Please check the examination details below before entering your candidate information

Candidate surname	Other names
StemUp Model Solution	

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Wednesday 14 May 2025

Morning (Time: 1 hour 30 minutes)

Paper reference **8PH0/01**

Physics

Advanced Subsidiary

PAPER 1: Core Physics I

You must have:
Scientific calculator and ruler
Data, Formulae and Relationships Booklet (enclosed)

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions in Sections A and B.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In the question marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- You are advised to show your working in calculations including units where appropriate.

Turn over ▶

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SECTION A

Answer ALL questions.

All multiple choice questions must be answered with a cross in the box ☒ for the correct answer from A to D. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 A ball bearing falls from rest through oil.

Which of the following statements is correct during the initial motion of the ball bearing?

☒ **A** The resultant force on the ball bearing decreases.

☐ **B** The resultant force on the ball bearing increases.

☐ **C** The resultant force on the ball bearing decreases then increases.

☐ **D** The resultant force on the ball bearing stays constant.

(Total for Question 1 = 1 mark)

2 As the temperature of a negative temperature coefficient thermistor increases, the resistance of the thermistor changes.

Which of the following statements is correct?

☐ **A** Resistance decreases as lattice ions vibrate with decreased amplitude.

☐ **B** Resistance increases as lattice ions vibrate with increased amplitude.

☒ **C** Resistance decreases as the number of conduction electrons increases.

☐ **D** Resistance increases as the number of conduction electrons decreases.

(Total for Question 2 = 1 mark)

3 Which of the following units is equivalent to the newton?

☐ **A** $\mathrm{kg\,m\,s^{-1}}$

☒ **B** $\mathrm{kg\,m\,s^{-2}}$

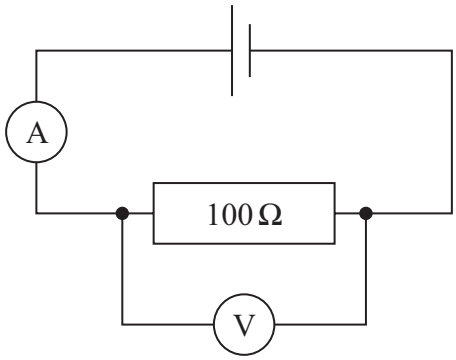
☐ **C** $\mathrm{kg\,m^2\,s^{-2}}$

☐ **D** $\mathrm{kg\,m^2\,s^{-1}}$

(Total for Question 3 = 1 mark)

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4 A circuit consists of a cell of e.m.f. 1.50 V connected to a 100 Ω resistor. A voltmeter is connected across the 100 Ω resistor, as shown. The voltmeter reading is 1.45 V.



Which of the following gives the internal resistance, in Ω, of the cell?

☒ **A** $\frac{(1.50 - 1.45) \times 100}{1.45}$

☒ **B** $\frac{1.50 \times 100}{1.45}$

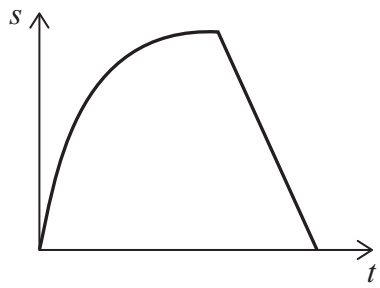
☒ **C** $\frac{(1.50 - 1.45) \times 100}{1.50}$

☒ **D** $\frac{1.45 \times 100}{1.50}$

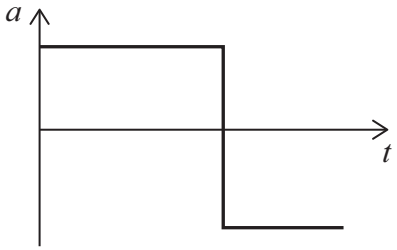
(Total for Question 4 = 1 mark)

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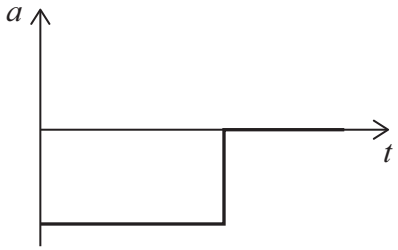
5 The graph shows how the displacement s varies with time t for an object.



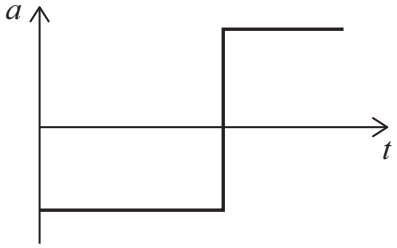
Which of the following graphs shows how acceleration a varies with time t for the object?



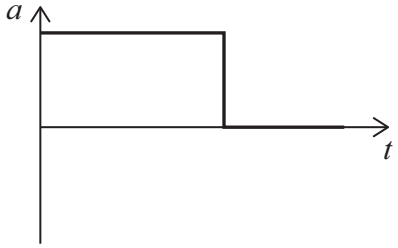
A



B



C



D

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 5 = 1 mark)

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6 A stone is dropped from rest down a well. The sound as the stone hits the water is heard 3.5 s after the stone is dropped.

Which of the following gives the distance, in m, travelled by the stone before it hits the water?

☒ **A** $\frac{9.81 \times 3.5^2}{2}$

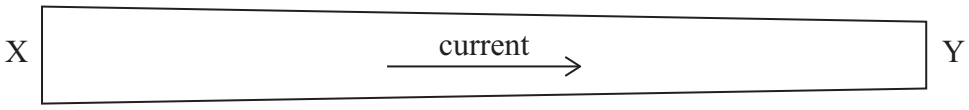
☒ **B** 9.81×3.5

☒ **C** $2 \times 9.81 \times 3.5^2$

☒ **D** $\frac{3.5^2 - 0}{2 \times 9.81}$

(Total for Question 6 = 1 mark)

7 A wire of decreasing diameter is connected in a circuit. There is a current from X to Y in the wire, as shown.



Which row of the table gives the current and the drift velocity of charge carriers at Y compared to X?

	Current	Drift velocity
☒ **A**	lower	higher
☒ **B**	lower	lower
☒ **C**	the same	higher
☒ **D**	the same	lower

(Total for Question 7 = 1 mark)

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8 A shopping trolley moves at velocity v. The trolley collides and combines with a stack of 5 identical stationary trolleys.

Which of the following expressions gives the velocity of the combined stack of trolleys?

☒ **A** $6v$

☒ **B** $5v$

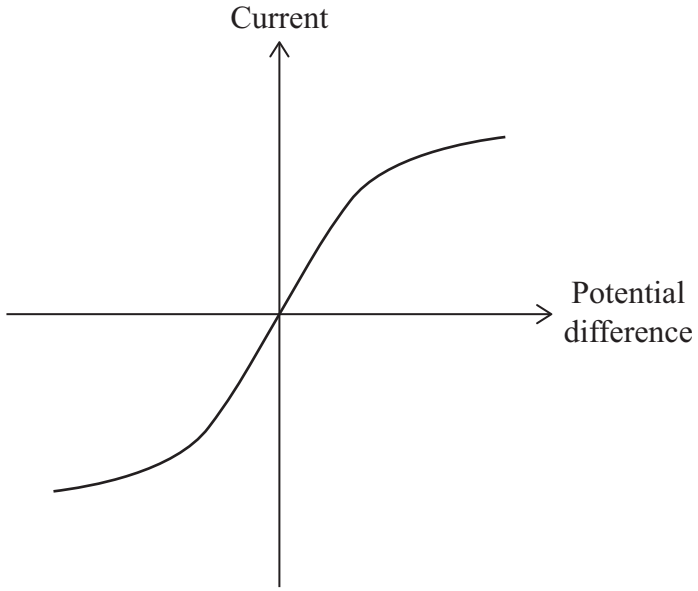
☒ **C** $\frac{v}{5}$

☒ **D** $\frac{v}{6}$

(Total for Question 8 = 1 mark)

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9 The graph shows how current varies with potential difference for a component in a circuit.



Explain how the graph shows what the component is.

As the potential difference increases, equal increases in potential difference produce gradually smaller increases in current (the current increases at a decreasing rate).

So the resistance of the component (V/I) increases as the potential difference and current increase.

The component is a filament bulb (the filament heats up and its resistance rises).

(Total for Question 9 = 3 marks)

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10 A person pushes a baby in a pram.

(a) The person pushes the pram with a constant force. The force is applied at an angle of 50° to the horizontal, as shown.



When a force of 35 N is applied, the pram moves at constant speed.

Calculate the work done to push the pram at constant speed for 500 m.

(3)

Horizontal component of force = 35 N × cos 50° = 22.5 N

ΔW = FΔs = 22.5 N × 500 m

ΔW = 1.1 × 10^4 J

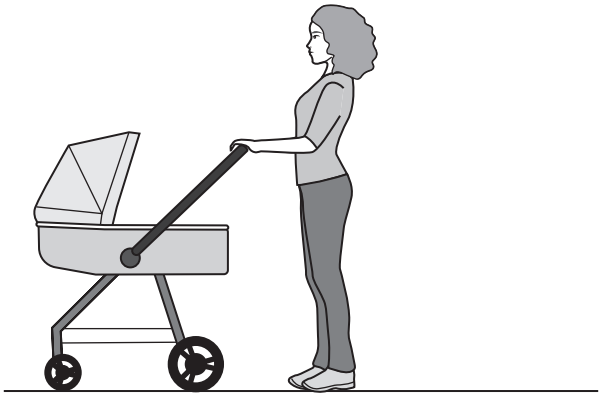
Work done = *1.1 × 10^4 J*

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(b) The pram is then moved along the same surface, at the same constant speed, by a different person. This person pushes the pram by applying a force horizontally, as shown.



Explain how applying a force horizontally changes the magnitude of the force needed to push the pram at the same constant speed.

(2)

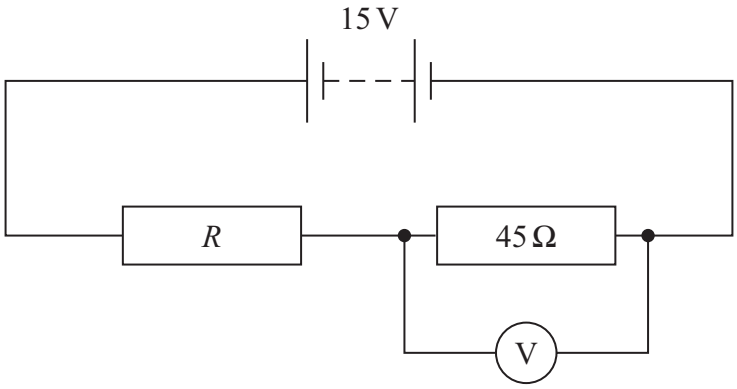
The whole force is now in the direction of motion (parallel to the motion), instead of only the horizontal component cos 50° of it.

So a lower applied force is needed: the force is now only 22 N.

(Total for Question 10 = 5 marks)

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11 Two resistors are connected in series in a circuit, as shown. The power supply has negligible internal resistance.



(a) Calculate the resistance R of the resistor when the voltmeter reads 5.5 V.

(3)

Current: $I = V/R = 5.5\ V / 45\ \Omega = 0.122\ A$

p.d. across $R = 15\ V - 5.5\ V = 9.5\ V$

$R = V/I = 9.5\ V / 0.122\ A = 78\ \Omega\ (\approx 80\ \Omega)$

$R =$ 78 Ω (≈ 80 Ω)

(b) A student uses the circuit to power an electric motor. He connects the motor in parallel with the 45 Ω resistor.

The electric motor has a resistance of 45 Ω and a normal working potential difference of 5.5 V.

Deduce how the motor performs when connected to the circuit. You do not need to do a further calculation.

(3)

The motor in parallel with the 45 Ω resistor gives a decreased resistance for the parallel combination (22.5 Ω), so the total current in the circuit increases.

The p.d. across R increases, so a lower proportion of the 15 V is across the parallel combination: the p.d. across the motor decreases below 5.5 V.

Hence the p.d. is too low and the motor runs slowly (below normal performance).

(Total for Question 11 = 6 marks)

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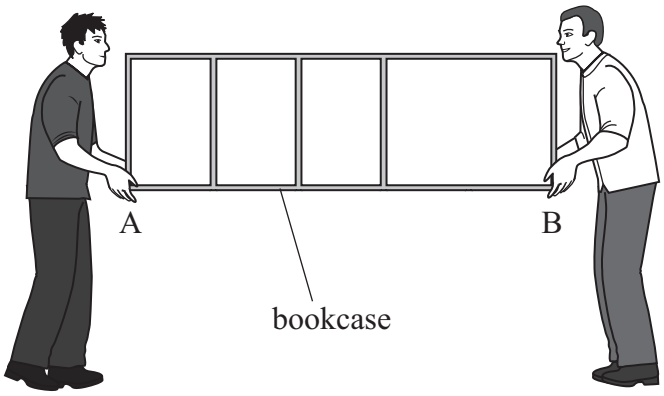
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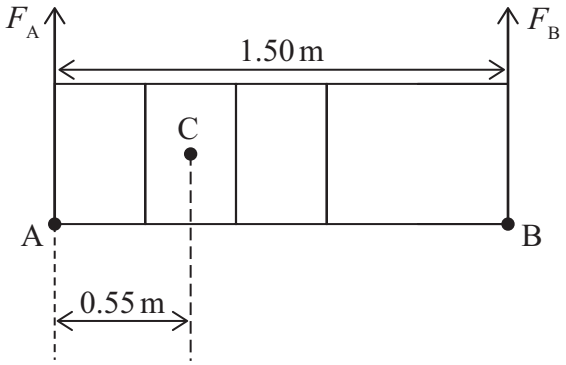
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12 Two people are carrying a bookcase. They are holding the bookcase at points A and B, as shown.



(a) The length of the bookcase is 1.50 m. The centre of gravity C of the bookcase is 0.55 m from one end. The people exert forces F_A and F_B on the bookcase at points A and B, as shown below.



Calculate F_A and F_B.

mass of bookcase = 25 kg

(5)

$W = mg = 25\ kg \times 9.81\ N\ kg^{-1} = 245\ N$

Moments about A: clockwise moment = anticlockwise moment

$245\ N \times 0.55\ m = F_B \times 1.50\ m$, so $F_B = 90\ N$

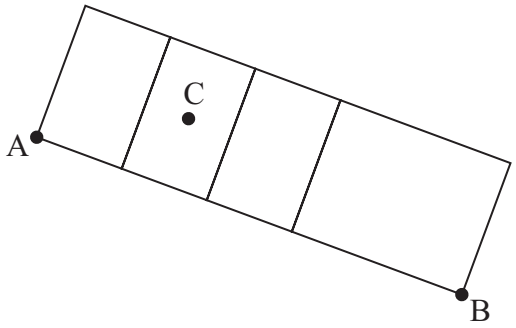
$F_A + F_B = W$, so $F_A = 245\ N - 90\ N = 155\ N$

$F_A =$ 155 N

$F_B =$ 90 N

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(b) The two people now support the bookcase so that it is tilted with point A higher than point B, as shown. The bookcase is stationary and the forces exerted at points A and B are still vertical.



Explain how the magnitude of the forces exerted at points A and B change. You should consider moments about point A.

(5)

When the bookcase is tilted, the horizontal (perpendicular) distance of the line of action of the weight from A increases.

So the clockwise moment of the weight about A increases.

Since the bookcase is in equilibrium, the anticlockwise moment of F_B about A must increase by the same amount.

But the horizontal distance of F_B from A decreases when it is tilted.

So F_B must increase, and since $F_A + F_B$ = weight, F_A decreases.

(Total for Question 12 = 10 marks)

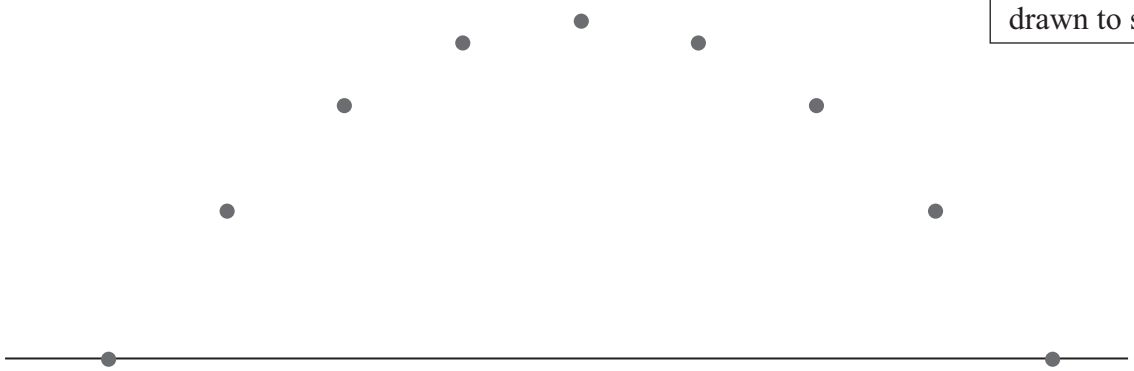
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13 A textbook has the following statement about the motion of a projectile with negligible air resistance acting on it.

'The only force acting on a projectile is the weight of the projectile. This affects the vertical motion of the projectile but not the horizontal motion.'

A ball was projected up from the ground at an angle. The position of the ball was plotted at equal time intervals, as shown.

Diagram is drawn to scale



*(a) Explain how the diagram gives evidence to support the statement in the textbook.

(6)

Horizontally, the ball moves a constant horizontal distance in each equal time interval on the diagram (the dots are evenly spaced across).

So the horizontal component of velocity is constant and the horizontal acceleration is zero.

By Newton's first law this means there is no horizontal force on the projectile, so horizontal motion is not affected.

Vertically, the vertical distance moved in each equal time interval changes: it gets smaller going up and larger coming down.

So the vertical component of velocity changes, meaning there is a vertical acceleration (downwards).

By ΣF = ma there must be a vertical (downward) force on the projectile, which is its weight. This supports the statement.

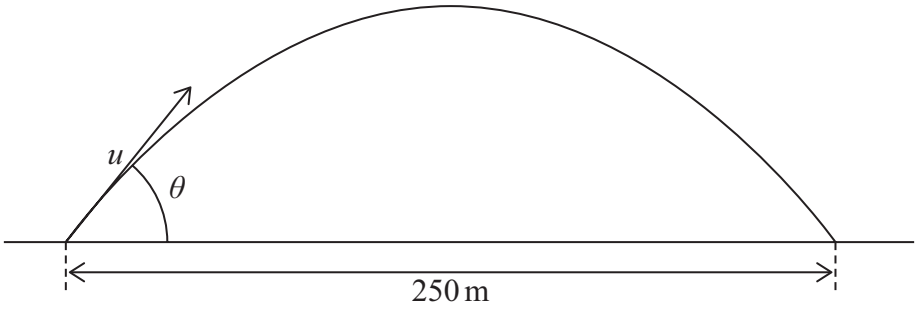
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(b) The photograph shows a cannon which was used to fire cannonballs over long distances in the 15th century.



(Source: © Ton Bangkeaw/Shutterstock)

A cannonball was projected over a horizontal distance of 250 m, as shown below. The time of flight of the cannonball was 7.5 s.



Calculate the angle θ at which the cannonball was fired and the initial speed u of the cannonball.

(5)

Vertically: $s = ut + \frac{1}{2}at^2$ with $s = 0$: $0 = u_V \times 7.5 - \frac{1}{2} \times 9.81 \times 7.5^2$

$u_V = u \sin \theta = 36.8 \text{ m s}^{-1}$

Horizontally: $s = ut$, $250 \text{ m} = u_H \times 7.5 \text{ s}$, $u_H = u \cos \theta = 33.3 \text{ m s}^{-1}$

$\tan \theta = u \sin \theta / u \cos \theta = 36.8 / 33.3 = 1.10$, $\theta = 47.9°$

$u = \sqrt{(36.8^2 + 33.3^2)} = 49.6 \text{ m s}^{-1}$

$\theta =$ 48°

$u =$ 50 m s^{-1} (49.6)

(Total for Question 13 = 11 marks)

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14 Since 2008, the Scottish island of Eigg has generated almost all its electrical power from renewable energy sources. The main source of power for the island is produced by hydroelectric generators.

(a) Water falls through a height of 124 m as it flows through a pipe to a hydroelectric generator.

(i) Calculate the maximum power input of the generator.

mass flow rate of the water = 130 kg s^{-1}

(2)

$P = \Delta E_{grav}/t = mg\Delta h/t = 130\ kg\ s^{-1} \times 9.81\ N\ kg^{-1} \times 124\ m$

$P = 1.6 \times 10^5\ W$

Maximum power input = 1.6×10^5 W

(ii) Explain why the power input of the generator is always less than this value.

(2)

There are frictional forces between the water and the pipe (the process is less than 100% efficient).

These do work, transferring energy to the surroundings as thermal energy.

(b) When demand for power is low on Eigg, excess energy is stored in a number of batteries. The batteries have a total capacity of 4400 Ah when fully charged.

When demand for power is greater than the output from the renewable sources, energy is supplied by the batteries. The batteries supply an average power of 20 kW.

Calculate the total time, in hours, for which the batteries can supply energy before they need recharging.

total output potential difference of batteries = 48 V

(3)

$Q = 4400\ A\ h \times 3600\ s\ h^{-1} = 1.58 \times 10^{7}\ C$

$W = QV = 1.58 \times 10^{7}\ C \times 48\ V = 7.60 \times 10^{8}\ J$

$t = E/P = 7.60 \times 10^{8}\ J / 20 \times 10^{3}\ W = 3.80 \times 10^{4}\ s = 10.6\ h$

Total time = 11 hours

(c) Each house on Eigg is allowed a maximum power of 5 kW.

(i) Show that the maximum current in an electrical cable to a house is about 22 A.

mains potential difference = 230 V

(2)

$P = IV$, so $I = P/V = 5 \times 10^{3}\ W / 230\ V$

$I = 21.7\ A$, which is about 22 A

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(ii) On Eigg the cables to the houses are made of aluminium instead of copper.

The rate of energy transfer to the environment is limited to 0.05 W per metre of cable.

The engineers claimed that using aluminium instead of copper reduced the cost of the electrical cables by 90%.

Evaluate this claim by comparing a 1 m length of cable made from each material.

Assume the current in each cable is 22 A.

Material	Resistivity / Ω m	Cost in £ per m^3
Copper	1.68×10^{-8}	77 090
Aluminium	2.65×10^{-8}	6070

(5)

$P = I^2R$, so R of 1 m of cable = 0.05 W / (22 A)^2 = 1.03×10^{-4} Ω

$R = \rho l/A$, so for 1 m of copper: A = 1.68×10^{-8} Ω m × 1 m / 1.03×10^{-4} Ω = 1.63×10^{-4} m^2

Volume = Al = 1.63×10^{-4} m^3, cost = 1.63×10^{-4} × £77 090 = £12.54

1 m of aluminium: A = $2.65 \times 10^{-8} \times 1 / 1.03 \times 10^{-4} = 2.57 \times 10^{-4}$ m^2, volume = 2.57×10^{-4} m^3, cost = 2.57×10^{-4} × £6070 = £1.56

Cost reduction = (£12.54 − £1.56) / £12.54 × 100 = 88%

88% is close to 90%, so the engineers' claim is correct.

(Total for Question 14 = 14 marks)

TOTAL FOR SECTION A = 57 MARKS

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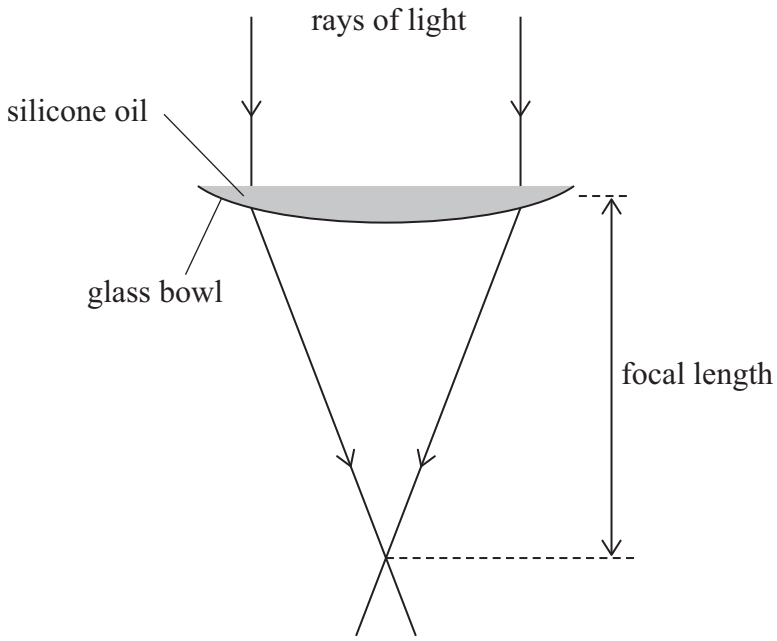
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SECTION B

Answer ALL questions in the spaces provided.

15 A student makes a lens by filling a glass bowl with silicone oil. She investigated the refraction of light through this lens.

The student shone light vertically downwards through the lens, as shown.



(a) The student measured the focal length of the lens to be 16.7 cm.

Calculate the power of the lens.

(2)

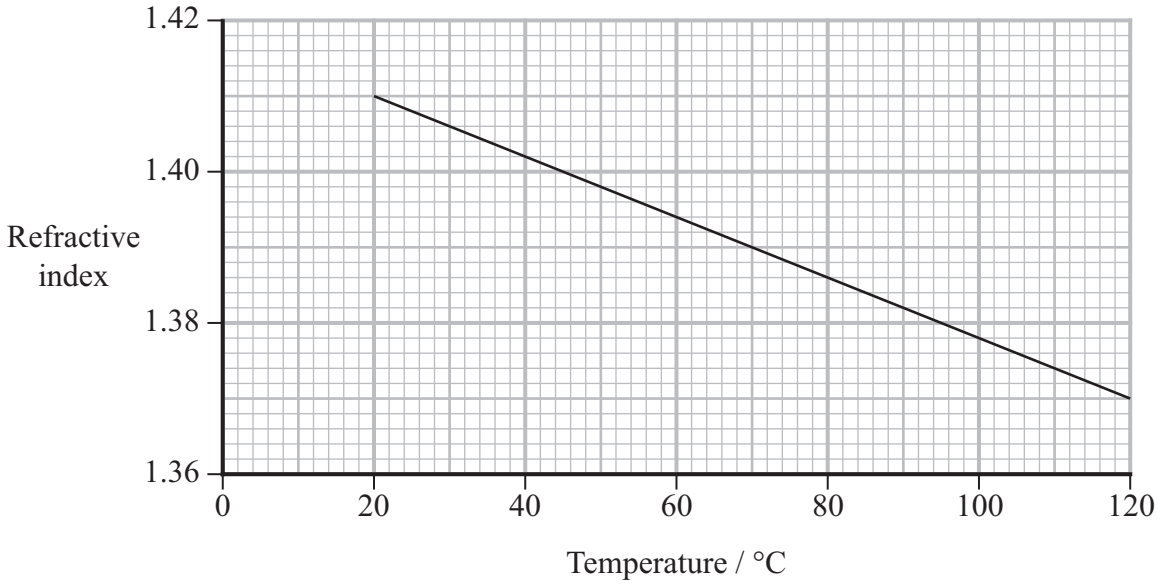
P = 1/f = 1 / 0.167 m

P = 6.0 D

Power = 6.0 D

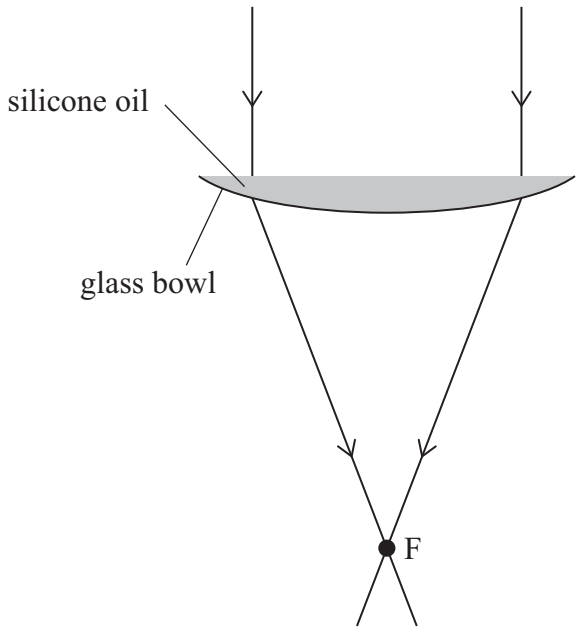
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(b) The refractive index of the silicone oil changes with temperature, as shown.



The student connected a light dependent resistor (LDR) to an ohmmeter.

The light was brought to a focus at the focal point F, as shown. The LDR was placed at F.



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The student recorded the resistance of the LDR. She then filled the glass bowl with silicone oil at a higher temperature and recorded the resistance of the LDR again.

Deduce the effect on the resistance of the LDR of increasing the temperature of the oil.

(5)

From the graph, as the temperature of the oil increases, the refractive index of the oil decreases.

So the light refracts less (bends less) at the boundaries of the lens.

So the focal length of the lens increases and the light is no longer brought to a focus at F (the rays are less converged when they reach the LDR).

So the light intensity at F (on the LDR) decreases.

Therefore the resistance of the LDR increases.

(Total for Question 15 = 7 marks)

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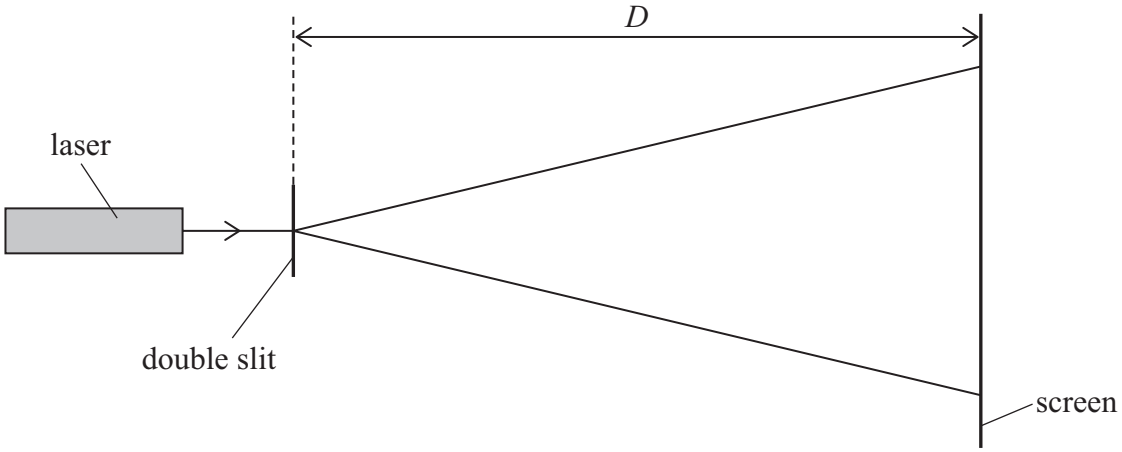
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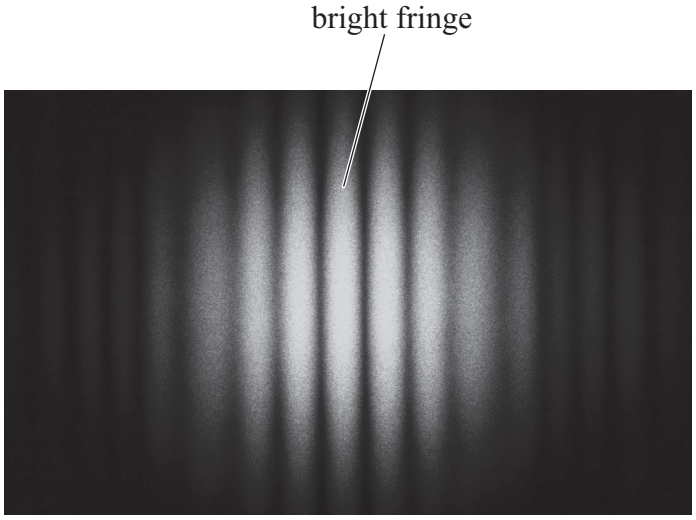
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16 A student directed light from a laser onto a double slit. The double slit consisted of two parallel narrow slits a distance s apart. The light spread out as it passed through the double slit and hit a screen a distance D away from the double slit, as shown.



The light produced a pattern of bright and dark fringes on the screen, as shown below.



(Source: © GIPhotoStock/SCIENCE PHOTO LIBRARY)

(a) The student used digital calipers to measure the separation of the fringes w by measuring between the centres of adjacent fringes.

Explain how the student could reduce the percentage uncertainty in his measurement of w.

(2)

Measure across several (n) fringe separations and divide by n (or increase D so w is larger).

The uncertainty in the reading stays the same but the measurement is larger, so the percentage uncertainty in w decreases.

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(b) The student varied s for the double slit and recorded corresponding values of w. The results are recorded below.

s / mm	w / m	$1/w$ / m^{-1}
0.10	0.0643	15.6
0.20	0.0301	33.2
0.30	0.0204	49.0
0.40	0.0159	62.9
0.50	0.0131	76.3

(i) Plot a graph of s on the y-axis and $1/w$ on the x-axis using the grid opposite.

Use the additional column in the table for your processed data.

(5)

(ii) The following equation can be used to determine the wavelength λ of laser light for the experiment.

$$s = \frac{\lambda D}{w}$$

Calculate λ for the light used in this experiment.

$D = 9.00\,\text{m}$

(3)

Gradient of line = $\Delta s/\Delta(1/w)$ = $(0.50 - 0.10) \times 10^{-3}$ m / $(77.8 - 17.0)$ m^{-1}

Gradient = 6.58×10^{-6} m^2

Gradient = λD, so $\lambda = 6.58 \times 10^{-6}$ m^2 / 9.00 m = 7.3×10^{-7} m

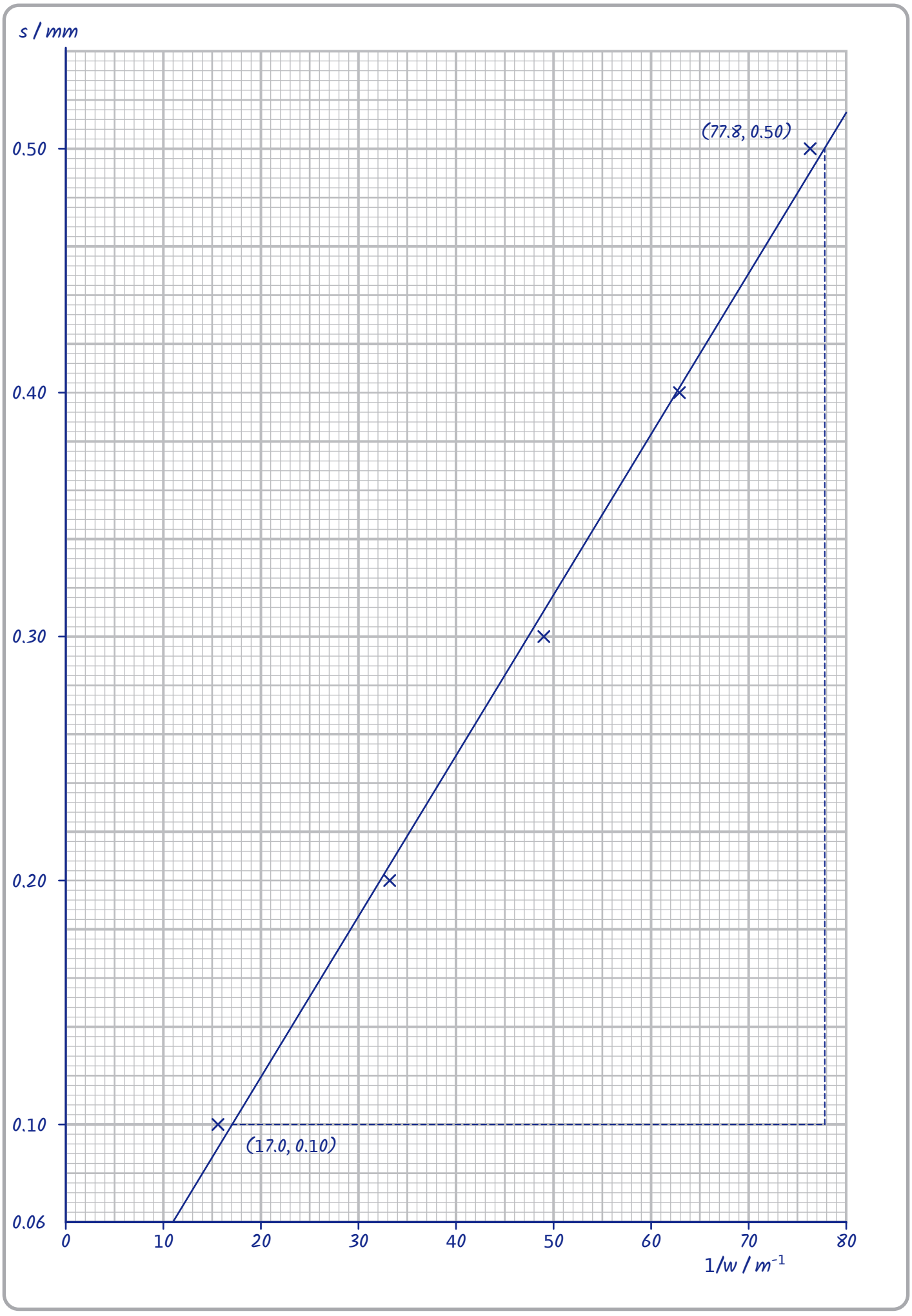
$\lambda =$ 7.3×10^{-7} m

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(c) Another student carried out the same experiment using a different laser labelled with a wavelength of 520 nm.

(i) She measured w several times for the same value of s. The results are recorded below.

w / mm				w_{mean} / mm
21	20	23	24	22

Calculate the percentage uncertainty in the value of w.

(2)

½ range = ½ × (24 − 20) mm = 2 mm

%U = 2 mm / 22 mm × 100 = 9%

Percentage uncertainty in w = 9%

(ii) Assess whether the student's results support the value of the wavelength of light given on the label.

$$s = \frac{\lambda D}{w}$$

$D = 9.00\,\text{m} \pm 0.01\,\text{m}$
$s = 0.20\,\text{mm} \pm 4\%$

(4)

$\lambda = sw/D = (0.20 \times 10^{-3}\ m \times 22 \times 10^{-3}\ m) / 9.00\ m = 4.89 \times 10^{-7}\ m$

%U in D = 0.01 m / 9.00 m × 100 = 0.1%

$\%U \text{ in } \lambda = \%U_D + \%U_s + \%U_w = 0.1\% + 4\% + 9\% = 13\%$

Uncertainty in $\lambda = 0.13 \times 4.89 \times 10^{-7}\ m = 6.4 \times 10^{-8}\ m$

Upper limit of $\lambda = 4.89 \times 10^{-7} + 0.64 \times 10^{-7} = 5.52 \times 10^{-7}\ m = 552\ nm$

552 nm is greater than 520 nm, so 520 nm lies within the range of the student's results: they support the value on the label.

(Total for Question 16 = 16 marks)

TOTAL FOR SECTION B = 23 MARKS
TOTAL FOR PAPER = 80 MARKS

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Pearson Edexcel Level 3 GCE

Wednesday 14 May 2025

Morning (Time: 1 hour 30 minutes)

Paper reference **8PH0/01**

Physics

Advanced Subsidiary

PAPER 1: Core Physics I

Data, Formulae and Relationships Booklet
Do not return this Booklet with the question paper.

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List of data, formulae and relationships

Acceleration of free fall	$g = 9.81\ \text{m s}^{-2}$	(close to Earth's surface)
Electron charge	$e = -1.60 \times 10^{-19}\ \text{C}$	
Electron mass	$m_e = 9.11 \times 10^{-31}\ \text{kg}$	
Electronvolt	$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$	
Gravitational field strength	$g = 9.81\ \text{N kg}^{-1}$	(close to Earth's surface)
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$	

Mechanics

Kinematic equations of motion

$$s = \frac{(u + v)t}{2}$$

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

Forces

$\Sigma F = ma$

$$g = \frac{F}{m}$$

$W = mg$

moment of force $= Fx$

Momentum

$p = mv$

Work, energy and power

$\Delta W = F\Delta s$

$E_k = \frac{1}{2}mv^2$

$\Delta E_{grav} = mg\Delta h$

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

Electricity

Potential difference

$$V = \frac{W}{Q}$$

Resistance

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

Electrical power and energy

$P = VI$

$P = I^2R$

$$P = \frac{V^2}{R}$$

$W = VIt$

Resistivity

$$R = \frac{\rho l}{A}$$

Current

$$I = \frac{\Delta Q}{\Delta t}$$

$I = nqvA$

Materials

Density

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

Stokes' law

$$F = 6\pi\eta r v$$

Hooke's law

$$\Delta F = k\Delta x$$

Young modulus

$$\text{Stress } \sigma = \frac{F}{A}$$

$$\text{Strain } \varepsilon = \frac{\Delta x}{x}$$

$$E = \frac{\sigma}{\varepsilon}$$

Elastic strain energy

$$\Delta E_{el} = \tfrac{1}{2} F \Delta x$$

Waves and particle nature of light

Wave speed

$$v = f\lambda$$

Speed of a transverse wave on a string

$$v = \sqrt{\frac{T}{\mu}}$$

Intensity of radiation

$$I = \frac{P}{A}$$

Power of a lens

$$P = \frac{1}{f}$$

$$P = P_1 + P_2 + P_3 + \ldots$$

Thin lens equation

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

Magnification for a lens

$$m = \frac{\text{image height}}{\text{object height}} = \frac{v}{u}$$

Diffraction grating

$$n\lambda = d \sin\theta$$

Refractive index

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$n = \frac{c}{v}$$

Critical angle

$$\sin C = \frac{1}{n}$$

Photon model

$$E = hf$$

Einstein's photoelectric equation

$$hf = \phi + \tfrac{1}{2} m v_{max}^2$$

de Broglie wavelength

$$\lambda = \frac{h}{p}$$

END OF DATA, FORMULAE AND RELATIONSHIPS LIST

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