

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

StemUp Model Solution

Forename(s)

Candidate signature

A-level PHYSICS

Paper 1

Monday 4 June 2018

Afternoon

Time allowed: 2 hours

Materials

For this paper you must have:

- a pencil and a ruler
- a scientific calculator
- a Data and Formulae Booklet.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do **all** rough work in this book. Cross through any work you do not want to be marked.
- Show **all** your working.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 85.
- You are expected to use a scientific calculator where appropriate.
- A Data and Formulae Booklet is provided as a loose insert.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7–31	
TOTAL	



J U N 1 8 7 4 0 8 1 0 1

Section A

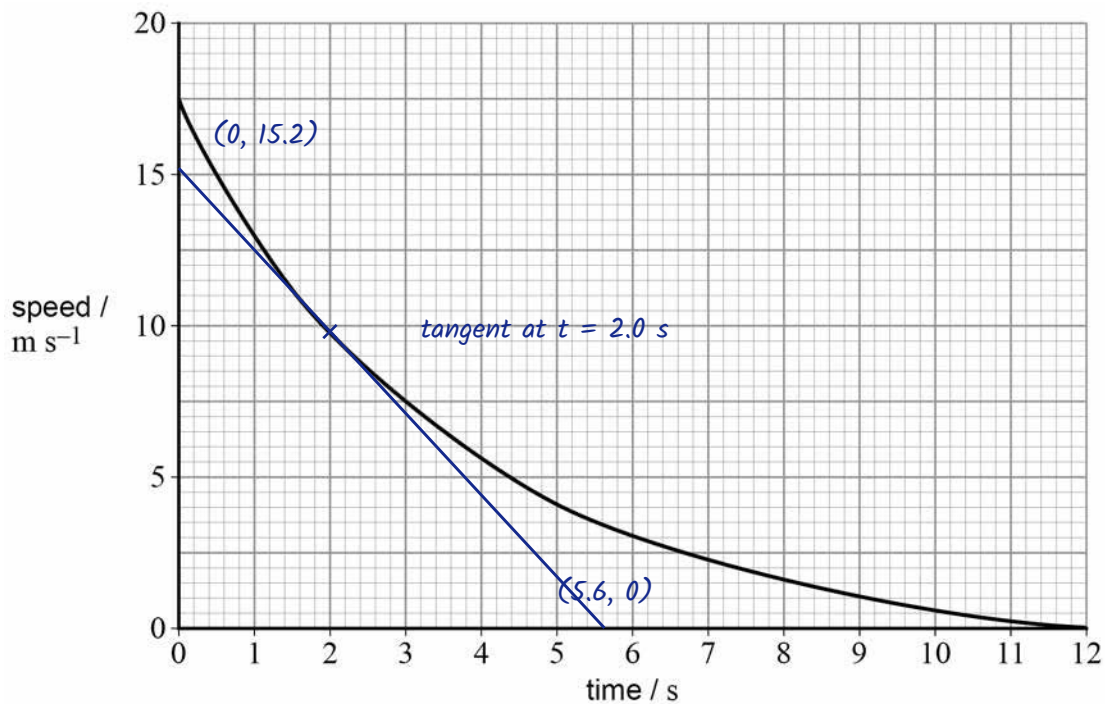
Answer **all** questions in this section.

0 1

Horizontal escape lanes made of loose gravel have been constructed at the side of some roads on steep hills so that vehicles can stop safely when their brakes fail.

Figure 1 shows an engineer's prediction of how the speed of an unpowered vehicle of mass 1.8×10^4 kg will vary with time as the vehicle comes to rest in an escape lane.

Figure 1



0 1 . 1

Determine the force decelerating the vehicle 2.0 s after entering the escape lane.

[3 marks]

gradient of tangent at $t = 2.0$ s:

$$a = \Delta v / \Delta t = (0 - 15.2) / (5.6 - 0) = -2.7 \text{ m s}^{-2}$$

so deceleration = 2.7 m s^{-2}

$$F = ma = 1.8 \times 10^4 \times 2.7$$

$$F = 4.9 \times 10^4 \text{ N}$$

force decelerating the vehicle = 4.9 × 10⁴ N



0 1 . 2

Deduce whether a lane of length 85 m is long enough to stop the vehicle, assuming that the engineer's graph is correct.

[3 marks]

distance = area under the speed-time graph

1 large square (10 mm) = 1 s $\times$ 2.5 m s⁻¹ = 2.5 m

number of squares under curve $\approx$ 22.5

distance $\approx$ 22.5 $\times$ 2.5 = 56 m

56 m < 85 m

The vehicle stops in about 56 m, which is less than 85 m, so the lane is long enough.

0 1 . 3

Discuss the energy transfers that take place when a vehicle is decelerated in an escape lane.

[2 marks]

The kinetic energy of the lorry is transferred to kinetic energy of the gravel as it is pushed aside, and some to potential energy of gravel thrown upwards.

Work is done on the gravel and lorry, so the KE is also transferred to thermal (internal) energy, heating the gravel, the ground and the lorry.

Question 1 continues on the next page

Turn over ►



0 1 . 4

An alternative to an escape lane containing gravel is an escape lane that consists of a ramp. An escape ramp is a straight road with a concrete surface that has a constant upward gradient.

One escape ramp makes an angle of 25° to the horizontal and is 85 m long.

Deduce whether this escape ramp is sufficient to stop the vehicle.

Assume that any frictional forces and air resistance that decelerate the vehicle are negligible.

[3 marks]

$$KE \text{ converted to PE: } \frac{1}{2}mv^2 = mgh$$

$$\text{initial KE} = \frac{1}{2} \times 1.8 \times 10^4 \times 17.5^2 = 2.76 \times 10^6 \text{ J}$$

$$h = 2.76 \times 10^6 / (1.8 \times 10^4 \times 9.81) = 15.6 \text{ m}$$

$$\text{Length of ramp needed} = 15.6 / \sin 25^\circ = 37 \text{ m, which is less than}$$

$$85 \text{ m, so the ramp is sufficient to stop the vehicle.}$$

0 1 . 5

Discuss whether an escape lane containing gravel or an escape ramp would provide the safer experience for the driver of the vehicle as it comes to rest.

[1 mark]

The ramp is safer, because on the straight ramp of uniform gradient the deceleration is uniform, whereas in gravel the initial deceleration is larger and may vary, and the vehicle could become unstable and bounce erratically.



0 2

Table 1 shows results of an experiment to investigate how the de Broglie wavelength λ of an electron varies with its velocity v .

Table 1

$v / 10^7 \text{ m s}^{-1}$	$\lambda / 10^{-11} \text{ m}$
1.5	4.9
2.5	2.9
3.5	2.1

0 2 . 1

Show that the data in **Table 1** are consistent with the relationship $\lambda \propto \frac{1}{v}$

[2 marks]

If $\lambda \propto 1/v$ then $\lambda v = \text{constant}$:

$$1.5 \times 10^7 \times 4.9 \times 10^{-11} = 7.35 \times 10^{-4} \text{ m}^2 \text{ s}^{-1}$$

$$2.5 \times 10^7 \times 2.9 \times 10^{-11} = 7.25 \times 10^{-4} \text{ m}^2 \text{ s}^{-1}$$

$$3.5 \times 10^7 \times 2.1 \times 10^{-11} = 7.35 \times 10^{-4} \text{ m}^2 \text{ s}^{-1}$$

λv is (approximately) constant for all three sets, so $\lambda \propto 1/v$.

0 2 . 2

Calculate a value for the Planck constant suggested by the data in **Table 1**.

[2 marks]

$$\lambda = h / mv \text{ so } h = m\lambda v$$

$$h = 9.11 \times 10^{-31} \times 4.9 \times 10^{-11} \times 1.5 \times 10^7$$

$$h = 6.7 \times 10^{-34} \text{ J s}$$

Planck constant = 6.7×10^{-34} J s

Question 2 continues on the next page

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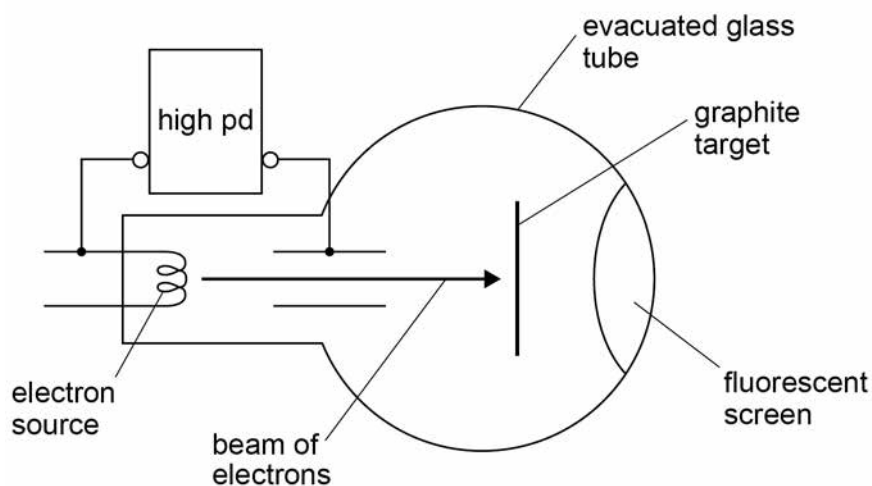


0 2 . 3

Figure 2 shows the side view of an electron diffraction tube used to demonstrate the wave properties of an electron.

Figure 2

Side view

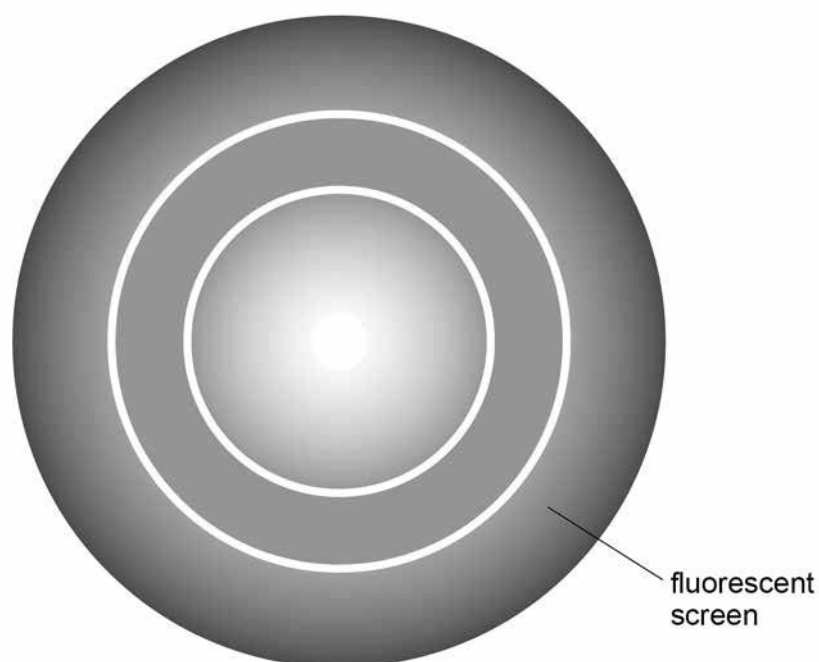


An electron beam is incident on a thin graphite target that behaves like the slits in a diffraction grating experiment. After passing through the graphite target the electrons strike a fluorescent screen.

Figure 3 shows the appearance of the fluorescent screen when the electrons are incident on it.

Figure 3

Front view



Explain how the pattern produced on the screen supports the idea that the electron beam is behaving as a wave rather than as a stream of particles.

[3 marks]

If the electrons behaved as particles they would travel in straight lines (or scatter randomly) and produce only a small spot or patch of light in the centre of the screen.

The rings show diffraction (and interference), which is a wave property.

The graphite causes the electron waves to spread out, travelling in particular directions.

Bright rings are where the diffracted waves meet in phase and interfere constructively, like the maxima of a diffraction grating where $d \sin \theta = n\lambda$.

0 2 . 4

Explain how the emission of light from the fluorescent screen shows that the electrons incident on it are behaving as particles.

[3 marks]

Each electron transfers its kinetic energy to an atom of the screen instantly in a one to one interaction (a discrete amount), not spread out over time as a wave would.

The incident electron collides with an electron in an atom of the screen and moves it up to a higher energy level, exciting the atom.

When the atom de-excites, the electron moves back down to a lower energy level and a photon of light is emitted.

10

Turn over ►



0	3
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Figure 4 shows the structure of a violin and **Figure 5** shows a close-up image of the tuning pegs.

Figure 4

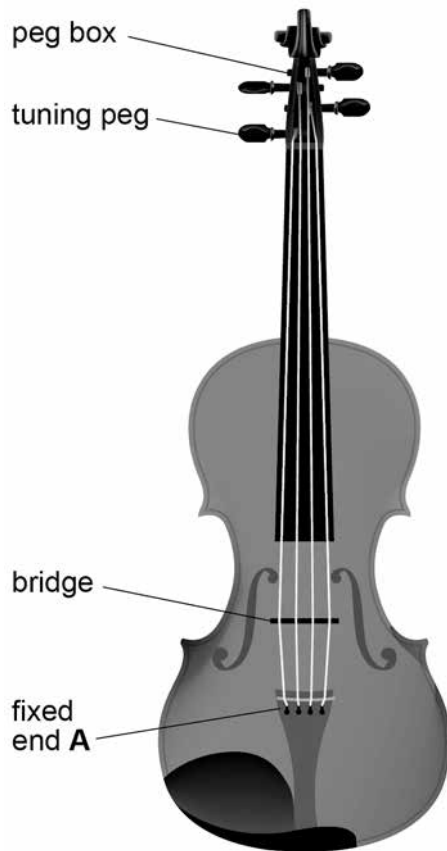
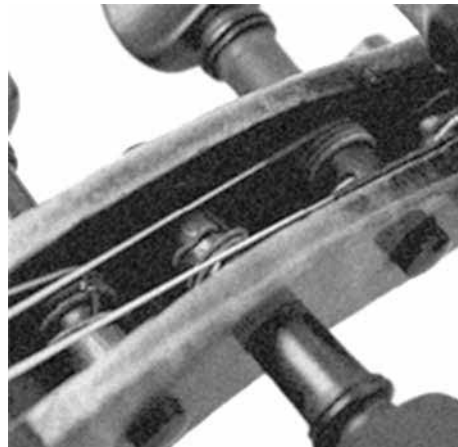


Figure 5



The strings are fixed at end **A**. The strings pass over a bridge and the other ends of the strings are wound around tuning pegs that have a circular cross-section. The tension in the strings can be increased or decreased by rotating the tuning pegs.



03.1

Explain how a stationary wave is produced when a stretched string is plucked.

[3 marks]

The waves travel along the string to the fixed ends and are reflected.

Two waves travelling in opposite directions (with the same frequency) superpose / interfere.

The fixed ends cannot move so they are nodes. At some positions the waves always cancel (destructive interference) giving nodes of zero amplitude, and at others they interfere constructively giving antinodes of maximum amplitude.

03.2

The vibrating length of one of the strings of a violin is 0.33 m
When the tension in the string is 25 N, the string vibrates with a first-harmonic frequency of 370 Hz

Show that the mass of a 1.0 m length of the string is about 4×10^{-4} kg

[2 marks]

$$f = (1/2l) \sqrt{T/\mu} \quad \text{so} \quad \mu = T / (4l^2 f^2)$$

$$\mu = 25 / (4 \times 0.33^2 \times 370^2)$$

$$\mu = 4.19 \times 10^{-4} \text{ kg m}^{-1}$$

$$\text{so mass of 1.0 m} = 4.2 \times 10^{-4} \text{ kg} \approx 4 \times 10^{-4} \text{ kg}$$

03.3

Determine the speed at which waves travel along the string in question 03.2 when it vibrates with a first-harmonic frequency of 370 Hz

[1 mark]

$$\lambda = 2l = 0.66 \text{ m}, \quad v = f\lambda = 370 \times 0.66$$

speed of waves = 244 m s⁻¹

Question 3 continues on the next page

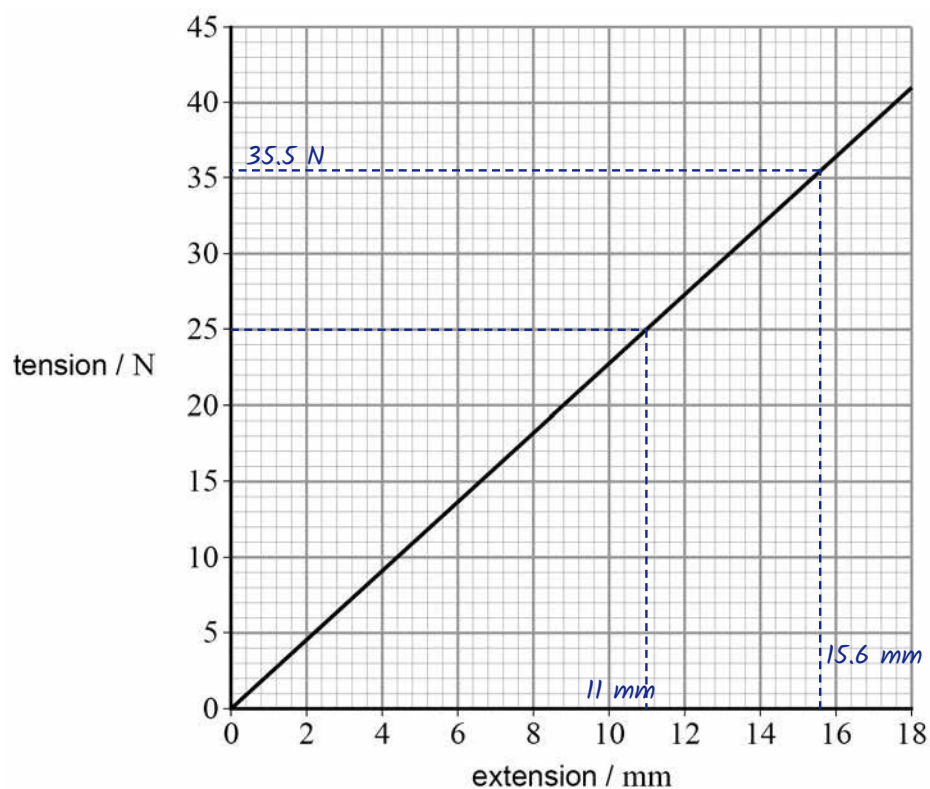
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0 3 . 4

Figure 6 shows how the tension in the string in question **03.2** varies with the extension of the string.

Figure 6



The string with its initial tension of 25 N is vibrating at a frequency of 370 Hz
The diameter of the circular peg is 7.02 mm



Determine the higher frequency that is produced when the string is stretched by rotating the tuning peg through an angle of 75°

Assume that there is no change in the diameter of the string.

[4 marks]

From graph: 25 N gives extension of 11 mm

1 rotation = $\pi d = \pi \times 7.02 = 22 \text{ mm}$

extra extension = $22 \times 75/360 = 4.6 \text{ mm}$

total extension = $11 + 4.6 = 15.6 \text{ mm}$, so $T = 35.5 \text{ N}$

$f = (1/2l) \sqrt{T/\mu} = (1/0.66) \times \sqrt{35.5 / 4.19 \times 10^{-4}}$

$f = 441 \text{ Hz}$

frequency = 441 Hz

10

Turn over for the next question

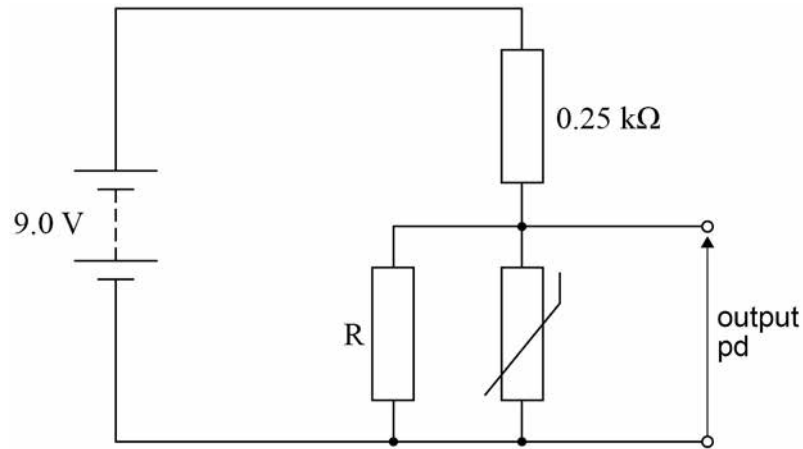
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0 4

Figure 7 shows a circuit designed by a student to monitor temperature changes.

Figure 7



The supply has negligible internal resistance and the thermistor has a resistance of $750\ \Omega$ at room temperature. The student wants the output potential difference (pd) at room temperature to be $5.0\ \text{V}$

0 4

. 1

The $0.25\ \text{k}\Omega$ resistor is made of 50 turns of wire that is wound around a non-conducting cylinder of diameter $8.0\ \text{mm}$

Resistivity of the wire = $4.2 \times 10^{-7}\ \Omega\ \text{m}$

Determine the area of cross-section of the wire that has been used for the resistor.

[3 marks]

$$\text{length of wire} = 50 \times \pi \times 8.0 \times 10^{-3} = 1.26\ \text{m}$$

$$R = \rho L/A \quad \text{so} \quad A = \rho L/R$$

$$A = 4.2 \times 10^{-7} \times 1.26 / 250$$

$$A = 2.1 \times 10^{-9}\ \text{m}^2$$

area of cross-section = 2.1×10^{-9} m^2



0 4 . 2

The student selects a resistor rated at 0.36 W for the 0.25 k Ω resistor in **Figure 7**.

Determine whether this resistor is suitable.

[2 marks]

Maximum possible pd across 0.25 k Ω is 9.0 V

$$\text{max power} = V^2/R = 9.0^2 / 250 = 0.32 \text{ W}$$

0.32 W is less than the 0.36 W rating, so the maximum power dissipated is below the rating and the resistor is suitable.

0 4 . 3

Determine the value of R that the student should select.

Give your answer to an appropriate number of significant figures.

[5 marks]

$$\text{Potential divider: pd across } 250 \Omega = 9.0 - 5.0 = 4.0 \text{ V}$$

$$\text{current} = 4.0 / 250 = 16 \text{ mA}$$

$$R_{\text{combination}} = 5.0 / 0.016 = 313 \Omega \text{ (0.313 k}\Omega\text{)}$$

$$\text{current in thermistor} = 5.0 / 750 = 6.7 \text{ mA} \quad (\text{or } 1/313 = 1/R + 1/750)$$

$$\text{current in } R = 16 - 6.7 = 9.3 \text{ mA}, \quad R = 5.0 / 9.3 \times 10^{-3}$$

value of R = 540 Ω

Question 4 continues on the next page

Turn over ►



0 4 . 4

State and explain the effect on the output pd of increasing the temperature of the thermistor.

[2 marks]

The resistance of the thermistor decreases, so the output pd decreases.

This is because the resistance of the parallel combination decreases, so a lower proportion of the 9.0 V is across it (a higher current, so a greater pd across the 0.25 k Ω resistor).

12



Turn over for the next question

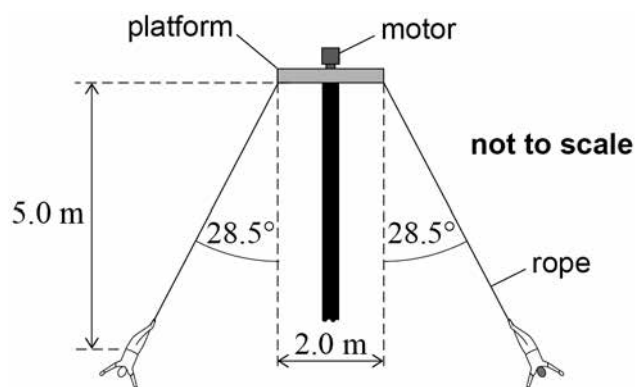
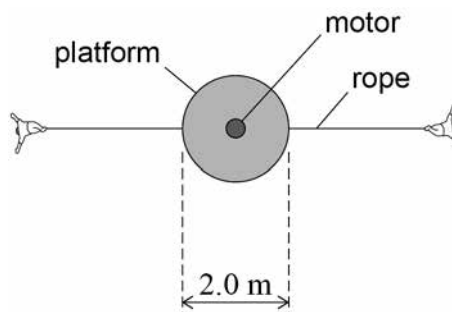
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ANSWER IN THE SPACES PROVIDED**

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0 5

Figure 8 shows a side view of an act performed by two acrobats. **Figure 9** shows the view from above.

Figure 8**Figure 9**

The acrobats, each of mass 85 kg, are suspended from ropes attached to opposite edges of a circular platform that is at the top of a vertical pole. The platform has a diameter of 2.0 m

A motor rotates the platform so that the acrobats move at a constant speed in a horizontal circle, on opposite sides of the pole.

When the period of rotation of the platform is 5.2 s, the centre of mass of each acrobat is 5.0 m below the platform and the ropes are at an angle of 28.5° to the vertical as shown in **Figure 8**.

0 5 . 1

Show that the linear speed of the acrobats is about 4.5 m s^{-1}

[2 marks]

$$\text{radius of orbit} = 5.0 \tan 28.5^\circ + 1.0$$

$$r = 2.71 + 1.0 = 3.71 \text{ m}$$

$$v = 2\pi r / T = 2 \times \pi \times 3.71 / 5.2$$

$$v = 4.49 \text{ m s}^{-1} \approx 4.5 \text{ m s}^{-1}$$



0 5 . 2

Determine the tension in each rope that supports the acrobats.

[3 marks]

$$\text{Vertically: } T \cos 28.5^\circ = \text{weight} = mg$$

$$\text{weight} = 85 \times 9.81 = 834 \text{ N}$$

$$T = 834 / \cos 28.5^\circ = 949 \text{ N}$$

$$\begin{aligned} \text{(check: centripetal force} &= mv^2/r = 85 \times 4.49^2 / 3.71 = 460 \text{ N} \\ &= T \sin 28.5^\circ, \text{ giving } T \approx 960 \text{ N)} \end{aligned}$$

tension = 950 N

0 5 . 3

Discuss the consequences for the forces acting on the pole when one acrobat has a much greater mass than the other.

[3 marks]

The greater mass has a greater weight, so the tension in its rope is greater (for the same angle), and the vertical (compressive) force on the pole increases.

The centripetal force on the more massive acrobat is greater, so the horizontal forces on the platform from the two ropes are not equal.

There is an unbalanced (resultant) horizontal force and an unbalanced moment (torque) acting on the pole, causing the pole to bend or sway, or the platform to tilt, towards the more massive acrobat.

Turn over ►



0 6

Figure 10 shows two railway trucks **A** and **B** travelling towards each other on the same railway line which is straight and horizontal.

Figure 10



The trucks are involved in an inelastic collision. They join when they collide and then move together.

The trucks move a distance of 15 m before coming to rest.

Truck **A** has a total mass of 16 000 kg and truck **B** has a total mass of 12 000 kg

Just before the collision, truck **A** was moving at a speed of 2.8 m s^{-1} and truck **B** was moving at a speed of 3.1 m s^{-1}

0 6 . 1

State the quantity that is **not** conserved in an inelastic collision.

[1 mark]

(Total) kinetic energy

0 6 . 2

Show that the speed of the joined trucks immediately after the collision is about 0.3 m s^{-1}

[3 marks]

Conservation of momentum (taking A's direction as positive):

total momentum before = total momentum after

$$16\,000 \times 2.8 - 12\,000 \times 3.1 = (16\,000 + 12\,000) v$$

$$44\,800 - 37\,200 = 28\,000 v$$

$$7600 = 28\,000 v$$

$$v = 7600 / 28\,000 = 0.271 \text{ m s}^{-1} \approx 0.3 \text{ m s}^{-1}$$



0 6 . 3

Calculate the impulse that acts on each truck during the collision.
Give an appropriate unit for your answer.

[2 marks]

impulse = change in momentum

for A: $16\,000 \times (2.8 - 0.271)$

= 4.05×10^4 N s (same size on B, opposite direction)

impulse = 4.05×10^4 unit N s

0 6 . 4

Explain, without doing a calculation, how the motion of the trucks immediately after the collision would be different for a collision that is perfectly elastic.

[2 marks]

*In a perfectly elastic collision the trucks would not join: they would
move in opposite directions (rebound) after the collision.*

*Truck B would move faster than truck A, because the total momentum
is to the right and B has the lower mass (B would have the momentum
that A had before the collision, and vice versa).*

8

Turn over ►



Section B

Each of Questions **07** to **31** is followed by four responses, **A**, **B**, **C** and **D**.

For each question select the best response.

Only **one** answer per question is **allowed**.

For each answer completely **fill** in the circle alongside the appropriate answer.

CORRECT METHOD



WRONG METHODS



If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

You may do your working in the blank space around each question but this **will** not be marked.

Do **not** use additional sheets for this working.

0 7

What is a correct unit for the area under a force–time graph?

[1 mark]

A N m

☐

B kg m s⁻¹

☒

C kg m s⁻²

☐

D N s⁻¹

☐

0 8

A student carries out an experiment to determine the resistivity of a metal wire. She determines the resistance from measurements of potential difference between the ends of the wire and the corresponding current. She measures the length of the wire with a ruler and the diameter of the wire using a micrometer. Each measurement is made with an uncertainty of 1%

Which measurement gives the largest uncertainty in the calculated value of the resistivity?

[1 mark]

A current

☐

B diameter

☒

C length

☐

D potential difference

☐


0 9 Fluoride ions are produced by the addition of a single electron to an atom of fluorine $^{19}_9\text{F}$.

What is the magnitude of specific charge of the fluoride ion?

[1 mark]

A $3.2 \times 10^{-26} \text{ C kg}^{-1}$

☐

B $8.4 \times 10^{-21} \text{ C kg}^{-1}$

☐

C $5.0 \times 10^6 \text{ C kg}^{-1}$

☒

D $4.5 \times 10^7 \text{ C kg}^{-1}$

☐

1 0 Two gamma photons are produced when a muon and an antimuon annihilate each other.

What is the minimum frequency of the gamma radiation that could be produced?

[1 mark]

A $2.55 \times 10^{16} \text{ Hz}$

☐

B $5.10 \times 10^{16} \text{ Hz}$

☐

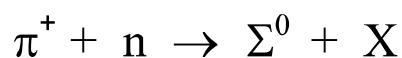
C $2.55 \times 10^{22} \text{ Hz}$

☒

D $5.10 \times 10^{22} \text{ Hz}$

☐

1 1 The Σ^0 baryon, composed of the quark combination uds , is produced through the strong interaction between a π^+ meson and a neutron.



What is the quark composition of X?

[1 mark]

A $u\bar{s}$

☒

B ud

☐

C $u\bar{d}$

☐

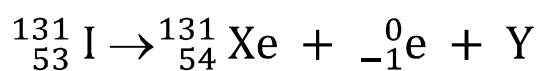
D $ud\bar{s}$

☐

Turn over ►



- 1 2** An iodine nucleus decays into a nucleus of Xe-131, a beta-minus particle and particle Y.



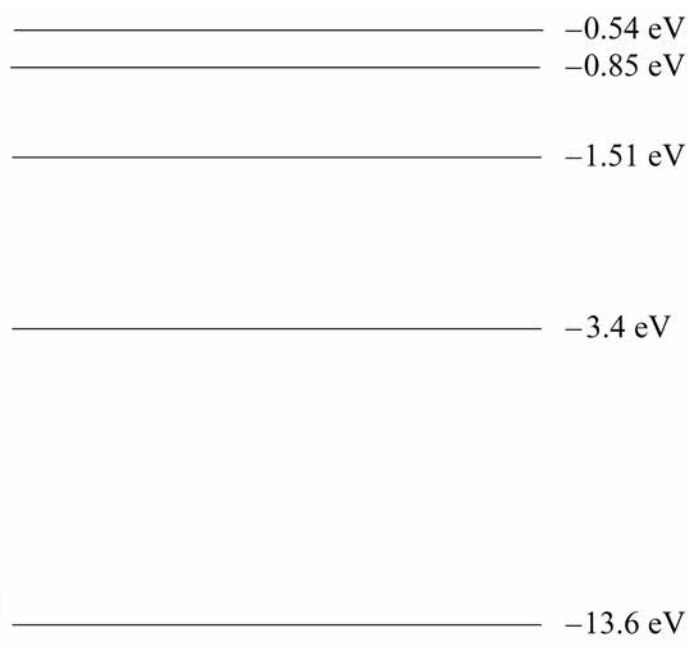
Which is a property of particle Y?

[1 mark]

- A** It has a lepton number of +1
- B** It is an antiparticle
- C** It is negatively charged
- D** It experiences the strong interaction

☐
☒
☐
☐

- 1 3** The diagram shows an energy-level diagram for a hydrogen atom.



Electrons, each having a kinetic energy of 2.0×10^{-18} J, collide with atoms of hydrogen in their ground state. Photons are emitted when the atoms de-excite.

How many different wavelengths can be observed with incident electrons of this energy?

[1 mark]

- A** 1
- B** 3
- C** 6
- D** 7

☐
☒
☐
☐

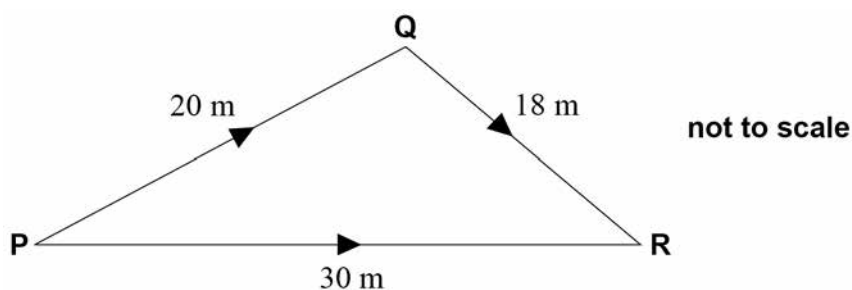

1 4

Photons of wavelength 290 nm are incident on a metal plate. The work function of the metal is 4.1 eV

What is the maximum kinetic energy of the emitted electrons?

[1 mark]**A** 0.19 eV☒**B** 4.3 eV☐**C** 6.9 eV☐**D** 8.4 eV☐**1 5**

In the diagram, **P** is the source of a wave of frequency 50 Hz



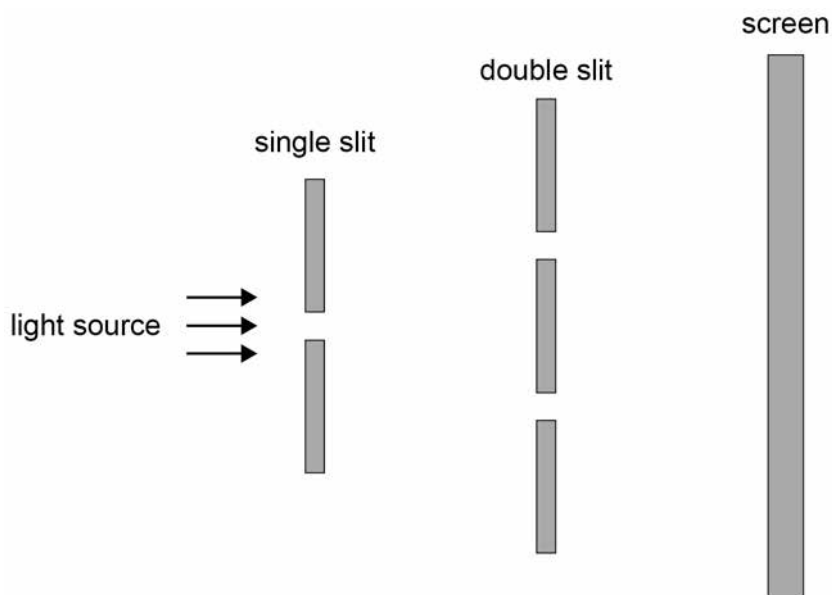
The wave travels to **R** by two routes, **P** → **Q** → **R** and **P** → **R**. The speed of the wave is 30 m s^{-1}

What is the path difference between the two waves at **R** in terms of the wavelength λ of the waves?

[1 mark]**A** 4.8λ ☐**B** 8.0λ ☐**C** 13.3λ ☒**D** 20.0λ ☐**Turn over ►**

1 6

Light from a point source passes through a single slit and is then incident on a double-slit arrangement. An interference pattern is observed on the screen.



What will increase the fringe spacing?

[1 mark]

- A** increasing the separation of the single slit and the double slit
- B** increasing the width of the single slit
- C** decreasing the distance between the double slits and the screen
- D** decreasing the separation of the double slits

☐
☐
☐
☒

1 7

A diffraction grating has 500 lines per mm. When monochromatic light is incident normally on the grating the third-order spectral line is formed at an angle of 60° from the normal to the grating.

What is the wavelength of the monochromatic light?

[1 mark]

- A** 220 nm
- B** 580 nm
- C** 960 nm
- D** 1700 nm

☐
☒
☐
☐


1 8

An electromagnetic wave enters a fibre-optic cable from air. On entering the cable, the wave slows down to three-fifths of its original speed.

What is the refractive index of the core of the fibre-optic cable?

[1 mark]

A 0.67

☐

B 1.33

☐

C 1.50

☐

D 1.67

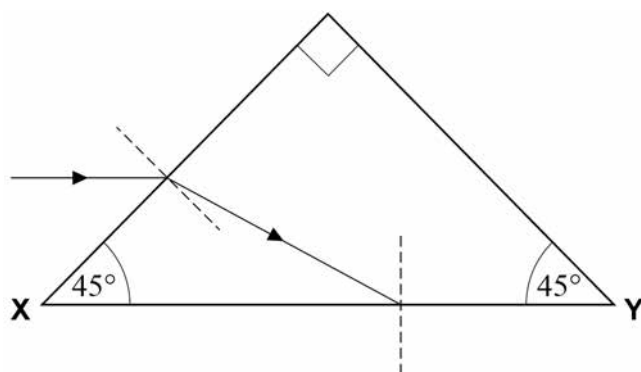
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Turn over for the next question

Turn over ►



- 1 9** The diagram shows part of the path of a ray of light through a right-angled prism.

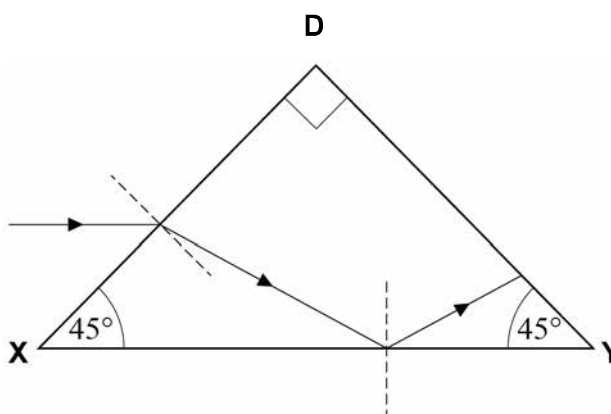
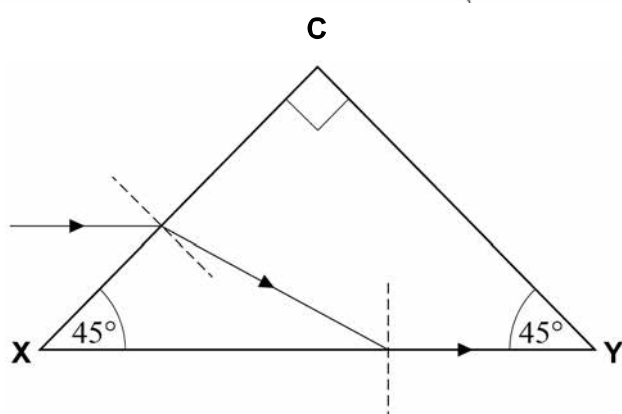
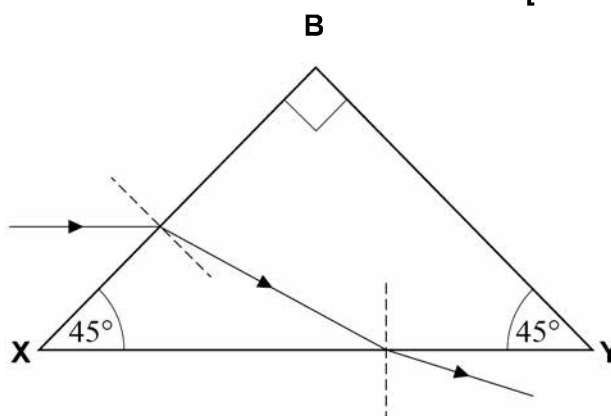
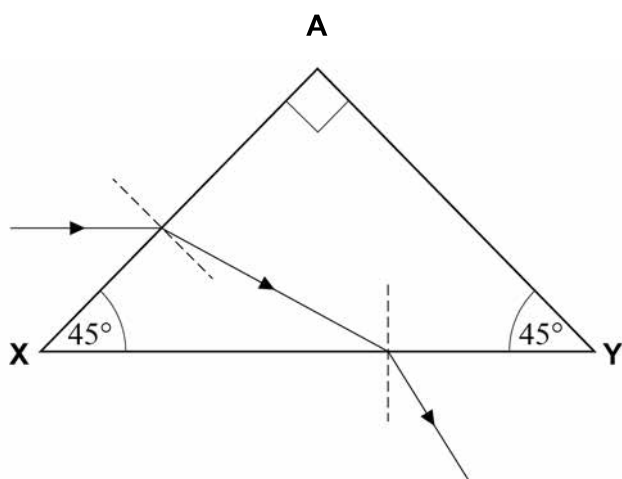


The prism is made of glass of refractive index 1.5

The incident light ray is parallel to the face **XY**. The ray is refracted towards the face **XY**.

What is the path of the ray after it is incident on face **XY**?

[1 mark]



- A** ☐
- B** ☐
- C** ☐
- D** ☒



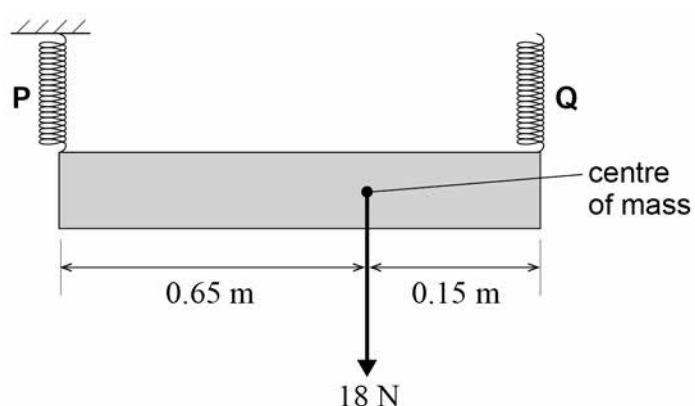
2 0 Three coplanar forces F_1 , F_2 and F_3 act on a point object.

Which combination of forces can never produce a resultant force of zero?

[1 mark]

	F_1 / N	F_2 / N	F_3 / N	
A	3	4	5	☐
B	8	8	8	☐
C	2	10	10	☐
D	3	6	10	☒

2 1 A non-uniform sign is 0.80 m long and has a weight of 18 N. It is suspended from two vertical springs **P** and **Q**. The springs obey Hooke's law and the spring constant of each spring is 240 N m^{-1} .



The top end of spring **P** is fixed and the top end of spring **Q** is adjusted until the sign is horizontal and in equilibrium.

What is the extension of spring **Q**?

[1 mark]

A 0.014 m

☐

B 0.038 m

☐

C 0.049 m

☐

D 0.061 m

☒

Turn over ►



- 2 2** Immediately after take-off from the surface of the Earth, a rocket of mass 12 000 kg accelerates vertically upwards at 1.4 m s^{-2}

What is the thrust produced by the rocket motor?

[1 mark]

A $1.7 \times 10^4 \text{ N}$

☐

B $1.0 \times 10^5 \text{ N}$

☐

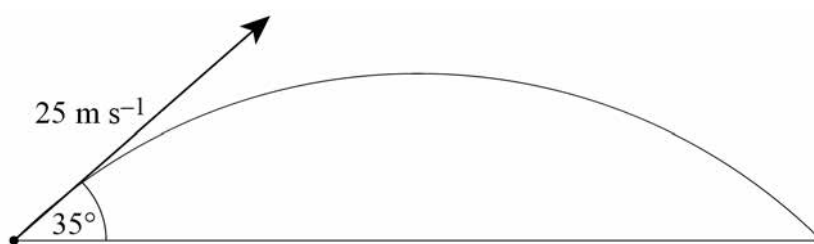
C $1.3 \times 10^5 \text{ N}$

☒

D $1.6 \times 10^5 \text{ N}$

☐

- 2 3** A projectile is launched with a speed of 25 m s^{-1} at an angle of 35° to the horizontal, as shown in the diagram.



Air resistance is negligible.

What is the time taken for the projectile to return to the ground?

[1 mark]

A 1.5 s

☐

B 2.1 s

☐

C 2.9 s

☒

D 4.2 s

☐

2 4

A steel wire **W** has a length l and a circular cross-section of radius r . When **W** hangs vertically and a load is attached to the bottom end, it extends by e . Another wire **X** made from the same material has the same load attached to it.

Which length and radius for **X** will produce an extension of $\frac{e}{4}$?

[1 mark]

	Length of X	Radius of X	
A	$0.5l$	$2r$	☐
B	l	$4r$	☐
C	$2l$	$2r$	☐
D	$4l$	$4r$	☒

2 5

A gas containing doubly-charged ions flows to give an electric current of 0.64 A

How many ions pass a point in 1.0 minute?

[1 mark]**A** 2.0×10^{18} ☐**B** 4.0×10^{18} ☐**C** 1.2×10^{20} ☒**D** 2.4×10^{20} ☐**2 6**

A mobile phone operates at a constant power of 200 mW

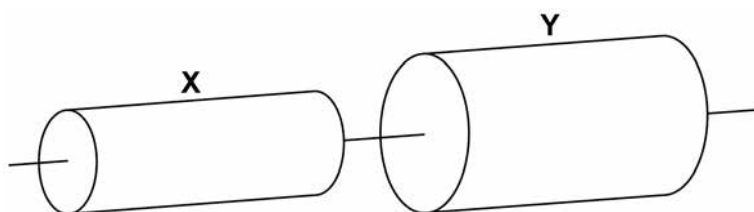
It has a 3.7 V lithium-ion battery that has a charge capacity of 9400 C

What is the time taken for the battery to discharge completely?

[1 mark]**A** 2 hours☐**B** 48 hours☒**C** 120 hours☐**D** 140 hours☐**Turn over ►**

2 7

The two resistors shown are both uniform cylinders of equal length made from the same conducting putty.



The diameter of **Y** is twice that of **X**. The resistance of **Y** is R .

What is the total resistance of the combination?

[1 mark]

A $\frac{4R}{5}$

☐

B $3R$

☐

C $4R$

☐

D $5R$

☒
2 8

A voltmeter is used to measure potential difference for a component **X**.

Which row gives the position and ideal resistance for the voltmeter?

[1 mark]

	Position	Ideal resistance	
A	in series with X	infinite	☐
B	in series with X	zero	☐
C	in parallel with X	infinite	☒
D	in parallel with X	zero	☐



2 9 A body performs simple harmonic motion.

What is the phase difference between the variation of displacement with time and the variation of acceleration with time for the body?

[1 mark]

A 0

☐

B $\frac{\pi}{4}$ rad

☐

C $\frac{\pi}{2}$ rad

☐

D π rad

☒

3 0 An object of mass 0.15 kg performs simple harmonic motion. It oscillates with amplitude 55 mm and frequency 0.80 Hz

What is the maximum value of its kinetic energy?

[1 mark]

A 5.7×10^{-3} J

☒

B 11×10^{-3} J

☐

C 0.57 J

☐

D 11 J

☐

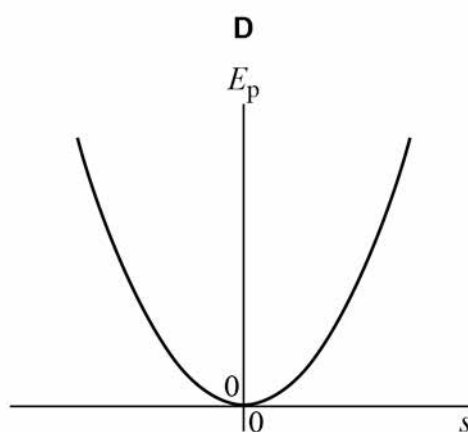
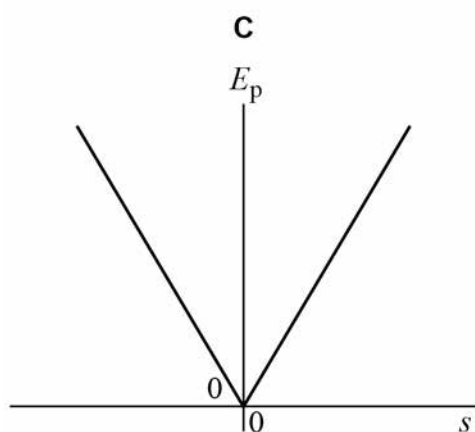
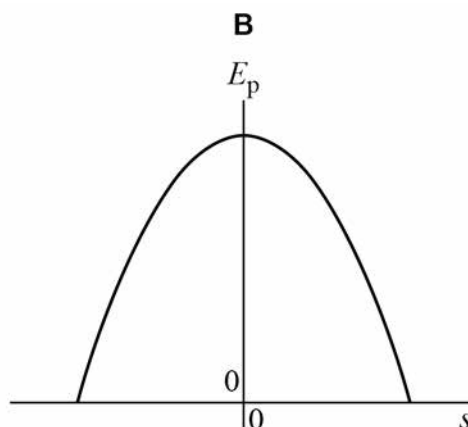
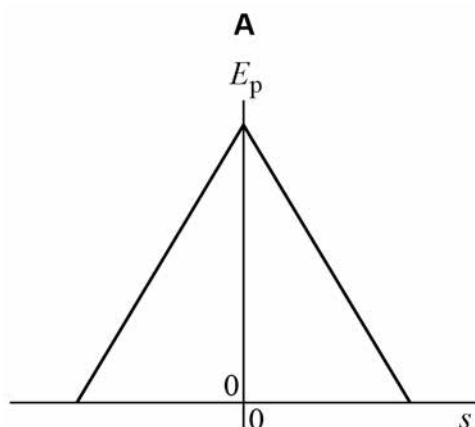
Turn over for the next question

Turn over ►



3 1

Which graph shows how the gravitational potential energy E_p of a simple pendulum varies with displacement s from the equilibrium position?

[1 mark]

A ☐

B ☐

C ☐

D ☒

END OF QUESTIONS**Copyright information**

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