

Examiners' report

AS LEVEL

PHYSICS A

**OCR Level 3 Advanced Subsidiary GCE
in Physics A**

H156

For first teaching in 2015

H156/02 Summer 2025 series

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate responses is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from [Teach Cambridge](#).

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Paper 2 series overview

This is the second paper of the AS Level Physics A course.

To perform well on this paper candidates need to have an in-depth knowledge and understanding of the subject content in Modules 3 and 4 as well as the foundation physics and practical skills in Modules 1 and 2.

Many candidates could have been credited more marks by stating definitions correctly and carefully answering the questions set showing all their working. It is important for all candidates to understand key command terms such as state, describe, define, etc.

For numerical questions, candidates should state the equation that is to be used and substitute the data before evaluating an answer.

It is worth reminding candidates that their scripts are scanned and then electronically marked by examiners. It is therefore important that answers are not written outside the space provided for the answers. The legibility of some candidates' work remains a concern.

There were two Levels of Response (LoR) questions which gave candidates the opportunity of demonstrating their knowledge and understanding of Physics. It is important that candidates' answers are structured and logical, with clear explanations. In both questions, candidates did always not demonstrate the in-depth understanding required for practical techniques and procedures. A number of candidates were also not aware of how to effectively analyse a graph, both in terms of relating constants in a straight-line equation to the gradient and y-intercept or to determining uncertainties from using a worst acceptable line.

There are a number of questions which test candidates' knowledge and understanding of practical skills that candidates have developed throughout their physics course.

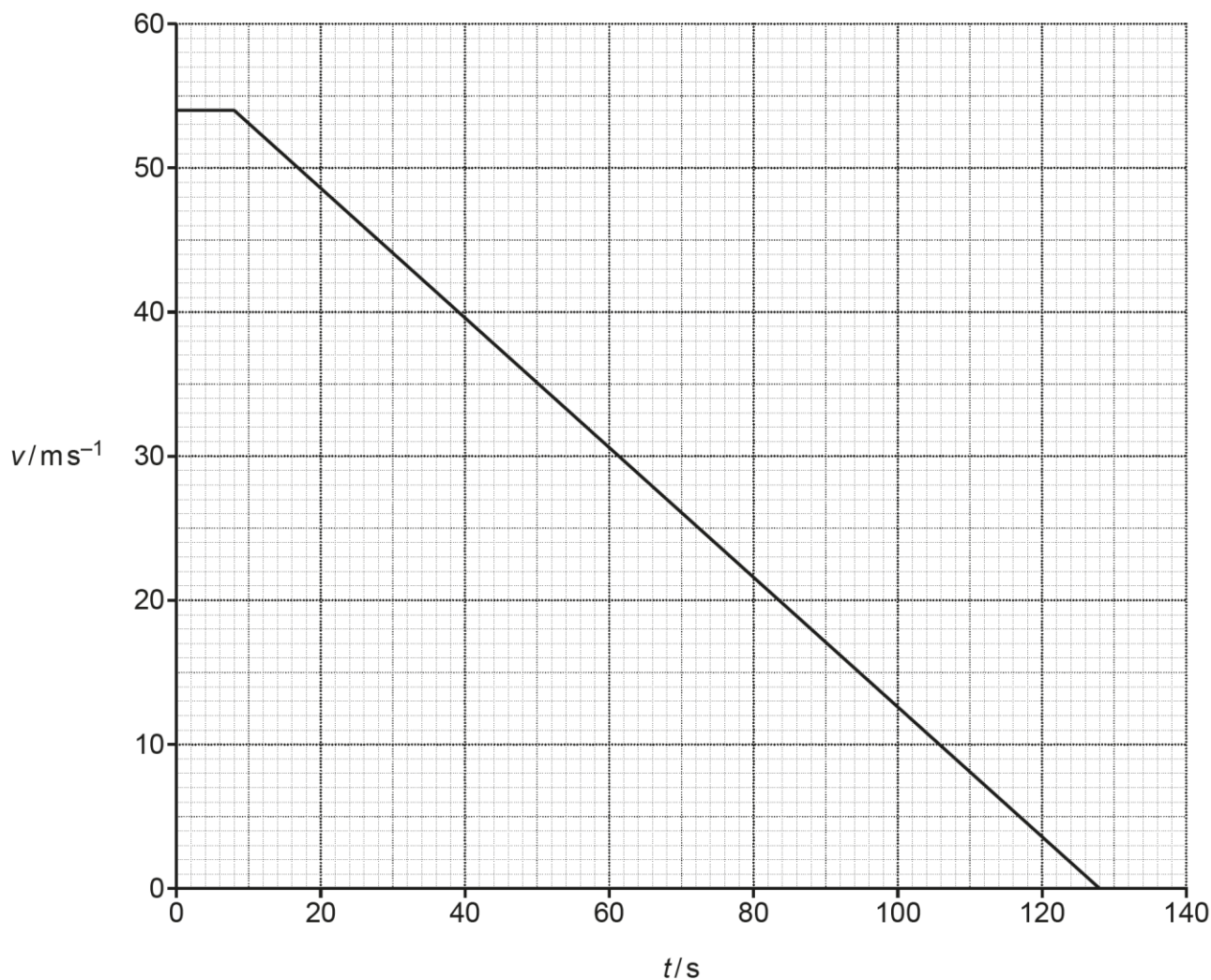
There were also several 'show' questions on the paper. These 'show' questions do require candidates to clearly indicate their method. The unknown should be the subject of any equation – credit is not given for using the 'show' value.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
- demonstrated good knowledge of definitions - wrote logical reasoned answers using their knowledge and understanding when answering explanation type questions - clearly demonstrated the working to numerical questions substituting in the appropriate numbers into stated equations - related their knowledge and understanding to the question set - demonstrated an understanding of practical skills.	- omitted detail when answering explanation type questions - omitted to show clear substitution of data into equations in calculation questions - did not use technical terms correctly - did not know definitions in sufficient detail - did not clearly explain their reasoning - omitted to explain practical procedures.

Question 1 (a)

- 1 A high speed passenger train is travelling at a velocity of 54 ms^{-1} .

The simplified graph shows the variation with time t of the velocity v of the train until it stops. At $t = 0$ the driver starts to think about applying the brakes.



- (a) Use the graph to determine the acceleration a of the train while the driver applies the brakes.

$$a = \text{.....} \text{ ms}^{-2} \text{ [1]}$$

Most candidates understood that the acceleration was the gradient of the line between $t = 8.0 \text{ s}$ and $t = 124.0 \text{ s}$. Higher scoring candidates clearly showed their gradient calculation by substituting data points from the line into the gradient equation: $\frac{y_2 - y_1}{x_2 - x_1}$.

Question 1 (b)

(b) Use the graph to determine the total stopping distance d of the train from $t = 0$.

$d = \dots\dots\dots$ m [2]

Most candidates correctly identified that the area under a velocity time graph is equal to displacement of distance travelled. A small minority of candidates did not use appropriate numbers.

A few candidates used their answers from part (a) and the equations of motion to determine the answer – this gained full credit.

Question 1 (c)

(c) Suggest why the graph does **not** show the real motion of the train.

.....
.....
..... [2]

The majority of candidates stated that the acceleration would not be constant but did not suggest reasons why.

Some high scoring candidates suggested that there would not be a sudden change in the acceleration at either the beginning or the end or that the brakes take time to be applied fully. Some candidates stated air resistance without explaining that air resistance will depend on the velocity of the train.

Some lower scoring candidates discussed different reaction times.

Candidates should consider the number of answer lines and the number of marks available. In this question, there were three answer lines and two marks which implies that there should be two distinct points to make.

Question 2 (a) (i)

- 2
- (a) A student has six similar metal spherical balls. To determine the mean mass of a ball, the student measures the diameters of the balls.

The table shows the measurements.

Diameter / cm	0.565	0.562	0.555	0.561	0.562	0.556
---------------	-------	-------	-------	-------	-------	-------

The density of the metal is $(8.9 \pm 0.1) \text{ g cm}^{-3}$.

- (i) Show that the mean mass m of each of the balls is approximately 0.82 g.

[2]

This question required candidates to carry out a multi-step calculation. Candidates needed to determine:

- the mean diameter
- the volume of a sphere, and
- using the density determine the mass of a ball.

High scoring candidates showed clearly the methods used, substituting data into expressions. Some candidates determined the mean radius – this also scored full marks.

Since the question stated that the mass was approximately 0.82 g, candidates should be encouraged to determine their answer to at least three significant figures, i.e. $0.819 \text{ (g)} \approx 0.82 \text{ (g)}$ so that the rounding can be seen to 0.82 (g).

Exemplar 1

$$8.9 \times \frac{4}{3} \pi \left(\frac{0.560}{2} \right)^3 = 0.81837 = \boxed{0.82 \text{ g}}$$

$$\frac{0.565 + 0.562 + 0.555 + 0.561 + 0.562 + 0.556}{6}$$

$$\rho \times V = m$$

$$\rho = \frac{m}{V}$$

$$V = \frac{4}{3} \pi r^3$$

$$V = \frac{4}{3} \pi \left(\frac{0.560}{2} \right)^3$$

[2]

This candidate clearly shows how the mean diameter is determined. The candidate has then stated the equation to be used to calculate volume and also the equation to calculate the mass using density and volume. The equations have been combined with the data correctly substituted. The answer from the calculator 0.81837 is stated and then rounded correctly to 0.82 (g).

Question 2 (a) (ii)

(ii) Calculate the percentage uncertainty in m .

percentage uncertainty = % [2]

Candidates found this question challenging.

Candidates needed to apply their understanding of combining uncertainties.

To determine the absolute uncertainty in repeated readings, candidates needed to determine half the range of the values.

Candidates also needed to understand that the percentage uncertainty in the volume was equal to three times the percentage uncertainty in the diameter.

Assessment for learning



Candidates should understand the rule for determining absolute uncertainties and percentage uncertainties.

When adding or subtracting quantities, the absolute uncertainties are added.

When multiplying or dividing quantities, the percentage uncertainties are added.

When dealing with power terms, the percentage uncertainty is multiplied by the power.

The absolute uncertainty in repeated measurements is half the range.

Exemplar 2

$$0.565 - 0.555 = 0.01$$

$$0.01 \div 2 = 0.005$$

$$3 \left(\frac{0.005}{0.56016} \times 100 \right) + \left(\frac{0.1}{8.9} \times 100 \right) = 3.801369978\% \\ \approx 3.8\% (2sf).$$

percentage uncertainty = 3.8 % [2]

This candidate correctly determined the range (0.01) and then finds the absolute uncertainty in d (0.005).

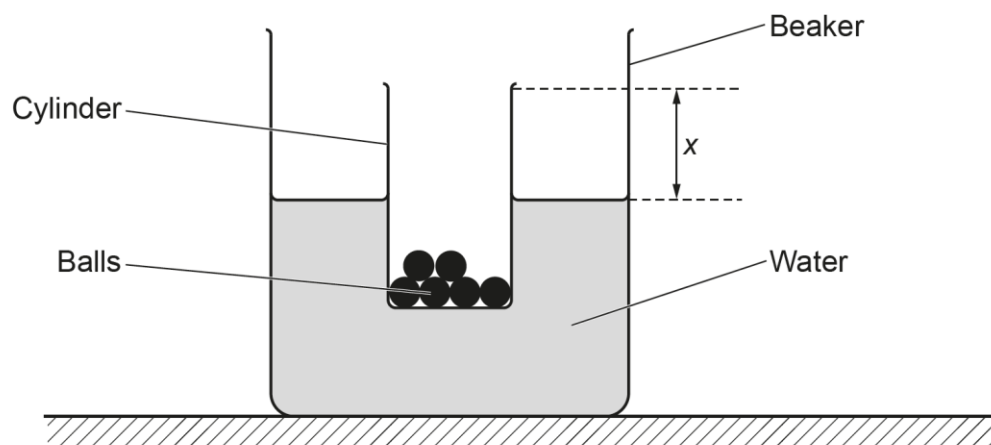
There is then a clear method shown by working out the percentage uncertainty in d^3 and adding it to the percentage uncertainty in ρ to give the correct answer of 3.8%.

Question 2 (b) (i)

(b) A hollow cylinder of mass 18 g has height 7.1 cm and cross-sectional area 6.2 cm^2 .

The six balls from part **(a)** are placed in the cylinder.

The cylinder is placed into a beaker of tap water. It floats upright as shown in the diagram.



The top of the cylinder is a distance x above the surface of the water.

The density of tap water is 1.0 g cm^{-3} .

(i) Calculate x .

$x = \dots\dots\dots \text{ cm}$ [3]

High performing candidates clearly showed their method. Candidates needed to work out the total mass of the cylinder and the six balls.

Since the weight of the cylinder and the balls is equal to the weight of the water (using Archimede's principle), the vertical height of the cylinder below the surface is determined. High performing candidates then determined h .

Assessment for learning

Candidates should practise answering calculation type questions.

Candidates should:

1. write down the equation(s) they are going to use
2. substitute the data into the equation(s)
3. consider the units
4. rearrange the equation
5. evaluate the answer
6. check that the answer is sensible.

Question 2 (b) (ii)

(ii) The student repeats the experiment using sea water.

State how the value of x changes.

Explain your answer.

.....

.....

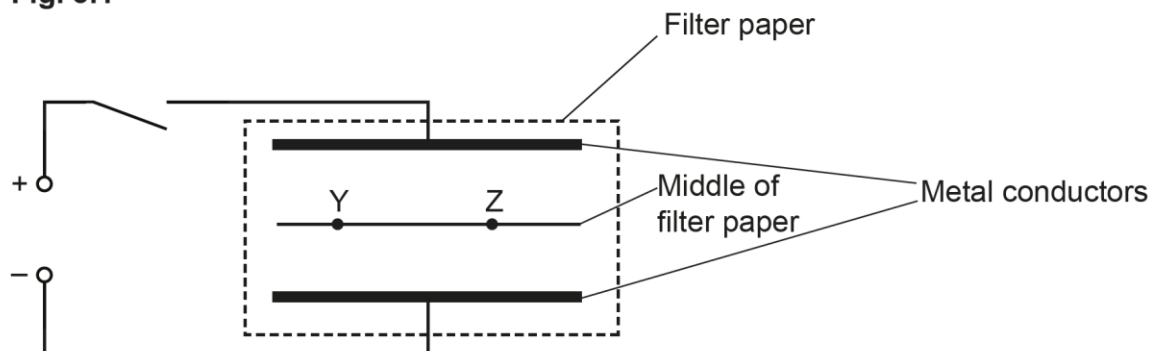
..... [2]

The majority of the candidates realised that the density of sea water is greater than tap water. Only a small minority of candidates successfully related this change in density to a smaller volume of sea water displaced and therefore x increases.

Question 3 (a) (i)

3

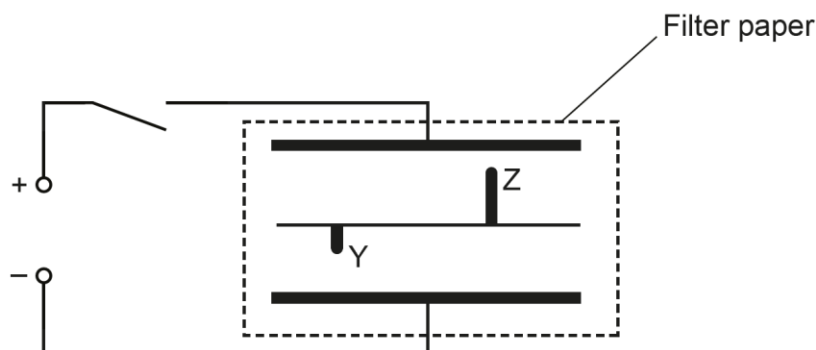
- (a) To investigate mobile charge carriers, a student soaks a sheet of filter paper in a solution of salt. They fix metal conductors to the filter paper and connect the conductors to a power supply as shown in **Fig. 3.1**.

Fig. 3.1

The student places two different soluble coloured crystals, Y and Z, on the middle of the filter paper as shown.

They close the switch.

After 20 s, due to the movement of the mobile charge carriers in crystals Y and Z, the filter paper appears as shown in **Fig. 3.2**.

Fig. 3.2

- (i) On the filter paper shown in **Fig. 3.2**, draw an arrow to indicate the conventional current I for the visible charge carriers of crystal Z. Label the arrow I . [1]

Many candidates did not draw an arrow on the filter paper. Some lower performing candidates incorrectly drew an upwards arrow on the filter paper.

Question 3 (a) (ii)

- (ii) Compare the visible charge carriers of crystal Y with the visible charge carriers of crystal Z.

Explain your answer.

.....

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.....

.....

..... [4]

The question was based on a practical showing the movement of charge carriers.

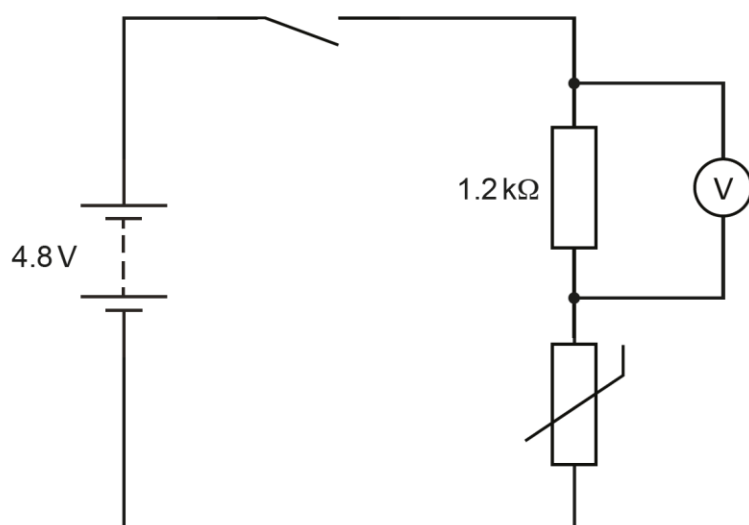
Many candidates correctly stated that since the charge carriers in Z were moving towards the positive metal conductor, these charge carriers were negative and that the charge carriers in Y were moving towards the negative metal conductor, these charge carriers were positive. Fewer candidates discussed the distance travelled by the charge carriers (in 20s) and related this to the speed of the charge carriers.

A small minority of candidates incorrectly discussed the number of charge carriers or the quantity of charge on the charge carriers – there was not enough information provided for any conclusion. In effect both crystal Y and Z also have invisible charge carriers which move in the opposite direction.

Question 3 (b) (i)

(b) A student sets up the circuit shown in **Fig. 3.3**.

Fig. 3.3



The battery has an electromotive force (e.m.f.) of 4.8 V and negligible internal resistance.

The voltmeter measures the potential difference (p.d.) across the resistor of resistance 1.2 kΩ.

(i) At a temperature of 20 °C, the resistance of the thermistor is 2.6 kΩ.

Calculate the voltmeter reading V .

$V = \dots\dots\dots$ V [2]

Most candidates correctly determined V using the potential divider equation. Some candidates correctly determined the current in the circuit and then determined the value of V .

Question 3 (b) (ii)

- (ii) The student places the thermistor in hot water.

At a temperature of 60°C , the voltmeter reads 3.2V .

Calculate the resistance R of the thermistor.

$R = \dots\dots\dots \Omega$ [2]

High scoring candidates clearly showed logical working. This included identifying that since the voltmeter was reading 3.2V , the potential difference across the thermistor was $(4.8 - 3.2 =) 1.6\text{V}$.

This was a question where candidates should be encouraged to think about their answers. Since the fixed resistor was taking a greater share of the potential difference, the resistance of the thermistor must have decreased and therefore the answer had to be less than $2.6\text{k}\Omega$.

Assessment for learning



Candidates should be encouraged to show their working in answering multiple step calculations.

Question 3 (b) (iii)

- (iii) The student replaces the resistor of resistance $1.2\text{k}\Omega$ with a resistor of resistance $120\text{k}\Omega$.

Suggest why $120\text{k}\Omega$ is **not** a sensible value to use to measure the temperature of a sample of water between 0°C and 100°C .

.....
.....
.....
..... [2]

This question was challenging. Candidates needed to understand that the share of the potential difference across the fixed resistor was great and that there would be little change with temperature so the voltmeter reading would not change.

Question 4 (a)

4 A student has a battery of electromotive force (e.m.f.) 2.2 V.

(a) The quantities e.m.f. and potential difference (p.d.) are both measured in volts, V.

Describe **one** other similarity and **one** difference between e.m.f. and p.d.

similarity

.....

difference

.....

[2]

Many candidates repeated the question by stating that a similarity was that both quantities were measured in volts. Few candidates were able to state that both quantities were related to the work done per unit charge.

Many candidates were able to give differences between the two quantities in terms of energy transfers or work done by charge carriers.

Question 4(b)*

(b)* The student has two cells **A** and **B**, the battery of e.m.f. 2.2V and a potentiometer. The potentiometer is constructed using 1.000 m of resistance wire.

Describe, with the aid of a suitable diagram, how the student can safely conduct an experiment to compare the e.m.f. of cell **A** with the e.m.f. of cell **B**.

The student uses the potentiometer. Include any other equipment they need.

[6]

In this Level or Response question, candidates had the opportunity of describing an experiment and including how the results would be analysed.

It was clear that many candidates had recalled the use of a potentiometer as a potential divider. Some low performing candidates treated the potentiometer as a device rather like an ammeter or voltmeter.

High performing candidates drew a suitable circuit diagram using correct symbols and then gave a description of how the circuit would be used and how the e.m.f.s of the two cells would be compared.

Few candidates discussed finding the balance point and then comparing the length of the potentiometer wire. Many candidates determined the e.m.f. using a graphical method with a range of current and potential difference readings across different lengths of the potentiometer.

Assessment for learning



Candidates are expected to know about a potentiometer as a potential divider and to be able to apply this knowledge and understanding.

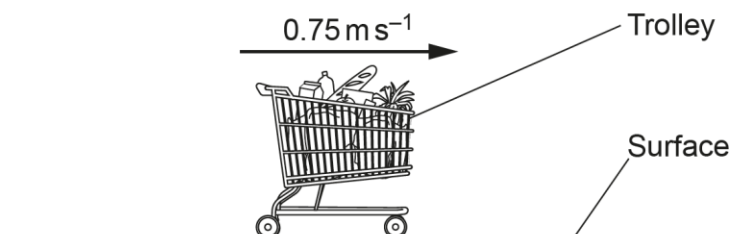
Assessment for learning



Candidates should have the opportunity of developing their practical skills so that they are able to describe methods to obtain accurate data.

Question 5 (a) (i)

- 5 A shopper pushes a trolley loaded with shopping at a constant speed of 0.75 m s^{-1} along a horizontal surface as shown in **Fig. 5.1**.

Fig. 5.1

The mass of the loaded trolley is 49 kg .

The force pushing the trolley is T .

The force of friction F_f between the trolley and the surface is 24 N .

- (a) The loaded trolley is represented by $\bullet$ in **Fig. 5.2**.

Fig. 5.2

- (i) On **Fig. 5.2** draw a free-body diagram representing **all** the forces acting on the loaded trolley. Label the forces.

[4]

Most candidates were able to draw two horizontal arrows in opposite directions and two vertical arrows in opposite directions. A common error was not taking care to ensure that the vertical arrows were the same length. A few candidates struggled to label the forces correctly. Gravity for weight was not accepted.

Question 5 (a) (ii)

(ii) State the value of T .

$T = \dots\dots\dots$ N [1]

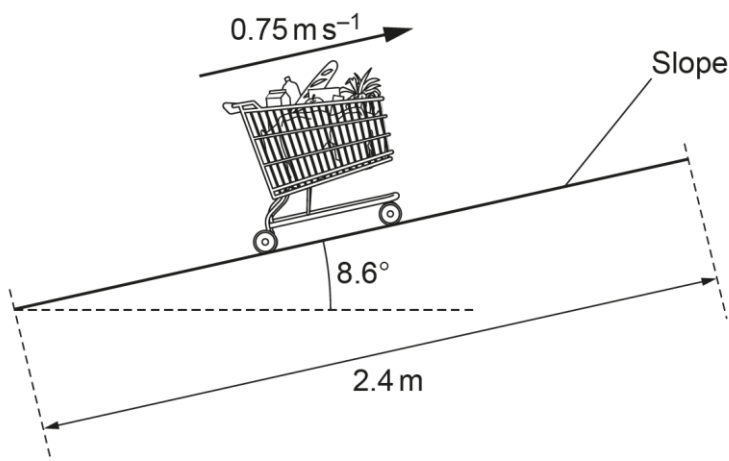
The majority of the candidates understood that since the trolley was travelling at constant speed, there would be no resultant force acting on the trolley so the value of T would be equal to 24 N.

A common error was to multiply the mass by the velocity and give an answer of 37 (N).

Question 5 (b) (i)

(b) The shopper now pushes the loaded trolley up a slope made from the same surface, as shown in Fig. 5.3.

Fig. 5.3



The angle between the horizontal and the slope is 8.6° and the trolley travels a distance of 2.4 m along the slope.

The force of friction F_f between the trolley and the surface is 24 N.

(i) The equation relating power P to force F and velocity v is $P = Fv$.

Derive this equation from first principles.

[2]

This question tested a specific learning outcome (3.3.3 (b)).

To successfully gain marks in this question, three equations for work done, power and velocity needed to be stated and then clear logical manipulation of the equations needed to show the given equation.

A common error was working out the power in base units.

Question 5 (b) (ii)

- (ii) Calculate the work done W against the force of gravity in moving the trolley along the slope.

$W = \dots\dots\dots$ J [2]

There were two possible methods of calculating W . One method was using the equation $W = Fx\cos\theta$ and the other was to use the vertical component of the distance. Some candidates for both methods did not use the correct angle.

Question 5 (b) (iii)

- (iii) Calculate the **total** power P needed to push the trolley up the slope at a constant speed of 0.75 m s^{-1} .

$P = \dots\dots\dots$ W [2]

This was a challenging question. Many candidates worked out part of the force but did not add on the friction force.

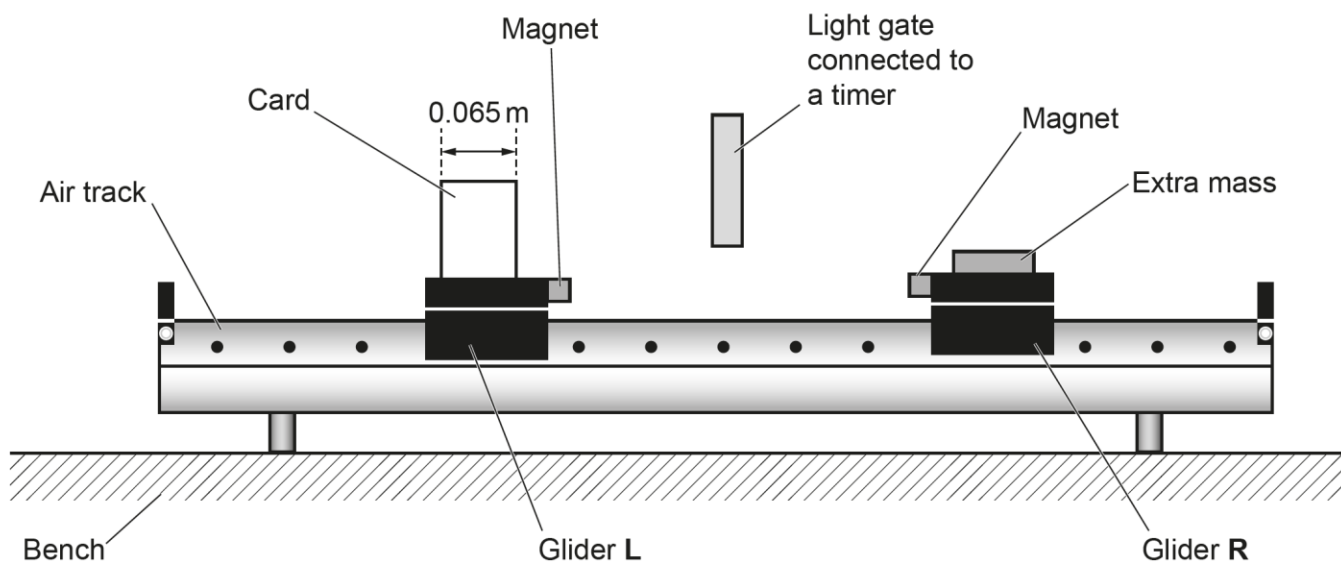
There were several methods, including determining the time.

Question 6 (a)

- 6 A teacher uses a linear air track to investigate collisions.

Fig. 6.1 shows the arrangement of apparatus.

Fig. 6.1



The teacher connects the light gate to a timer. The timer records the time for the card on glider L to pass through the light gate. The length of the card is 0.065 m.

The mass of glider L is 0.18 kg and the mass of glider R and the extra mass is 0.27 kg.

The two magnets are positioned so that they will repel each other.

- (a) State the principle of conservation of momentum.

.....

.....

..... [2]

Most candidates discussed the total momentum but many candidates did not state provided there was no external force. Lower performing candidates often gave vague detail such as the 'momentum is the same'.

Assessment for learning



Candidates should be encouraged to learn basic definitions in detail.

Question 6 (b) (i)

- (b) Glider **R** is stationary. Glider **L** moves at velocity u from left to right and collides with **R**. After the collision **L** rebounds and passes back through the light gate and **R** moves to the right.

The table records the time taken t for the card to pass through the light gate.

	t/s
L moving to the right before the collision	0.26
L moving to the left after the collision	1.30

- (i) Show that the momentum of **L** before the collision is $0.045 \text{ kg m s}^{-1}$.

[1]

This was another show question where candidates needed to show initially that the velocity of the glider was $0.065 \div 0.26 = 0.25 \text{ m s}^{-1}$ before showing that momentum is mass $\times$ velocity.

Exemplar 3

$$\begin{array}{l}
 0.18 \text{ kg} \\
 0.26 \text{ s}
 \end{array}
 \quad
 0.18 \times 0.26 = 0.0468
 \quad
 0.047 \approx 0.045 \text{ kg m s}^{-1}$$

[1]

This candidate has multiplied the mass by the time and then rounded the answer to two significant figures. They then stated that this is the same as the given answer to two significant figures.

Question 6 (b) (ii)

- (ii) Determine the impulse of the force acting on **R**.

impulse = N s [2]

Many candidates correctly worked out that the momentum after the collision of glider **L** was $0.0090 \text{ kg m s}^{-1}$. However, they did not understand the vector nature of momentum and incorrectly determined the impulse as 0.036 N s .

Question 6 (b) (iii)

(iii) Calculate the velocity v of **R** after the collision.

$v = \dots\dots\dots \text{ms}^{-1}$ [1]

Many candidates did not understand that impulse is equal to the change in momentum and thus the impulse divided by the mass of **R** would give v .

Question 6 (c)

(c) The teacher changes one of the magnets to a cork and the other magnet to a pin and repeats the experiment.

Glider **L** moves from left to right. The time for the card to pass through the light gate is 0.26 s.

Glider **L** collides and sticks to glider **R**. After the collision **L** and **R** move together to the right.

Show, using energy considerations and the principle of conservation of momentum, that the collision is **inelastic**.

Include relevant calculations in your answer.

.....

.....

..... [4]

This question gave candidates the opportunity of structuring their answer for several calculations.

High performing candidates clearly showed their working, firstly working out the initial kinetic energy before then working out the speed of both gliders after the collision, using the principle of conservation of momentum and then the kinetic energy after the collision. A conclusion in terms of the kinetic energy not being conserved was needed for the final mark.

Assessment for learning



Candidates should be encouraged to practise answering multiple step calculations with clear working.

Question 7 (a)

7 A laser emits green light of wavelength $5.32 \times 10^{-7} \text{ m}$.

(a) The power of the laser is 1.0 mW.

Calculate the number of photons N emitted per second.

$$N = \dots\dots\dots \text{ s}^{-1} \text{ [2]}$$

High performing candidates determined the energy of one photon before determining the number of photons emitted.

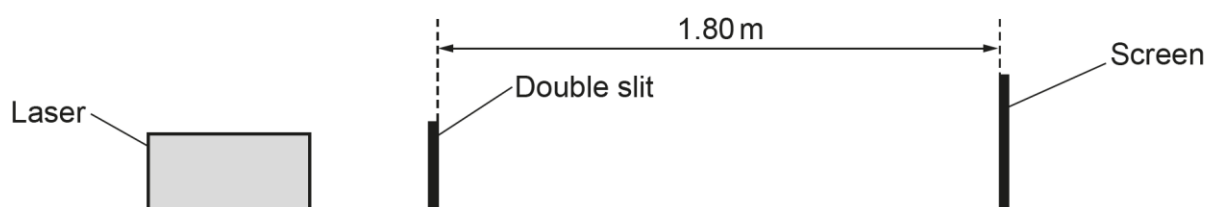
Some low performing candidates tried to guess the answer by dividing 1.0 mW by the wavelength.

Question 7 (b) (i)

(b) A student uses the laser to look at the interference pattern through a double slit.

The student arranges the apparatus as shown in **Fig. 7.1**.

Fig. 7.1 (not to scale)



The width of the screen is about 6 cm.

The distance between the double slit and the screen is 1.80 m.

The student determines that the fringe width is $3.82 \pm 0.02 \text{ mm}$.

(i) The light from the laser that falls on the double slit is coherent.

State the meaning of the term coherent.

.....
 [1]

The majority of candidates were able to state there was a constant phase difference. Examiners did not accept same for constant.

Question 7 (b) (ii)

(ii) Explain how the student determined the fringe width.

.....

.....

.....

..... [2]

Candidates found this question challenging. Many candidates answered it in term of rearranging the equation for Young slits equation. Some candidates realised that a good method would be to measure the distance for a number n fringes and divide the distance by n . Very few candidates realised that with the fringe width determined to the nearest 0.01 mm the original distance would need to be measured with a measuring instrument of 0.1 mm resolution, i.e. callipers.

Assessment for learning



Candidates should be able to select appropriate measuring instruments. The resolution of the data provided should give an idea as to the resolution of the measuring instrument.

Question 7 (b) (iii)

(iii) Calculate the separation a of the slits.

Give your answer to **3** significant figures.

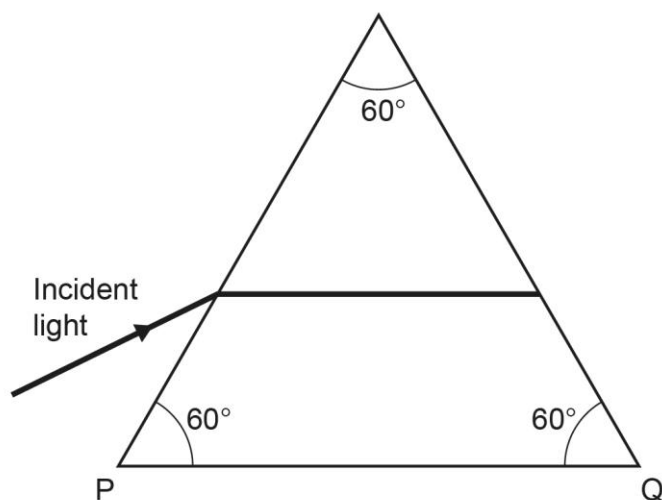
$a =$ m [2]

This question was answered well. Some candidates did not give an answer to 3 significant figures.

Question 7 (c) (i)

(c) Light from the laser is incident on an equilateral triangular glass prism as shown in **Fig. 7.2**.

Fig. 7.2



The refracted ray in the prism is parallel to PQ.

The refractive index of the glass is 1.48.

Calculate:

- (i) the wavelength λ of the light in the glass

$\lambda = \dots\dots\dots$ m [1]

This question appeared to challenge candidates. Some candidates worked out the speed of light in glass but did not then calculate the wavelength.

Question 7 (c) (ii)

(ii) the angle of incidence i of the incident ray.

$i = \dots\dots\dots^\circ$ [2]

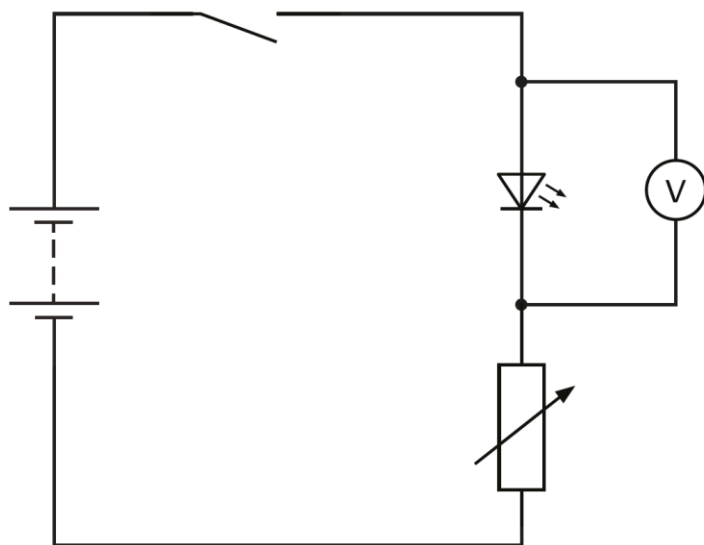
High scoring candidates correctly identified that the angle of refraction in this case was 30° . Many of these candidates had added a normal to the diagram. These candidates usually then correctly calculated the angle of incidence using the refractive index.

Assessment for learning

Candidates should be encouraged to add notes to diagrams (or even sketch diagrams) to assist in the answering of a question.

Question 8*

- 8* A student carries out an experiment to determine the Planck constant. They use the circuit shown.



The frequency of the emitted light from the LED is f and the potential difference for the LED to just light is V .

The student repeats the experiment for LEDs that emit light of different frequency.

The table shows their results.

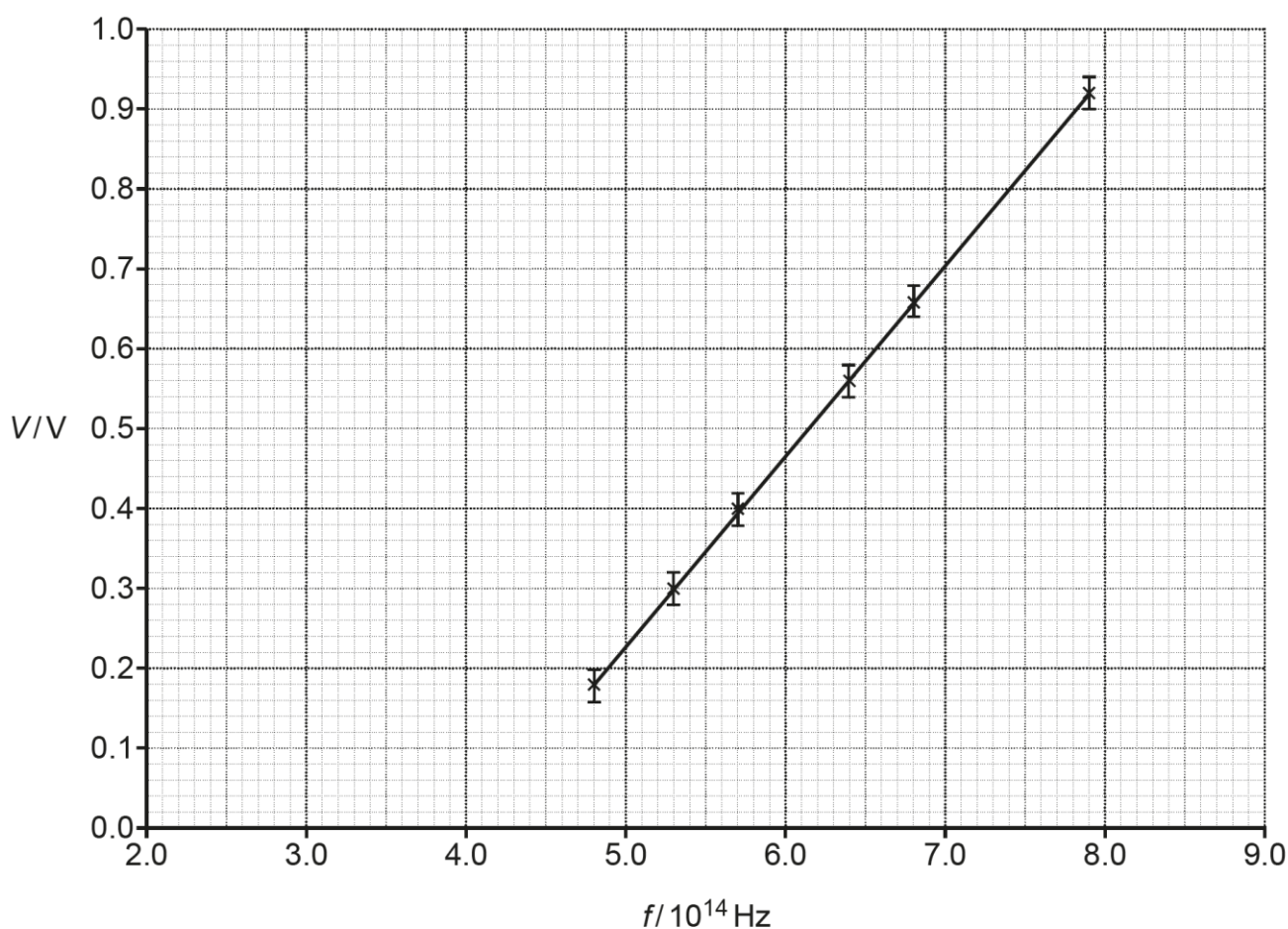
$f/10^{14}\text{Hz}$	V/V
4.8	0.18 ± 0.02
5.3	0.30 ± 0.02
5.7	0.40 ± 0.02
6.4	0.56 ± 0.02
6.8	0.66 ± 0.02
7.9	0.92 ± 0.02

It is suggested that the relationship between V and f is

$$V = \frac{h}{e}f - \frac{K}{e}$$

where e is the charge on an electron, h is the Planck constant and K is a constant.

The student plots a graph of V/V on the y -axis against $f/10^{14}$ Hz on the x -axis is plotted.



Describe how to measure V accurately **and** use the graph to determine h and K .

Include the percentage uncertainty in your value of h .

[6]

This question was designed to test candidates' understanding of practical techniques in both designing an experiment and analysing results.

A basic description of how V was measured needed to be described. Many higher performing candidates discussed the use of a tube to shield background light and repeating the experiment by increasing the resistance. A simple repeat the experiment and take an average was not credit worthy.

For the analysis, candidates were expected to link the given equation to the equation of a straight line and thus identify how h was related to the gradient and how K was related to the y -intercept. The next logical step would then be to calculate the gradient and y -intercept. For this it was expected that candidates would demonstrate substituting values from the line on the graph (not data points from the table) to determine the gradient and thus calculate a value of h with an appropriate unit. Similarly since the y -intercept could not be read off the graph, candidates needed to substitute a data point from their line into $y = mx + c$.

To determine percentage uncertainty, candidate needed to draw the worst acceptable line. This should be either the steepest or shallowest line that passes within all the error bars. Candidates then needed to calculate the worst acceptable gradient. Candidates gained credit for either calculating the percentage uncertainty in the gradient or from calculating worst value of h and then determining the percentage uncertainty.

Assessment for learning



Candidates should have the opportunity to practise determining values for constants using the gradient and y -intercept of straight-line graphs.

Candidates should have the opportunity to practise drawing worst acceptable straight lines through error bars and understand the techniques to determine uncertainties in calculated constants using the worst acceptable gradient and/or the worst acceptable y -intercept.

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