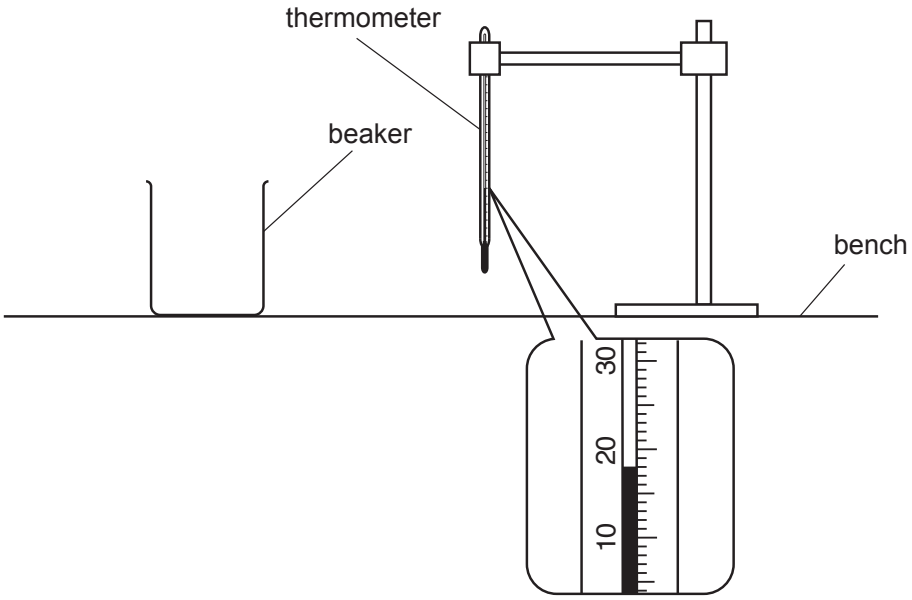


Fig. 2.1

(e) Another student repeats the experiment.

State **two** variables, other than initial water temperature, that he should control to obtain readings that are as close as possible to those in Table 2.1.

（2024 夏季 0625/63 第2题(e)）

【答案】烧杯的材料；室温。
【解析】烧杯材料和室温都会影响水的冷却速率。为使重复实验的读数与原实验接近，应使用材料相同的烧杯，并保持室温相同。
答：烧杯的材料；室温。

二. 取足数据覆盖合理范围

知识点　完整研究一个量随另一个量的变化时，自变量应在安全且可测的范围内覆盖较宽区间，并取至少_____个分布较均匀的值。
若预期变化在区间端部才明显，应_____观测时间或连续调节自变量，使该区域内也有数据。
题干已有部分取值时，按题目要求补足数据；自变量单位与对应物理量的单位相同。

答案：5；延长

怎么认 题目出现 suitable values、需取得多组数据或趋势未显现时，先扩大安全可测范围并补足均匀取值。

例题 2 In this experiment, you will investigate the cooling of water.

Carry out the following instructions, referring to Fig. 2.1.

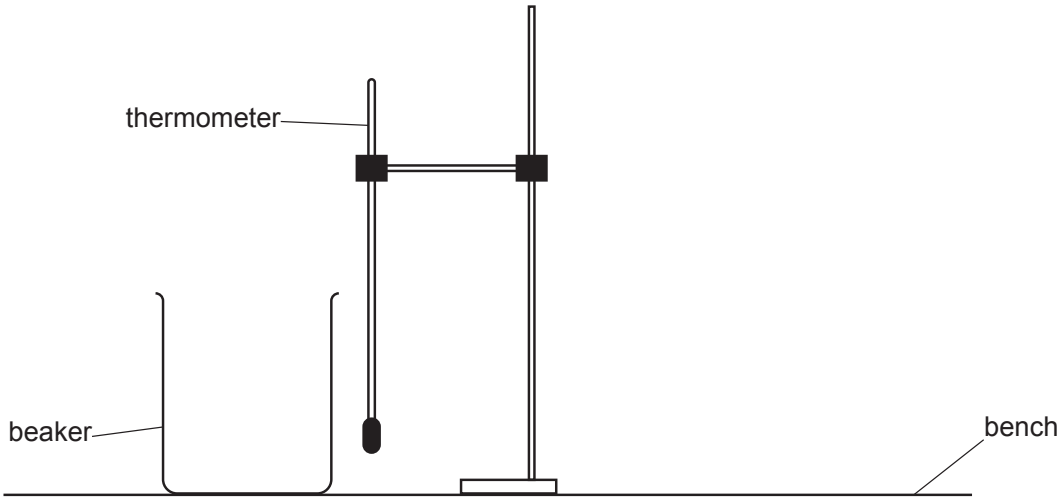


Fig. 2.1

(d) A student states that the average rate of cooling of the water decreases as the temperature comes nearer to room temperature.

(i) Suggest **one** change to the experiment that you could make to test the statement.

(ii) Suggest how to display the results to make it easier to see the trend in the rate of cooling.

（2023 夏季 0625/51 第2题(d)）

解：(i) 继续在较长时间内测量水温，直到水温接近室温，使温差较小时也有测量数据。
(ii) 以时间为横轴、水温为纵轴作图，曲线斜率的大小表示冷却速率随时间的变化。
答：延长测温时间至水温接近室温；作温度–时间图。

针对练习

3. In this experiment, you will investigate circuits containing different combinations of resistors.

Circuit A has been set up for you.
Refer to Fig. 3.1.

Resistor R_P must remain in place throughout the experiment.

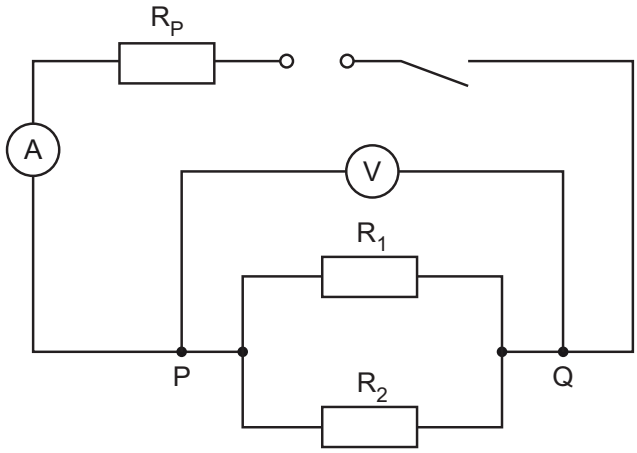


Fig. 3.1

Circuit A

(f) A student determines the resistance of R_1. He uses a variable resistor in circuit B to control the current and draws a graph of V against I.

Briefly explain **one** advantage of using a variable resistor to control the current.

（2025 夏季 0625/53 第3题(f)）

【答案】使用滑动变阻器可方便地取得多组不同电流值。
【解析】改变滑动变阻器接入电路的电阻，电流可连续改变，因而容易取得多组I与V的数据。
答：可方便地取得多组不同电流值。

4. A student investigates the period of a pendulum.

Fig. 1.1 shows the set-up.

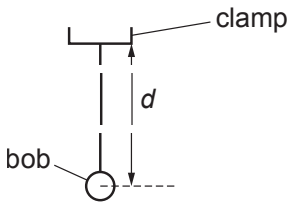


Fig. 1.1

(c) The procedure can be repeated to plot a graph.

Suggest additional values of d that are suitable for the experiment.

（2023 冬季 0625/62 第1题(c)）

【答案】20 cm、40 cm、60 cm、80 cm
【解析】d的取值应分布在10 cm到100 cm的范围内，可取20 cm、40 cm、60 cm、80 cm。
答：20 cm、40 cm、60 cm、80 cm。

5. A student investigates a circuit containing different combinations of resistors.

She uses **circuit A**, shown in Fig. 2.1.
Circuit A is not yet complete.

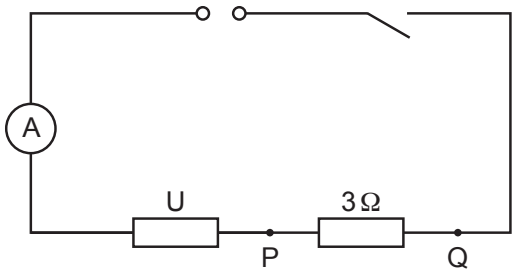


Fig. 2.1

(b) Circuit A

The student measures the potential difference (p.d.) V across resistor U and the current I in the circuit.

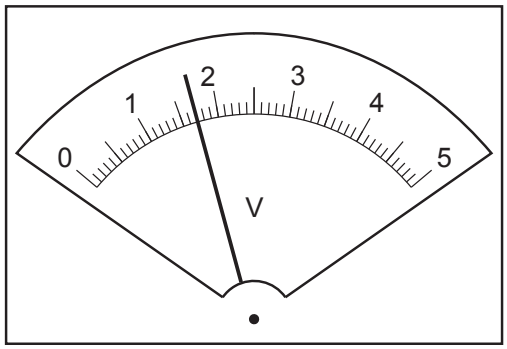


Fig. 2.2

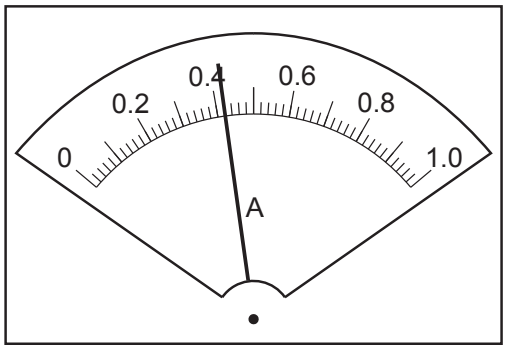


Fig. 2.3

Read, and record in Table 2.1, the values of V and I shown on the meters in Fig. 2.2 and Fig. 2.3.

Table 2.1

circuit	V/V	I/A	R/Ω
A			
B	2.1	0.54	
C	2.4	0.63	

(d) A student determines the resistance of resistor U using a variable resistor to control the current in the circuit.

(i) Complete the circuit in Fig. 2.6 to show a variable resistor used for this purpose.

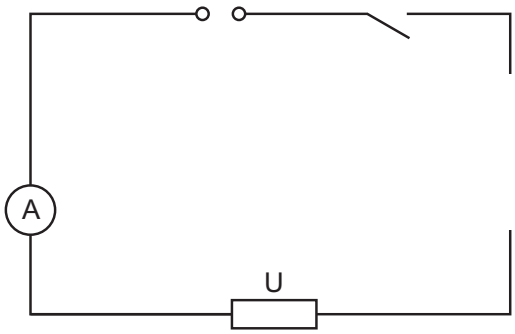


Fig. 2.6

(ii) Briefly explain **one** advantage of using a variable resistor to determine the resistance of resistor U rather than the procedure carried out in **(b)** and **(c)**.

（2023 夏季 0625/63 第2题(d)）

【答案】(i) 将带斜箭头穿过矩形的滑动变阻器串联接入电路。; (ii) 可方便地连续改变电流并取得更多组数据。

【解析】(i) 在电流表与电阻U所在的主回路中串联滑动变阻器，其符号为斜箭头穿过矩形电阻。

(ii) 改变滑动变阻器接入电路的电阻，电流可连续改变，因而容易取得更多组I与V的数据。

答：(i) 滑动变阻器串联接入电路；(ii) 可方便地取得更多组数据。

题型 2：规划热学实验（考频★★★☆☆）

知识点 冷却率表示单位时间内液体温度的降低量，可用 $r=\frac{\theta_0-\theta_1}{\Delta}t$ 计算，单位为 °C/s 或 °C/min。

研究散热条件对冷却率的影响时，散热条件是_____，冷却率是_____；其余影响冷却的量应保持不变。

每个自变量取至少 5 个适当且分布均匀的值，每个值重复测量并取平均值。

答案：自变量；因变量

怎么认 题目出现改变保温层厚度、盖子厚度或液面直径并比较冷却快慢时，先统一初温和水量。

一. 改散热条件测冷却率

例题 1

A student investigates the effect of insulation on the cooling of a liquid.

Plan an experiment which will enable her to investigate how changing the thickness of insulation surrounding a beaker affects the rate of cooling of hot water in the beaker.

You are **not** required to do the experiment.

The apparatus available includes:

- a glass beaker
- a supply of hot water
- a lid to fit the beaker
- strips of insulation which can be cut to size.

In your plan:

- list any additional apparatus needed
- explain briefly how to do the experiment, including the measurements to take so that the rate of cooling can be determined
- state the key variables to keep constant
- draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

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

（2024 春季 0625/52 第4题）

解： 另取温度计、计时器、直尺和量筒。用直尺测保温层厚度 d，在材料允许范围内取至少 5 个近似等间隔的厚度值。

量取相同体积的热水倒入同一烧杯，包上保温材料并盖好；水温达到统一初温 θ_0 时开始计时，经过相同时间 Δt 后测末温 θ_1。每个厚度重复测量并取平均值。

保持水的体积、初温、烧杯、盖子、保温材料覆盖面积、冷却时间和周围环境相同。表头为：保温层厚度/mm，初温/°C，末温/°C，冷却时间/s，冷却率/(°C/s)。

由 $r=\frac{\theta_0-\theta_1}{\Delta}t$ 计算各厚度对应的平均冷却率。以 d 为横轴、r 为纵轴作图；若 d 增大时 r 减小，则保温层越厚，热水冷却越慢。

答：按保温层厚度与平均冷却率的关系得出结论。

针对练习

1. A student investigates the rate of cooling of hot water in a container which has a lid.

Plan an experiment which will enable him to compare the effect of lids of different thicknesses on the rate of cooling.

The apparatus available includes:

- a beaker
- a supply of hot water
- insulating material from which lids can be cut.

In your plan, you should:

- list any additional apparatus needed
- explain briefly how to do the experiment, including the measurements to take so that the rate of cooling can be determined
- state the key variables to keep constant
- draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

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

（2023 夏季 0625/63 第4题）

【答案】测量盖子厚度、初末温度和冷却时间，控制水量与初温，计算并比较平均冷却率。

【解析】另取温度计、计时器、直尺和量筒，将同种材料制成直径相同而厚度 d 不同的盖子，取至少 5 个厚度值。

量取相同体积的热水，每次从相同初温 θ_0 开始计时，经过相同时间 Δt 后测末温 θ_1；保持烧杯、盖子直径和周围环境相同，每组重复测量并取平均值。

表头为：盖子厚度/mm，初温/°C，末温/°C，冷却时间/s，冷却率/(°C/s)。

由 $r=\frac{\theta_0-\theta_1}{\Delta}t$ 求平均冷却率，以 d 为横轴、r 为纵轴作图，据图判断盖子厚度对冷却率的影响。

2. Hot water is poured into a glass beaker and allowed to cool down.

Plan an experiment to investigate how the rate at which the water cools depends upon the diameter of the water surface exposed to the air.

You are provided with:

- a supply of hot water
- a set of glass beakers of different sizes
- 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 key 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 reach a conclusion.

You may include a labelled diagram if you wish.

（2024 冬季 0625/62 第4题）

【答案】测量水面直径和相同温降所需时间，控制水量与初温，计算并比较平均冷却率。

【解析】另取温度计、计时器和游标卡尺，在水面高度处测各烧杯的内径 d，选取至少 5 个不同的直径。用量筒量取相同体积的热水，每次从相同初温 θ_0 开始计时，测量温度降低相同数值 $\Delta\theta$ 所需的时间 Δt；保持周围环境相同，每组重复测量并取平均值。

表头为：水面直径/mm，初温/°C，末温/°C，冷却时间/s，冷却率/(°C/s)。

由 $r=\Delta\frac{\theta}{\Delta}t$ 求平均冷却率，以 d 为横轴、r 为纵轴作图，据图判断水面直径对冷却率的影响。

二. 改初温、盘径或加热器测温降或用时

知识点 研究一个因素对实验结果的影响时，主动改变的量称为_____，随之测量的量称为_____；其余能影响结果的量应保持不变。

冷却速率等于温度降低量除以冷却时间，即 $r=\frac{T_i-T_f}{t}$，单位可用 $\frac{°C}{min}$；比较不同初温时，冷却时间应相同。

自变量应取至少 5 个适当数值，每组测量应重复并求平均值；记录表的每列须标明物理量和单位。

答案：自变量；因变量

怎么认 题目出现改变初温、盘径或加热条件并测温降或用时时，先确定自变量和因变量。

例题 2

Hot water is poured into a glass beaker and allowed to cool down for 5 minutes.

Plan an experiment to investigate whether the rate of cooling of the hot water depends upon the initial temperature of the hot water.

The rate of cooling of the water can be calculated using the equation:

$$\text{rate of cooling} = \frac{\text{decrease in temperature}}{\text{time taken}}$$

You are provided with:

- a supply of cold water
- an electric kettle
- a 250 cm^3 glass beaker
- a measuring cylinder.

You may use any other common laboratory apparatus.

You are **not** required to do this investigation.

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 reach a conclusion.

You may include a labelled diagram.

（2025 夏季 0625/52 第4题）

解： 另取温度计和计时器。用量筒量取相同体积的水倒入同一玻璃烧杯，将热水与冷水混合至某一初温；轻轻搅拌，温度计的液泡完全浸入水中且不接触杯壁和杯底，待示数稳定后平视读取初温 T_i，同时开始计时。

经过 $t = 5\ \text{min}$，再次搅拌并读取末温 T_f。改变初温，取至少 5 个适当数值；每个初温重复测量并求平均值。保持水的体积、烧杯、冷却时间、室温和烧杯位置相同。

记录表：初温 $\frac{T_i}{^\circ\text{C}}$ | 末温 $\frac{T_f}{^\circ\text{C}}$ | 温降 $\frac{T_i - T_f}{^\circ\text{C}}$ | 冷却时间 $\frac{t}{\text{min}}$ | 冷却速率 $\frac{r}{\frac{^\circ\text{C}}{\text{min}}}$。

由冷却速率的定义得

$r = \frac{T_i - T_f}{t}$

分别计算各初温对应的平均冷却速率，作 r 随 T_i 变化的图。若 r 随 T_i 发生有规律的变化，则冷却速率依赖初温。答：根据冷却速率与初温的关系得出结论。

针对练习

3. A student investigates the time taken for water to evaporate to dryness when heated from above.

Fig. 4.1 shows the set-up. The power of the heater is constant.

The following is also available:

- supply of water at room temperature
- metre ruler.

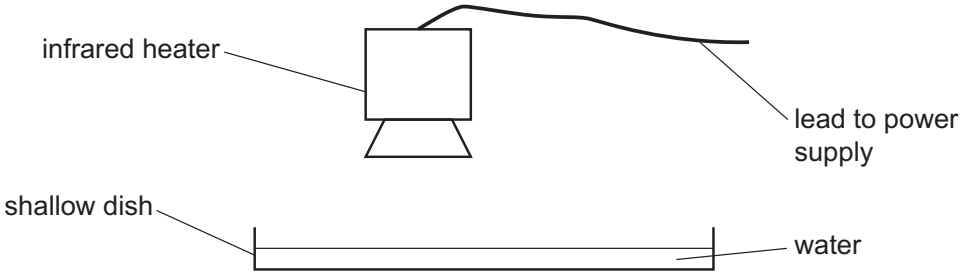


Fig. 4.1

Plan an experiment to investigate how **one** factor affects the time taken for the water to evaporate.

You do **not** need to write about safety precautions.

You should:

- state any additional apparatus required
- explain briefly how you would do the investigation
- state the key variables that you would keep constant
- draw a table, or tables, with column headings, to show how you would display your readings (you are **not** required to enter any readings in the table)
- explain how you would use your readings to reach a conclusion.

（2023 冬季 0625/61 第4题）

【答案】改变红外加热器与水面的距离，测量水蒸干所需的时间并比较。

【解析】另取计时器。用米尺测量红外加热器与水面的距离 h，在浅盘中加入相同体积的室温水；接通加热器并开始计时，水刚好完全蒸干时记录时间 t。

改变距离 h，取至少 5 个适当数值，每组重复测量并求平均值；保持水的体积、浅盘、水的初温、加热器功率和室温相同，并避免气流影响。

记录表：加热器与水面的距离 $\frac{h}{\text{cm}}$ | 蒸干时间 $\frac{t}{\text{s}}$。

比较表中不同 h 对应的平均时间 t，或作 t 随 h 变化的图。答：根据时间随距离的变化关系得出结论。

4. A student investigates the evaporation of water in an open dish.

Plan an experiment which will enable the student to compare the effect on evaporation of using different diameters of dish.

The mass m_e of water evaporated can be determined by using the equation:

$$m_e = m_b - m_a$$

where m_b = the mass of water in the dish before experiment and
m_a = the mass of water in the dish after experiment.

The apparatus available includes:

- a range of shallow dishes with different diameters
- an adjustable laboratory lamp to heat the water
- a variable power supply for the lamp
- a stop-watch
- a supply of cold water.

You are **not** required to do the experiment.
You do **not** need to write about any safety precautions.

In your plan:

- list any additional apparatus needed
- explain briefly how to do the experiment, including what measurements need to be taken
- state the key variables to keep constant
- draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

You may draw a diagram or add to Fig. 4.1 if it helps to explain your plan.

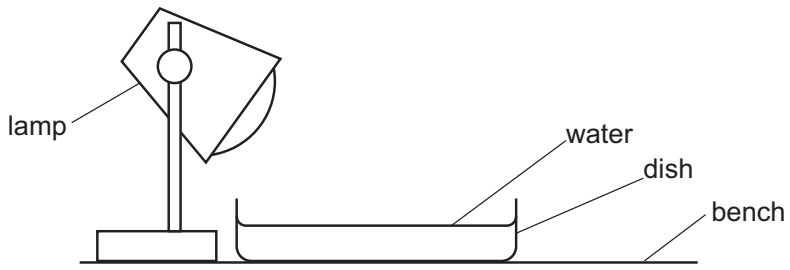


Fig. 4.1

（2025 冬季 0625/53 第4题）

【答案】改变浅盘直径，在相同加热时间内测量蒸发水的质量并比较。
【解析】另取米尺、量筒和电子天平。用米尺测量浅盘直径 d，向浅盘加入相同体积的冷水，用天平测得加热前水的质量 m_b；接通灯并加热相同时间，再测得剩余水的质量 m_a。
换用不同直径的浅盘，取至少 5 个直径，每组重复测量并求平均值；保持水的初始体积、加热时间、灯的功率、灯与水面的距离、灯的角度和水的初温相同。
记录表：浅盘直径 $\frac{d}{\text{cm}}$ | 加热前水的质量 $\frac{m_b}{\text{g}}$ | 加热后水的质量 $\frac{m_a}{\text{g}}$ | 蒸发水的质量 $\frac{m_e}{\text{g}}$。

由 $m_e = m_b - m_a$ 计算平均蒸发质量，作 m_e 随 d 变化的图。答：根据蒸发质量随浅盘直径的变化关系得出结论。

题型 3：规划电学实验（考频★★★★☆）

知识点 测量导线电阻时，电流表与待测导线_____，电压表_____在待测导线两端。

在电流和电势差均处于仪表量程内且导线温度不变时，由 $R = \frac{V}{I}$ 计算电阻。

研究长度或直径对电阻的影响时，仅改变一个自变量，并保持其余相关量不变；电阻的单位是_____。

答案：串联；并联；欧姆（Ω）

怎么认 题目出现改变线长或线径并用伏安法测阻时，先画电流表串联、电压表并联的电路。

一. 改线长或线径伏安测阻

例题 1 A student investigates the resistance of a wire.

Plan an experiment which enables the student to investigate how the length of a wire affects the resistance of the wire.

Resistance R is calculated from the equation: $R = \frac{V}{I}$

where V is the potential difference (p.d.) across the wire and I is the current in the wire.

You are **not** required to do the experiment.

The apparatus available includes:

- a selection of wires
- a variable power supply
- an ammeter
- a voltmeter.

In your plan:

- list any additional apparatus needed
- complete Fig. 4.1 to show a voltmeter connected to measure the potential difference across the wire
- explain briefly how to do the experiment, including the measurements to take so that the resistance can be determined
- state the key variables to keep constant
- draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

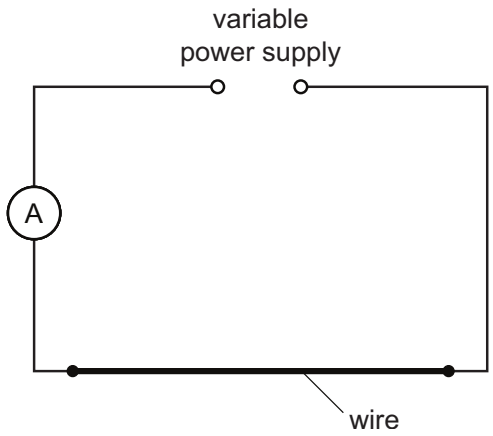


Fig. 4.1

（2025 春季 0625/52 第4题）

解：另需米尺、开关、连接导线和保护电阻；在图中将电压表并联在待测导线两端，电流表与待测导线串联。把同一根均匀导线沿米尺放置，用接线夹选定长度 l；闭合开关，记录电压表读数 V 和电流表读数 I，随后断开开关。

$R = \frac{V}{I}$

改变接线夹位置，在仪表量程允许的较宽范围内取至少 5 个不同的 l；每个长度重复测量并求 R 的平均值。保持导线材料、直径和温度不变，采用较小电流并在读数后断开开关以限制温升。

长度 l / m	电势差 V / V	电流 I / A	电阻 R / Ω	平均电阻 $\lvert R\rvert$ / Ω

以 l 为横轴、$|R|$ 为纵轴作图，根据图线的变化趋势判断导线长度对电阻的影响。答：由各组电势差和电流求出电阻，比较或作图得出电阻与长度的关系。

针对练习

1. A student investigates the relationship between the diameter of a wire and the electrical resistance of the wire.

Plan an experiment which enables her to investigate how the diameter of a wire affects the resistance of the wire.

Resistance R is calculated from the equation $R = \frac{V}{I}$

where V is the potential difference (p.d.) across the wire and I is the current in the wire.

The apparatus available includes wires of different known diameters.

In your plan:

- list any additional apparatus needed
- complete Fig. 4.1 to show a circuit suitable for measuring the resistance of a wire
- explain briefly how to do the experiment, including the measurements to take so that the resistance can be determined
- state the key variables to keep constant
- draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

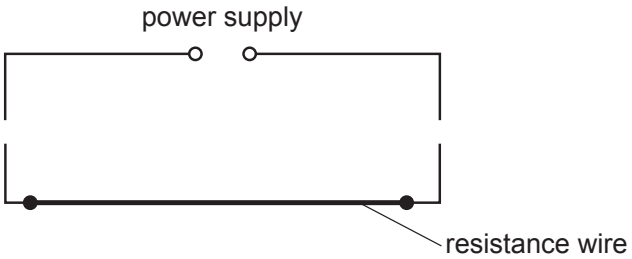


Fig. 4.1

（2024 夏季 0625/63 第4题）

【答案】电流表与导线串联，电压表并联在导线两端；逐组求出不同直径导线的电阻并作图比较。

【解析】另需电流表、电压表、米尺、开关和连接导线。电源、开关、电流表与待测导线串联，电压表并联在待测导线两端。

取材料和长度相同、直径 d 不同的导线，记录 d，闭合开关后记录 V 和 I，随后断开开关。

$R = \frac{V}{I}$

测量至少 5 种直径，每种直径重复测量并求平均值，保持导线长度、材料和温度不变。表头为直径 d / mm、电势差 V / V、电流 I / A、电阻 R / Ω、平均电阻 $|R|$ / Ω。以 d 为横轴、$|R|$ 为纵轴作图，根据图线判断直径对电阻的影响。

2. A student investigates the relationship between the diameter and the resistance of wires.

The following apparatus is available:

- wires with different diameters
- instrument for measuring the diameter of a wire
- metre ruler
- ammeter
- voltmeter
- power supply.

Other apparatus normally found in a school laboratory is also available.

Plan an experiment to investigate how the diameter of a wire affects its resistance.

Resistance R is given by the equation $R = \frac{V}{I}$, where V is the potential difference (p.d.) across the wire and I is the current in the wire.

You do **not** need to write about safety precautions.

In your plan:

- draw a circuit diagram to show the circuit you use
- explain briefly how to do the investigation
- state **one** key variable to keep constant
- draw a table, or tables, with column headings, to display the readings (you are **not** required to enter any readings in the table)
- explain how to use your results to reach a conclusion.

（2025 夏季 0625/61 第4题）

【答案】电流表与导线串联，电压表并联在导线两端；逐组求出不同直径导线的电阻并作图比较。
【解析】电源、开关、电流表与待测导线串联，电压表并联在待测导线两端。用测径仪器在导线多处测量直径并取平均值 d，用米尺截取相同长度的导线。
闭合开关，记录 V 和 I，随后断开开关。
$R = \frac{V}{I}$
换用材料和长度相同的不同直径导线，取得至少 5 组数据，保持导线长度、材料和温度不变。表头为平均直径 d / mm、电势差 V / V、电流 I / A、电阻 R / Ω。以 d 为横轴、R 为纵轴作图，根据图线判断直径对电阻的影响。

二. 调电流测灯阻或亮度

知识点 探究灯泡的电阻或亮度随电流变化时，灯中电流 I 是_____，测得的电阻 R 或光照强度是_____。
电流表和变阻器与灯泡串联；测电阻时，电压表并联在灯泡两端，并由 $R = \frac{V}{I}$ 计算。
V、I、R 的单位分别为伏特（V）、安培（A）、欧姆（Ω）；读数必须在灯泡的安全工作范围内取得。
实验中应在适当范围内取多个电流值，保持其他影响因素不变，用表格和因变量随 I 的关系图归纳结论。

答案：自变量；因变量

怎么认 题目出现调节灯中电流并测电阻或亮度时，先把电流表和变阻器与灯泡串联。

例题 2 A student investigates the change in resistance of a lamp filament when the current in the lamp is increased.

The following apparatus is available:

- a power supply
- a low-voltage filament lamp
- an ammeter
- a voltmeter
- connecting wires.

Other apparatus normally found in a school laboratory is also available.

Plan an experiment to investigate the change in resistance of the lamp filament when the current in the lamp is increased.

Resistance R is given by the equation $R = \frac{V}{I}$, where V is the potential difference (p.d.) across the lamp and I is the current in the lamp.

You are **not** required to do this investigation.

You should:

- draw a diagram of the circuit used
- explain briefly how to do the investigation, including how to change the current
- draw a table, or tables, with column headings, to show how to display your readings (you are **not** required to enter any readings in the table)
- explain how to use your readings to reach a conclusion.

（2023 夏季 0625/51 第4题）

解： 将电源、开关、电流表、变阻器和灯泡串联，电压表并联在灯泡两端。
闭合开关，调节变阻器，在灯泡安全工作范围内取至少 5 个不同的电流值；每次待示数稳定，记录电流 I 和电势差 V。
由 $R = \frac{V}{I}$，计算每组灯丝电阻 R；表格列为电势差 $\frac{V}{\mathrm{V}}$、电流 $\frac{I}{\mathrm{A}}$、电阻 $\frac{R}{\Omega}$。
以 $\frac{I}{\mathrm{A}}$ 为横轴、$\frac{R}{\Omega}$ 为纵轴作图，根据图线的总体趋势判断 R 随 I 增大如何变化。
答：由电阻随电流关系图得出灯丝电阻随电流增大的变化规律。

针对练习

3. A student investigates the brightness of a lamp.

Plan an experiment to investigate how the intensity (brightness) of the light produced by the lamp is affected by the current in the lamp.

The apparatus available includes:

- a lamp and power supply
- a light meter which measures the intensity of light arriving at it
- an ammeter
- a variable resistor.

In your plan, you should:

- complete the circuit diagram in Fig. 4.1 to show the variable resistor connected to control the current in the lamp
- state the key variables to be kept constant
- explain briefly how to do the experiment
- draw a table with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

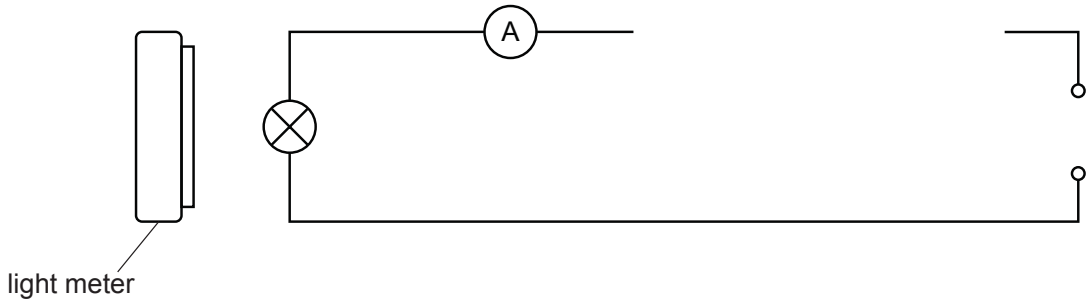


Fig. 4.1

（2023 冬季 0625/63 第4题）

【答案】实验方案见解析。

【解析】将变阻器与灯泡和电流表串联，把光照强度计固定在灯泡前；保持环境光照和灯泡到光照强度计的距离不变。

调节变阻器，在安全范围内取至少 5 个不同的电流值，每次待示数稳定后同时记录 I 和光照强度；各组测量重复后取平均值。

表格列为电流 $\frac{I}{\mathrm{A}}$、平均光照强度（按仪表所示单位）；以 $\frac{I}{\mathrm{A}}$ 为横轴、平均光照强度为纵轴作图。

答：由图线的总体趋势得出光照强度随电流的变化规律。

三. 改电极距或熔丝条件

知识点 规划实验时，只改变_____，测量随之改变的_____，其余会影响读数的量保持不变。

考查电极间距时，间距单位可用 cm，电流单位为 A，并至少测量五个不同间距。

考查熔丝时，只改变金属种类或直径中的一种；直径单位可用 mm，熔断电流单位为 A，另一特征和有效长度保持_____。

答案：自变量；因变量；不变

怎么认 题目出现改变电极间距或熔丝某一特征并测电流时，先确定唯一自变量和对应电流。

例题 3 A student investigates the change in current in a conducting liquid as the distance between two electrodes is changed. The circuit is shown in Fig. 4.1.

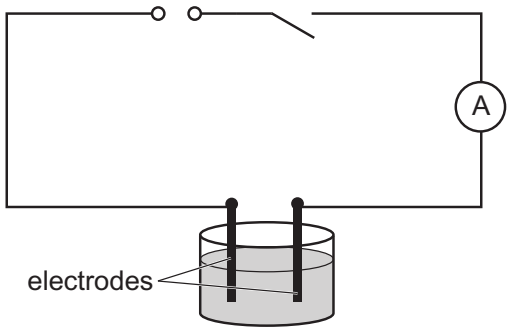


Fig. 4.1

Plan an experiment to investigate the change in current in the liquid as the distance between the electrodes is changed.

You are **not** required to do this investigation.

You should:

- explain briefly how to do the investigation
- state the key variables to keep constant
- draw a table, or tables, with column headings, to show how to display your readings (you are **not** required to enter any readings in the table)
- explain how to use your readings to reach a conclusion.

（2023 夏季 0625/52 第4题）

解： 用刻度尺测量两电极内侧面之间的距离 d，闭合开关，记录电流表读数 I。

改变两电极的距离，至少再取四个不同的 d，每次记录对应的 I。保持电源电压、电极材料和尺寸、电极浸入深度、导电液体的种类、浓度、体积与温度不变。

记录表头为：电极间距 $\frac{d}{\text{cm}}$；电流 $\frac{I}{\text{A}}$。

以 d 为横轴、I 为纵轴作图，根据图线判断电流随电极间距的变化关系。答：由电流与电极间距关系图得出结论。

针对练习

4. A student investigates the current required to melt different fuse wires.

Fig. 4.1 shows part of the circuit the student uses.

The following equipment is also available:

- fuse wires with a selection of different diameters and metals (all with the same length)
- metre ruler
- ammeter
- variable resistor

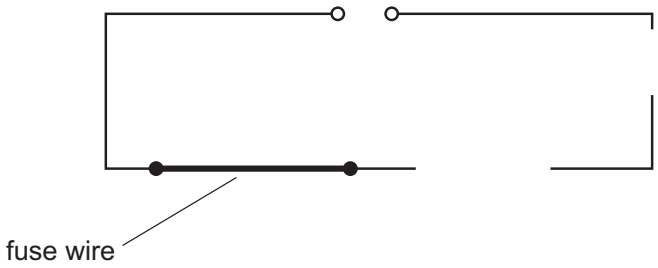


Fig. 4.1

Plan an experiment to investigate how **one** factor affects the current required to melt a fuse wire.

You do **not** need to write about safety precautions.

In your plan:

- state the variable that you choose to investigate
- complete the circuit diagram on Fig. 4.1
- explain briefly how to do the investigation
- state a key variable to keep constant
- draw a table, or tables, with column headings, to display the readings (you are **not** required to enter any readings in the table)
- explain how to use your results to reach a conclusion.

（2024 冬季 0625/61 第4题）

【答案】选熔丝直径为自变量，将电流表和可变电阻器与熔丝串联；保持金属种类和长度不变，测量不同直径熔丝的熔断电流并作图。

【解析】选熔丝直径为自变量，在图中将电流表和可变电阻器均与熔丝串联。

选用同一种金属、相同长度而直径不同的熔丝，调节可变电阻器使电流逐渐增大；熔丝刚熔断时，记录熔断前的电流表示数。对其余直径重复测量。

记录表头为：熔丝直径 $\frac{d}{\mathrm{mm}}$；熔断电流 $\frac{I}{\mathrm{A}}$。

以 d 为横轴、I 为纵轴作图，由图线判断熔断电流随直径的变化关系。答：所得关系图表示熔丝直径对熔断电流的影响。

题型 4：规划力学实验（考频★★★☆☆）

知识点 实验中，主动改变的量称为_____，随之观察并测量的量称为_____。
除研究量外，可能影响结果的量应保持不变，称为_____，使因变量的变化与所研究的自变量对应。
自变量应在安全可行范围内取至少 5 个分散的值，每组重复测量并求平均值。
记录表的表头应写明物理量及单位，角度用 °，长度用 cm 或 m；作图时横轴为自变量，纵轴为因变量。

答案：自变量；因变量；控制变量

怎么认 题目出现可调释放角度、高度或位置，并要求研究落距或回升高度时，先把可调量定为自变量。

一. 改释放条件测落距或回升

例题 1 A student investigates the motion of a ball through the air.

Plan an experiment which will enable him to investigate how the range of the ball depends on the angle at which it is launched.
The range is the horizontal distance that the ball travels after leaving the end of the channel shown in Fig. 4.1 and before hitting the ground.

You are **not** required to do the experiment.

The apparatus available includes:

- a flexible channel, as shown in Fig. 4.1, which can be bent at different angles
- a selection of balls, each of different diameter and mass.

In your plan, you should:

- list any additional apparatus needed
- explain briefly how to do the experiment – you may add to Fig. 4.1 if it helps your explanation
- state the key variables to keep constant
- draw a table with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the results to reach a conclusion.

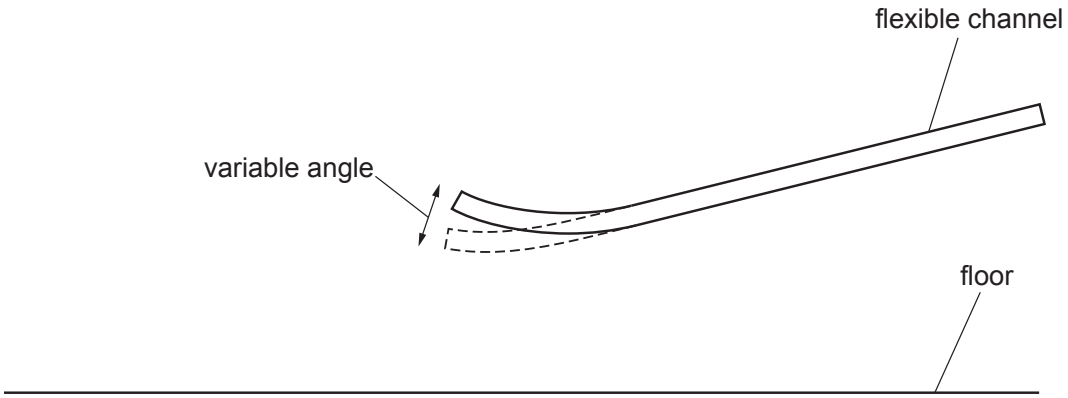


Fig. 4.1

（2023 春季 0625/52 第4题）

解：另备量角器、米尺、铅垂线、白纸和复写纸。用量角器测量槽口处轨道切线与水平面的夹角 θ，调至选定值；用铅垂线在地面标出槽口正下方的位置。
选定一个小球，在轨道上端标出固定释放位置，每次使球从该处由静止释放。小球落在复写纸上留下落点，用米尺测量槽口正下方标记至落点的水平距离 R。

同一 θ 下重复测量 3 次，求平均水平落距 $R_{平均}$；在安全可行范围内选取至少 5 个分散的 θ 值，重复上述测量。实验中保持小球的质量和直径、轨道上端的高度和倾角、释放位置、槽口的位置与高度不变。

发射角 $\frac{\theta}{°}$	水平落距 $\frac{R_1}{\text{cm}}$	水平落距 $\frac{R_2}{\text{cm}}$	水平落距 $\frac{R_3}{\text{cm}}$	平均水平落距 $\frac{R_{平均}}{\text{cm}}$

以 θ 为横轴、$R_{平均}$ 为纵轴作图，根据图线判断水平落距随发射角怎样变化。答：发射角与水平落距的关系由该图线确定。

针对练习

1. A student sets up a flexible track on the laboratory bench.

The student investigates the motion of a metal ball as it rolls from rest down the track. The metal ball rolls down the track, up the other side of the track, and comes momentarily to rest at a height *h* above the bench before rolling back down again.

Plan an experiment to investigate how **one** variable affects the size of this height *h*.

The apparatus available includes:

- flexible track
- two clamps, bosses and stands to support the track
- selection of metal balls.

Fig. 4.1 shows how the flexible track is supported.

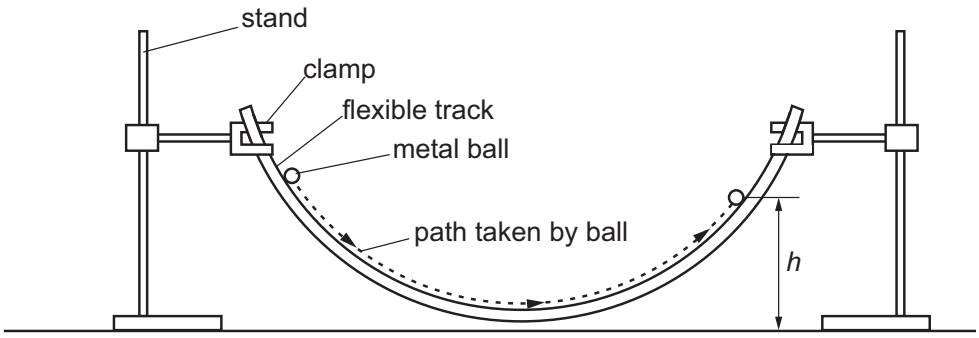


Fig. 4.1

In your plan:

- state the **one** variable you have chosen to investigate
- list any additional apparatus needed
- explain how to do the experiment
- state the key variables to be kept constant
- draw a table, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

（2025 冬季 0625/62 第4题）

【答案】以释放高度 H 为自变量，作平均回升高度 $h_{平均}$ 随 H 变化的图线。

【解析】取释放高度 H 为自变量、回升高度 h 为因变量，另备米尺。将米尺竖直固定在轨道旁，以工作台面为高度零点。

选定同一个金属球，测量球心的释放高度 H，使球从静止释放；球滚上另一侧并短暂停止时，读取球心

高度 h。同一 H 重复测量 3 次并求平均值，再取至少 5 个分散的 H 值。
保持金属球的质量和直径、轨道形状以及两支架和夹具的位置不变，并夹紧支架。

释放高度 $\frac{H}{\text{cm}}$	回升高度 $\frac{h}{\text{cm}}$	平均回升高度 $\frac{h_{平均}}{\text{cm}}$

以 H 为横轴、$h_{平均}$ 为纵轴作图。答：由图线判断释放高度对回升高度的影响。

2. A student sets up a flexible track at the edge of a bench. The student investigates a metal ball as it rolls from rest down the track and travels through the air. The metal ball travels a horizontal distance *d* through the air and lands in a tray of sand placed on the floor.

Plan an experiment to investigate how **one** variable affects the size of this distance *d*.

The apparatus available includes:

- flexible track
- clamp, boss and stand to support the track
- selection of metal balls.

Fig. 4.1 shows how the flexible track is supported.

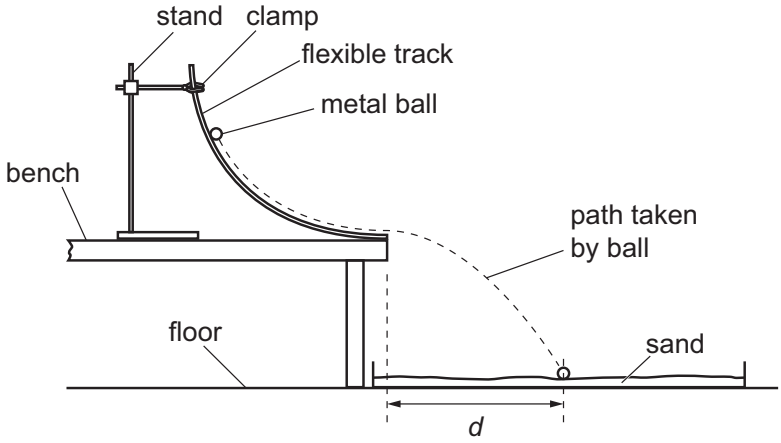


Fig. 4.1

In your plan:

- state the **one** variable you have chosen to investigate
- list any additional apparatus needed to measure this variable
- explain how to do the experiment
- state the key variables to be kept constant
- draw a table, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

（2024 夏季 0625/62 第4题）

【答案】以释放高度 H 为自变量，作平均水平距离 $d_{平均}$ 随 H 变化的图线。
【解析】取球心的释放高度 H 为自变量、水平距离 d 为因变量，另备米尺和铅垂线。用铅垂线在地面标出轨道末端正下方的位置。
选定同一个金属球，测量 H 后使球从静止释放。球落入沙盘后，用米尺测量地面标记至沙面落点的水平距离 d。同一 H 重复测量 3 次并求平均值，再取至少 5 个分散的 H 值。
保持金属球的质量和直径、轨道形状、轨道末端的高度和方向以及支架位置不变。

释放高度 $\frac{H}{\text{cm}}$	水平距离 $\frac{d}{\text{cm}}$	平均水平距离 $\frac{d_{平均}}{\text{cm}}$

以 H 为横轴、$d_{\text{平均}}$ 为纵轴作图。答：由图线判断释放高度对水平距离的影响。

二. 改木条层数或斜角测挠度或速率

知识点 实验中主动改变的量称为_____，随之测量的量称为_____；其余会影响结果的量应保持不变。

木条挠度等于加载前后自由端高度之差，单位可用 cm；小车在固定测量区间内的平均速率为 $v_{\text{avg}} = \frac{s}{t}$，单位为 m s^{-1}。

自变量应在合适范围内取多组数值；每组测量可重复进行并求平均值，再用表格和图像判断因变量随自变量的变化关系。

答案：独立变量；因变量

怎么认 题目出现改变木条层数或斜面角度并测挠度或平均速率时，先确定自变量、因变量和控制变量。

例题 2 A student investigates the bending of composite strips of wood when they are loaded at one end. The composite strips are made from identical layers of wood stuck together, as shown in Fig. 4.1.

Plan an experiment to investigate how much composite strips bend when they are loaded at one end. Fig. 4.2 shows the set-up the student uses.

The student has a number of composite strips made with two or more layers of wood.

You are **not** required to do this investigation.

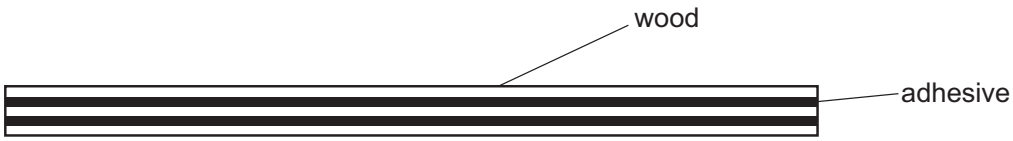


Fig. 4.1

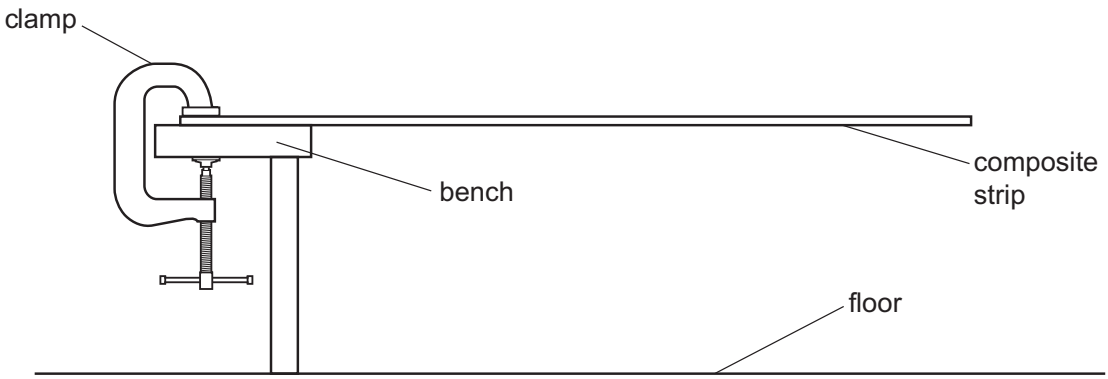


Fig. 4.2

In your plan:

- state the variable that you are testing
- list any additional apparatus that you would use
- explain briefly how to do the investigation
- state the key variables to keep constant
- draw a table, or tables, with column headings, to show how to display your readings (you are **not** required to enter any readings in the table)
- explain how to use your readings to reach a conclusion.

（2024 夏季 0625/51 第4题）

解： 以木条层数 n 为自变量，以自由端挠度 Δh 为因变量。另取米尺、相同砝码和砝码挂钩。将复合木条夹在桌边，使悬伸长度 L 相同，在自由端旁竖直固定米尺。未加载时读自由端高度 h_0，在自由端同一位置挂上固定载荷，静止后读高度 h。

$\Delta h = h_0 - h$

在器材所含范围内选取不同层数的木条，重复上述测量；每种层数测量三次并求平均值。保持载荷、加载位置、悬伸长度、木层材料和每层尺寸不变。记录表的表头为：

n（无单位） | $\frac{(\Delta h)_1}{\text{cm}}$ | $\frac{(\Delta h)_2}{\text{cm}}$ | $\frac{(\Delta h)_3}{\text{cm}}$ | $\frac{(\Delta h)_{\text{avg}}}{\text{cm}}$

以 n 为横轴、$(\Delta h)_{\text{avg}}$ 为纵轴作图，根据图像判断木条层数对挠度的影响。答：比较不同层数所对应的平均挠度，得出复合木条弯曲量随层数变化的关系。

针对练习

3. A student investigates the speed of a small trolley moving down a sloping ramp.

Plan an experiment which will enable her to compare the effect of different angles of slope on the average speed of the trolley between points on the ramp.

Average speed can be calculated from the equation:

$$\text{average speed} = \frac{\text{distance}}{\text{time}}$$

The apparatus available includes:

- a long ramp with a support that enables it to be set at different angles of slope
- a small trolley.

In your plan:

- list any additional apparatus needed
- explain briefly how to do the experiment, including how to take the measurements so that the average speed can be determined
- suggest a possible source of inaccuracy even if the method is carried out carefully
- state the key variables to keep constant
- draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

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

（2024 冬季 0625/63 第4题）

【答案】改变斜面角度，测量小车通过固定区间的时间并计算平均速率；保持释放位置和测量距离不变。

【解析】另取秒表、米尺和量角器。在斜面上标出 A、B 两点，用米尺测得两点间距离 s；固定释放点，使释放点到 A 点的距离不变。用量角器测量斜面角 θ。由静止释放同一小车，小车车头通过 A 点时启动秒表，通过 B 点时停止秒表，记录时间 t。

同一角度测量三次，得 t_1、t_2、t_3。

$t_{\text{avg}} = \frac{t_1+t_2+t_3}{3}$

$v_{\text{avg}} = \frac{s}{t_{\text{avg}}}$

在安全范围内选取至少五个不同的斜面角度，重复测量。保持释放位置到 A 点的距离、A 与 B 间的距离、小车和斜面表面不变。即使操作谨慎，小车通过标记点的时刻仍难与秒表操作完全同步，会使时间读数不准确。记录表的表头为：

$\frac{\theta}{^\circ}$ | $\frac{t_1}{\text{s}}$ | $\frac{t_2}{\text{s}}$ | $\frac{t_3}{\text{s}}$ | $\frac{t_{\text{avg}}}{\text{s}}$ | $\frac{v_{\text{avg}}}{\text{m s}^{-1}}$

以 θ 为横轴、v_{avg} 为纵轴作图，比较图中各点的变化趋势。答：由图像得出斜面角度对小车平均速率的影响。

题型 5：规划光学实验（考频★★☆☆☆）

知识点 实验中有意改变的量是自变量，随之测量的量是因变量；其余会影响因变量的量应保持_____。

自变量应取不少于_____个、分布范围适当的值；每个值重复测量并取平均值。

连续型自变量可作图判断关系，类别型自变量可比较各组结果；表头应写物理量及其_____。

研究光的颜色时固定物距 u，研究凝胶浓度时固定入射角；每次只改变一种滤光片或一块凝胶。

答案：不变；5；单位

怎么认 题目出现改变光的颜色或凝胶浓度并测量焦距或折射角时，先确定自变量和因变量，再固定其余几何条件。

例题 1 A student investigates the refraction of light.

Refraction is the change in direction of a ray of light when passing into a transparent substance, as shown in Fig. 4.1.

Plan an experiment which enables him to investigate how the concentration of a gel affects the angle at which light is refracted when passing from air into the gel.

A transparent gel block can be made by dissolving gel powder in hot water in a mould and allowing it to cool. Changing the amount of powder will change the concentration.

Concentration is measured in g / cm^3.

You are **not** required to do the experiment.

The apparatus available includes:

- samples of gel made at different concentrations and labelled with those concentrations
- a ray-lamp which produces a narrow ray of light.

In your plan:

- list any additional apparatus needed
- explain briefly how to do the experiment, including the measurements to take
- state the key variable to keep constant
- draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

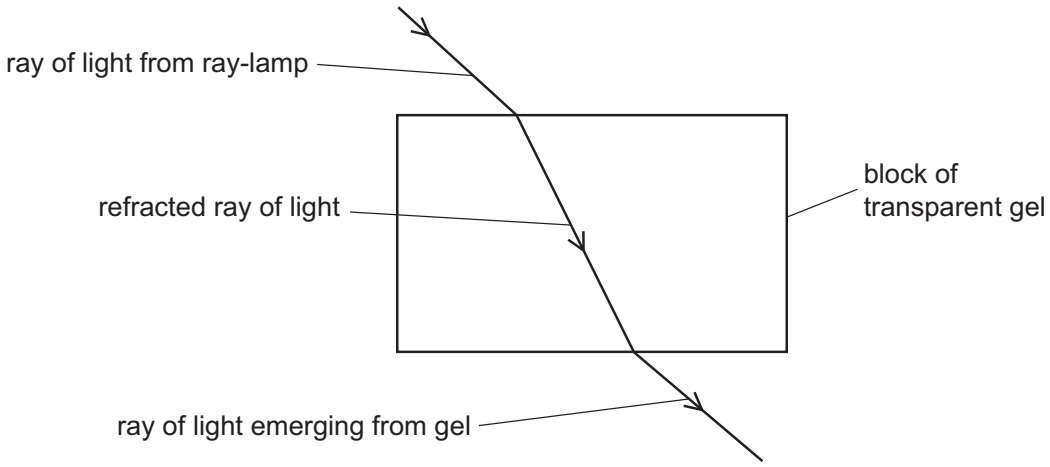


Fig. 4.1

（2025 夏季 0625/53 第4题）

解： 另备白纸、铅笔、直尺和量角器。将凝胶块放在白纸上并描出轮廓，画出入射点处的法线；用量角器设定入射角，使窄光束由空气射入凝胶。

标出光线进入和射出凝胶的位置，移去凝胶，用直尺连接两点得到凝胶内的折射光线，用量角器测量折射光线与法线的夹角 r。更换另一浓度的凝胶，保持凝胶块位置和入射角不变，至少选取 5 种浓度；每种浓度重复测量并求 r 的平均值。

凝胶浓度 / g cm^{-3}	折射角 r_1 / °	折射角 r_2 / °	折射角 r_3 / °	平均折射角 r / °

以凝胶浓度为横轴、平均折射角为纵轴作折线图，根据图线判断凝胶浓度改变时折射角怎样变化。答：按图线所示趋势得出凝胶浓度对折射角的影响。

针对练习

1. A student investigates the effect of changing the colour of light on the focal length of a lens.

The focal length f of a lens is given by the equation $f = \frac{uv}{(u + v)}$.

The distance u is the distance between an object and the lens. The distance v is the distance between the lens and the image that is formed on a screen.

Plan an experiment to investigate the effect of changing the colour of light on the focal length of a lens.

You are **not** required to do this experiment.

The following apparatus is available to the student:

- illuminated object
- a selection of coloured filters to change the colour of the light
- converging lens
- screen
- metre ruler.

Other apparatus normally available in a school laboratory can also be used.

In your plan, you should:

- draw a labelled diagram to show the arrangement of the apparatus
- explain briefly how you would do the investigation, including the measurements you would take
- draw a suitable table, with column headings, to show how you would display your readings (you are **not** required to enter any readings in the table)
- state how you would use your results to reach a conclusion.

（2023 冬季 0625/52 第4题）

【答案】固定物距 u，分别使用不同颜色的滤光片，测量 u、v 并由 $f = \frac{uv}{u+v}$ 求焦距；比较各颜色对应的 f。

【解析】装置沿同一直线排列如下。

发光物体 ｜ 彩色滤光片 ｜ 会聚透镜 ｜ 光屏

固定发光物体和透镜，使物距 u 保持不变。装入一种滤光片，移动光屏至屏上形成清晰的像，用米尺测量物距 u 和像距 v。

$f = \frac{uv}{u+v}$

由测得的 u、v 计算焦距 f，再依次更换不同颜色的滤光片并重复测量。

滤光片颜色	物距 u / cm	像距 v / cm	焦距 f / cm	

比较不同颜色对应的焦距，或以滤光片颜色为横轴、焦距为纵轴作柱状图。答：根据各颜色对应的焦距判断光的颜色对透镜焦距的影响。

P.3 观察与测量

题型 1：按刻度直接读数（考频★★★★☆）

知识点 温度计相邻两条最小刻线对应温度之差称为_____，由标注数值之差除以两标注刻度间的格数求得。

读数时，视线应与液柱顶端等高，并与刻度面_____，以减小视差。

液柱顶端位于两刻线之间时，按题图清晰程度读至最小分度值的_____；温度单位为 °C。

答案：分度值；垂直；一半

怎么认 题目出现温度计刻度图并要求记录温度时，先确定相邻刻线的分度值。

一. 温度计读单点温度

例题 1 A student investigates the cooling of hot water from different initial temperatures.

She uses the apparatus shown in Fig. 2.1.

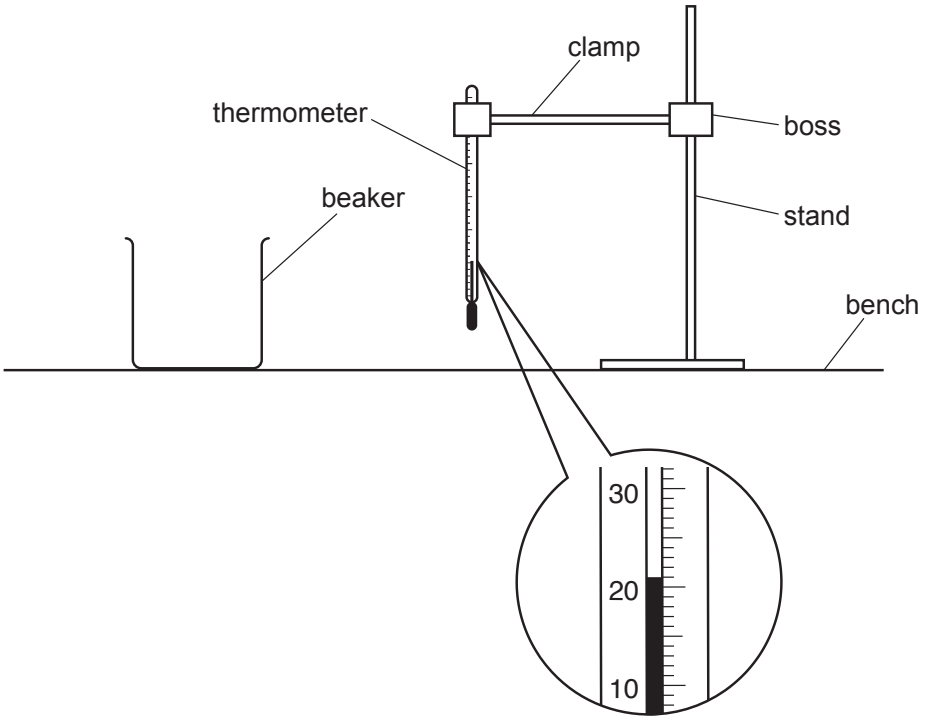


Fig. 2.1

(a) **(i)** The student measures the room temperature.
Record room temperature θ_R shown on the thermometer in Fig. 2.1.

(ii) Describe **one** precaution that the student takes to ensure that this temperature reading is as accurate as possible.

（2023 春季 0625/62 第2题(a)）

解：相邻标注刻度间共有 10 格，故分度值为

$\frac{30-20}{10} = 1$ °C

液柱顶端位于 20 °C 上方第一条小刻线处，得

$\theta_R = 21.0$ °C

为减小视差，读数时视线应与液柱顶端等高并垂直于刻度面。
答：室温为 21.0 °C；读数时视线应垂直于刻度面。

针对练习

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

She uses the apparatus shown in Fig. 2.1.

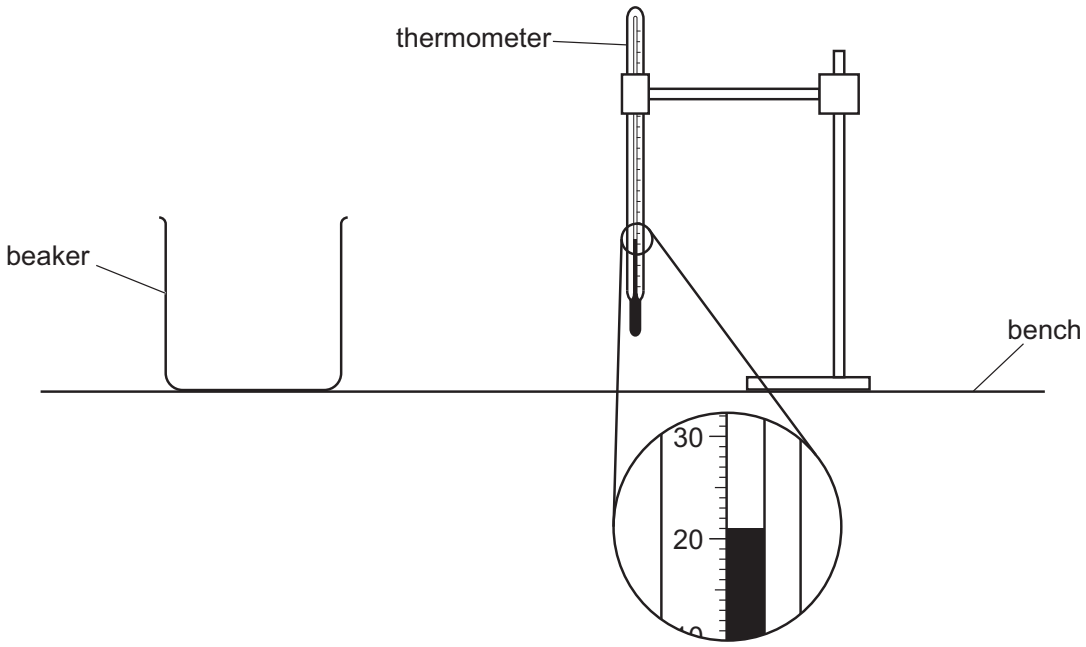


Fig. 2.1

(a) Record room temperature θ_R shown on the thermometer in Fig. 2.1.

（2025 夏季 0625/63 第2题(a)）

【答案】21 °C
【解析】由刻度标注得温度计的分度值为 1 °C。
液柱顶端位于 20 °C 上方第一条小刻线处，得
$\theta_R = 21$ °C
答：21 °C。

二. 按量程读电压和电流

知识点 模拟电表读数时，先根据接线端确定量程，再由相邻标注值之差除以其间小格数，求出_____。
指针示值等于起始标注值加上指针越过的小格数与每小格值的乘积；按最小分度记录，题目要求时读到半小格。
电压表读数的单位是_____，电流表读数的单位是_____。

答案：每小格的值；V；A

怎么认 题目出现带量程和指针位置的电压表、电流表图时，先确定每小格的值。

例题 2 A student investigates the properties of a resistance wire.

He uses the circuit shown in Fig. 3.1.

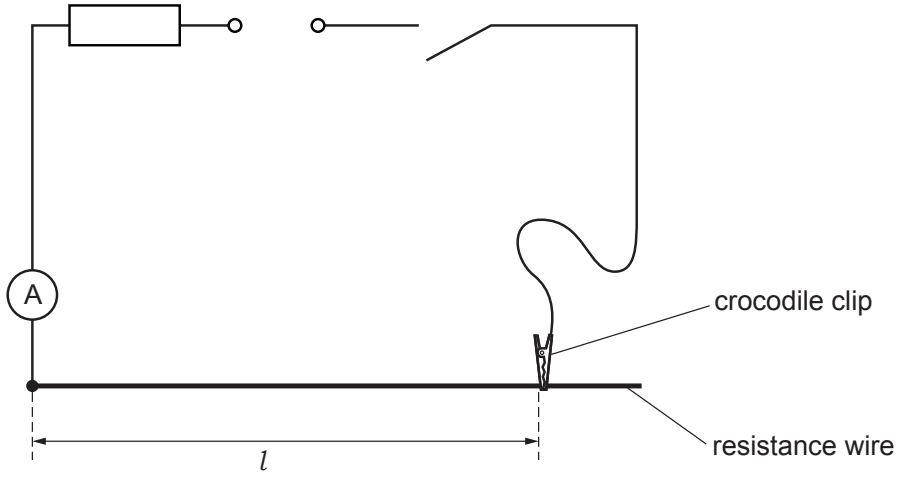


Fig. 3.1

(b) (i) The student connects the crocodile clip to a length l = 20.0 cm of the resistance wire. He measures the value of potential difference V and current I for the resistance wire.

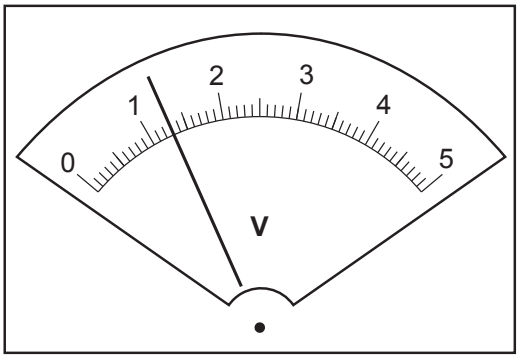


Fig. 3.2

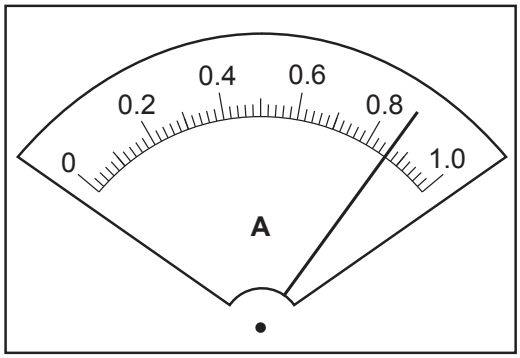


Fig. 3.3

Read, and record in the first line of Table 3.1, the values of V and I shown on the meters in Fig. 3.2 and Fig. 3.3.

The student repeats the process for lengths l = 40.0 cm, l = 60.0 cm, l = 80.0 cm and l = 100.0 cm of the resistance wire in turn.
His results are shown in Table 3.1.

Table 3.1

l/cm	V/V	I/A	R/Ω
20.0			
40.0	1.7	0.47	3.6
60.0	2.2	0.52	4.2
80.0	2.3	0.35	6.6
100.0	2.4	0.29	8.3

(ii) For length $l = 20.0\,\text{cm}$, calculate and record in Table 3.1 the resistance R of the resistance wire. Use your values of V and I from **(b)(i)** and the equation

$$\frac{V}{I}.$$

（2023 春季 0625/62 第3题(b)）

解： 电压表量程为 0 至 5 V，每相邻 1 V 间有 10 小格，

每小格 $= 1\frac{\text{V}}{10} = 0.1\ \text{V}$

$V = 1.0\ \text{V} + 3 \times 0.1\ \text{V} = 1.3\ \text{V}$

电流表量程为 0 至 1.0 A，每相邻 0.2 A 间有 10 小格，

每小格 $= 0.2\frac{\text{A}}{10} = 0.02\ \text{A}$

$I = 0.80\ \text{A} + 3 \times 0.02\ \text{A} = 0.86\ \text{A}$

由 $R = \frac{V}{I}$ 得

$R = \frac{1.3\ \text{V}}{0.86\ \text{A}} \approx 1.5\ \Omega$

答：$V = 1.3\ \text{V}$，$I = 0.86\ \text{A}$，$R = 1.5\ \Omega$。

2. A student investigates a circuit containing different combinations of resistors.

She uses **circuit A**, shown in Fig. 2.1.
Circuit A is not yet complete.

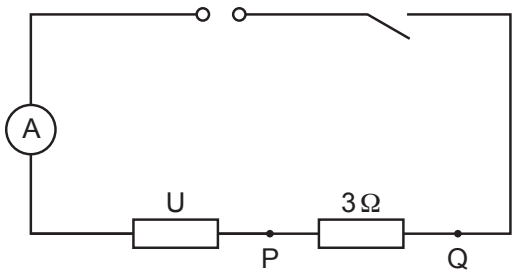


Fig. 2.1

(b) Circuit A

The student measures the potential difference (p.d.) V across resistor U and the current I in the circuit.

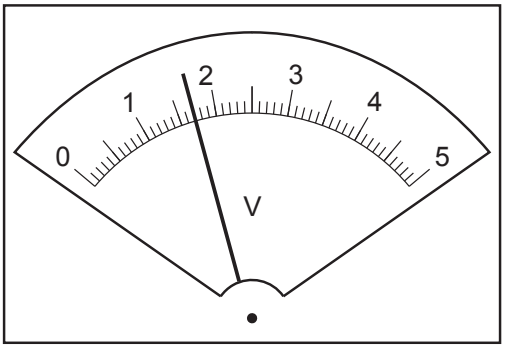


Fig. 2.2

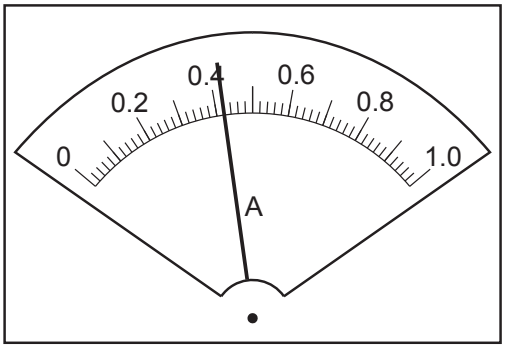


Fig. 2.3

Read, and record in Table 2.1, the values of V and I shown on the meters in Fig. 2.2 and Fig. 2.3.

Table 2.1

circuit	V/V	I/A	R/Ω
A			
B	2.1	0.54	
C	2.4	0.63	

（2023 夏季 0625/63 第2题(b)）

【答案】$V = 1.7$ V；$I = 0.42$ A
【解析】电压表每小格为 0.1 V，指针位于 1.7 V；电流表每小格为 0.02 A，指针位于 0.42 A。
答：$V = 1.7$ V，$I = 0.42$ A。

3. In this experiment, you will investigate the resistance of a light-emitting diode (LED) when the current in it changes.

The supervisor has set up the circuit as shown in Fig. 2.1.

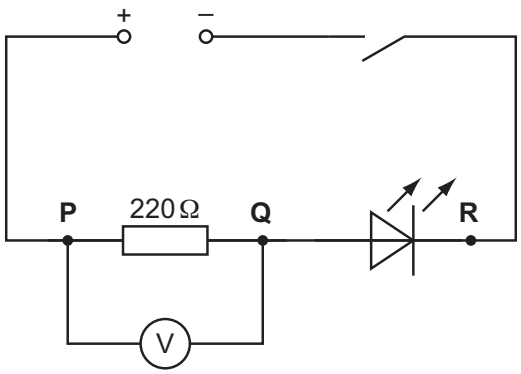


Fig. 2.1

(b)
- Disconnect the voltmeter from points P and Q.
- Reconnect the voltmeter across the LED between points Q and R.
- Ensure that the positive terminal of the voltmeter is connected to Q.
- Close the switch.

Record the voltmeter reading V_{QR} in the top row of Table 2.1.

- Open the switch.

（2024 冬季 0625/52 第2题(b)）

【答案】实测 V_{QR}，精确到至少 0.1 V
【解析】电压表接在 Q、R 两点间，闭合开关后读取示数。
答：记录实测 V_{QR}，精确到至少 0.1 V。

4. In this experiment, you will investigate the resistances of identical wires connected in parallel.

A circuit has been set up for you. Resistor R_P must remain in place throughout the experiment.

Refer to Fig. 2.1.

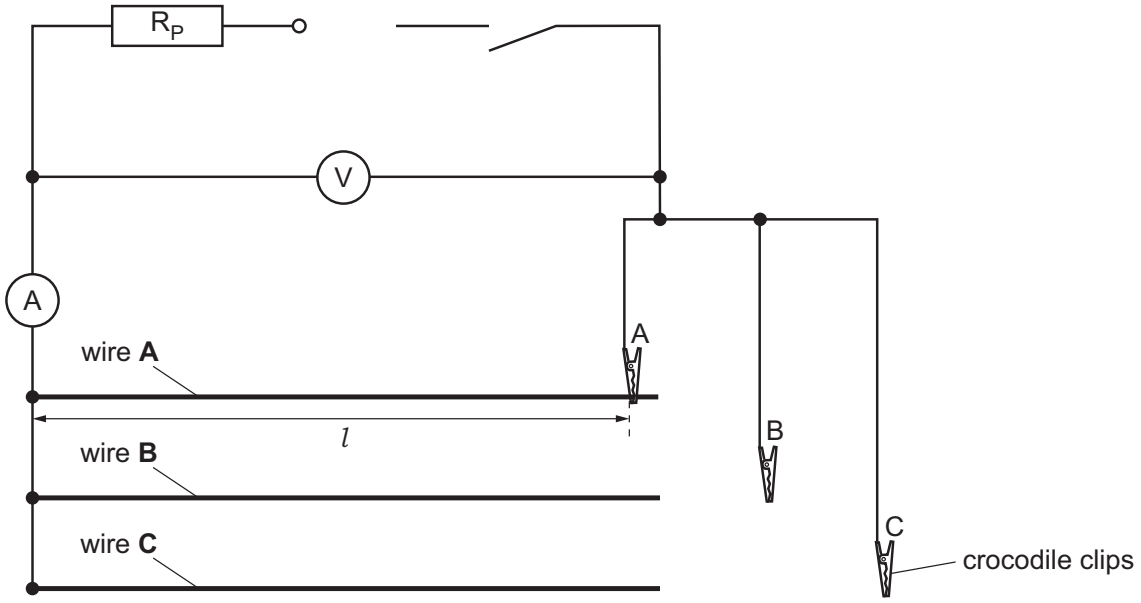


Fig. 2.1

Circuit A

Move crocodile clip A to a length l = 95.0 cm of resistance wire A.

(a) Close the switch.

Measure, and record in Table 2.1, the values of potential difference (p.d.) V across the resistance wire and current I in the circuit.

Open the switch.

Table 2.1

circuit	V/V	I/A	R/Ω
A			
B			
C			

Circuit B

Do **not** disconnect crocodile clip A.

Connect crocodile clip B to a length l = 95.0 cm of resistance wire B.
It does not matter if crocodile clip A and crocodile clip B touch.
Wire A and wire B are now connected in parallel.

（2025 冬季 0625/53 第2题(a)）

【答案】符合 $V < 3.0$ V、$I < 1.00$ A 的实测值
【解析】闭合开关，分别读取电压表和电流表示数并记入表格。
答：记录符合 $V < 3.0$ V、$I < 1.00$ A 的实测值。

5. In this experiment, you will investigate the resistance of a resistance wire.

Carry out the following instructions, referring to Fig. 2.1.

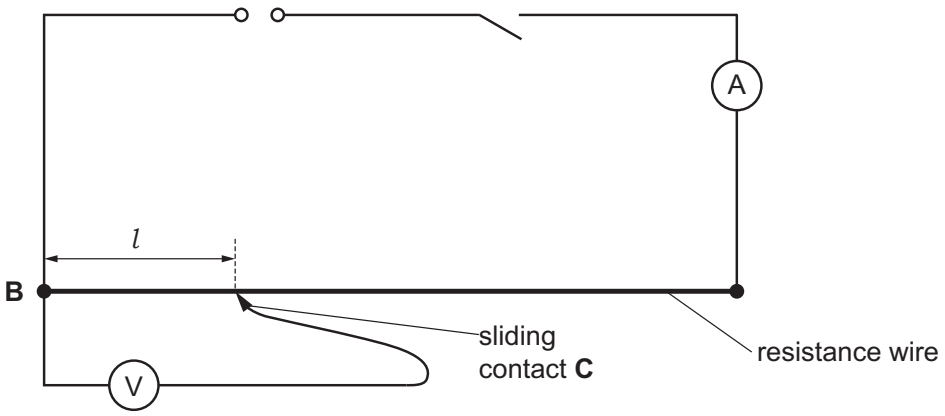


Fig. 2.1

(a) (i) Close the switch.

Measure the current I in the circuit.

(ii) Place the sliding contact **C** at a distance l = 20.0 cm from **B**.

Measure, and record in Table 2.1, the potential difference (p.d.) V across length l of the resistance wire.

Calculate, and record in Table 2.1, the resistance R of 20.0 cm of the resistance wire. Use the equation $R = \frac{V}{I}$.

Repeat the procedure using l = 60.0 cm and l = 100.0 cm.

Open the switch.

(iii) Calculate, and record in Table 2.1, $\frac{R}{l}$ for each value of l.

(iv) Complete the column headings in Table 2.1.

Table 2.1

l/	*V*/	*R*/	$\frac{R}{l}$ /
20.0			
60.0			
100.0			

（2023 冬季 0625/51 第2题(a)）

【答案】$I < 2$ A，至少保留两位小数，单位 A；V 至少保留一位小数并随 l 增大；$R = \frac{V}{I}$；$\frac{R}{l}$；cm，V，Ω，Ω/cm
【解析】电流表读数记为 I；各长度下电压表读数记为 V，且 V 随 l 增大。

$R = \frac{V}{I}$

$\frac{R}{l} = \frac{V}{Il}$

答：表头单位依次为 cm、V、Ω、Ω/cm。

三. 测力计、天平或秒表读数

知识点 仪器读数是按仪器精度记录示值；读数前应检查零点和_____，若有零误差，应作相应修正。模拟仪器按刻度读取，题目要求时读至最小分度的一半；数字仪器记录屏幕显示的_____。测量结果应按仪器精度记录，并写明_____。

答案：分度值；全部位数；单位

怎么认 题目出现测力计、天平或秒表的示数时，先检查零点和分度值。

例题 3

A student determines the density of modelling clay by two methods.

Method 1

He uses the block of modelling clay shown in Fig. 1.1.

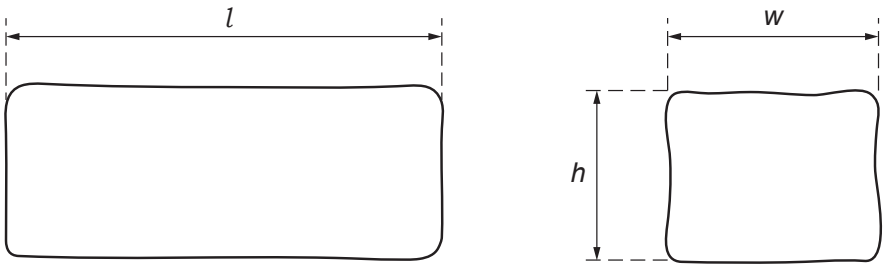


Fig. 1.1

Method 2

(d) The student then uses a smaller block of modelling clay.

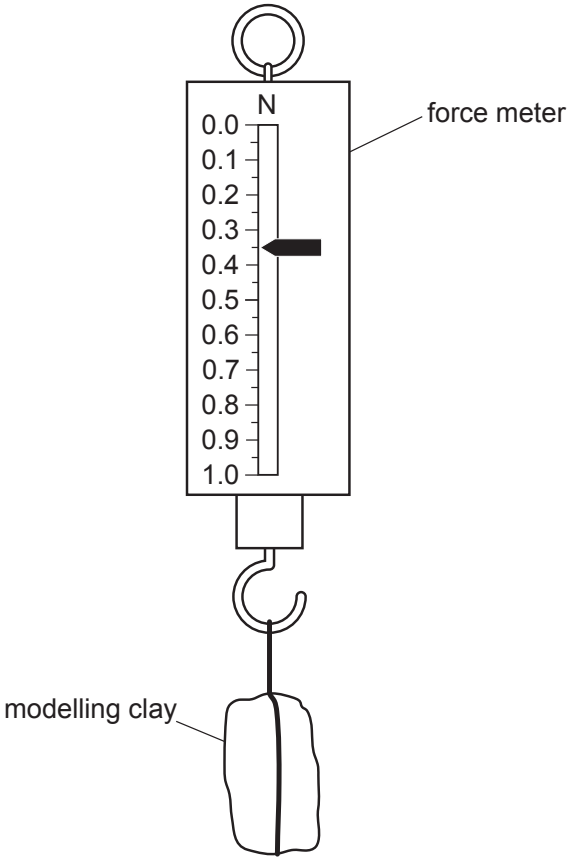


Fig. 1.3

Record the weight W_B of the block of modelling clay shown in Fig. 1.3.

（2024 夏季 0625/63 第1题(d)）

解：相邻标数相差 0.1 N，指针位于 0.3 N 与 0.4 N 的中点，

$W_B = 0.35$ N。

答：0.35 N。

针对练习

6. A student uses a stop-watch to measure the time for one complete oscillation of a pendulum.

Fig. 2.1 shows his measurement.



Fig. 2.1

(a) State the time taken for **one** complete oscillation. Use the information in Fig. 2.1.

（2025 夏季 0625/31 第2题(a)）

【答案】0.83 s

【解析】显示屏中分钟位和整秒位均为 0，百分之一秒位显示 83，

$t = 0.83$ s。

答：0.83 s。

7. A student determines the density of a ball.

(c) The student measures the mass m_D of a dish.

m_D = ... 102.5 ..... g

He places the ball in the dish and measures the combined mass m_C of the dish and the ball.

Fig. 1.2 shows the dish and the ball on a balance.

Record the reading shown on the balance.

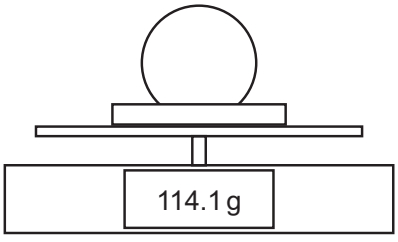


Fig. 1.2

Calculate the mass m_B of the ball. Show your working.

（2025 夏季 0625/61 第1题(c)）

【答案】11.6 g

【解析】由总质量等于碟子与球的质量之和得

$m_B = m_C - m_D$

$= 114.1\ \text{g} - 102.5\ \text{g}$

$= 11.6\ \text{g}$。
答：$11.6\ \text{g}$。

四. 量筒读体积或液面

知识点 量筒的分度值是相邻刻度线所表示体积之差；液面位于两线之间时，按要求读至半个分度。
读水的体积时，视线应与液面_____，并与量筒轴线_____；水形成凹液面，应按凹液面_____对应的刻度读数。
用排水法测物体体积时，物体体积 $V = V_2 - V_1$，其中 V_1、V_2 分别为浸入前后的量筒读数；体积单位常用 cm^3 或 mL，$1\text{cm}^3 = 1\ \text{mL}$。

答案：同高；垂直；最低点

怎么认 题目出现量筒刻度、凹液面或浸入物体前后两次读数时，先使视线与液面同高，再按最低点读数或作 $V_2 - V_1$。

例题 4 A student investigates the cooling of water.

Fig. 2.1 shows the set-up.

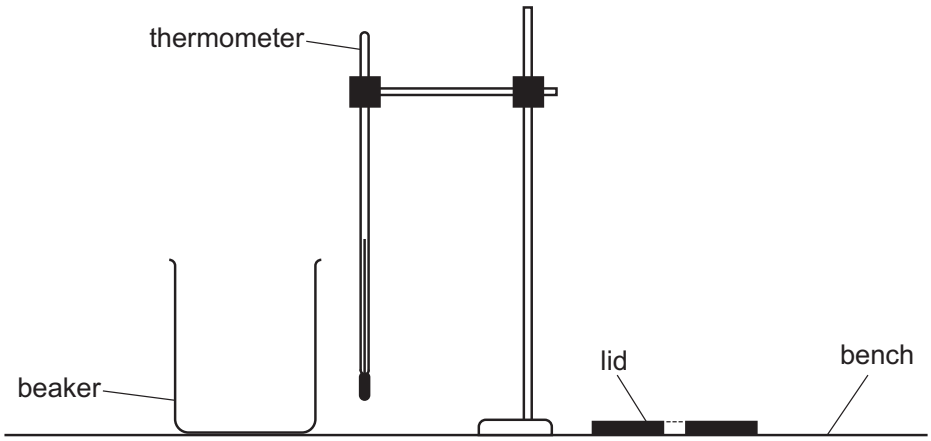


Fig. 2.1

(f) The student uses a measuring cylinder to measure 200 cm^3 of water. He takes the reading from the bottom of the meniscus.

Explain the reason for taking the reading at the bottom of the meniscus rather than at the top of the meniscus.

（2023 夏季 0625/62 第2题(f)）

解： 量筒中水的液面为凹液面，最低点与最高点之间所含水的体积很小，可忽略不计。
答：最低点与最高点之间的水量很小，取最低点读数不会造成明显差异。

8. A student determines the volume of a block of modelling clay by two methods.

Method 1

He measures the block of modelling clay shown full size in Fig. 1.1.

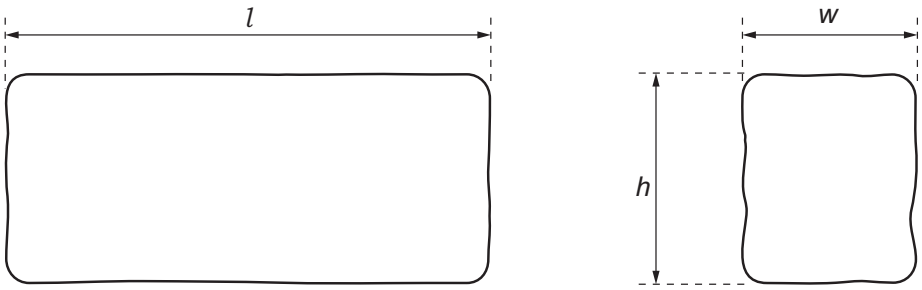


Fig. 1.1

Method 2

(d) (i) The student pours water into a measuring cylinder.

Record the volume V_1 of the water in the measuring cylinder shown in Fig. 1.2.

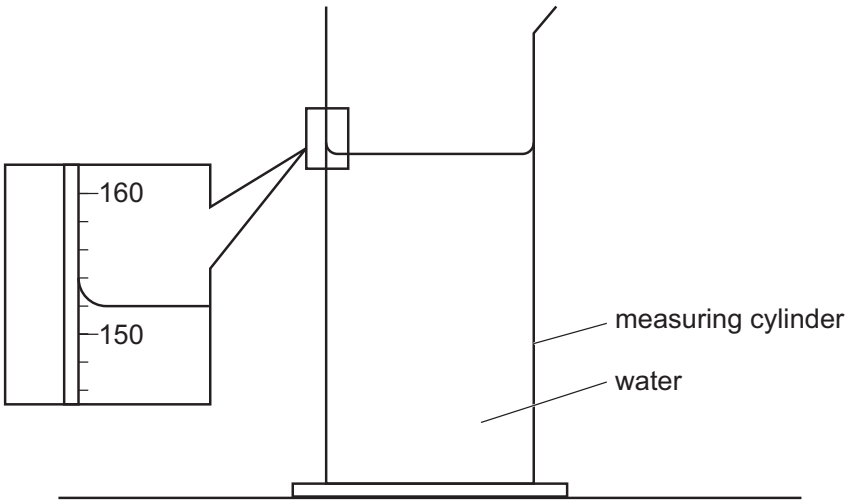


Fig. 1.2

(ii) Describe briefly how a measuring cylinder is read to obtain an accurate value for the volume of water.

（2025 冬季 0625/63 第1题(d)）

【答案】(i) 152cm^3；(ii) 视线与液面同高，并与量筒轴线垂直。
【解析】按图中分度，凹液面最低点对应 152 刻度，故
$V_1 = 152\text{cm}^3$
读数时，视线与液面同高，并与量筒轴线垂直。
答：(i) 152cm^3；(ii) 视线与液面同高，并与量筒轴线垂直。

9. A student determines the density of modelling clay by two methods.

Method 1

He uses the block of modelling clay shown in Fig. 1.1.

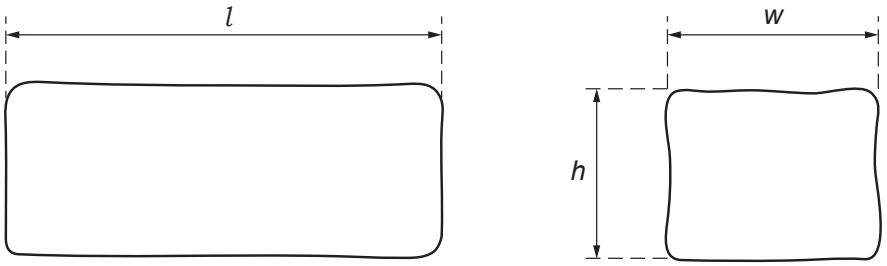


Fig. 1.1

(e) (i) The student pours water into a measuring cylinder.

Record the volume V_1 of the water in the measuring cylinder shown in Fig. 1.4.

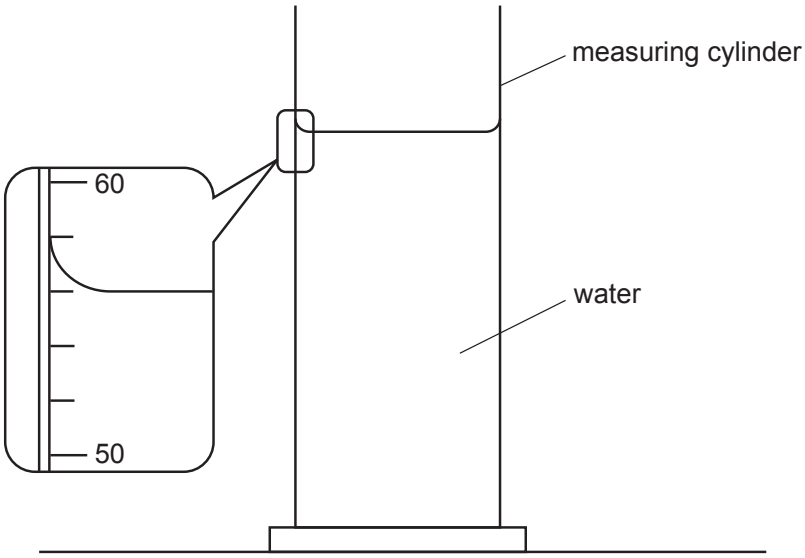


Fig. 1.4

(ii) Describe briefly how a measuring cylinder is read to obtain a value for the volume of water.

（2024 夏季 0625/63 第1题(e)）

【答案】(i) 56cm^3；(ii) 视线与液面同高，并与量筒轴线垂直。
【解析】按图中分度，凹液面最低点对应 56 刻度，故
$V_1 = 56\text{cm}^3$
读数时，视线与液面同高，并与量筒轴线垂直。
答：(i) 56cm^3；(ii) 视线与液面同高，并与量筒轴线垂直。

题型 2：用尺与量角器测量（考频★★★★☆）

知识点 直尺上两点间的距离等于较大刻度值与较小刻度值之_____，两点可以是物体的端点或中心。

对称物体的中心被遮挡时，中心位置等于左右边缘所对刻度值的_____，两边缘必须关于中心对称。

读数应按最小分度值记录；题目要求时，读到最小分度值的_____，长度单位常用 cm 或 mm。

答案：差；平均值；一半

怎么认 题目出现直尺刻度、物体端点或中心及所求距离时，先读出相应刻度，再作差或求平均值。

一. 两刻度作差或读位置

例题 1 In this experiment, you will investigate the balancing of a metre ruler.

Refer to Fig. 1.1.

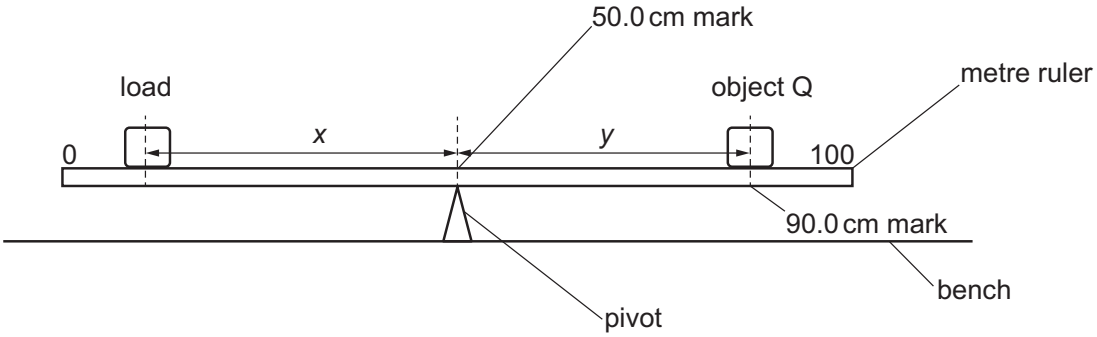


Fig. 1.1

(a)
- Place the metre ruler on the pivot at the 50.0 cm mark.
- Place the object Q with its centre on the metre ruler at the 90.0 cm mark.

Determine the distance *y* from the 50.0 cm mark to the centre of the object Q.

（2025 冬季 0625/51 第1题(a)）

解： 由两刻度作差得

$y = 90.0\ \text{cm} - 50.0\ \text{cm} = 40.0\ \text{cm}$

答：$y = 40.0\ \text{cm}$。

针对练习

1. A student determines the mass M_R of a metre ruler by a balancing method.

He uses the apparatus shown in Fig. 1.1.

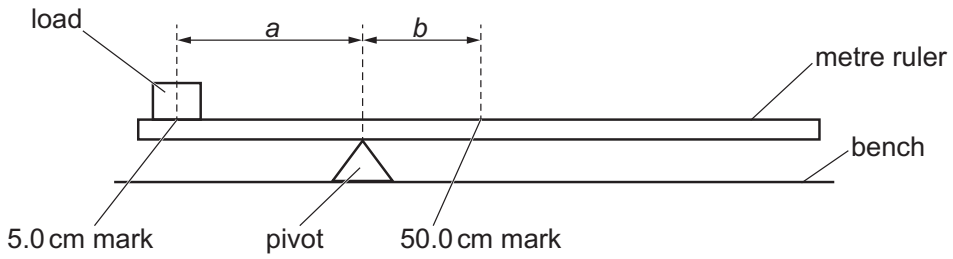


Fig. 1.1

(a) The student places a circular load of mass M = 20 g on the metre ruler but in a position different from that shown in Fig. 1.1.

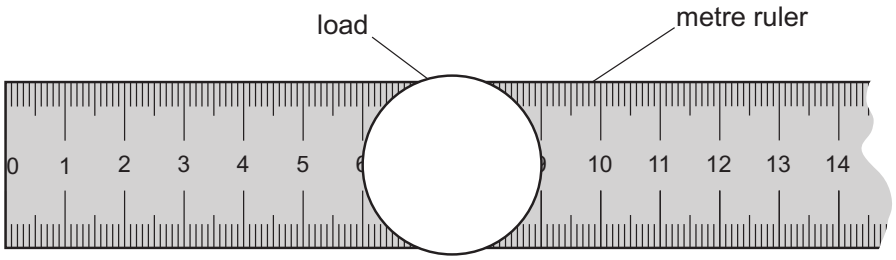


Fig. 1.2 (not to scale)

Determine the distance d_0 of the centre of the load from the zero end of the ruler, as shown in Fig. 1.2. Fig. 1.2 is **not** to scale.

（2023 夏季 0625/63 第1题(a)）

【答案】7.5 cm

【解析】载荷左右边缘所对刻度分别为 6.0 cm 和 9.0 cm。

$d_0 = \frac{6.0\ \text{cm} + 9.0\ \text{cm}}{2} = 7.5\ \text{cm}$

答：$d_0 = 7.5\ \text{cm}$。

2. A student determines the mass of a metre ruler by a balancing method.

He is using the apparatus shown in Fig. 1.1.

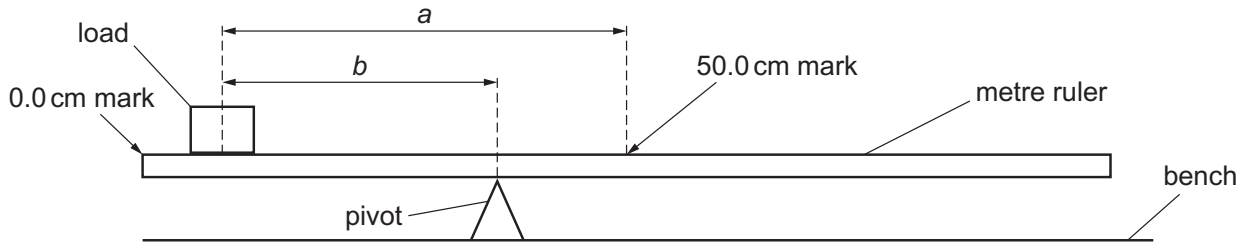


Fig. 1.1

(a) The student places a circular load on the metre ruler shown in Fig. 1.2.

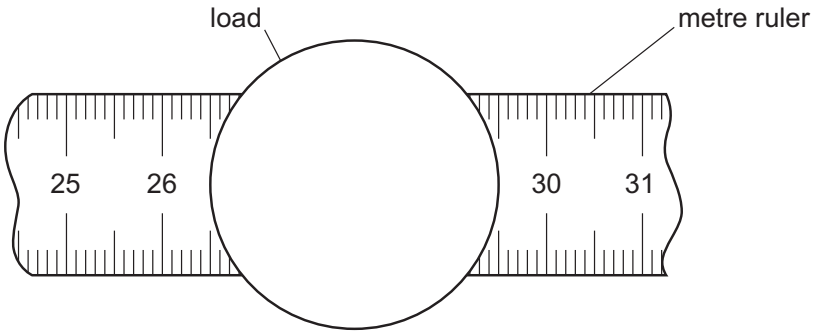


Fig. 1.2 (not to scale)

Determine the distance *d* of the centre of the load from the zero end of the ruler, as shown in Fig. 1.2. Fig. 1.2 is **not** to scale.

（2024 春季 0625/62 第1题(a)）

【答案】28.0 cm

【解析】载荷左右边缘所对刻度分别为 26.5 cm 和 29.5 cm。

$d = \frac{26.5\ \text{cm} + 29.5\ \text{cm}}{2} = 28.0\ \text{cm}$

答：$d = 28.0\ \text{cm}$。

3. A student investigates the balancing of a metre ruler.

Fig. 1.1 shows the apparatus.

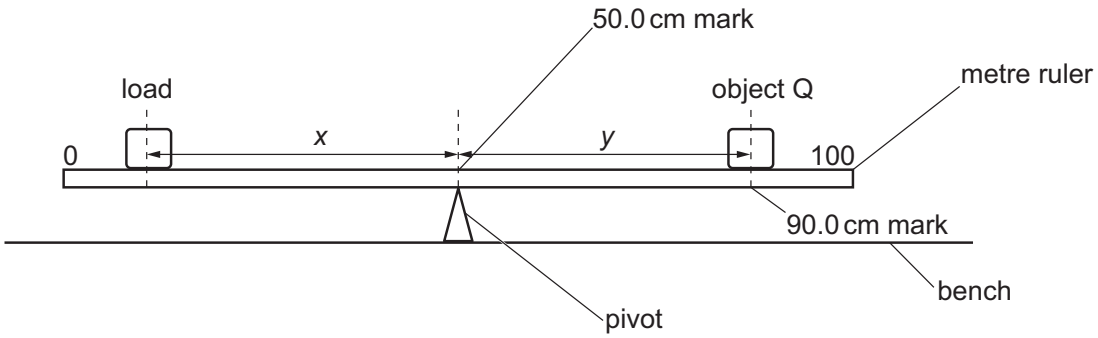


Fig. 1.1

(f)

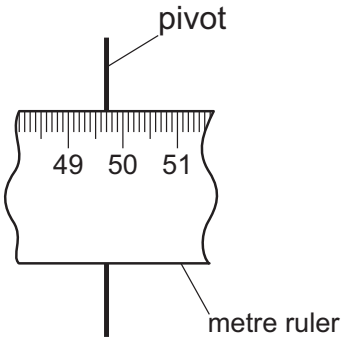


Fig. 1.2

Fig. 1.2 shows the metre ruler balanced on the pivot with no loads. The balance point shows the position of the centre of mass of the metre ruler.

Determine the distance d between the 50.0 cm mark on the metre ruler and the centre of mass.

Show your working.

（2025 冬季 0625/61 第1题(f)）

【答案】0.3 cm

【解析】支点中心所对刻度为 49.7 cm。

$d = 50.0\ \text{cm} - 49.7\ \text{cm} = 0.3\ \text{cm}$

答：$d = 0.3$ cm。

二. 量尺寸或按比例换算

知识点　直尺刻度边应沿_____放置，分别读出两端刻度，图上长度等于_____。

读数应按题目要求记录到规定精度；精确到 1 mm 时，以 cm 为单位应保留一位小数。

若图按 1 : n 缩小绘制，则实际长度等于图上长度的_____倍；结果必须带长度单位。

答案：被测方向；末端读数减去始端读数；n

怎么认 题目出现测量要求及尺寸线、实物图或比例尺时，先把直尺沿被测方向放置并读数。

例题 2 A student investigates the magnification of the image produced by a lens.

Fig. 3.1 shows the set-up.

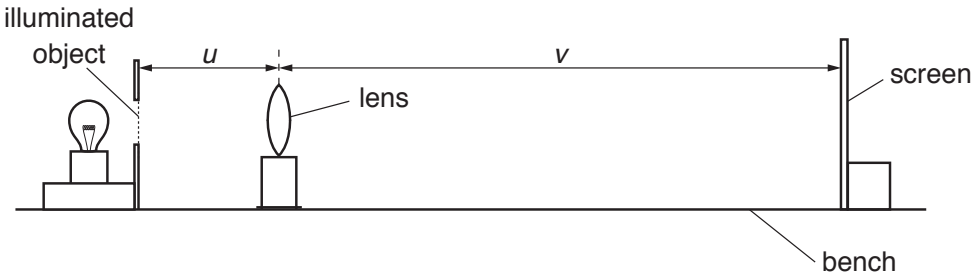


Fig. 3.1

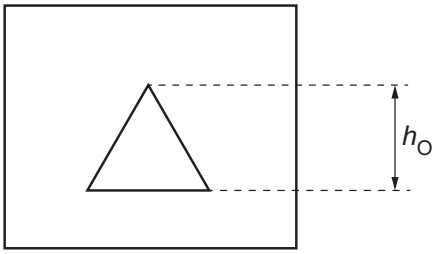


Fig. 3.2

(a) On Fig. 3.2, measure the height h_O of the illuminated object.

（2023 冬季 0625/61 第3题(a)）

解：将直尺沿图中 h_O 标出的竖直方向放置，测量三角形顶点与底边之间的距离，得 $h_O = 1.5\ \text{cm}$。

答：$h_O = 1.5\ \text{cm}$。

针对练习

4. A student investigates the image formed by a converging lens.

The apparatus is set up as shown in Fig. 3.1.

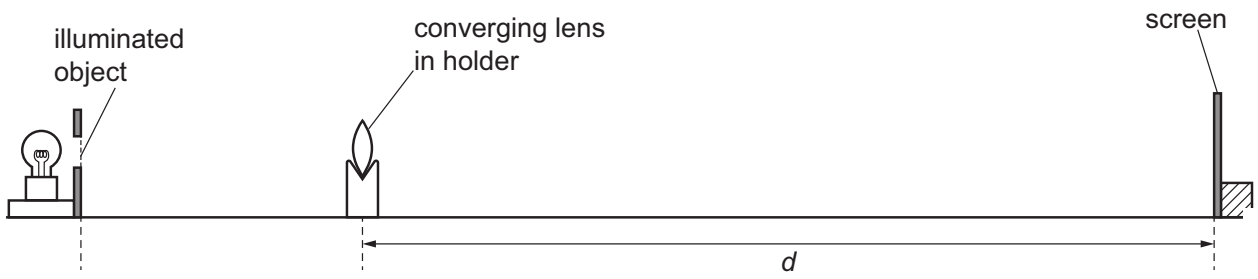


Fig. 3.1

(a) (i) The student:

- switches on the lamp
- places the lens a distance u = 20.0 cm from the illuminated object (a triangular hole in the card)
- adjusts the position of the screen until a sharp image of the illuminated object is formed on the screen.

Measure on Fig. 3.1, to the nearest 0.1 cm, the image distance d from the centre of the lens to the screen.

(ii) Fig. 3.1 is drawn to a scale of one-fifth $\left(\frac{1}{5}\right)$ full size.

Calculate the actual image distance v from the lens and record your value in Table 3.1.

Table 3.1

object distance u / cm	image distance v / cm
20.0	
25.0	37.2
35.0	26.5
45.0	22.7
55.0	20.9
60.0	20.2

（2024 冬季 0625/62 第3题(a)）

【答案】$d = 12.1\ \text{cm}$；$v = 60.5\ \text{cm}$

【解析】沿透镜中心到光屏的方向测量图上距离，得

$d = 12.1\ \text{cm}$。

图按 1 : 5 缩小绘制，故

$v = 5d = 5 \times 12.1\ \text{cm} = 60.5\ \text{cm}$。

答：$d = 12.1\ \text{cm}$，$v = 60.5\ \text{cm}$。

三. 对焦后量像距或像高

知识点 会聚透镜在光屏上形成清晰实像时，物体、透镜和光屏的中心应位于同一高度。

对焦时缓慢前后移动光屏，以像最_____的位置作为测量位置。

像距 v 从透镜中心量至光屏；题目要求估读时，读到最小分度的_____，长度单位通常为 cm。

物高与像高采用相同单位时，放大率 $M = \frac{h_I}{h_O}$，放大率_____单位。

答案：清晰；一半；没有

怎么认 题目出现会聚透镜、光屏和清晰像时，先缓慢调焦，再从透镜中心测量。

例题 3 A student investigates the image produced by a converging lens.

He uses the equipment shown in Fig. 3.1.

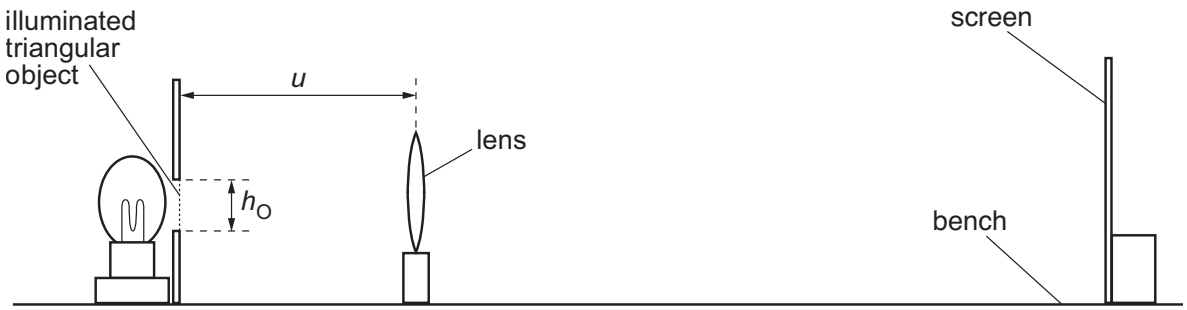


Fig. 3.1 (not to scale)

(b) (i) The screen is shown full size in Fig. 3.2.
Measure, and record in the first line of Table 3.1, the height h_I of the image on the screen, as shown in Fig. 3.2.

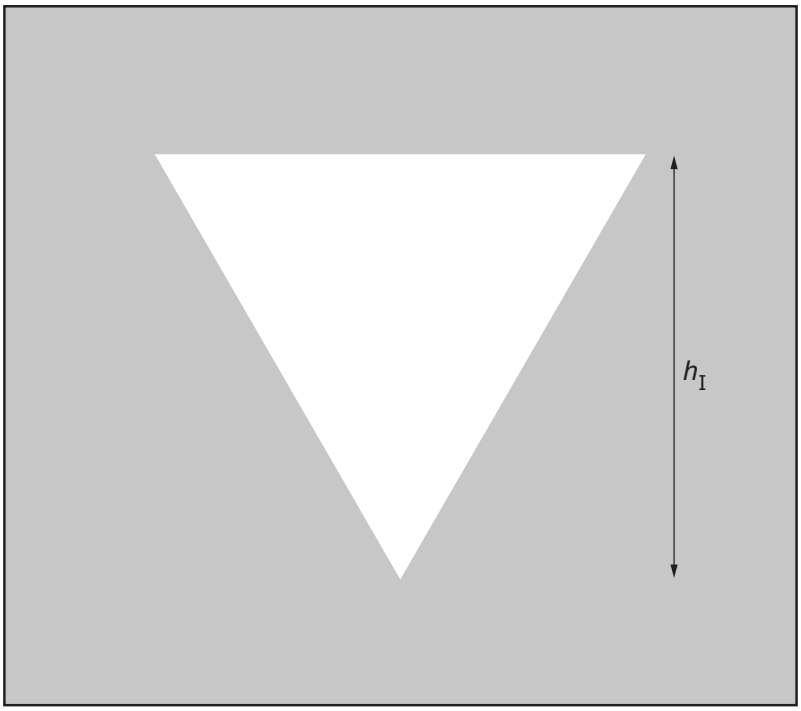


Fig. 3.2

Table 3.1

u/cm	h_I/cm	$D / \frac{1}{\text{cm}}$
20.0		
25.0	2.8	0.36
30.0	2.0	0.50
35.0	1.6	0.63
40.0	1.2	0.83

(ii) For distance u = 20.0 cm, calculate, and record in Table 3.1, a value D. Use your value of h_I from Table 3.1 and the equation:

$$D = \frac{1}{h}$$

（2025 冬季 0625/63 第3题(b)）

解： 由图量得

$h_I = 6.0\ \text{cm}$

由 $D = \frac{1}{h_I}$ 得

$D = \frac{1}{6.0}\ \text{cm} = 0.17\text{cm}^{-1}$

答：$h_I = 6.0\ \text{cm}$，$D = 0.17\text{cm}^{-1}$。

针对练习

5. A student investigates the image formed by a converging lens.

Refer to Fig. 3.1.

(a) The student:

- switches on the lamp
- places the screen a distance D = 80.0 cm from the illuminated object (a triangular hole in a piece of card)
- places the lens close to the illuminated object
- moves the lens away from the illuminated object until a magnified, inverted, sharp image of the illuminated object is formed on the screen.

Fig. 3.1 shows the position of the lens when the image is sharp.

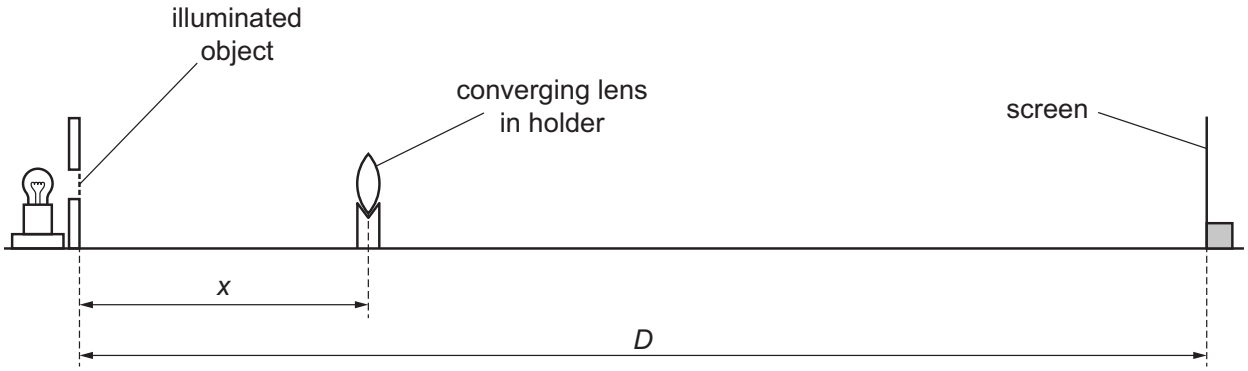


Fig. 3.1

(i) On Fig. 3.1, measure, to the nearest 0.1 cm, the object distance x from the centre of the lens to the illuminated object.

(ii) Fig. 3.1 is drawn to a scale of one-fifth full size.

Calculate the actual object distance X.

（2025 夏季 0625/62 第3题(a)）

【答案】$x = 4.1$ cm；$X = 20.5$ cm

【解析】从透镜中心量至发光物体，得

$x = 4.1$ cm

图的比例为实物的五分之一，故

$X = 5x$

$X = 5 \times 4.1\ \text{cm} = 20.5\ \text{cm}$

答：$x = 4.1$ cm，$X = 20.5$ cm。

四. 连接针迹再量角或线段

知识点 法线是过入射点且与界面_____的直线。

连接相应针孔时，直尺边缘应同时通过两点，并将直线延长到指定界面或法线。

量角器中心与两线交点重合，0° 刻线与_____重合，读取另一条线对应的刻度。

角度单位为_____；要求锐角时，应满足 $0° < \theta < 90°$。

答案：垂直；作为基准的直线；度

怎么认 题目出现针孔、界面和法线并要求连线量角时，先连接针孔并延长，再以法线为基准量锐角。

例题 4 A student investigates the refraction of light by a transparent block.

The student's ray-trace sheet is shown full-size in Fig. 3.1.

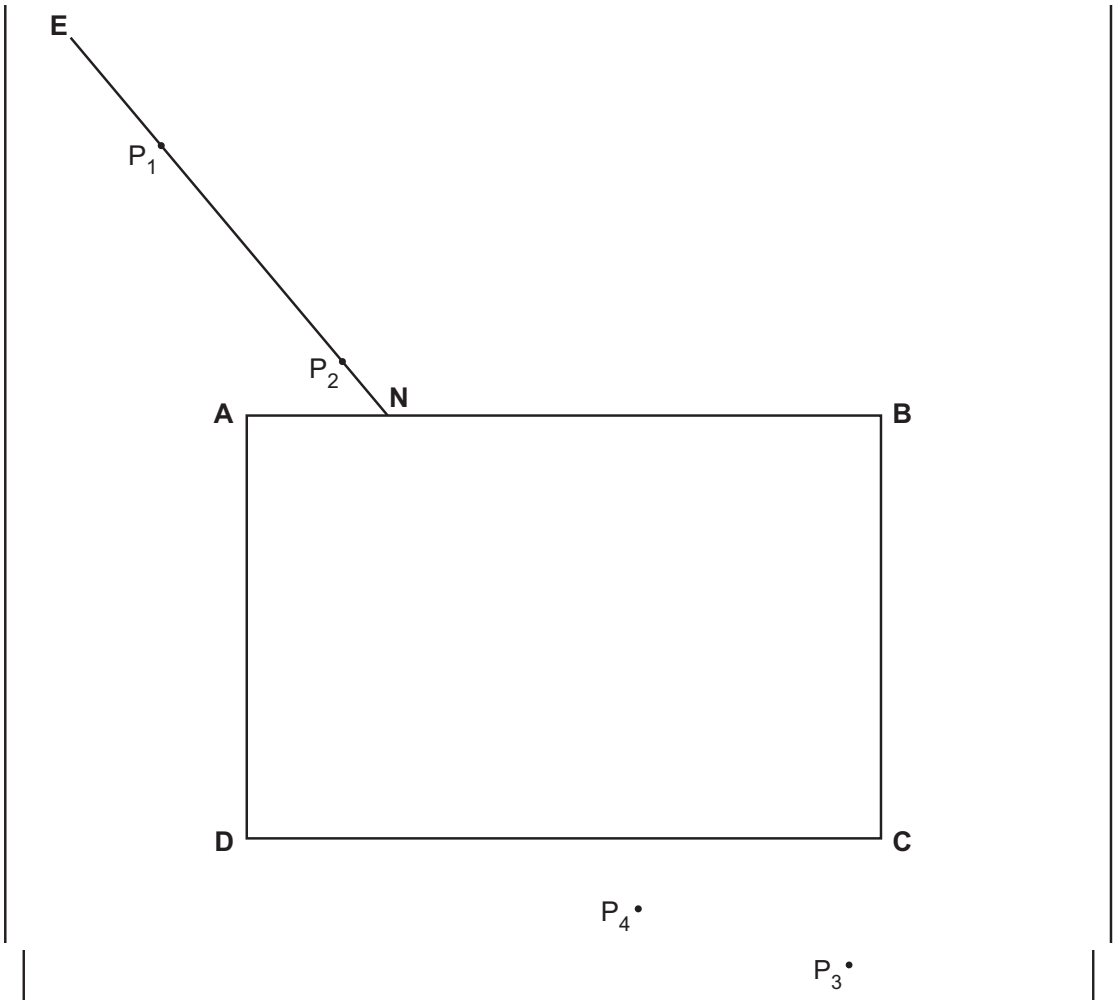


Fig. 3.1

(a) The student places a transparent block **ABCD** near the centre of the ray-trace sheet as indicated in Fig. 3.1.

(i) Draw a normal to point **N**, extending above **AB**. Label the upper end of the normal with the letter **L**.

(ii) The student draws line **EN** as shown in Fig. 3.1.
On Fig. 3.1, measure the acute angle θ between the lines **LN** and **EN**.
An acute angle is an angle of less than 90°.

（2025 春季 0625/62 第3题(a)）

解： 过 N 作 AB 的垂线并向上延长，在上端标 L。
量角器中心与 N 重合，0° 刻线沿 LN，读取 EN 对应的锐角，得
$\theta = 40°$
答：法线为 LN，$\theta = 40°$。

题型 3：取得成组数据（考频★★★★☆）

知识点 等时记录温度序列，是在同一冷却过程中按相等的时间间隔读取并记录温度，相邻读数的 Δt 相同。

若题目规定初温，应先使水温达到该值；在 $t = 0$ s 读初温并_____启动计时器。

以后每到规定时刻立即读数并依次填表，时间单位为 s，温度单位为 °C。

冷却过程中，温度应随时间_____；各次读数采用相同精度，记录到 1 °C 或更高精度。

答案：立即；降低

怎么认 题目出现温度计、计时器及每隔固定时间记录温度时，先在 $t = 0$ s 读初温并启动计时器。

一. 等时记录温度序列

例题 1 In this experiment, you will investigate the cooling of hot water from different initial temperatures.

Carry out the following instructions, referring to Fig. 2.1.

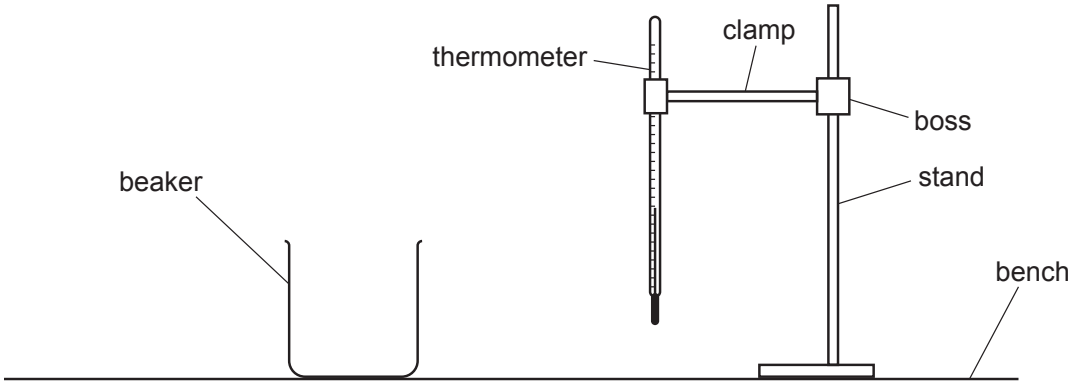


Fig. 2.1

(a) Experiment A

Pour 100 cm^3 of hot water into the beaker.

Place the thermometer in the water in the beaker.

In the first row of Table 2.1, record the temperature θ_A of the water at time t = 0 s and immediately start the stop-watch.

Record, in Table 2.1, the temperature θ_A of the water at times t = 30 s, t = 60 s, t = 9 t = 120 s, t = 150 s and t = 180 s.

Empty the beaker.

（2023 春季 0625/52 第2题(a)）

解： 在 $t = 0$ s 读取 θ_A，并立即启动计时器。

由相邻时刻均相差 30 s，依次在 $t = 30$ s, 60 s, 90 s, 120 s, 150 s, 180 s 时记录温度。

由热水持续冷却，表中 θ_A 随 t 增大而减小，各温度记录到 1 °C 或更高精度。

答：得到一组时间间隔为 30 s 的递减温度序列。

针对练习

1. In this experiment, you will investigate the cooling of hot water in a beaker.

Refer to Fig. 2.1.

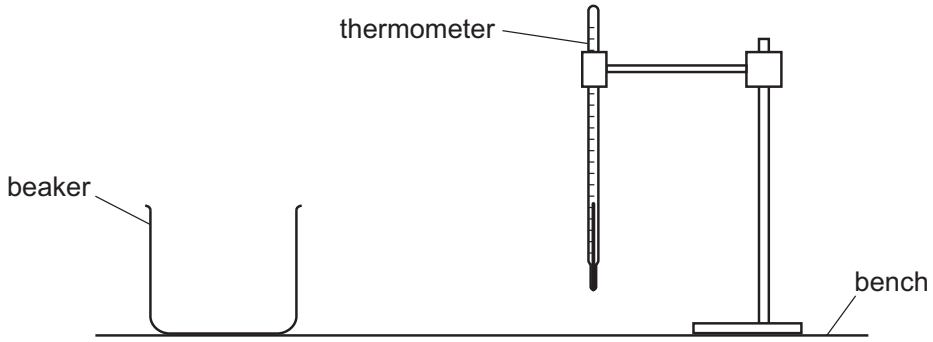


Fig. 2.1

(b) Pour 200 cm^3 of hot water into the beaker.
Place the thermometer into the water in the beaker.

In the first row of Table 2.1, record the temperature θ of the water at time t = 0 and immediately start the stop-watch.

Record, in Table 2.1, the temperature θ of the water every 30 s until t = 270 s.

Table 2.1

t/s	θ/°C
0	
30	
60	
90	
120	
150	
180	
210	
240	
270	

（2025 夏季 0625/53 第2题(b)）

【答案】θ 随 t 增大而减小，各温度记录到 1 °C 或更高精度。
【解析】在 $t=0$ s 读取 θ，并立即启动计时器。
由记录间隔为 30 s，依次在 $t=30$ s, 60 s, 90 s, 120 s, 150 s, 180 s, 210 s, 240 s, 270 s 时读数。
由热水持续冷却，θ 随 t 增大而减小，各温度记录到 1 °C 或更高精度。
答：得到十组等时记录的递减温度数据。

2. In this experiment, you will investigate the cooling of hot water.

Complete the following instructions, referring to Fig. 3.1.

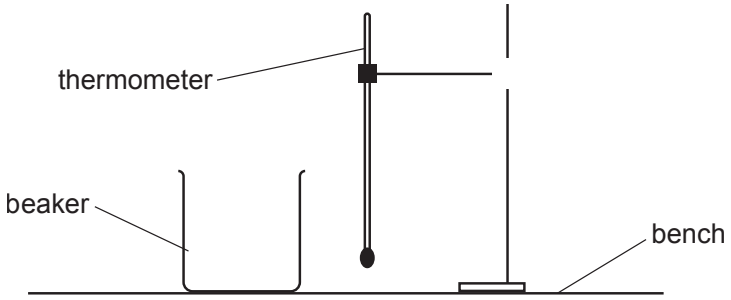


Fig. 3.1

(b) (i) Pour 200 cm^3 of hot water into the beaker. Place the thermometer in the water in the beaker.

Record in Table 3.1 the temperature θ of the hot water at time t = 0. Immediately start the stop-watch.

Continue recording the temperature and the time in Table 3.1 at 30 s intervals until have seven sets of readings.

(ii) Complete the column headings in Table 3.1.

Table 3.1

t/	*θ*/

（2023 冬季 0625/52 第3题(b)）

【答案】$t=0$ s, 30 s, 60 s, 90 s, 120 s, 150 s, 180 s；温度依次降低；s，℃

【解析】由首个时刻为 0 s，以后每隔 30 s 记录一次，共记录七组，得 $t=$ 0 s, 30 s, 60 s, 90 s, 120 s, 150 s, 180 s。

由热水持续冷却，温度读数依次降低。

时间列记录 t，单位为 s；温度列记录 θ，单位为 ℃。

答：表头单位为 s、℃，七组时刻如上。

3. In this experiment, you will investigate the cooling of water in different sized beakers.

Refer to Fig. 1.1.

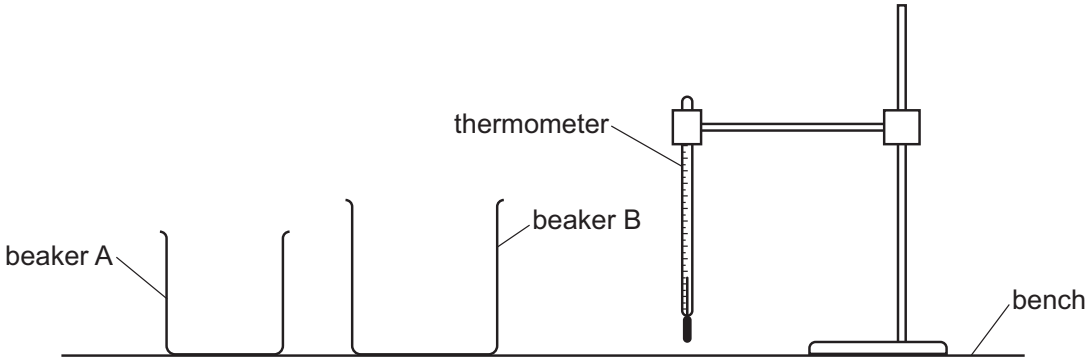


Fig. 1.1

(a) (i) Pour an estimated 75 cm^3 of hot water into beaker A. Use the markings on the beaker as a guide.
Place the thermometer in the water in beaker A.

Record, in the first row of Table 1.1, the temperature θ of the water at time t = 0 and immediately start the stop-watch.
Record the temperature θ of the water at times t = 30 s, t = 60 s, t = 90 s, t = 120 s, t = 150 s and t = 180 s.

Remove the thermometer from the beaker.

(ii) Repeat the procedure in **(a)(i)** for beaker B.

(iii) Suggest **one** possible source of inaccuracy in the procedure, even if it is carried out carefully.

（2024 冬季 0625/53 第1题(a)）

【答案】(i) 烧杯 A 中温度依次降低，记录到 1 °C 或更高精度；(ii) 烧杯 B 中温度依次降低，且比烧杯 A 降低得更快；(iii) 烧杯刻度间隔较大，估计 75cm^3 的体积不准确。

【解析】两次实验均在 $t = 0$ s 读温度并启动计时器，随后在 $t = 30\ \text{s}, 60\ \text{s}, 90\ \text{s}, 120\ \text{s}, 150\ \text{s}, 180\ \text{s}$ 时读数。

由热水持续冷却，烧杯 A、B 中的温度均依次降低，烧杯 B 中的温度降低得更快。

烧杯刻度间隔较大，75cm^3 的水量由烧杯刻度估计，所得体积不准确。

答：(i)、(ii)、(iii) 如上。

4. In this experiment, you will investigate the cooling of hot water in a beaker. Refer to Fig. 2.1.

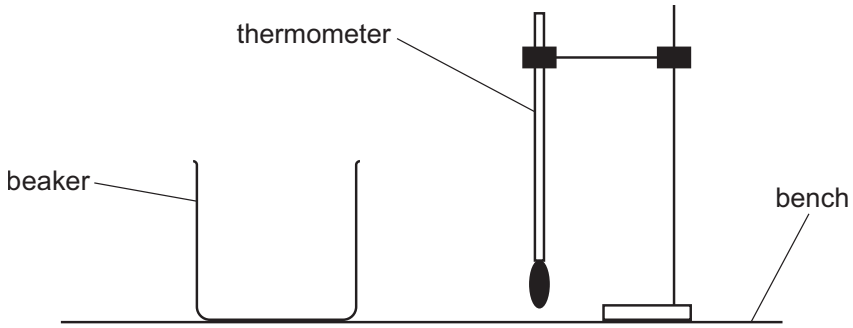


Fig. 2.1

(b) (i) *V* is the total volume of water in beaker **A**.

Complete the column headings in Table 2.1.

Table 2.1

V/	*θ*/
100	
120	
140	
160	
180	
200	

(ii)
- Pour 100 cm^3 of hot water into beaker **A**.
- Place the thermometer in the hot water in beaker **A**.
- Record in Table 2.1 the temperature θ of the hot water.
- Without delay, use the measuring cylinder to add 20 cm^3 of the cold water to the water in beaker **A**.
- Stir the water in beaker **A**.
- Record in Table 2.1 the temperature of the mixture of hot and cold water.
- Repeat the procedure, adding 20 cm^3 of cold water each time, until you have a total of 200 cm^3 of water in beaker **A**.

（2025 夏季 0625/51 第2题(b)）

【答案】(i) cm^3，°C；(ii) 60 °C ≤ θ ≤ 100 °C，温度随总体积增加而降低，各温度记录到 1 °C 或更高精度。
【解析】V 表示水的总体积，单位为 cm^3；θ 表示温度，单位为 °C。
首次记录的热水温度满足 60 °C ≤ θ ≤ 100 °C。
每次加入 20cm^3 冷水并搅拌，V 从 100cm^3 增至 200cm^3，θ 随 V 增大而减小，各温度记录到 1 °C 或更高精度。
答：(i) cm^3，°C；(ii) 温度数据满足上述范围和变化关系。

二. 改变条件重复读数

知识点 取得成组数据，是在一系列给定条件下按同一方法进行测量，并把读数系统记录在同一表格中。

每次只改变题目指定的_____，其余条件保持不变；待装置重新稳定后读数，并覆盖全部给定条件。

表头写作物理量 / 单位，同一列的测量精度应保持一致。

读数偏离预期趋势时，应在相同条件下_____测量。

答案：一项条件；重复

怎么认 题目出现多个给定条件并要求重复测量、填写数据表时，先只改变指定量，再按同一方法逐项读数。

例题 2 A student investigates the reflection of light by a plane mirror.
The student's ray-trace is shown full-size in Fig. 1.1.

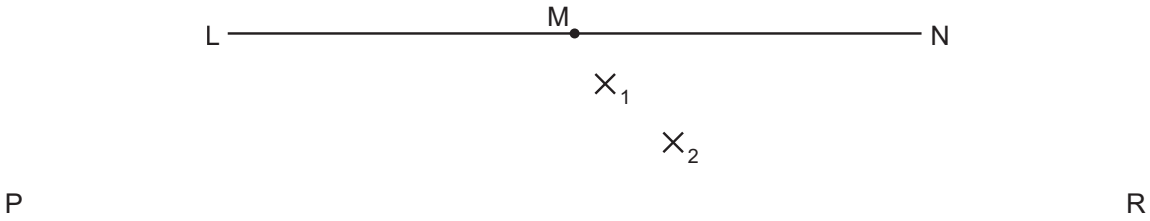


Fig. 1.1

(b) On Fig. 1.1, draw a line 14.0 cm long from point **M** at an angle $\theta = 10°$, as shown in Fig. 1.2. Label the other end of the line **O**.

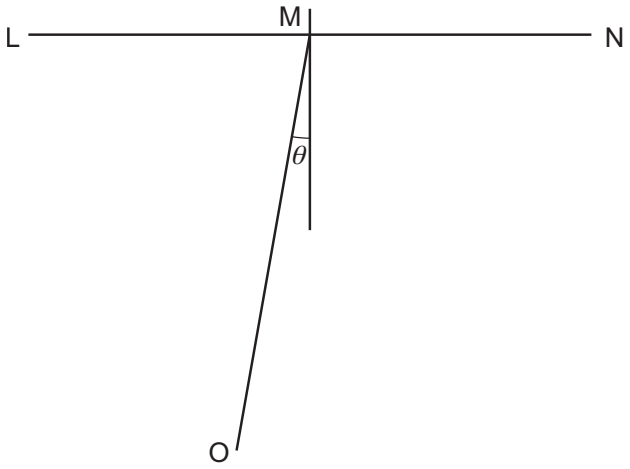


Fig. 1.2

(e) The student repeats the procedure in **(b)** and **(c)** for values of $\theta = 20°$ and $\theta = 30°$.

The student's results are recorded in Table 1.1.

The student states that r is directly proportional to θ.

State if you agree with the student.

Use values from Table 1.1 to justify your answer.

(f) Suggest what the student can do to have more confidence in their answer to part **(e)**.

（2025 冬季 0625/62 第1题(f)）

解：取更多不同的 θ 值重复作图和测量，可用更多数据检验 r 与 θ 的关系。
答：取更多不同的 θ 值扩展实验。

三. 多次振动求周期

知识点 周期 T 是摆完成一次完整振动所用的时间，单位为 _____。

测量 n 次完整振动的总时间 t，则单次周期 $T=$ _____；n 较大时，起止反应时间对单次周期的影响较小。

计时应以摆球沿同一方向通过固定标记为起点，改变摆长后按相同方法重复测量。

若表中记录 T^2，其单位为 _____，同一列数据应采用相同的有效数字。

答案：s；$\frac{t}{n}$；s^2

怎么认 题目出现摆球、若干次完整振动及周期 T 时，先以固定标记计时，再用总时间除以振动次数。

例题 3 In this experiment, you will investigate the period of a pendulum.

Complete the following instructions, referring to Fig. 1.1 and Fig. 1.2.

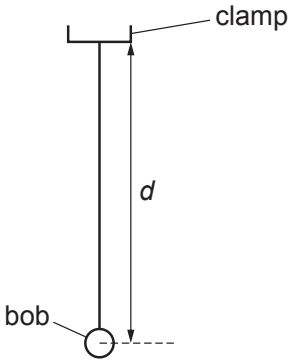


Fig. 1.1

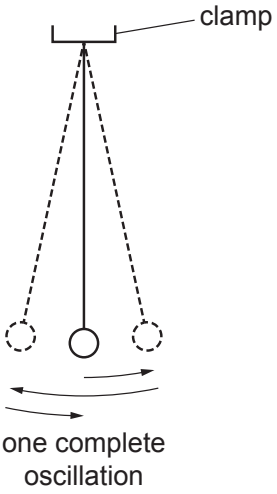


Fig. 1.2

A pendulum has been set up for you as shown in Fig. 1.1.

(a) The distance *d* is measured from the bottom of the clamp to the centre of the bob.

- Adjust the length of the pendulum until *d* = 50.0 cm.
- Displace the bob slightly and release it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.
- Measure, and record in Table 1.1, the time *t* for 10 complete oscillations.
- Calculate, and record in Table 1.1, the period *T* of the pendulum. The period is the time for one complete oscillation.
- Calculate T^2 and record the value in Table 1.1.
- Write the unit for T^2 in the column heading.

Table 1.1

d/cm	*t*/s	*T*/s	T^2/
50.0			
100.0			

（2023 冬季 0625/52 第1题(a)）

解： 测量 10 次完整振动的总时间，记为 t，实验记录应满足 $12\ \text{s} \le t \le 16\ \text{s}$。

由周期定义得

$T = \frac{t}{10}$

故

$T^2 = \left(\frac{t}{10}\right)^2$

T^2 的单位为 s^2。

答：表中记录实测的 t、$T = \frac{t}{10}$、$T^2 = \left(\frac{t}{10}\right)^2$，单位填 s^2。

5. A student investigates the period of a pendulum. Fig. 1.1 shows the set up.

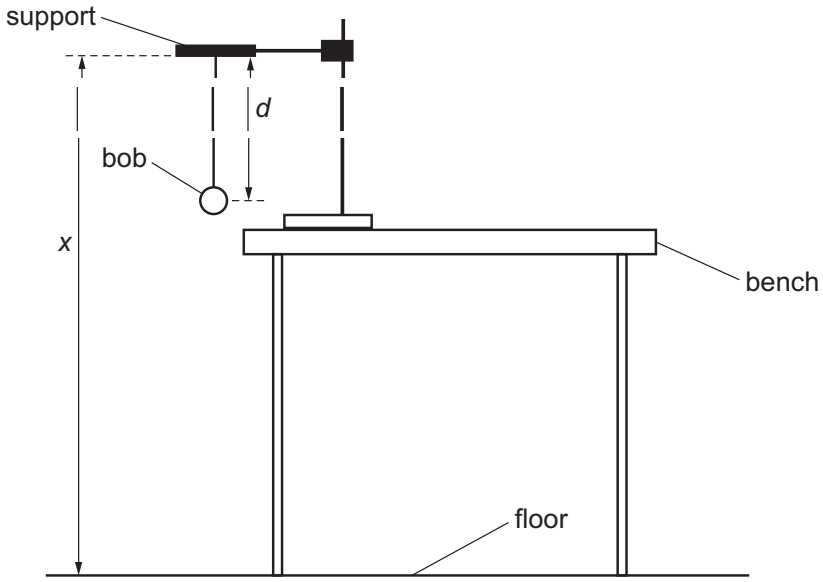


Fig. 1.1

(f) Describe **one** technique that you use to improve accuracy when measuring the time *t* for 10 oscillations.

（2024 冬季 0625/61 第1题(f)）

【答案】以摆球沿同一方向经过竖直位置为固定标记，从 0 开始计数。

【解析】摆球沿同一方向经过竖直位置时开始计时并从 0 计数，完成 10 次完整振动后在同一位置停止计时。

答：以固定标记统一计时的起止位置。

6. In this experiment, you will investigate the period of a pendulum.

Complete the following instructions, referring to Fig. 1.1 and Fig. 1.2.

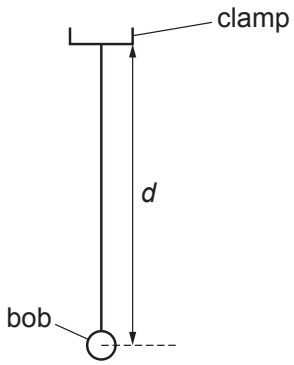


Fig. 1.1

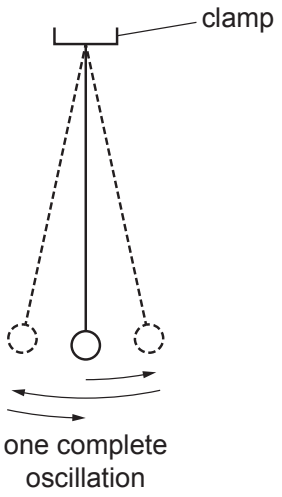


Fig. 1.2

A pendulum has been set up for you as shown in Fig. 1.1.

(a) The distance *d* is measured from the bottom of the clamp to the centre of the bob.

- Adjust the length of the pendulum until *d* = 50.0 cm.
- Displace the bob slightly and release it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.
- Measure, and record in Table 1.1, the time *t* for 10 complete oscillations.
- Calculate, and record in Table 1.1, the period *T* of the pendulum. The period is the time for one complete oscillation.
- Calculate T^2 and record the value in Table 1.1.
- Write the unit for T^2 in the column heading.

Table 1.1

d / cm	*t* / s	*T* / s	T^2 /
50.0			
100.0			

(b) Repeat the procedure in **(a)** using *d* = 100.0 cm.

（2023 冬季 0625/52 第1题(b)）

【答案】$19\ \text{s} \le t \le 21\ \text{s}$；$T = \frac{t}{10}$；$T^2 = \left(\frac{t}{10}\right)^2$，两项 T^2 取相同有效数字。

【解析】当 $d = 100.0\ \text{cm}$ 时，测得 10 次完整振动的总时间满足

$19\ \text{s} \le t \le 21\ \text{s}$

由周期定义得

$T = \frac{t}{10}$

故

$T^2 = \left(\frac{t}{10}\right)^2$

答：记录实测值，并使表中两项 T^2 采用相同的有效数字。

7. In this experiment, you will investigate the period of a pendulum.

Refer to Fig. 1.1 and Fig. 1.2.

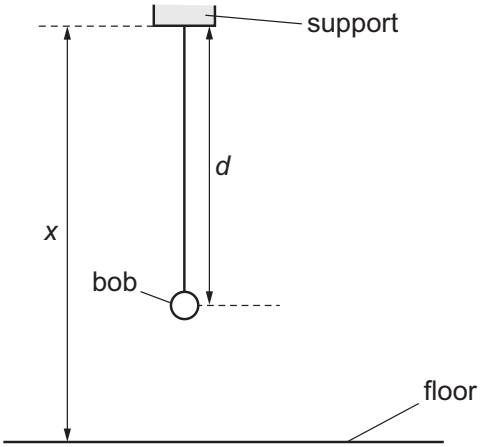


Fig. 1.1

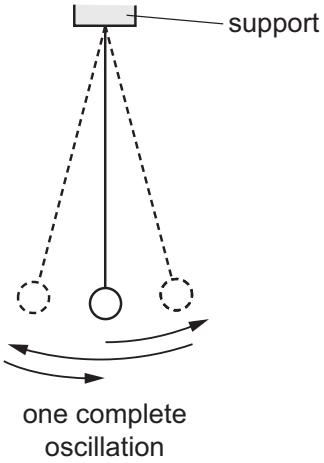


Fig. 1.2

A pendulum has been set up for you as shown in Fig. 1.1. Do **not** change the height of the support.

(a)
- Adjust the length of the pendulum until the distance *d* measured from the bottom of the support to the centre of the bob is 90.0 cm.
- Displace the bob slightly and release it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.
- Measure, and record in Table 1.1, the time *t* for 10 complete oscillations.
- Calculate, and record in Table 1.1, the period *T* of the pendulum. The period is the time for **one** complete oscillation.
- Calculate T^2 and record in Table 1.1.

Table 1.1

d/cm	*t*/s	*T*/s	T^2/s^2
90.0			
45.0			

(b) Repeat the procedure in **(a)** using a distance *d* = 45.0 cm.

（2024 冬季 0625/51 第1题(b)）

【答案】$13\ s < t < 14\ s$；$T = \frac{t}{10}$；$T^2 = \left(\frac{t}{10}\right)^2$，两项 T^2 均取 2、3 或 4 位有效数字。

【解析】当 $d = 45.0\ cm$ 时，测得 10 次完整振动的总时间满足

$13\ s < t < 14\ s$

由周期定义得

$T = \frac{t}{10}$

$T^2 = \left(\frac{t}{10}\right)^2$

答：记录实测值，表中两项 T^2 均取相同的 2、3 或 4 位有效数字。

8. In this experiment, you will investigate the period of a pendulum.

Refer to Fig. 1.1 and Fig. 1.2.

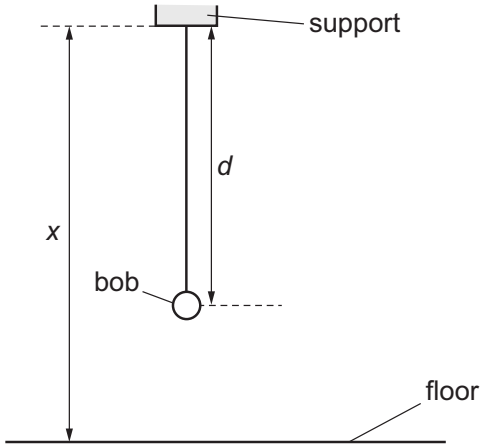


Fig. 1.1

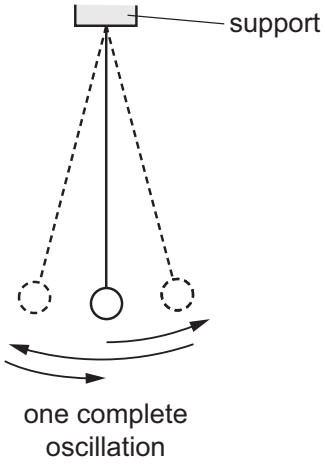


Fig. 1.2

A pendulum has been set up for you as shown in Fig. 1.1. Do **not** change the height of the support.

(a)
- Adjust the length of the pendulum until the distance *d* measured from the bottom of the support to the centre of the bob is 90.0 cm.
- Displace the bob slightly and release it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.
- Measure, and record in Table 1.1, the time *t* for 10 complete oscillations.
- Calculate, and record in Table 1.1, the period *T* of the pendulum. The period is the time for **one** complete oscillation.
- Calculate T^2 and record in Table 1.1.

Table 1.1

d/cm	*t*/s	*T*/s	T^2/s^2
90.0			
45.0			

（2024 冬季 0625/51 第1题(a)）

【答案】$18\ \text{s} < t < 20\ \text{s}$；$T = \frac{t}{10}$；$T^2 = \left(\frac{t}{10}\right)^2$。

【解析】当 $d = 90.0\ \text{cm}$ 时，测得 10 次完整振动的总时间满足

$18\ \text{s} < t < 20\ \text{s}$

由周期定义得

$T = \frac{t}{10}$

故

$T^2 = \left(\frac{t}{10}\right)^2$

答：将实测的 t 及算得的 T、T^2 记录在表中。

题型 4：规范记录结果（考频★★☆☆☆）

知识点 表格表头应写成物理量/单位，数值栏不重复写单位，如 $\frac{V}{\mathrm{cm^3}}$、$\frac{\theta}{^\circ\mathrm{C}}$。

同一物理量用同一仪器测量时，同一列数据应保留相同的_____，并与仪器的最小分度值相适应。测量结果的有效数字不能超过仪器和实验方法所能支持的_____；需要估读时，读至最小分度值的_____。

答案：小数位数；精度；一半

怎么认 题目出现填写表头、记录测量值或比较有效数字时，先看物理量的单位和仪器分度值。

例题 1 A student investigates the cooling of hot water in a beaker.

The apparatus is shown in Fig. 2.1.

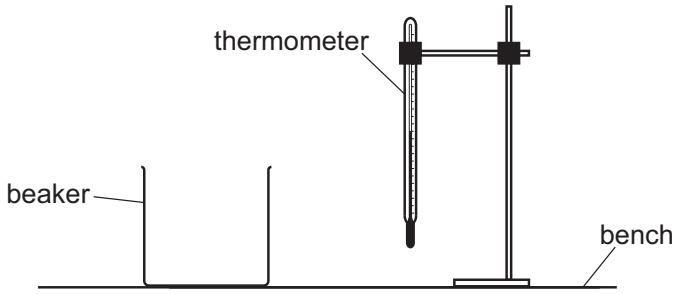


Fig. 2.1

(b) The student pours 100 $\mathrm{cm^3}$ of hot water into an empty beaker. She records the temperature θ of the hot water in the V = 100 $\mathrm{cm^3}$ row of Table 2.1, as shown.

Without delay, she pours 20 $\mathrm{cm^3}$ of cold water into the beaker. She stirs the water and measures the temperature of the mixture of hot and cold water. She repeats the procedure until she has added a total of 100 $\mathrm{cm^3}$ of cold water to the beaker.

All the readings are shown in Table 2.1. V is the total volume of water in the beaker.

Complete the column headings in Table 2.1.

Table 2.1

V/	θ/
100	87
120	73
140	65
160	59
180	54
200	49

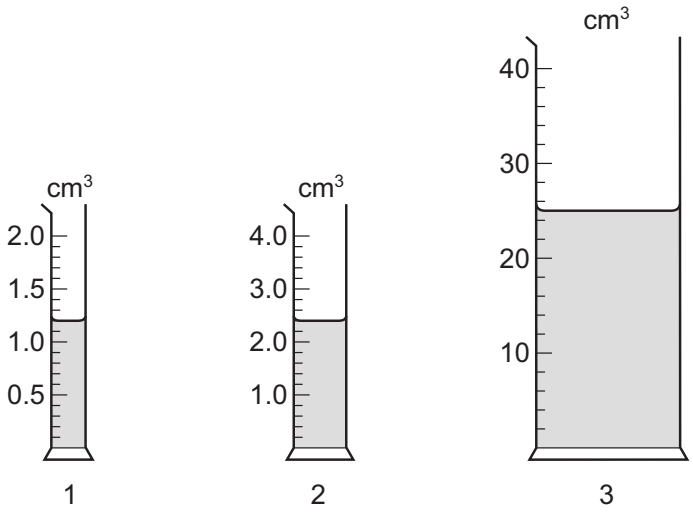
（2025 夏季 0625/61 第2题(b)）

解： V 表示体积，题中体积用 $\mathrm{cm^3}$ 记录；θ 表示温度，温度计读数用 °C 记录。

答：表头分别填 $\mathrm{cm^3}$、°C。

针对练习

1. A student measures the volumes of three liquids using three different measuring cylinders.



The table shows the volumes recorded by the student.

measuring cylinder	volume / cm^3
1	1.2
2	2.2
3	25

Which readings are correctly recorded?

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

（2024 冬季 0625/12 第1题）

【答案】C
【解析】按凹液面最低点读数，量筒 1 为 1.2cm^3，量筒 2 为 2.4cm^3，量筒 3 为 25cm^3。
与表中记录比较，量筒 1 和量筒 3 的记录正确。
故选 C。

P.4 数据、图表与结论

题型 1：整理表格并计算（考频★★★★☆）

知识点 表格列标题由_____和单位组成，常写作物理量 / 单位；单位应与题干及数据量级一致。
按固定时间间隔记录时，相邻时刻之差等于该间隔，并从规定的起始时刻排起。
题干规定某量等于表中已有量时，先定位对应的行，再将该行的_____填入缺项；由公式得到的新列还要写明_____。

答案：物理量或符号；数值；导出单位

怎么认 题目出现缺失的表头、单位、等间隔数据或由条件指定的表格空格时，先依据题干和相邻数据确定应填内容。

一. 补表头、单位或给定条件

例题 1 A student investigates the cooling of hot water from different initial temperatures.

She uses the apparatus shown in Fig. 2.1.

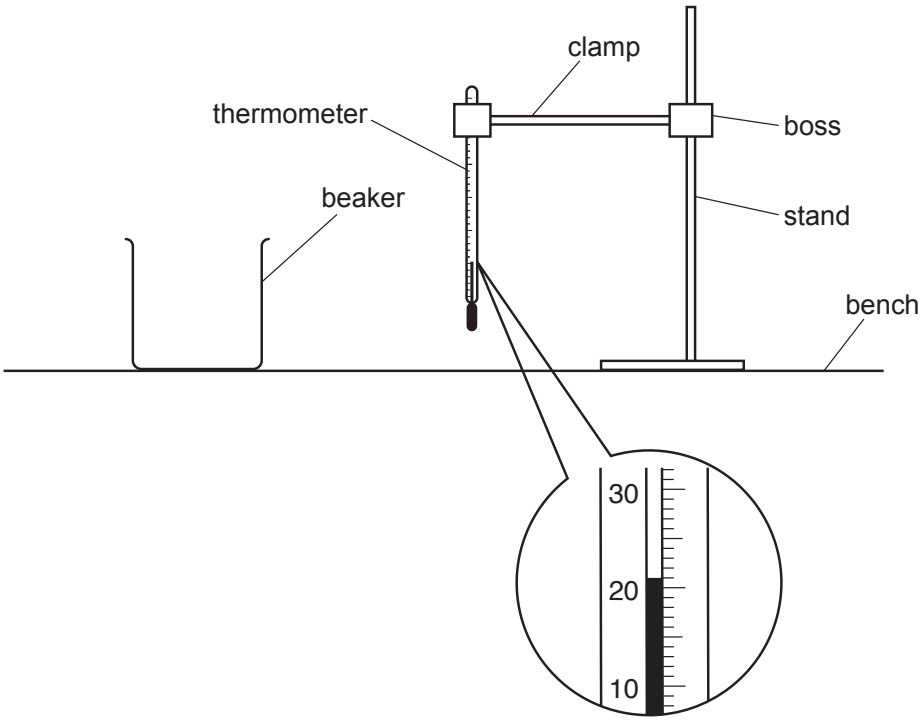


Fig. 2.1

(b) Experiment A

The student pours a volume of 100 cm^3 of hot water into the beaker and records the temperature θ_A at time t = 0 s.
She records the temperature of the water in the beaker every 30 s.

Her readings for **Experiment A** are shown in Table 2.1.

Experiment B

The student repeats the process. She waits until the initial temperature θ_B of the water is the same value as the temperature θ_A at 90 s in **Experiment A**.
In the first line of Table 2.1, record her initial temperature θ_B for **Experiment B**.

Her readings for the remainder of **Experiment B** are shown in Table 2.1.

Table 2.1

t/s	θ_A/°C	θ_B/°C
0	92.0	
30	89.5	83.5
60	87.0	81.5
90	85.0	79.5
120	83.5	78.0
150	82.0	76.5
180	80.0	75.0

（2023 春季 0625/62 第2题(b)）

解：由实验 B 的初始温度等于实验 A 在 $t = 90$ s 时的温度，查表得 $\theta_B = 85.0$ °C。
答：表中 $t = 0$ s 时，$\theta_B = 85.0$ °C。

针对练习

1. A student investigates the cooling of water under different conditions.

Fig. 2.1 shows the set-up.

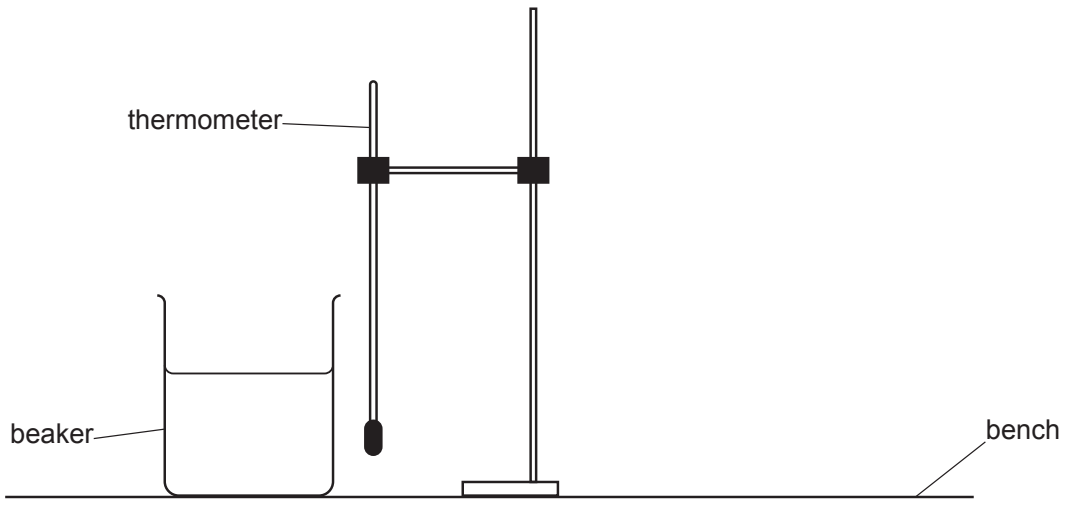


Fig. 2.1

(b) The student pours 200 cm^3 of hot water into the beaker.

She records the temperature θ of the hot water at time t = 0. She immediately starts a stop-watch.
She continues recording the temperature at 30 s intervals. The temperature readings are shown in Table 2.1.

(i) Complete the column headings in Table 2.1.

(ii) Complete the first column of Table 2.1.

Table 2.1

t/	θ/
	92
	84
	78
	74
	71
	69
	67

（2023 夏季 0625/61 第2题(b)）

【答案】$\frac{t}{s}$，$\frac{\theta}{℃}$；$0, 30, 60, 90, 120, 150, 180$
【解析】由题意，时间单位为 s，温度单位为 °C，故表头为 $\frac{t}{s}$ 与 $\frac{\theta}{℃}$。
每隔 30 s 记录一次，且初始时刻为 $t = 0$ s，故第一列为 $0, 30, 60, 90, 120, 150, 180$。
答：$\frac{t}{s}$，$\frac{\theta}{℃}$；$0, 30, 60, 90, 120, 150, 180$。

2. A student investigates the stretching of a spring.

Fig. 1.1 shows the set-up.

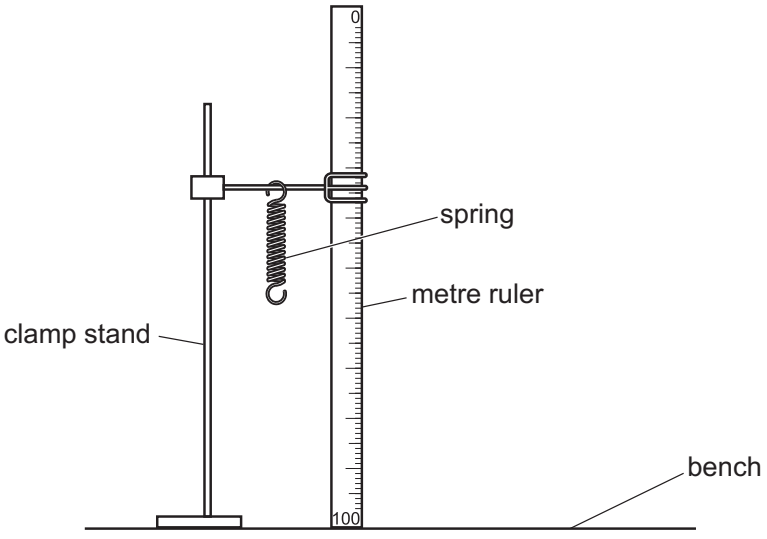


Fig. 1.1

(b) The student suspends a load L = 0.20 N from the spring. She records the new length l of the spring in Table 1.1.

She repeats the procedure using loads L = 0.40 N, 0.60 N, 0.80 N and 1.00 N. The readings are shown in Table 1.1.

(i) Calculate the extension e of the spring for each load using the equation $e = (l - l_0)$.

Record the values of e in Table 1.1.

(ii) Complete the column headings in Table 1.1.

Table 1.1

L /	*l* /	*e* /
0.00	16	0
0.20	18	
0.40	21	
0.60	23	
0.80	24	
1.00	26	

（2023 夏季 0625/62 第1题(b)）

【答案】$e = 0, 2, 5, 7, 8, 10$ mm；$\frac{L}{\text{N}}$，$\frac{l}{\text{mm}}$，$\frac{e}{\text{mm}}$

【解析】由 $e = l - l_0$，且 $l_0 = 16$ mm，得

$e = 0, 2, 5, 7, 8, 10$ mm。

载荷单位为 N，长度与伸长量单位均为 mm。

答：表头为 $\frac{L}{\text{N}}$，$\frac{l}{\text{mm}}$，$\frac{e}{\text{mm}}$。

3. A student investigates the resistance of a resistance wire.

Fig. 2.1 shows the circuit that he uses.

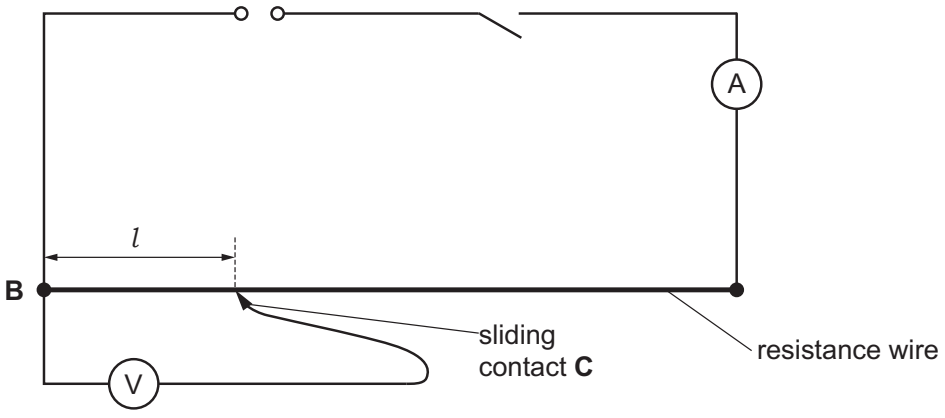


Fig. 2.1

(a) The student places a sliding contact **C** at a distance l = 20.0 cm from **B**.

He measures the potential difference (p.d.) V across length l of the resistance wire.
He measures the current I in the circuit.

The meters are shown in Fig. 2.2 and Fig. 2.3.

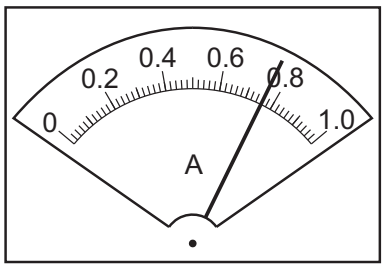


Fig. 2.2

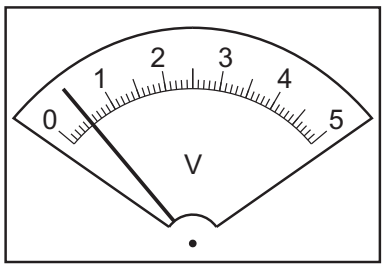


Fig. 2.3

Table 2.1

l/	V/	R/	$\frac{R}{l}$/
20.0			
60.0	1.6	2.1	0.035
100.0	2.5	3.3	0.033

(i) Write down the current I shown on the student's ammeter.

(ii) Record the potential difference V shown on the student's voltmeter in the first ro Table 2.1.

(iii) Calculate, and record in Table 2.1, the resistance R of 20.0 cm of the resistance wire.
Use the equation $R = \frac{V}{I}$.

(iv) Calculate, and record in the first row of Table 2.1, $\frac{R}{l}$ for l = 20.0 cm.

(v) Complete the column headings in Table 2.1.

（2023 冬季 0625/61 第2题(a)）

【答案】$I = 0.76\ \text{A}$；$V = 0.5\ \text{V}$；$R = 0.66\ \Omega$；$\frac{R}{l} = 0.033\ \Omega\ \text{cm}^{-1}$；$\frac{l}{\text{cm}}$，$\frac{V}{\text{V}}$，$\frac{R}{\Omega}$，$\frac{\frac{R}{l}}{\Omega\ \text{cm}^{-1}}$

【解析】由电流表和电压表读数得

$I = 0.76\ \text{A}$，$V = 0.5\ \text{V}$。

由 $R = \frac{V}{I}$ 得 $R = \frac{0.5}{0.76} \approx 0.66\ \Omega$，故 $\frac{R}{l} = \frac{0.66}{20.0} = 0.033\ \Omega\ \text{cm}^{-1}$。

答：表头为 $\frac{l}{\text{cm}}$，$\frac{V}{\text{V}}$，$\frac{R}{\Omega}$，$\frac{\frac{R}{l}}{\Omega\ \text{cm}^{-1}}$。

二. 作差得到长度或伸长

知识点　同一物理量的改变量等于_____；用刻度位置求长度时，右端读数相当于终值，左端读数相当于初值。

两位置沿同一刻度方向计数时，$s = x_2 - x_1$；弹簧伸长量为 $e = l - l_0$；已用体积等于_____。

各读数必须使用相同单位，差值按题目要求保留精度；求比值时两量的单位应相同。

答案：终读数减初读数；初始总体积减剩余体积

怎么认 题目出现两个刻度位置、初末长度或总量与剩余量时，先按两端顺序作差。

例题 2 In this experiment, you will determine the mass M_R of a metre ruler using a balancing method.

Carry out the following instructions, referring to Fig. 1.1.

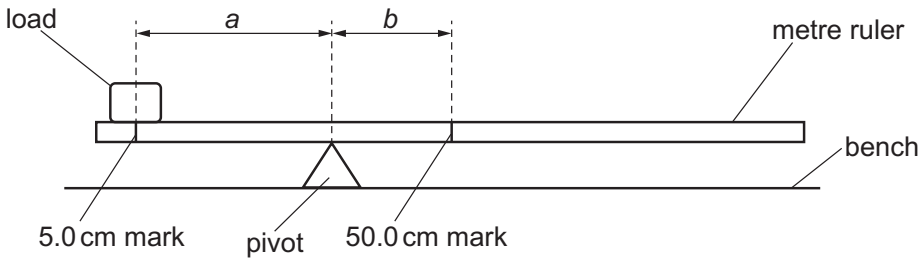


Fig. 1.1

(b) For each value of M, calculate and record in Table 1.1 the value $\frac{b}{a}$.

（2023 夏季 0625/53 第1题(b)）

解：表中每组数据均按 $\frac{b}{a}$ 计算，并将结果保留至少 2 位小数。

针对练习

4. A student investigates the stretching of a spring.

Fig. 1.1 shows the set-up.

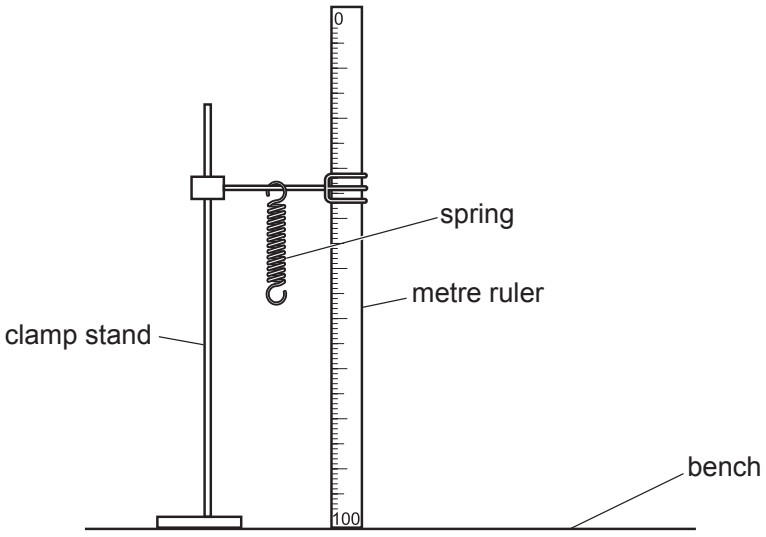


Fig. 1.1

(b) The student suspends a load L = 1.00 N from the spring. He records the new length l of the spring in Table 1.1.

He calculates the extension e of the spring using the equation $e = (l - l_0)$ and records the value of e in Table 1.1.

The student repeats the procedure using loads L = 2.00 N, 3.00 N, 4.00 N and 5.00 N.
The readings and results are recorded in Table 1.1.

Calculate the extension *e* of the spring using the equation $e = (l - l_0)$ when $L = 5.00$ N. Record this value of *e* in Table 1.1.

Table 1.1

L / N	*l* / cm	*e* / cm
0.00	2.1	0.0
1.00	6.0	3.9
2.00	10.6	8.5
3.00	14.9	12.8
4.00	19.3	17.2
5.00	23.7	

（2024 夏季 0625/61 第1题(b)）

【答案】21.6 cm
【解析】由 $e = l - l_0$ 得
$e = 23.7\ \text{cm} - 2.1\ \text{cm}$
$= 21.6\ \text{cm}$
答：21.6 cm。

5. A student investigates the balancing of a metre ruler.

Fig. 1.1 shows the apparatus.

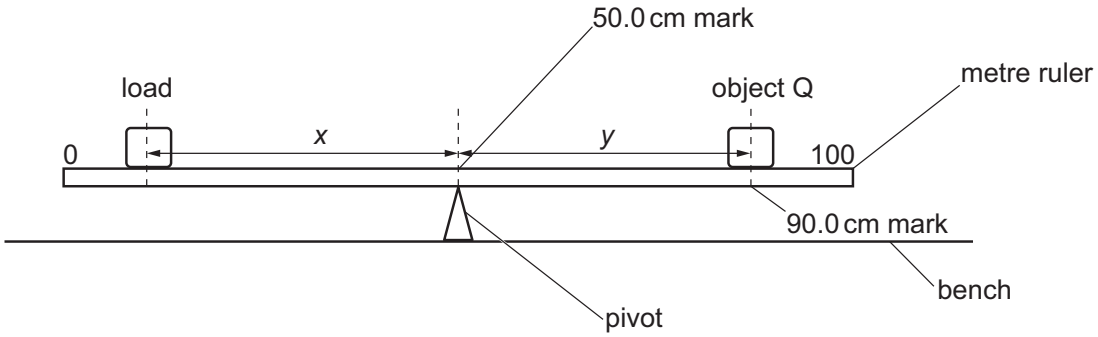


Fig. 1.1

(a) The student places a metre ruler on a pivot at the 50.0 cm mark.

She places an object Q with its centre on the metre ruler at the 90.0 cm mark.

Determine the distance *y* from the 50.0 cm mark to the centre of the object Q.

（2025 冬季 0625/61 第1题(a)）

【答案】40.0 cm
【解析】物体中心位于 90.0 cm 刻度处，支点位于 50.0 cm 刻度处，故
$y = 90.0\ \text{cm} - 50.0\ \text{cm}$
$= 40.0\ \text{cm}$
答：40.0 cm。

三. 温差除时间求冷却率

知识点 一段时间内的平均冷却率等于这段时间的_____除以_____，温降等于起始温度减结束温度。

$R = \frac{\theta_{初}-\theta_{末}}{\Delta t}$，其中 Δt 为所取时间段。

温度用°C、时间用 s 时，冷却率单位为_____；时间用 min 时，单位为°C/min。

答案：温降；时间间隔；°C/s

怎么认 题目出现某段起止温度、对应时间并求平均冷却率时，先用起始温度减结束温度求温降。

例题 3 In this experiment, you will investigate the cooling of hot water from different initial temperatures.

Carry out the following instructions, referring to Fig. 2.1.

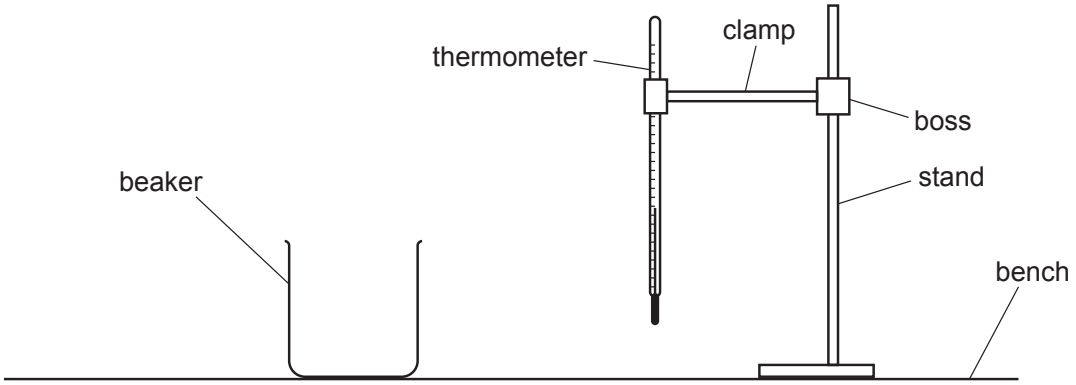


Fig. 2.1

(d) (i) Calculate the average cooling rate x_1 during the second half of **Experiment A**.
Use your readings from Table 2.1 and the equation

$$\frac{\theta_{A90} - \theta_{A180}}{T}$$

where T = 90 s and θ_{A90} and θ_{A180} are the temperatures at t = 90 s and t = 180 s in **Experiment A**.
Include the unit for the cooling rate.

(ii) Calculate the average cooling rate x_2 during the first half of **Experiment B**.
Use the readings from Table 2.1 and the equation

$$\frac{\theta_{B0} - \theta_{B90}}{T}$$

where T = 90 s and θ_{B0} and θ_{B90} are the temperatures at t = 0 s and t = 90 s in **Experiment B**.

(iii) A student suggests that x_1 and x_2 should be the same.
State whether your results support this suggestion.
Justify your statement by reference to your results.

（2023 春季 0625/52 第2题(d)）

解： 实验 A 后半段的时间为 180 s − 90 s = 90 s，故

$x_1 = \frac{\theta_{A90}-\theta_{A180}}{90\ s}$

实验 B 前半段的时间为 90 s − 0 s = 90 s，故

$x_2 = \frac{\theta_{B0}-\theta_{B90}}{90\ s}$

所得冷却率的单位均为°C/s。若 x_1 与 x_2 的差异在实验精度允许范围内，则结果支持该观点；否则不支持。

答：将表 2.1 的读数代入上式，并根据所得结果与实验精度作出判断。

四. 按关系式求物理量

知识点 按关系式求物理量，是把同一次实验得到的测量值代入物理量之间的定量关系。

计算前应将各量统一到_____，并写出题目适用的_____；关系式的分母不得为零。

结果单位由式中各量的单位共同决定，无量纲比值不写单位，数值按测量精度保留适当的_____。

答案：同一单位制；关系式；有效数字

怎么认 题目出现测量表格、计算式和所求物理量时，先统一单位并写出题给关系式。

例题 4 A student investigates the resistance of a wire.

Fig. 2.1 shows the circuit he uses.

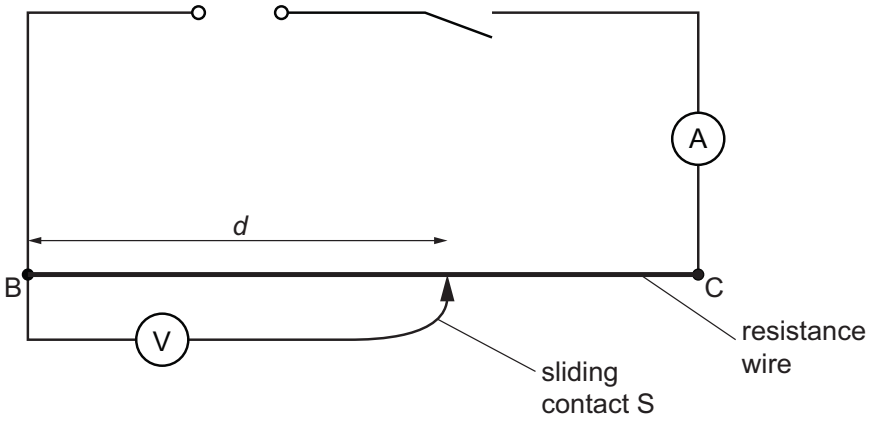


Fig. 2.1

(b) The student places the sliding contact 15.0 cm from B.

He measures the potential difference (p.d.) V across the length d = 15.0 cm of resistance wire BC.

He repeats the procedure using values of d = 40.0 cm, d = 60.0 cm and d = 80.0 cm.

The values of d, V and R are shown in Table 2.1.

The voltmeter reading he obtains when d = 100.0 cm is shown in Fig. 2.3.

(i) Record, in the last row of Table 2.1, the voltmeter reading shown in Fig. 2.3.

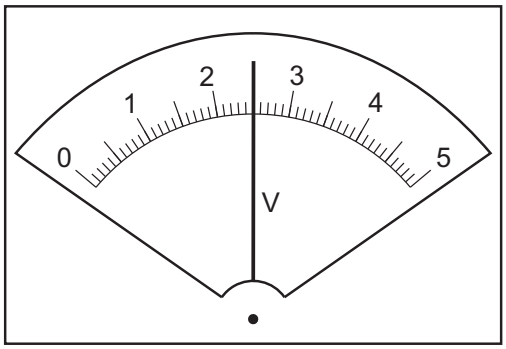


Fig. 2.3

(ii) Calculate the resistance R of 100.0 cm of the resistance wire, using the equation

$$R = \frac{V}{I}.$$

Record R in the last row of Table 2.1.

(iii) Complete the column headings in Table 2.1.

Table 2.1

d/	*V*/	*R*/
15.0	0.4	1.25
40.0	1.1	3.44
60.0	1.4	4.38
80.0	2.1	6.56
100.0		

（2025 冬季 0625/61 第2题(b)）

解：由电压表指针位置得

$V = 2.5$ V

由表中 0.4 V 对应 1.25 Ω，得

$I = \frac{V}{R} = \frac{0.4}{1.25} = 0.320$ A

$R = \frac{V}{I} = \frac{2.5}{0.320} = 7.81$ Ω

d、V、R 的单位分别为 cm、V、Ω。

答：2.5 V；7.81 Ω；cm，V，Ω。

题型 2：规范作图（考频★★★☆☆）

知识点 作图时，横轴表示题目指定的自变量，纵轴表示因变量；坐标轴采用_____标度，并使极端数据点间的跨度至少占格面的一半。

坐标轴标签应同时写变量和单位，如 $\frac{l}{\text{cm}}$、$\frac{R}{\Omega}$；无单位量只写变量。

各点应按数据准确描至半个小格，最佳拟合直线应细而连续，并使散点在直线两侧大致_____分布。

答案：均匀；均衡

怎么认 题目出现数据、坐标格并要求描点画最佳拟合直线时，先标明两轴变量和单位。

一. 描点画最佳拟合直线

例题 1 In this experiment, you will determine the resistance per unit length of a resistance wire.
The circuit has been set up for you.

Carry out the following instructions, referring to Fig. 3.1.

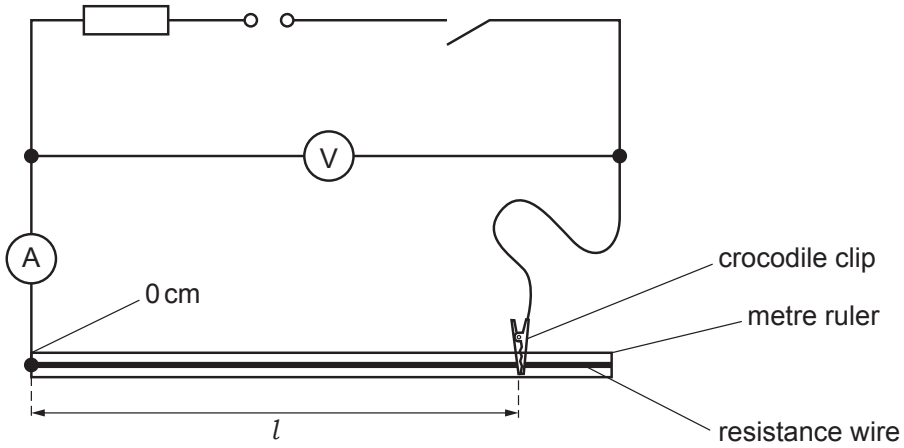


Fig. 3.1

(c) Plot a graph of R/Ω (y-axis) against l/cm (x-axis).
Draw a straight line of best fit.

（2023 春季 0625/52 第3题(c)）

解： 以 $\frac{l}{\text{cm}}$ 为横轴，以 $\frac{R}{\Omega}$ 为纵轴，取均匀标度，使极端数据点间的跨度不少于格面的一半。

由实验数据描出各组 (l, R)，各点位置精确到半个小格。

作一条细而连续的直线，使散点在直线两侧大致均衡分布。

答：所得 R–l 图像及其最佳拟合直线见作图。

二. 描点画平滑拟合曲线

知识点 绘制 y 对 x 的图像时，横轴表示 x，纵轴表示 y，两轴都应标出物理量及_____。

坐标刻度必须均匀，范围可不从零开始，并应使数据至少占据半个网格；各点的位置误差不超过半个小格。

最佳拟合曲线应_____，贴近全部数据的总体趋势，不逐点连接成折线。

答案：单位；细而连续、平滑

怎么认 题目出现成组数据、坐标网格并要求画最佳拟合曲线时，先确定横纵轴、单位和均匀刻度。

例题 2 A student investigates the image formed by a converging lens.

The apparatus is set up as shown in Fig. 3.1.

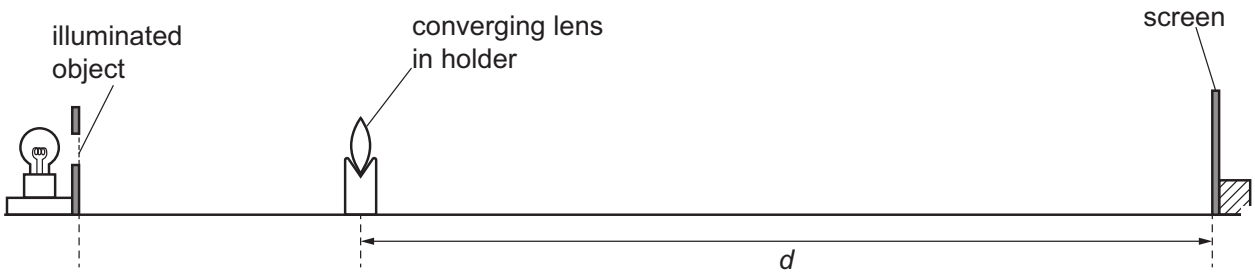


Fig. 3.1

(a) (i) The student:

- switches on the lamp
- places the lens a distance u = 20.0 cm from the illuminated object (a triangular hole in the card)
- adjusts the position of the screen until a sharp image of the illuminated object is formed on the screen.

Measure on Fig. 3.1, to the nearest 0.1 cm, the image distance d from the centre of the lens to the screen.

(ii) Fig. 3.1 is drawn to a scale of one-fifth $\left(\frac{1}{5}\right)$ full size.

Calculate the actual image distance v from the lens and record your value in Table 3.1.

Table 3.1

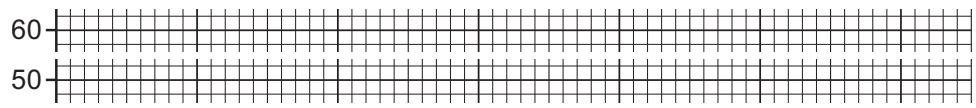
object distance u / cm	image distance v / cm
20.0	
25.0	37.2
35.0	26.5
45.0	22.7
55.0	20.9
60.0	20.2

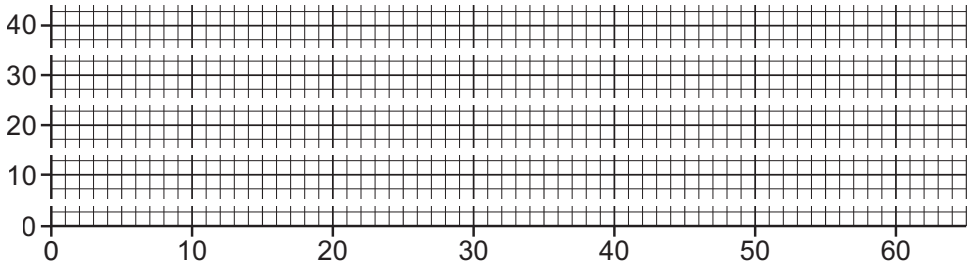
(c) The student repeats the procedure in **(a)(i)** for values of u = 25.0 cm, u = 35.0 cm, u = 45.0 cm, u = 55.0 cm and u = 60.0 cm.

The student's results are shown in Table 3.1.

Plot a graph of v / cm (y-axis) against u / cm (x-axis).

Draw the best-fit curve.





（2024 冬季 0625/62 第3题(c)）

解： 由图中测量得 $d = 12.1\ \text{cm}$，故 $v = 5d = 60.5\ \text{cm}$。

在横轴为 $\frac{u}{\text{cm}}$、纵轴为 $\frac{v}{\text{cm}}$ 的图中描出 $(20.0, 60.5)$、$(25.0, 37.2)$、$(35.0, 26.5)$、$(45.0, 22.7)$、$(55.0, 20.9)$、$(60.0, 20.2)$。

作细而连续的平滑下降曲线，使曲线贴近六点的总体趋势。

题型 3：从图线取结果（考频★★★★☆）

知识点 内插是在已测数据范围内，利用图线求两个变量对应值的方法。

从已知量所在坐标轴取值，作平行于另一坐标轴的辅助线至图线，再转向另一轴读出_____。

辅助线应保留在图上，读数精确到_____，所得数值的单位与所读坐标轴的单位_____。

答案：未知量的对应值；半个最小格；相同

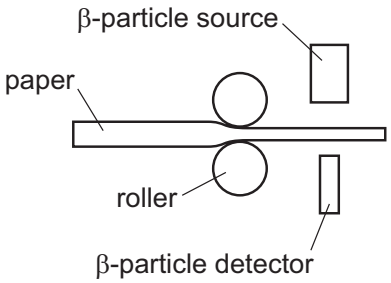
怎么认 题目出现给定一个坐标量并要求由图求另一量时，先从给定值所在轴作辅助线至图线，再转向另一轴读数。

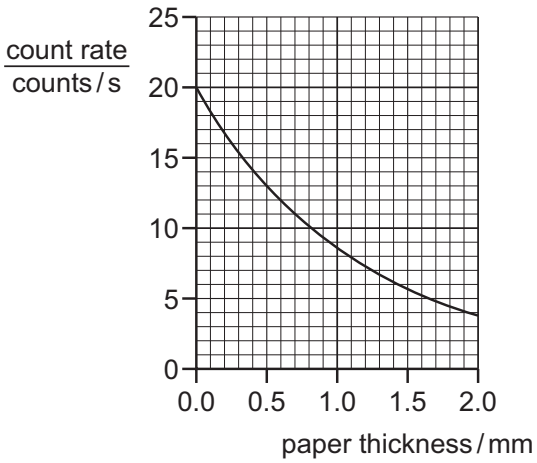
一. 内插或阈值读数

例题 1 The diagram shows a system to control the thickness of paper produced by a machine.

The graph shows how the count rate at the detector varies with the thickness of the paper.

The rollers squeeze the paper when the count rate at the detector drops below 12 counts per second and then stop squeezing when the count rate rises above 13 counts per second.





What is the thickness of the paper coming out of the machine?

A between 0.40 mm and 0.50 mm

B between 0.50 mm and 0.60 mm

C between 0.60 mm and 0.70 mm

D between 0.70 mm and 0.80 mm

（2024 冬季 0625/23 第37题）

解：由题意，停止挤压时计数率刚升至 13 counts/s 以上。
从纵轴 13 counts/s 作水平线至曲线，再向下读得纸厚在 0.50 mm 与 0.60 mm 之间。
故选 B。

二. 取大三角求斜率

知识点 图线的斜率表示纵坐标量对横坐标量的变化率，$G = \Delta\frac{y}{\Delta}x$。

求实验图线的斜率时，应在最佳拟合线上选取相距较远的两点作大三角形；两点不必是原始数据点，横向跨度至少为图线有效长度的一半。

大三角形中，斜率等于_____除以_____；斜率单位为_____。

答案：纵轴变化量；横轴变化量；纵轴单位除以横轴单位

怎么认 题目出现最佳拟合线并要求求斜率及标示取值时，先在线上取相距较远的两点画大三角。

例题 2 In this experiment, you will determine the resistance per unit length of a resistance wire.
The circuit has been set up for you.

Carry out the following instructions, referring to Fig. 3.1.

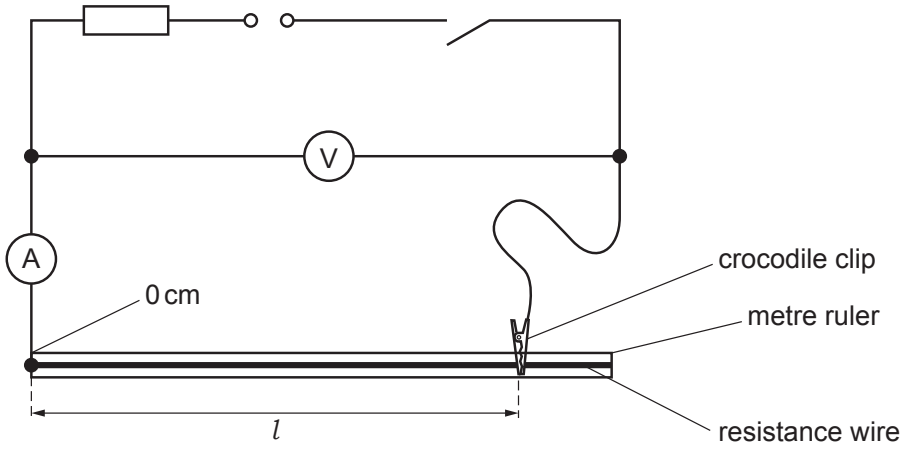


Fig. 3.1

(d) (i) Determine the gradient *G* of the graph. Show clearly on the graph how you obtained the necessary information.

(ii) The gradient *G* is numerically equal to the resistance per unit length R_0 of the resistance wire.
Write down the value of R_0 for the resistance wire.

（2023 春季 0625/52 第3题(d)）

解：在最佳拟合线上取相距较远的两点 (l_1, R_1)、(l_2, R_2)，在图上画出大三角。

$\Delta l = l_2 - l_1$

$\Delta R = R_2 - R_1$

$G = \Delta \frac{R}{\Delta} l$

由题意，电阻丝的单位长度电阻 R_0 数值等于 G，

$R_0 = G$

$0.05\ \Omega/\text{cm} \leq R_0 \leq 0.11\ \Omega/\text{cm}$

答：$R_0 = G$，其值在 $0.05\ \Omega/\text{cm}$ 至 $0.11\ \Omega/\text{cm}$ 之间。

三. 读截距再代入

知识点 最佳拟合线与坐标轴交点所对应的数值称为该轴上的_____。

当所求状态位于已测数据范围之外时，可将最佳拟合线按原趋势_____至坐标轴，再按刻度读取交点。

若题目另给物理量关系式，应先读出截距，再代入关系式；读数单位与对应坐标轴的_____相同。

答案：截距；延长；单位

怎么认 题目要求某量为零时的数值或由截距继续计算时，先将最佳拟合线延长至相应坐标轴读截距。

例题 3

In this experiment, you will determine the focal length of a converging lens.

Carry out the following instructions, referring to Fig. 3.1.

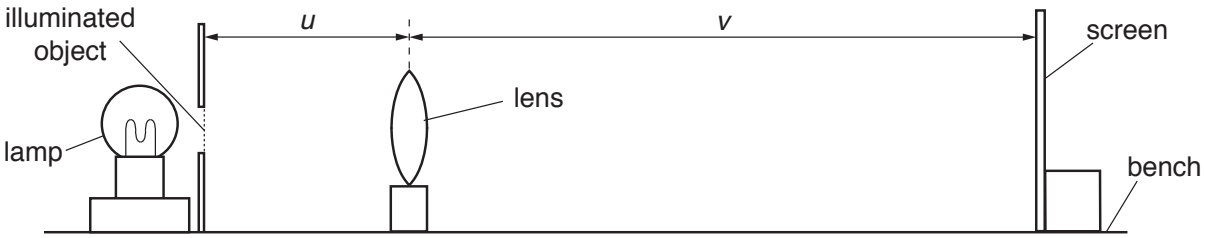


Fig. 3.1

(d) (i) Determine the value u_0 of u when $\frac{u}{v} = 0$.

(ii) The gradient of the graph is numerically equal to the focal length f of the lens.

Determine the value of f for this experiment.

Show clearly on the graph how you obtained the necessary information to determine the gradient.

（2023 冬季 0625/53 第3题(d)）

解： 将最佳拟合线延长至 $\frac{u}{v} = 0$，由纵轴截距得

$13\ \text{cm} \leq u_0 \leq 17\ \text{cm}$

在最佳拟合线上取相距较远的两点作大三角形，由斜率得

$f = \frac{u_2 - u_1}{\left(\frac{u}{v}\right)_2 - \left(\frac{u}{v}\right)_1}$

$0.9u_0 \leq f \leq 1.1u_0$，且 f 的单位为 cm。

答：$13\ \text{cm} \leq u_0 \leq 17\ \text{cm}$，$f$ 为图线斜率。

针对练习

1. A student determines the focal length of a converging lens.

She uses the apparatus shown in Fig. 3.1.

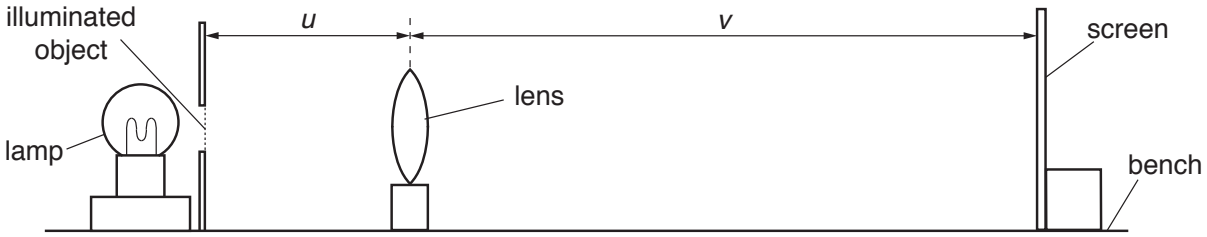


Fig. 3.1

(d) (i) Determine the value u_0 of u when $\frac{u}{v} = 0$.

(ii) The gradient of the graph is numerically equal to the focal length f of the lens.

Determine the value of f for this experiment.

Show clearly on the graph how you obtained the necessary information to determine the gradient.

（2023 冬季 0625/63 第3题(d)）

【答案】13 cm ≤ u_0 ≤ 18 cm；f 为图线斜率，单位为 cm，保留 2 或 3 位有效数字

【解析】将最佳拟合线延长至 $\frac{u}{v} = 0$，由纵轴截距得

13 cm ≤ u_0 ≤ 18 cm

在最佳拟合线上取相距较远的两点作大三角形，由斜率得

$f = \frac{u_2 - u_1}{\left(\frac{u}{v}\right)_2 - \left(\frac{u}{v}\right)_1}$

答：u_0 为纵轴截距，f 为图线斜率，单位为 cm，保留 2 或 3 位有效数字。

题型 4：由数据写结论（考频★★★★★）

知识点 一段时间内的平均冷却率等于温降除以时间：$R = \frac{\theta_1 - \theta_2}{\Delta t}$；时间以 s 计时，单位为 _____。

比较两组冷却快慢时，应选取_____的时间段；相同时间内温降较大的组，平均冷却率较大。

温度–时间曲线越陡，斜率绝对值越大，冷却越_____；曲线逐渐变平，表示冷却率逐渐减小。

实验结论应写出变量间的关系，并引用温降、平均冷却率或曲线形状作为依据。

答案：°C/s；相同；快

怎么认 题目出现两组冷却数据或温度–时间曲线并要求比较冷却快慢时，先取相同时间段比较温降或斜率绝对值。

一. 比较温降或斜率判快慢

例题 1

A student investigates how the volume of water affects the rate at which water in a beaker cools.

She uses the apparatus shown in Fig. 2.1.

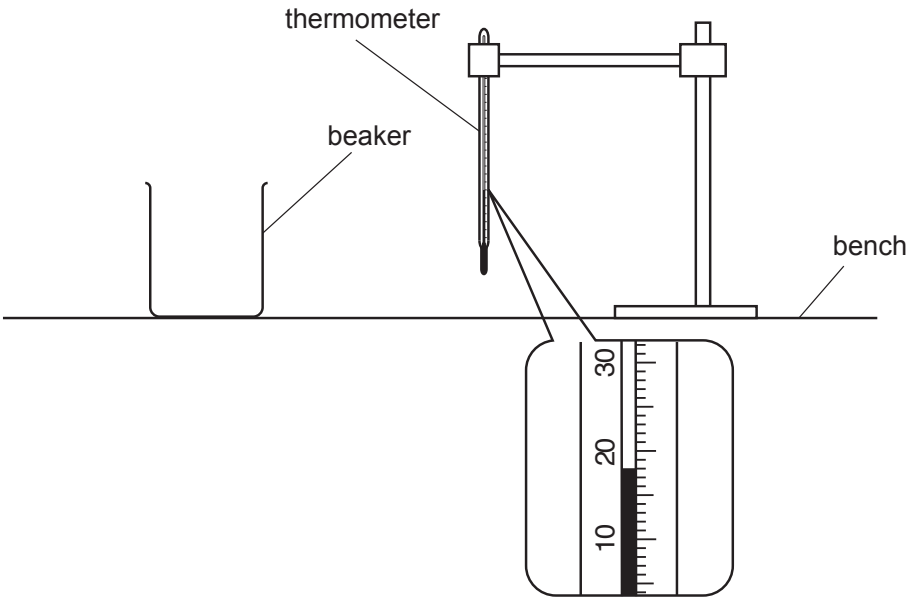


Fig. 2.1

(b) The student pours a volume of 200 cm^3 of hot water into the beaker and records the temperature θ of the water at time t = 0.

She records the temperature of the water in the beaker every 30 s.

She pours the water out and pours a volume of 75 cm^3 of hot water into the beaker.

The student repeats the temperature measurements for this volume of water.

(i) Describe **two** precautions that can be taken to ensure that temperature readings in the experiment are as accurate as possible.

(ii) Her readings are shown in Table 2.1.

Add units to the column headings in Table 2.1.

Table 2.1

beaker with 200 cm^3 of hot water	beaker with 75 cm^3 of hot water

t/	θ/	θ/
0	87.5	85.5
30	85.5	82.0
60	84.0	78.5
90	82.5	75.0
120	81.0	72.0
150	80.0	69.5
180	79.0	67.0

(d) **(i)** Using the values for 75 cm^3 of water, calculate the average cooling rate x_1 for the first 90 s of the experiment. Use the readings from Table 2.1 and the equation

$$x_1 = \frac{\theta_0 - \theta_{90}}{T}$$

where T = 90 s and θ_0 and θ_{90} are the temperatures at t = 0 and t = 90 s.
Include the unit for the cooling rate.

Using the values for 75 cm^3 of water, calculate the average cooling rate x_2 for the last 90 s of the experiment. Use the readings from Table 2.1 and the equation

$$x_2 = \frac{\theta_{90} - \theta_{180}}{T}$$

where T = 90 s and θ_{90} and θ_{180} are the temperatures at t = 90 s and t = 180 s.

(ii) A student states that it is important to start the two experiments in **(b)** with water at the same initial temperature.

Explain whether your values for x_1 and x_2 support this statement.

（2024 夏季 0625/63 第2题(d)）

解：由表中读数得

$x_1 = \frac{85.5-75.0}{90} = 0.117 \approx 0.12\ ^\circ\mathrm{C/s}$

$x_2 = \frac{75.0-67.0}{90} = 0.0889 \approx 0.089\ ^\circ\mathrm{C/s}$

$\because x_1 > x_2$，说明水在较高温度区间冷却较快，$\therefore$比较不同体积对冷却率的影响时，应使初始温度相同。

二. 算比值检验关系

知识点 检验若干结果是否一致时，应按题目规定逐组计算同一种比值或归一量，并在相同单位下比较。

各结果在实验精度允许范围内_____，才支持结果相等；差异明显则不支持。

检验两物理量是否成正比时，纵量–横量图像应为_____。

比值单位等于分子单位除以分母单位；分子、分母同单位时，比值_____单位。

答案：近似相等；过原点的直线；没有

怎么认 题目出现计算比值并判断关系或用图像确认正比时，先逐组求规定比值或检验图线是否为过原点直线。

例题 2

A student investigates a circuit containing different combinations of resistors.

She uses **circuit A**, shown in Fig. 2.1.
Circuit A is not yet complete.

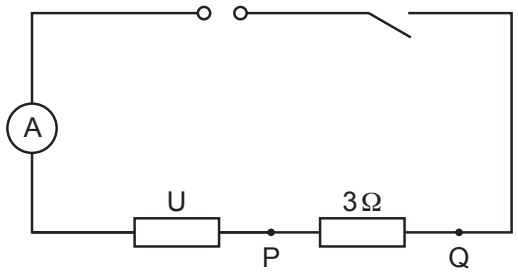


Fig. 2.1

(e) A student suggests that potential difference and current for resistor U are proportional.

State how a graph of potential difference against current for resistor U can confirm this suggestion.

（2023 夏季 0625/63 第2题(e)）

解：若电势差与电流成正比，则
$\frac{V}{I} = k$
故 V 对 I 的图像应为过原点的直线。
答：图像为过原点的直线时，支持该观点。

三. 比较角度检验规律

知识点 检验两个角是否相等时，应以同一直线为基准，分别量出对应的锐角。

若角度差不超过实验允许误差，则结果_____猜想；若明显超过，则结果_____猜想。

角度单位为_____，锐角满足 $0° < \theta < 90°$。

答案：支持；不支持；度（°）

怎么认 题目出现两个锐角及检验两角相等的猜想时，先以同一基准量角并比较差值。

例题 3 In this experiment, you will investigate the reflection of light by two mirrors.

Carry out the following instructions, using the separate ray-trace sheet provided.
You may refer to Fig. 3.1 for guidance.

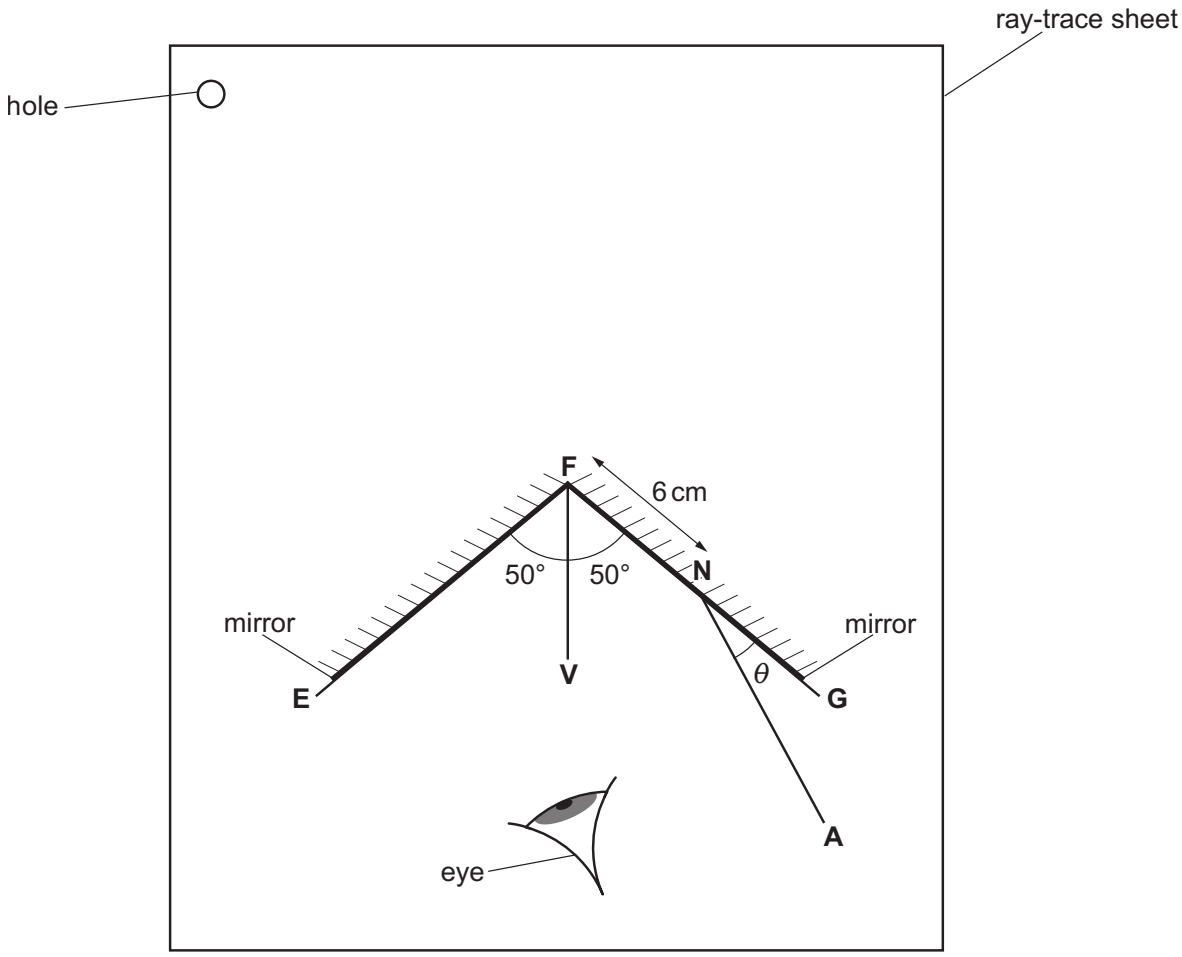


Fig. 3.1

(c)
- Draw a line joining P_3 and P_4. Extend this line 10 cm above **FE**.
- Label the lower end of this line with the letter **B**. Label the upper end with the letter **R**

（2023 夏季 0625/53 第3题(c)）

解：过点 P_3、P_4 作直线，并将其向直线 FE 上方延长 10 cm。
将下端标为 B，上端标为 R。
答：作图如题意。

四. 比较电路数据看趋势

知识点 比较同一组电路数据时，应按同一变量的增减顺序逐项比较电流、电势差和电阻。

若电流减小时各组电势差相近，应写电势差_____；若数值仍连续变小，应写电势差_____。

电阻由 $R = \frac{V}{I}$ 计算；当 V 变化较小而 I 减小时，R _____。

电势差、电流和电阻的单位分别为 V、A 和 Ω，上述关系适用于同一元件、同一实验条件下的数据。

答案：保持近似不变；略有减小；增大

怎么认 题目出现同一电路的多组电流、电势差或电阻数据并要求写结论时，先按同一变量的增减顺序逐项比较。

例题 4 A student investigates a light-dependent resistor (LDR).

The student assembles a series circuit consisting of a power supply, a switch, a 470 Ω resistor and an LDR.

(e) (i) The student covers the LDR with a piece of card and repeats the procedure described in **(b)** and **(d)**.

V_{XY} = ... 0.15 V .....

Calculate the resistance R_D of the LDR in the dark using the equation:

$$R_D = \frac{470\,\Omega \times V_{YZ}}{V_{XY}}.$$

(ii) The student removes the card from the top of the LDR and slowly lifts it vertically upwards away from the LDR until the card is 30 cm above the LDR. The student observes and records the readings on the voltmeter across the LDR (V_{YZ}) as the card is raised.

Table 2.1 shows the student's results.

Table 2.1

distance / cm	potential difference V_{YZ} / V
0	2.9
5	2.5
10	2.4
15	2.3
20	2.2
25	2.2
30	2.2

Describe how the p.d. across the LDR (V_{YZ}) changes as the distance between the card and the LDR increases.

（2025 夏季 0625/62 第2题(e)）

解：(i) 由表 2.1 中距离为 0 cm 时的数据，$V_{YZ} = 2.9$ V。

$R_D = \frac{470\ \Omega \times 2.9\ \text{V}}{0.15\ \text{V}} = 9086.7\ \Omega \approx 9.09 \times 10^3\ \Omega$。

(ii) 距离由 0 cm 增至 15 cm 时，V_{YZ} 逐渐减小；从 20 cm 起，$V_{YZ} = 2.2$ V，保持不变。

答：(i) $9.09 \times 10^3\ \Omega$；(ii) 电势差随距离增大而减小，从 20 cm 起保持不变。

五. 沿趋势外推下一结果

知识点 根据已有数据的变化规律估计测量范围以后的值，称为_____。

在周围环境近似不变时，冷却过程中温度降低，相邻等时段的降温幅度通常逐渐_____。

平均冷却速率为 $x = \frac{\theta_1 - \theta_2}{t_2 - t_1}$，单位为 °C/s。

物体放置足够长时间后温度趋近室温；按趋势外推的结果应符合物理下限或_____。

答案：外推；减小；终值

怎么认 题目出现已有数据并要求估计更晚时刻或更大范围的值时，先判断变化方向和变化幅度，再沿趋势外推。

例题 5 In this experiment, you will investigate the cooling of hot water in a beaker.

Refer to Fig. 2.1.

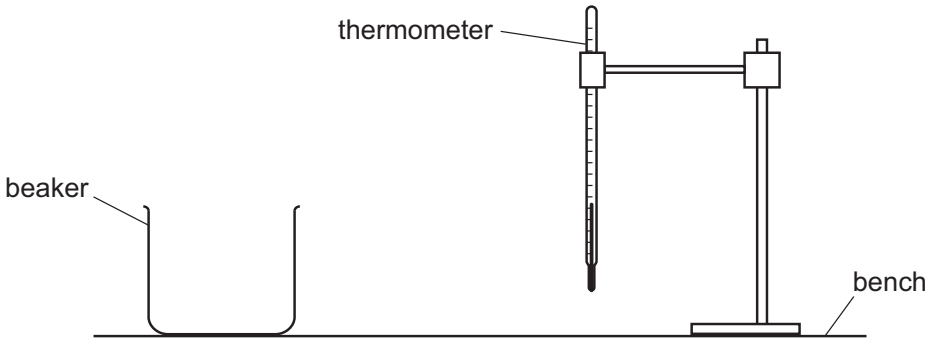


Fig. 2.1

(c) (i) Calculate the average cooling rate x_1 during the first 90 s of the experiment. Use your readings from Table 2.1 and the equation:

$$x_1 = \frac{\theta_0 - \theta_{90}}{T}$$

where T = 90 s and θ_0 and θ_{90} are the temperatures at t = 0 and t = 90 s.
Include the unit for the cooling rate.

(ii) Calculate the average cooling rate x_2 during the middle 90 s of the experiment. Use your readings from Table 2.1 and the equation:

$$x_2 = \frac{\theta_{90} - \theta_{180}}{T}$$

where T = 90 s and θ_{90} and θ_{180} are the temperatures at t = 90 s and t = 180 s.

(iii) Calculate the average cooling rate x_3 during the last 90 s of the experiment. Use your readings from Table 2.1 and the equation:

$$x_3 = \frac{\theta_{180} - \theta_{270}}{T}$$

where T = 90 s and θ_{180} and θ_{270} are the temperatures at t = 180 s and t = 270 s.

(d) (i) The temperature of the water decreases over time.

Use your results from **(c)** to describe the overall pattern of the rate of cooling of the water in the experiment. Justify your answer by reference to your results.

(ii) Estimate the final temperature θ_F of the water after several hours.

（2025 夏季 0625/53 第2题(d)）

解：由(c)的三个计算结果可见，$x_1 > x_2 > x_3$。
因此，水的冷却速率随时间逐渐减小。
数小时后水温趋近室温，故 $\theta_F \approx \theta_R$。
答：(i) 冷却速率随时间逐渐减小；(ii) $\theta_F \approx \theta_R$。

P.5 评估与改进

题型 1：判断结果是否可信（考频★★★☆☆）

知识点 实验测量所得的两个数值不必完全相同；差异在实验准确限度内时，可认为两者相等。

以参考值 x_0 与待比较值 x 计算，$p=\frac{|x-x_0|}{|x_0|}\times 100\%$；百分差 p 没有_____。

参考值优先取题目给定的理论值或指定值；未指定时，可取其中一个测量值并在计算中保持一致。

本课程的实验准确限度通常按约 _____ 估计；判断两值是否相等时，将 p 与 10% 比较。

当 p _____ 10% 时，结果支持相等关系；超过该限度时，结果不支持相等关系。

答案：单位；$\pm 10\%$；不大于

怎么认 题目出现是否在实验准确限度内相等及两组数值时，先算百分差并与 10% 比较。

一. 算百分差再与 10% 比较

例题 1 In this experiment, you will investigate the magnification of the image produced by a lens.

Carry out the following instructions, referring to Fig. 3.1 and Fig. 3.2.

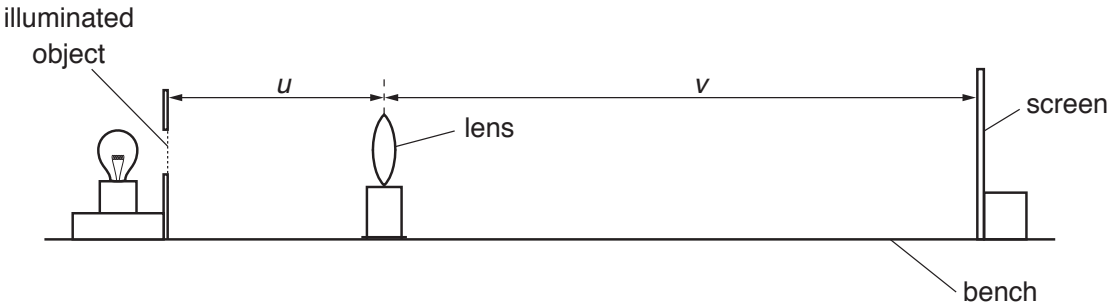


Fig. 3.1

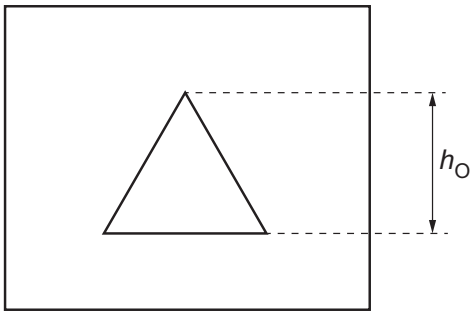


Fig. 3.2 (not to scale)

(c) A student suggests that the magnification m is equal to the ratio $\frac{h_I}{h}$

(i) State whether your results agree with the suggestion. Justify your statement by reference to your results.

(ii) Suggest how you would continue to use the same apparatus to test the suggestion that the magnification m is equal to the ratio $\frac{h_I}{h}$

（2023 冬季 0625/51 第3题(c)）

解：（i）取 m 为参考，

$p=\frac{\left|m-\frac{h_I}{h_O}\right|}{m}\times 100\%$

由实验结果得 $p\le 10\%$，故实验结果同意该观点。

（ii）改变物距 u，重复测量并计算 m 与 $\frac{h_I}{h_O}$，使读数总数不少于 5 组，再比较每组结果。

二. 换人换条件复测并查散点

知识点 再现性表示更换实验者或装置后，在_____下所得结果的一致程度；结果的差值沿用被测量量的单位，相对差异用 % 表示。

两结果的相对差异不超过约 10% 时，可认为它们在实验精度范围内相等；超过时应查找测量误差、随机误差或系统误差。

判断结果是否可信，应看散点是否紧贴_____，再增加数据、重复测量取_____，必要时换实验者和装置复测。

答案：相同条件；最佳拟合线；平均值

怎么认 题目出现不同学生读数不一致或散点图时，先找装置固有限制，或看散点是否贴近最佳拟合线。

例题 2 In this experiment, you will determine the resistance per unit length of a resistance wire. The circuit has been set up for you.

Carry out the following instructions, referring to Fig. 3.1.

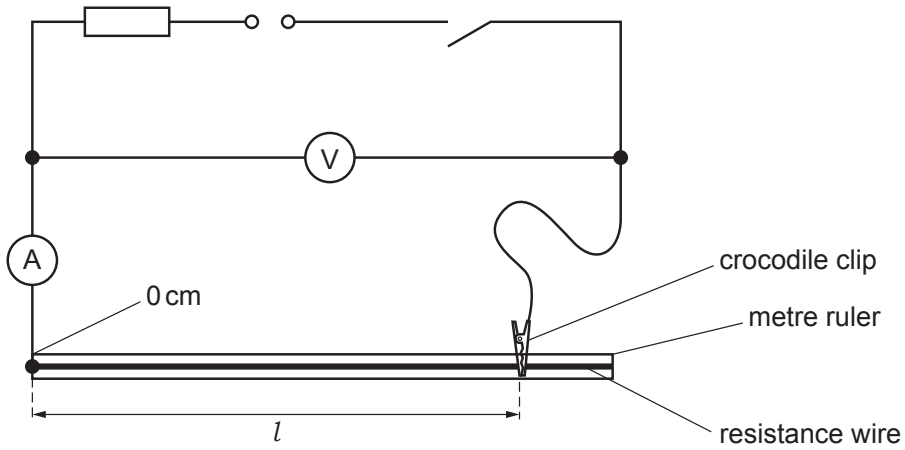


Fig. 3.1

(e) Suggest **one** practical reason why students carrying out this experiment may not obtain the same readings as yours. Assume that the procedure has been done carefully.

（2023 春季 0625/52 第3题(e)）

解：由图可知，鳄鱼夹决定接入电路的电阻丝长度。

鳄鱼夹与电阻丝的接触位置难以精确确定，不同学生接入的长度略有不同，因而读数不同。

答：鳄鱼夹的接触位置难以精确确定。

针对练习

1. A student investigates the refraction of light by a transparent block.

The student's ray-trace sheet is shown full-size in Fig. 3.1.

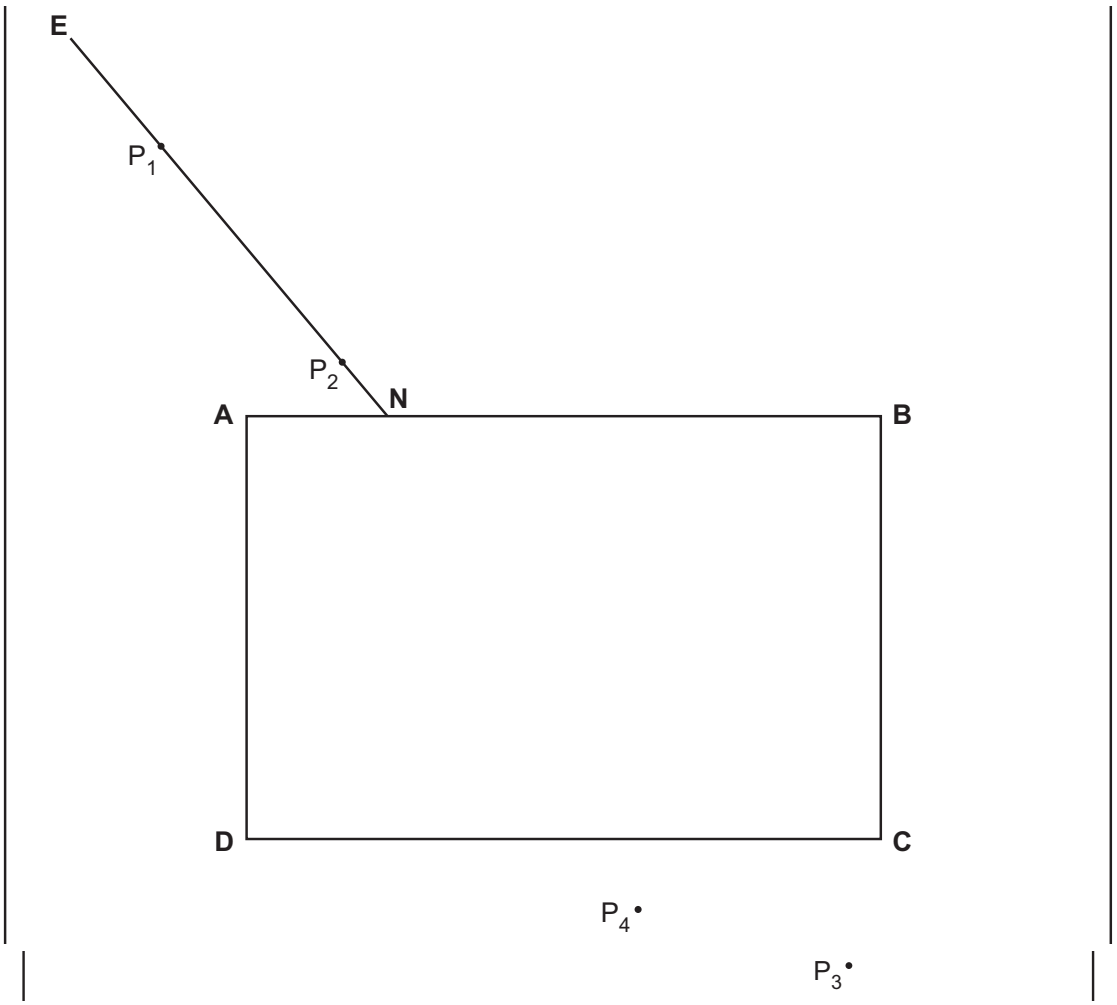


Fig. 3.1

(f) Suggest **one** reason why different students, all doing this experiment carefully, may not obtain identical results.

（2025 春季 0625/62 第3题(f)）

【答案】插针难以精确对准。
【解析】插针有一定粗细，沿视线对准时，各针的位置难以完全重合，因而不同学生画出的光线路径略有差异。
答：插针难以精确对准。

2. A student determines the resistance of a resistor.

She uses the apparatus shown in Fig. 2.1.

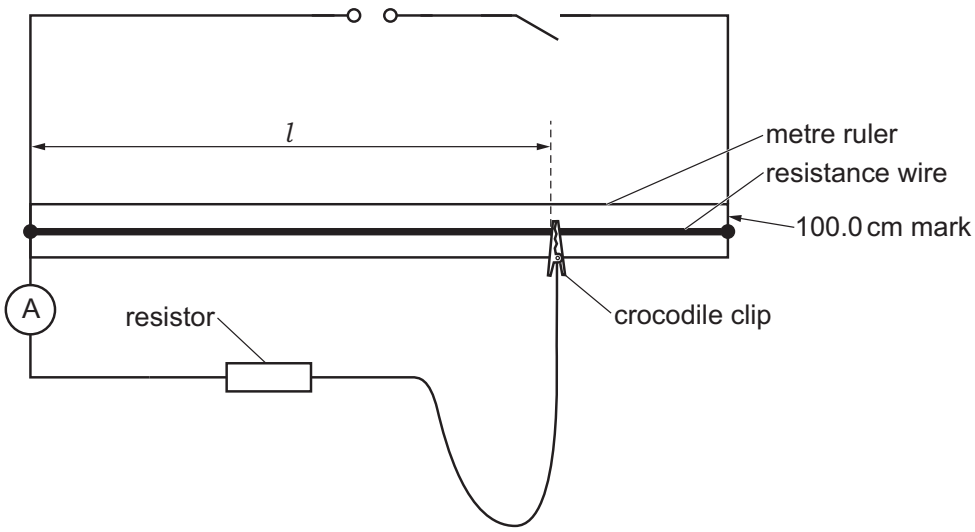


Fig. 2.1

(f) Suggest **one** practical reason why other students might not obtain the same result as this student, even if they do the experiment carefully.

（2024 冬季 0625/63 第2题(f)）

【答案】电阻丝粗细不均匀。

【解析】电阻丝各处粗细可能不完全相同，由 $R=\rho\frac{l}{A}$ 得，横截面积 A 不同会使测得的电阻不同。

答：电阻丝粗细不均匀。

题型 2：定位误差并配对改进（考频★★★★★）

知识点　实际光束、铅笔线和针孔都有宽度，靠目测判断共线时，所确定的光线方向存在_____。

用削尖的铅笔画细线，并使插针_____于纸面，可减小画线和对准造成的方向误差。

同一直线上的两枚插针应相距较远；针距越大，相同位置偏差造成的方向误差越_____。针距是长度，单位为 cm 或 mm。

答案：不确定度；垂直；小

怎么认 题目出现光线图、插针或要求评价光线追踪的准确性时，先判断线宽、插针方向和针距。

一. 光线宽度或插针对准误差

例题 1 A student investigates the refraction of light by a transparent block.

The student's ray-trace sheet is shown full-size in Fig. 3.1.

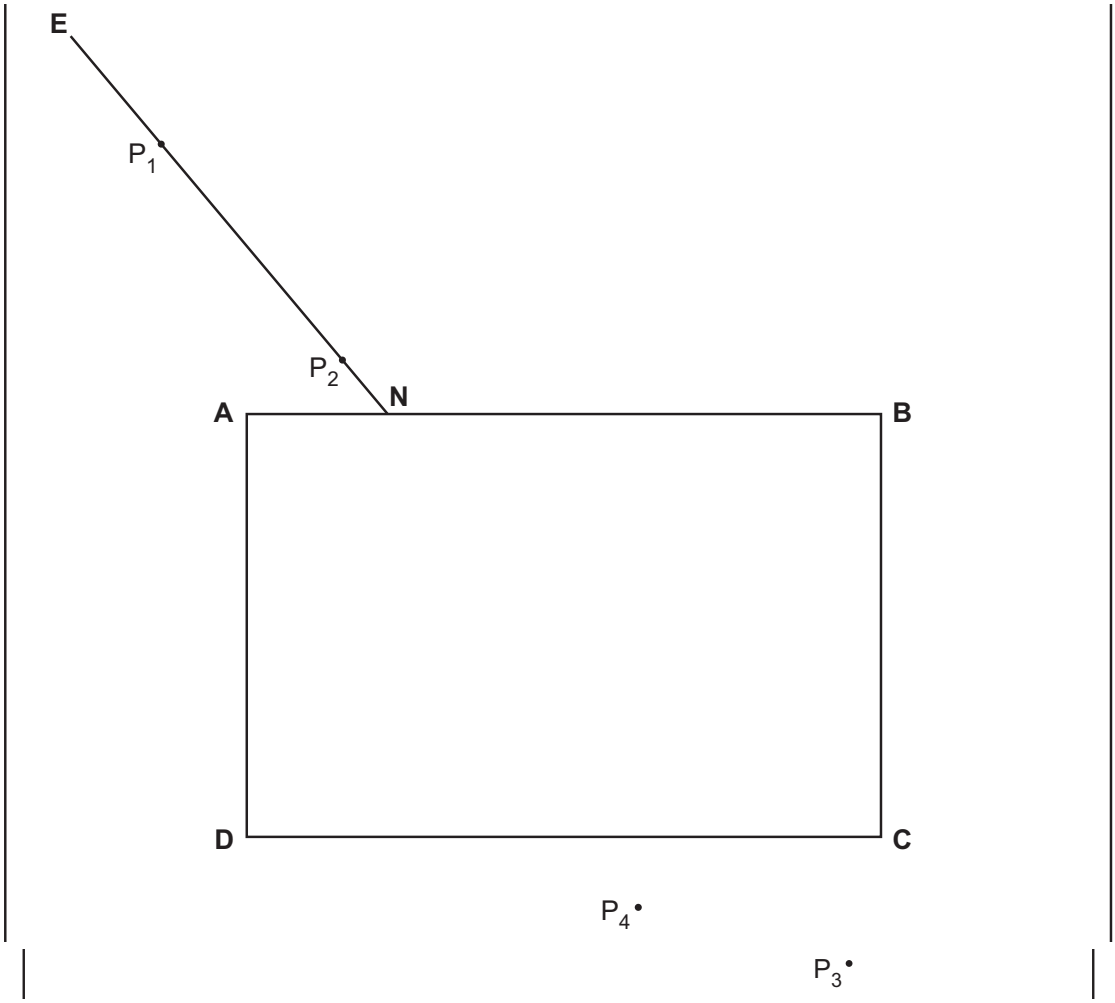


Fig. 3.1

(b) The student places two pins P_1 and P_2 on line **EN** as shown in Fig. 3.1.

(i) Measure distance *d* between pins P_1 and P_2.

(ii) State whether the two pins are a suitable distance apart for accurate ray tracing. Explain your answer.

（2025 春季 0625/62 第3题(b)）

解：由图按全尺寸量得

$d = 4.0$ cm

两针间距较小，相同的位置偏差会造成较大的方向误差；针距应尽可能大。

答：$d = 4.0$ cm；两针距离不适合准确的光线追踪，应增大针距。

针对练习

1. A student investigates the refraction of light by a transparent block.
He determines a quantity known as the refractive index of the material of the block.

The student's ray-trace sheet is shown full-size in Fig. 3.1.

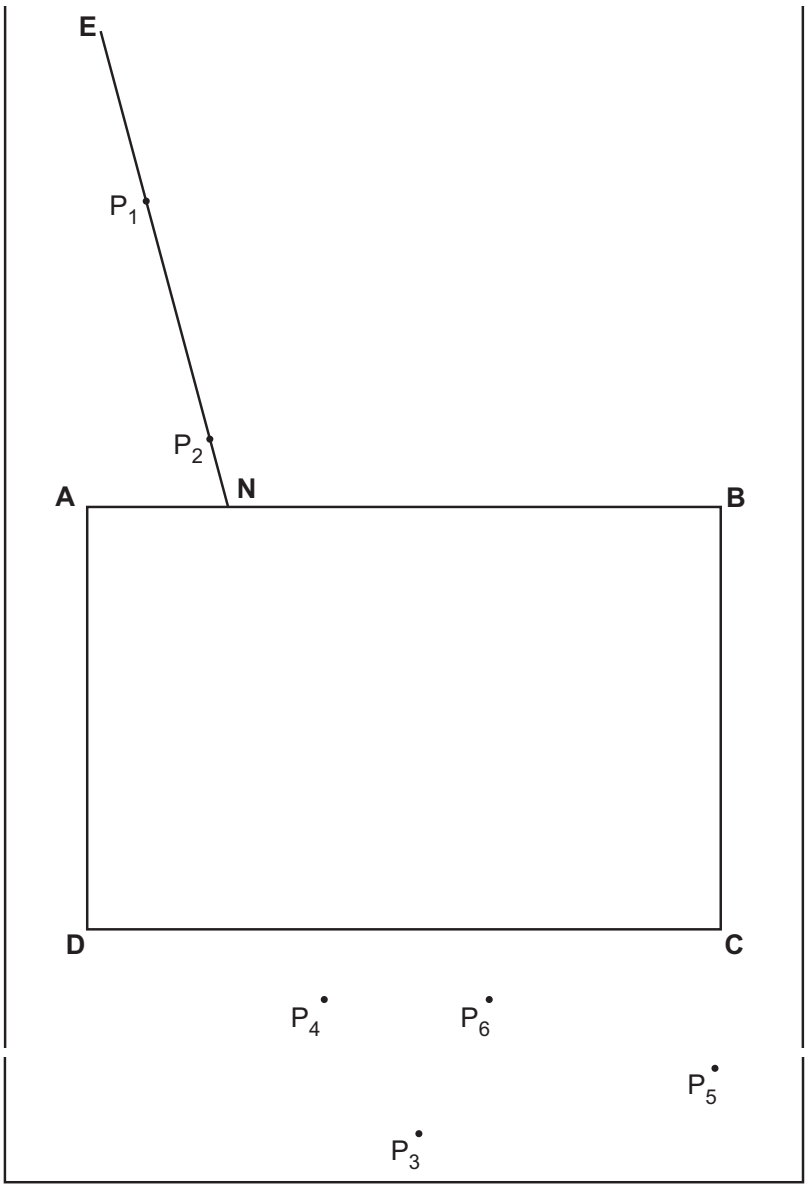


Fig. 3.1

(f) Suggest **one** technique to use in this type of experiment to ensure results are accurate.

（2024 冬季 0625/63 第3题(f)）

【答案】用削尖的铅笔画细线。
【解析】铅笔线越细，判定光线路径中心的位置不确定度越小。
答：用削尖的铅笔画细线。

2. In this experiment, you will investigate the reflection of light by two mirrors.

Carry out the following instructions, using the separate ray-trace sheet provided.
You may refer to Fig. 3.1 for guidance.

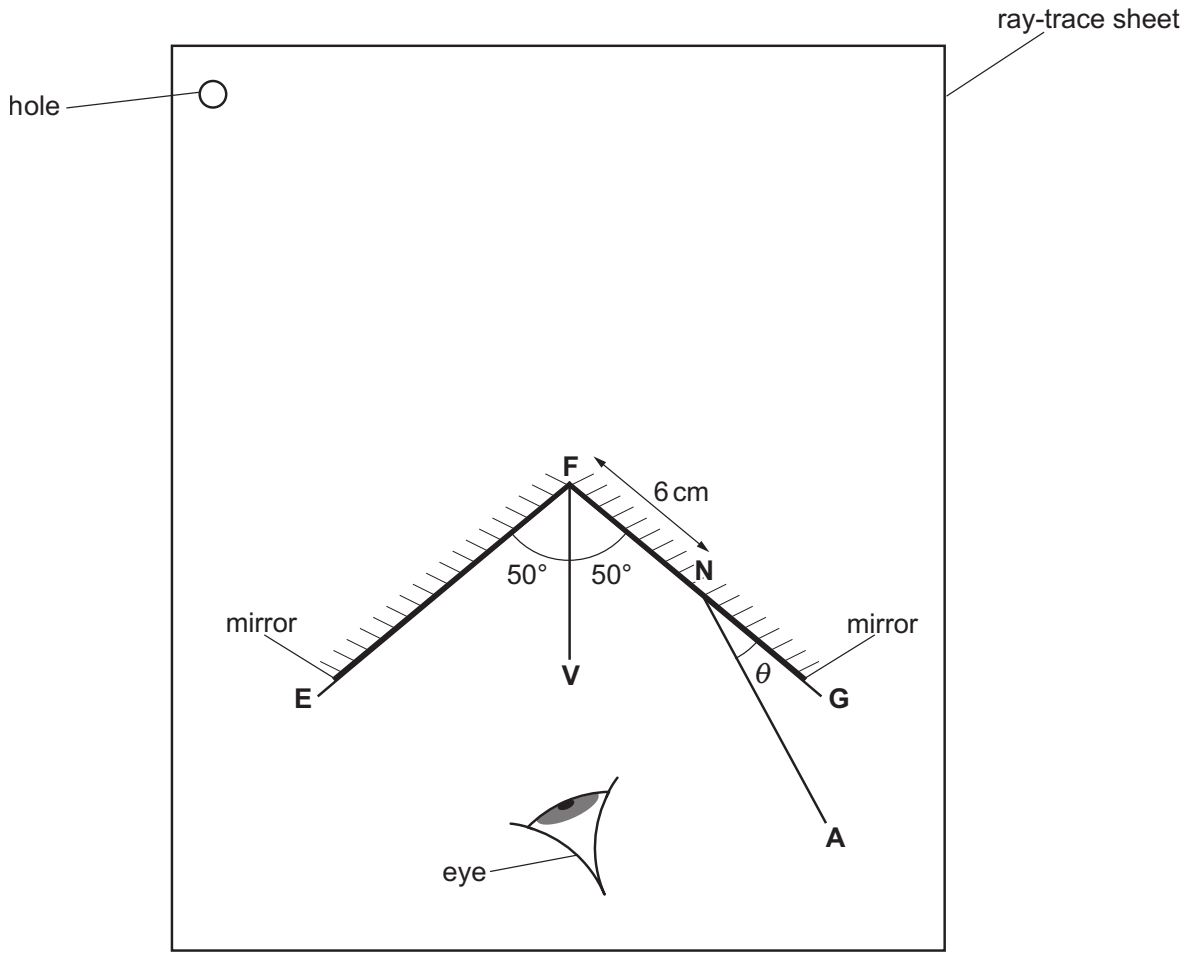


Fig. 3.1

(e) Suggest **one** precaution to take in this type of experiment to ensure accurate results.

（2023 夏季 0625/53 第3题(e)）

【答案】使两枚插针相距较远。
【解析】增大针距后，相同的位置偏差造成的方向误差较小。
答：使两枚插针相距较远。

3. A student investigates the reflection of light by a plane mirror.
The student's ray-trace is shown full-size in Fig. 1.1.

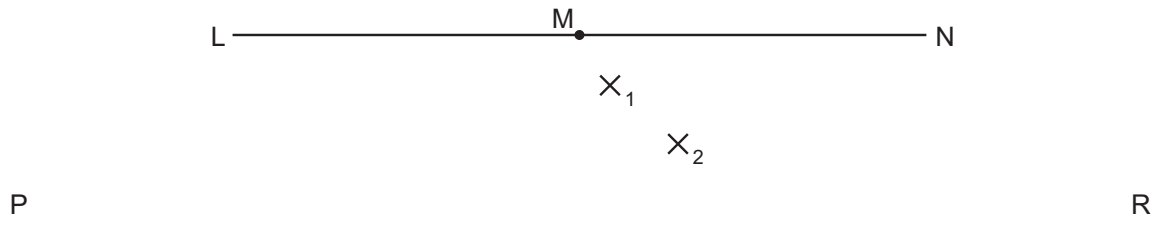


Fig. 1.1

(g) Suggest **one** source of inaccuracy in this experiment, even if it is carried out very carefully.

（2025 冬季 0625/62 第1题(g)）

【答案】光线有宽度，难以确定光线的中心。
【解析】实际光线有一定宽度，其中心位置不能被准确判定。
答：光线有宽度，难以确定光线的中心。

4. In this experiment, you will investigate the deviation of a ray of light passing through a transparent block and determine a quantity called the refractive index *n* of the block.

(d) Suggest **one** source of inaccuracy in this experiment, even if it is carried out very carefully.

（2024 夏季 0625/52 第3题(d)）

【答案】难以使入射光线与 FE 准确重合。
【解析】光线和所画线条均有宽度，依靠目测不能使两者完全重合。
答：难以使入射光线与 FE 准确重合。

二. 夹持、多点或排气泡

知识点 测量误差是测量值与真值之间的偏离，来源包括测量误差、随机误差和系统误差；不确定度与被测量使用相同单位。
改进措施必须与误差来源_____；量具分度值越小，读数不确定度通常越_____。
物体边界不规则时，应在多处测量并取平均值；必要时可用平行挡板确定两端位置。
排水法测体积时，物体须完全浸没，并排尽附着的_____。

答案：对应；小；气泡

怎么认 题目出现测量装置、近似结果或要求评价改进时，先定位误差来源，再写与其配对的改进。

例题 2 In this experiment, you will determine the diameter of a marble by two methods and calculate the density of the material from which the marble is made.

Method 1

Carry out the following instructions, referring to Fig. 1.1.

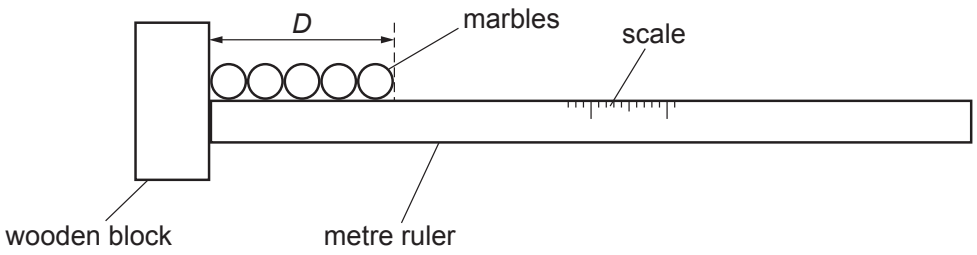


Fig. 1.1 (Apparatus viewed from above)

(c) **(i)** Use the top-pan balance as shown in Fig. 1.2 to measure the mass *m* of one of the marbles.

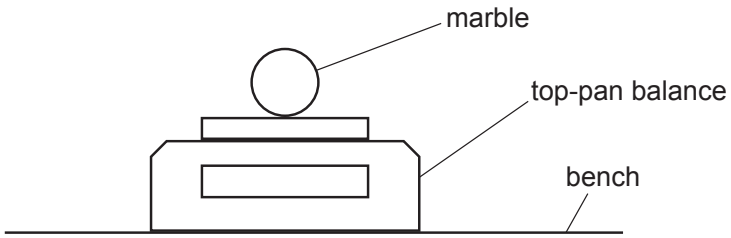


Fig. 1.2

(ii) Pour approximately 25 cm^3 of water into the measuring cylinder.

Record the reading V_1 of the water level in the measuring cylinder.

Carefully place the 5 marbles into the water in the measuring cylinder as shown in Fig. 1.3.

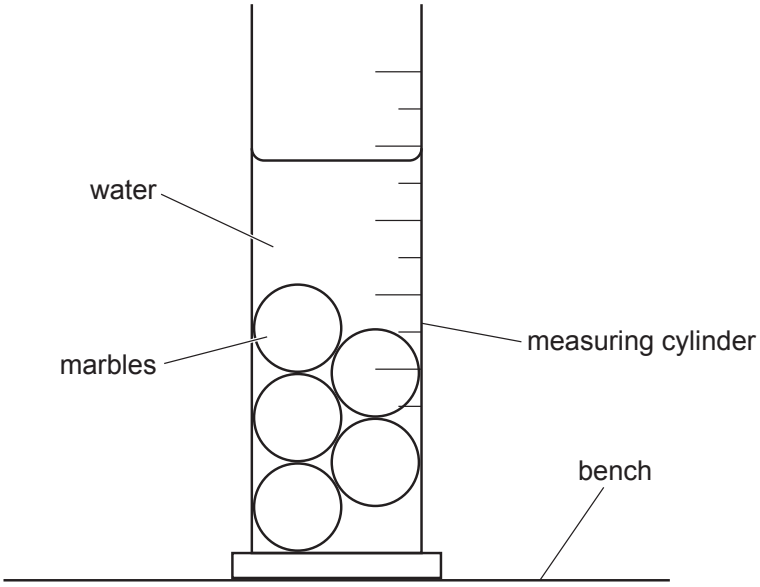


Fig. 1.3

Record the new reading V_2 of the water level in the measuring cylinder.

Calculate a value for the average volume V of **one** marble. Use the equation

$$\frac{V_2 - V_1}{5}$$

(iii) Draw, on Fig. 1.3, an arrow showing the correct line of sight for reading the water level in the measuring cylinder.

(iv) Calculate a value for the density ρ of the material from which the marble is made. Use your values of m from **(c)(i)**, V from **(c)(ii)** and the equation

$$\rho = \frac{m}{V}.$$

(d) Describe **one** possible source of inaccuracy in the method described in **(c)** and suggest **one** improvement to reduce its effect.

（2023 春季 0625/52 第1题(d)）

解：量筒分度值较大，水位读数的不确定度较大。

换用量程较小、分度值较小的量筒，可减小读数不确定度。

答：误差来源是量筒分度值较大；改用分度值较小的量筒。

5. A student determines the density of modelling clay by two methods.

Method 1

He uses the block of modelling clay shown in Fig. 1.1.

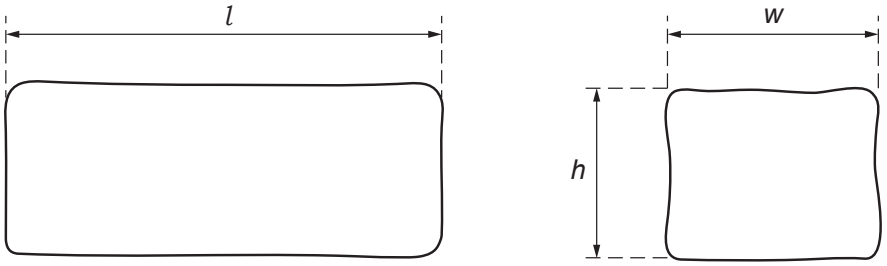


Fig. 1.1

(b) Suggest why the value of V_A is only an approximation of the volume of the block.

Describe how the accuracy of V_A can be improved.

（2024 夏季 0625/63 第1题(b)）

【答案】黏土块边界不规则，长、宽、高难以准确测量；在各方向的多个位置测量并分别取平均值。
【解析】黏土块表面不规则，同一方向在不同位置的尺寸不同，故 $V_A = lwh$ 仅为近似值。
在长、宽、高方向各选多个位置测量并分别取平均值，再由 $V_A = l_{平均}w_{平均}h_{平均}$ 求体积。
答：不规则边界使尺寸难以准确测量；应多处测量并取平均值。

6. Sand is a granular material composed of very small, irregularly-shaped mineral particles. A student determines the density of sand by two methods.

She uses the apparatus shown in Fig. 1.1 and Fig. 1.2.

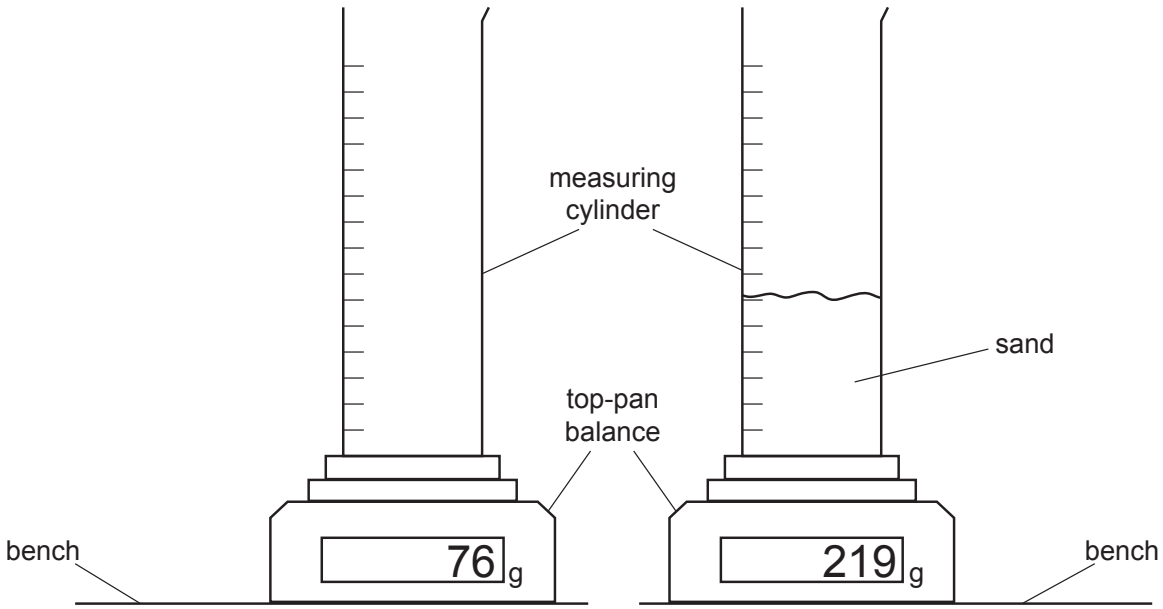


Fig. 1.1 **Fig. 1.2**

Method 1

(iii)

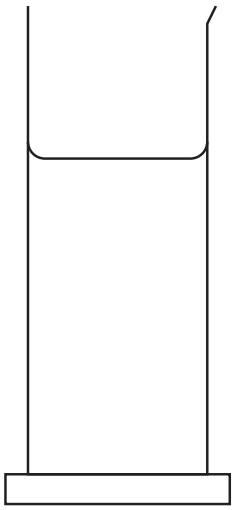


Fig. 1.4

On Fig. 1.4, draw an arrow showing the correct line of sight for reading the volum water in the measuring cylinder.

(c) Another student wants to determine the density of the particles in a similar sample of sand.

(i) Explain why **method 1** would **not** be a suitable method for him to use.

(ii) Explain why **method 2** would give a more accurate value for the density **of the particles** in this sample of sand.

（2023 冬季 0625/63 第1题(c)）

【答案】(i) 方法 1 测得的体积包含砂粒间的空隙；(ii) 方法 2 中水填满砂粒间隙，排水体积更接近砂粒本身的总体积。

【解析】方法 1 测得的总体积包含砂粒间的空气间隙，所得体积大于砂粒本身的总体积。

方法 2 中水进入砂粒间隙并排出其中的空气，排水体积对应砂粒本身的总体积，故所得密度更准确。

答：(i) 方法 1 包含砂粒间隙；(ii) 方法 2 用水填满间隙，测得砂粒本身的总体积。

三. 往返判焦或放大像再量

知识点 测量改进应针对误差来源：直尺或手遮挡光路时，应改变读数方式，使测量过程不影响成像。

像边缘模糊时，应_____移动屏，从两个方向分别确定最清晰位置，再取中间位置。

测量像高时，可在屏上固定_____，或使用半透明屏从背面读数；像高很小时，应得到_____的像，以减小百分比不确定度。

像高和屏的位置用 cm 或 mm 表示；比较不同测量结果时，装置的其他条件应保持不变。

答案：缓慢往返；方格纸；更大

怎么认 题目出现测量像高或判断最清晰屏位置并要求困难与改进时，先定位遮光、边缘模糊或像过小，再配对改进。

例题 3 In this experiment, you will determine the focal length of a converging lens by two methods.

Refer to Fig. 3.1.

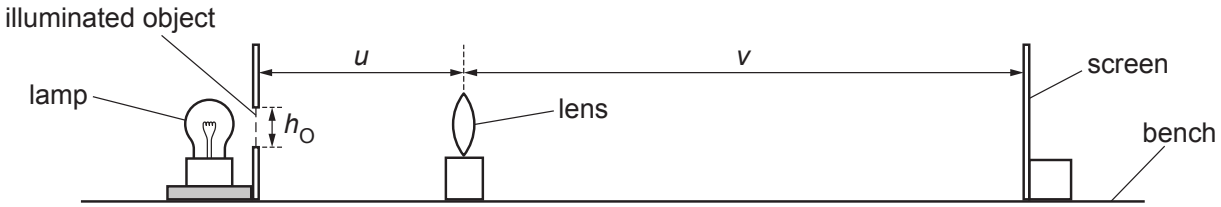


Fig. 3.1

(c) Describe **one** difficulty that is experienced when using a ruler to measure the height of the image. Suggest an improvement to the apparatus to overcome this.
You are **not** required to do an experiment with this improved apparatus.

（2024 春季 0625/52 第3题(c)）

解：答：用直尺测量像高时，直尺或手会遮挡光线，使屏上的像不完整。可把方格纸固定在屏上，按方格测量像高。

7. In this experiment, you will investigate the image produced by a lens.

Refer to Fig. 3.1 and Fig. 3.2.

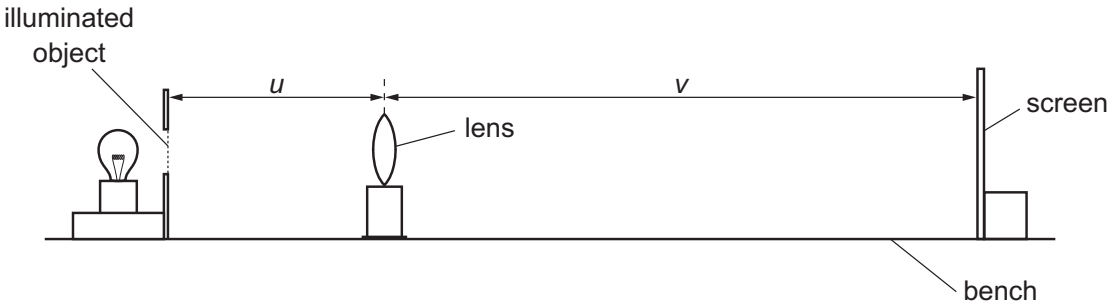


Fig. 3.1

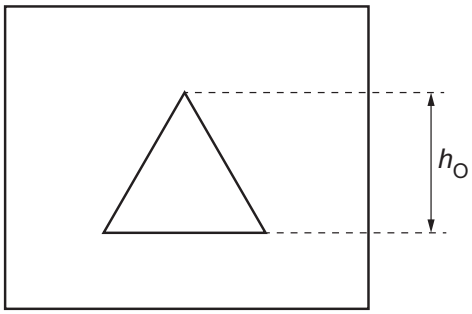


Fig. 3.2

(f) In this type of experiment, it can be difficult to judge the screen position that produces the clearest image.

Suggest **one** precaution or technique to overcome this difficulty.

（2024 夏季 0625/51 第3题(f)）

【答案】缓慢往返移动屏，从两个方向接近最清晰位置并取平均位置。
【解析】答：缓慢往返移动屏，从两个方向分别接近最清晰像的位置，记录两次屏的位置并取平均值。

8. In this experiment, you will investigate the inverted image produced by a converging lens.

Refer to Fig. 3.1.

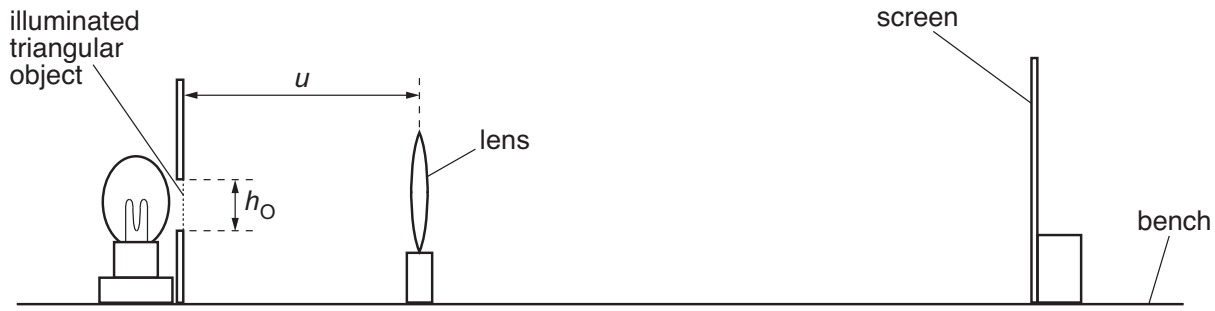


Fig. 3.1

(e) Describe **one** difficulty that can be experienced when measuring the height of the image in this experiment.

Suggest an improvement to overcome this difficulty.

（2025 冬季 0625/53 第3题(e)）

【答案】手或直尺遮挡像；使用半透明屏并从背面测量。
【解析】答：测量像高时，手或直尺会挡住光线，使屏上的像不完整。可使用半透明屏，并从屏的背面测量像高。

四. 夹逼平衡点或校正重心

知识点　米尺在支点两侧力矩相等时平衡；平衡状态难以判定时，可分别记录尺刚向两侧倾斜时的负载位置，取两位置的_____作为平衡位置。

无负载的米尺若不在 50.0 cm 标记处平衡，说明实际_____偏离名义中点；计算米尺重力的力臂时，应由实际重心量至支点，长度用 cm。

在尺端添加黏土会改变待测米尺的_____；测量原米尺的质量时不宜采用这种校正。

答案：中点；重心；质量

怎么认 题目出现难以准确平衡或无负载时不在 50.0 cm 处平衡时，先夹逼平衡位置或改用实际重心。

例题 4

In this experiment, you will use a balancing method to determine the mass of a metre ruler.

Refer to Fig. 1.1.

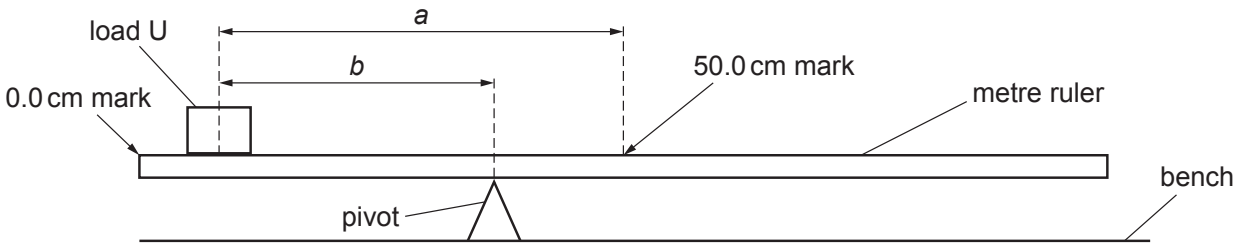


Fig. 1.1

(e) The accuracy of the result obtained by this procedure depends on the metre ruler, without a load, balancing with the pivot at the 50.0 cm mark.
A student finds that this does not happen. He adds a small piece of modelling clay to one end of the metre ruler to correct it.
Suggest if this is a suitable change for this experiment. Explain your answer.

（2024 春季 0625/52 第1题(e)）

解：所测物理量为原米尺的质量。加入黏土后，黏土与米尺共同参与平衡，使被测物的质量增大。

答：不适合，因为黏土改变了待测米尺的质量。

9. A student investigates the balancing of a metre ruler.

Fig. 1.1 shows the set-up.

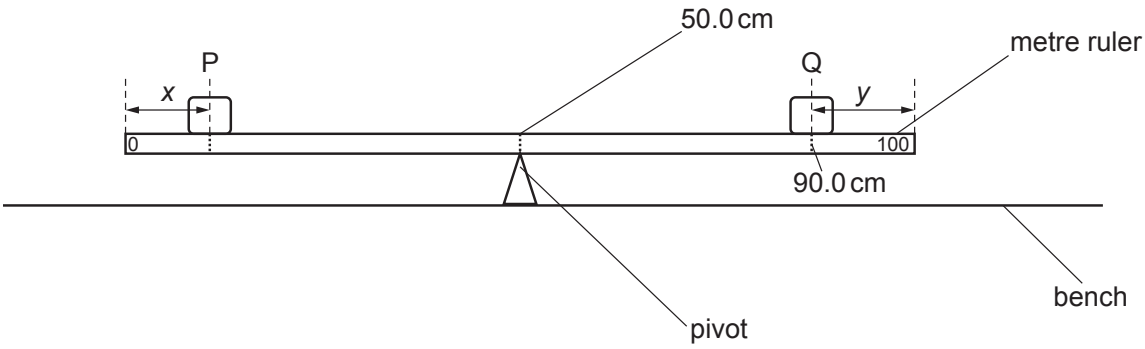


Fig. 1.1

(b) The student places a load P of weight P = 2.0 N on the metre ruler.

He adjusts the position of the load so that the metre ruler is as near as possible to being balanced. He measures the distance x from the centre of P to the zero end of the ruler.

He repeats the procedure using loads of weight P = 3.0 N, 4.0 N, 5.0 N and 6.0 N. The values of P and x are shown in Table 1.1.

Table 1.1

P/N	x/cm
2.0	10.2
3.0	23.1
4.0	30.0
5.0	33.8
6.0	36.8

Describe the main difficulty that a student has when doing this experiment as accurately as possible.

（2023 夏季 0625/61 第1题(b)）

【答案】难以获得准确平衡。
【解析】负载位置连续改变，而米尺由向一侧倾斜转为向另一侧倾斜，恰好平衡的位置难以判定。
答：难以获得准确平衡。

10. In this experiment, you will investigate the balancing of a metre ruler.

Refer to Fig. 1.1.

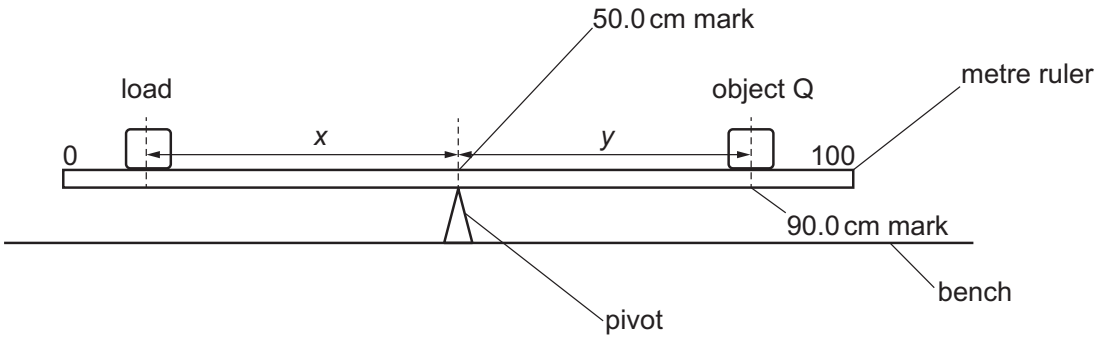


Fig. 1.1

(f) It is difficult to find the position of the load to obtain the exact balance of the metre ruler.

Explain how you try to overcome this difficulty.

（2025 冬季 0625/51 第1题(f)）

【答案】缓慢来回移动负载，分别找出米尺刚向两侧倾斜时的位置，取两位置的中点。
【解析】缓慢来回移动负载，设米尺刚向两侧倾斜时的负载位置分别为 x_1 和 x_2。
$x = \frac{x_1+x_2}{2}$
答：取两临界位置的中点作为平衡位置。

11. In this experiment, you will determine the mass M_R of a metre ruler using a balancing method.

Carry out the following instructions, referring to Fig. 1.1.

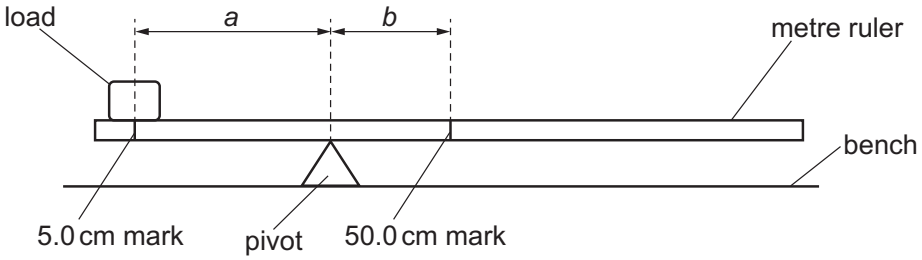


Fig. 1.1

(a) (i) Place a load of mass M = 20 g with its centre at the 5.0 cm mark of the metre ruler.

Explain briefly how you make sure that the centre of the load is at the 5.0 cm mark.
You may draw a diagram if it helps your explanation.

(ii) Place the metre ruler on the pivot. Adjust the position of the metre ruler on the pivot until the metre ruler is as near as possible to being balanced. Check that the position of the centre of the load remains at the 5.0 cm mark.

Record, in Table 1.1, the scale reading p on the ruler at the position of the pivot.

Calculate, and record in Table 1.1:

- The distance a between the 5.0 cm mark and the pivot.
  Use your value of p and the equation $a = p - 5.0$.
- The distance b between the 50.0 cm mark and the pivot.
  Use your value of p and the equation $b = 50.0 - p$.

Repeat this procedure for values of M = 40 g, 60 g, 80 g and 100 g.

Table 1.1

M/g	p/cm	a/cm	b/cm	$\frac{b}{a}$
20				
40				
60				
80				
100				

(e) The determination of M_R by this method assumes that the centre of mass of the metre ruler is at the 50.0 cm mark.

A student finds that the centre of mass of his metre ruler is at the 48.7 cm mark.

Suggest how he changes the procedure in **(a)(ii)** to allow for this.

（2023 夏季 0625/53 第1题(e)）

【答案】将 $b = 50.0 - p$ 改为 $b = 48.7 - p$。
【解析】米尺重力作用于 48.7 cm 标记处，支点标记读数为 p，故重力力臂为
$b = 48.7 - p$
其中各长度均以 cm 计。
答：将 $b = 50.0 - p$ 改为 $b = 48.7 - p$。

五. 增大被测量减小相对误差

知识点 测量的不确定度表示读数可能偏离测量值的范围，绝对不确定度与被测量具有相同单位；相对不确定度为 $\Delta\frac{x}{x}$，没有单位。
在仪器和读数方法不变时，绝对不确定度近似固定；被测量越小，相对不确定度越_____。
测量距离或尺寸时，可增大被测量；测量周期性过程时，可测量_____次过程的总时间，再求单次时间。
总距离或总时间增大后，固定不确定度所占比例变_____，测量准确程度提高。

答案：大；多；小

怎么认 题目出现被测距离、尺寸或时间很小，并要求解释误差或改进方法时，先比较固定不确定度所占比例。

例题 5 A student strikes a tuning fork on a wooden block. The tuning fork is held close to the students' ear as shown in Fig. 8.1.



Fig. 8.1

(c) Two students determine a value for the speed of sound in air. Fig. 8.2 illustrates the method they use.

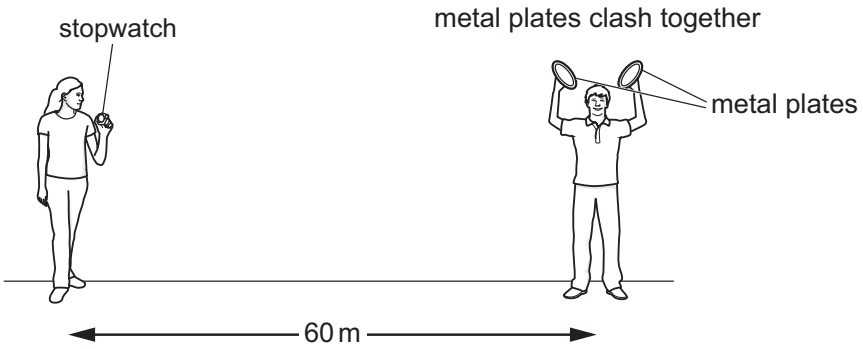


Fig. 8.2 (Not to scale)

The girl starts the stopwatch when she sees the metal plates clash together. She stops the stopwatch when she hears the sound of the clashing metal plates. The students use the time on the stopwatch to calculate the speed of sound.

The value for the speed of sound obtained by the students is different from the true value for the speed of sound in air.
Explain why the students' value is different.

（2025 春季 0625/32 第8题(c)）

解：女孩启动和停止停表时均存在反应时间，所测时间间隔与声音的实际传播时间不同。
所测距离和时间间隔较小，反应时间所占比例较大，由 $v = \frac{s}{t}$ 算得的声速因而与真实值不同。
答：人的反应时间使计时产生误差，且距离或时间间隔太小。

针对练习

12. A student determines the volume of a block of modelling clay by two methods.

Method 1

He measures the block of modelling clay shown full size in Fig. 1.1.

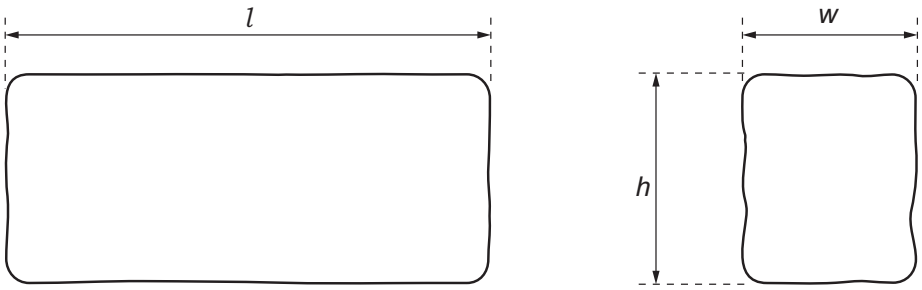


Fig. 1.1

(a) (i) Measure the length l, width w and height h of the block of modelling clay on Fig. 1.1. Record your values in centimetres to the nearest millimetre.

(ii) Calculate a value V_A for the volume of the block. Use your measurements from **(a)(i)** and the equation:

$$V_A = l \times w \times h.$$

(c) Another student measures the dimensions of a block of clay which is much smaller than the block in **(a)**. Suggest why these measurements may not be as accurate as yours, even if they are done carefully.

（2025 冬季 0625/63 第1题(c)）

【答案】黏土块的尺寸较小，固定读数不确定度所占比例较大，百分比不确定度较大。
【解析】刻度尺的绝对不确定度近似固定。
黏土块的 l、w、h 较小，$\Delta\frac{l}{l}$、$\Delta\frac{w}{w}$、$\Delta\frac{h}{h}$ 较大，故由 $V_A = l \times w \times h$ 得到的体积准确程度较低。
答：尺寸越小，百分比不确定度越大。

题型 3：排查装置系统偏差（考频★★☆☆☆）

知识点 系统偏差是由装置或实验方法造成的、使测量结果持续向同一方向偏移的误差。

公平比较要求除研究因素外，其余条件均保持_____；比较隔热效果时，两杯水的初温、水量、容器和环境条件应相同。

平均冷却率 $R = \frac{\theta_0 - \theta_t}{\Delta t}$，单位为_____；周围水升温会使温差减小，使测得的冷却率偏小。

应按偏差来源改进装置，如增大恒温浴、加盖或包覆隔热材料。

答案：相同；$^\circ C\ s^{-1}$

怎么认 题目出现装置条件改变或要求减小实验影响时，先判断结果偏移方向，再消除偏差来源。

例题 1

In this experiment, you will investigate the cooling of hot water in surroundings with different temperatures.

Carry out the following instructions, referring to Fig. 2.1 and Fig. 2.2.

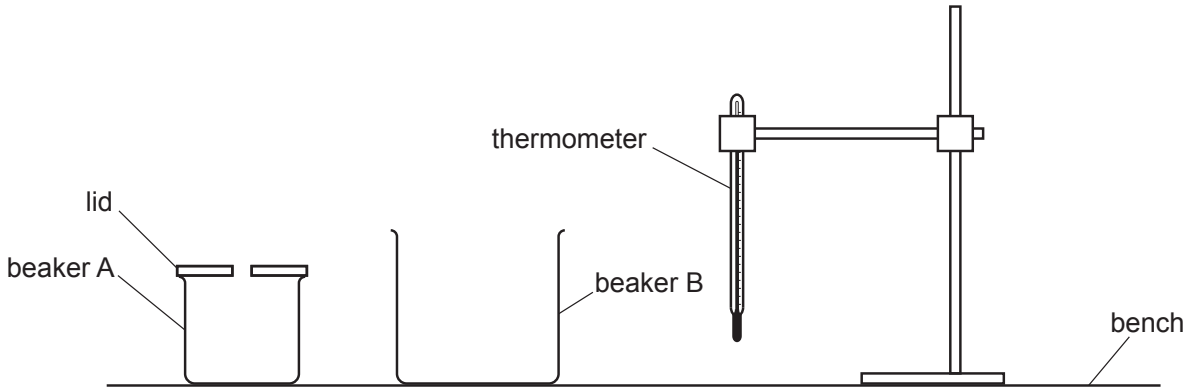


Fig. 2.1

(f) During the experiment, the increase in temperature of the water surrounding beaker A affects the results of the investigation.

Suggest **one** change to the experiment to reduce this effect.

（2023 冬季 0625/53 第2题(f)）

解：由 $\Delta\theta = \frac{Q}{mc}$ 得，周围水的质量越大，吸收相同热量时温升越小。

答：增大烧杯 A 周围水的体积。

针对练习

1. A student investigates the cooling of hot water in surroundings with different temperatures.

He uses the apparatus shown in Fig. 2.1.

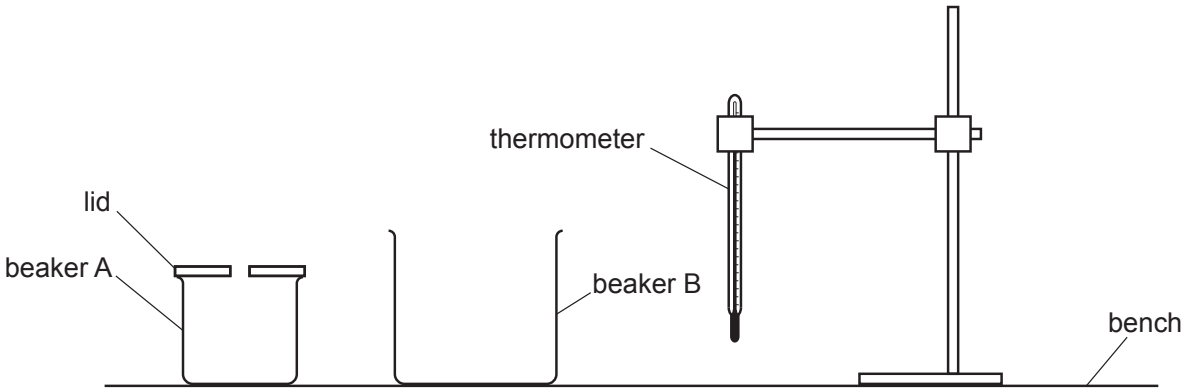


Fig. 2.1

(f) After 180 s, the student measures the temperature of the water surrounding beaker A in the first experiment and finds that θ_1 = 49 °C.

(i) State the reason why this can affect the results of the investigation and suggest what effect it has on the value of cooling rate *R*.

(ii) Suggest **one** change to the experiment to reduce the effect in **(f)(i)**.

（2023 冬季 0625/63 第2题(f)）

【答案】周围水的温度未保持恒定，末温较高；R 偏小；增大烧杯 A 周围水的体积。
【解析】实验后烧杯 A 周围水温升至 49 °C，故环境温度未保持恒定。
水与环境的温差减小，单位时间传出的热量减少，故冷却率 R 偏小。
答：增大烧杯 A 周围水的体积。

2. In this experiment, you will investigate the cooling of hot water in a beaker. Refer to Fig. 2.1.

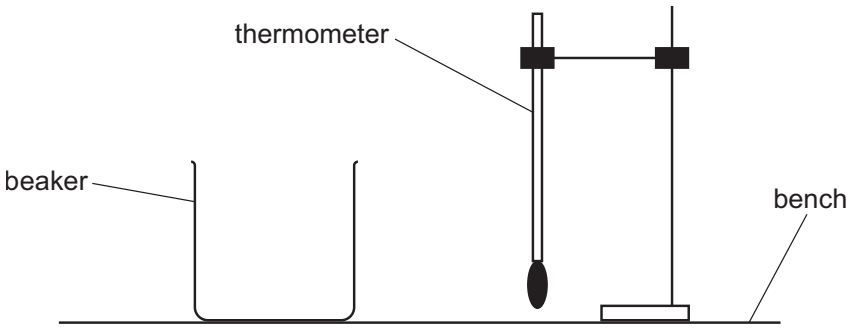


Fig. 2.1

(d) Suggest **two** ways to minimise the loss of thermal energy from the beaker during the experiment.

（2025 夏季 0625/51 第2题(d)）

【答案】在烧杯外包覆隔热材料，并给烧杯加盖。
【解析】隔热材料减少烧杯壁处的热传递，加盖减少水面处的热传递和蒸发。
答：在烧杯外包覆隔热材料，并给烧杯加盖。