OXFORD AQA

INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

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Forename(s) _____

Candidate signature _____

I declare this is my own work.

INTERNATIONAL AS

PHYSICS

Unit 1 Mechanics, materials and atoms

Monday 12 January 2026 07:00 UK Time Time allowed: 2 hours

Materials

For this paper you must have:

- a Data and Formulae Booklet as a loose insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate
- a protractor.

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.
- All working must be shown.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12–25	
TOTAL	

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Section A

Answer **all** questions in this section.

0 1 Determine the fundamental (base) unit of power.

[2 marks]

fundamental (base) unit of power = _____

2

0 2 . 1 State what is meant by a vector quantity.

[1 mark]

_____

_____

_____

0 2 . 2 State **one** example of a vector quantity and **one** example of a scalar quantity.

[1 mark]

vector quantity: _____

scalar quantity: _____

2

0 3 Complete the equation for the decay of a free neutron.

[2 marks]

$$^{1}_{0}n \rightarrow \begin{matrix}\ldots..\\ \ldots..\end{matrix} \ldots.. + \begin{matrix}\ldots..\\ \ldots..\end{matrix} \ldots.. + \begin{matrix}\ldots..\\ \ldots..\end{matrix} \ldots..$$

2

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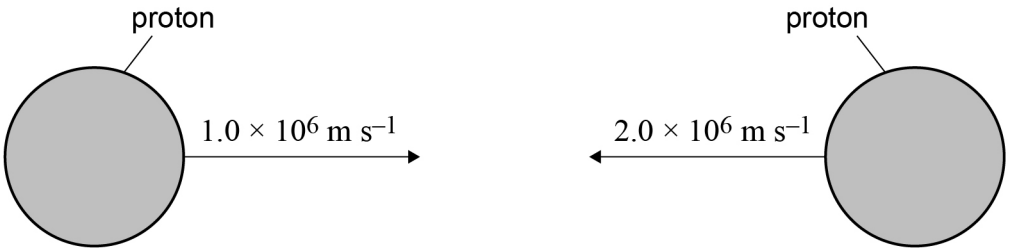
0 4 **Figure 1** shows two protons travelling towards each other just before they collide. The speeds of the protons are 1.0×10^6 m s^{-1} and 2.0×10^6 m s^{-1}.

Figure 1



Deduce whether the kinetic energy of this collision can produce an electron–positron pair.

rest energy of an electron = 0.511 MeV

[3 marks]

3

Turn over for the next question

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0 5 Outline the Rutherford scattering experiment.

In your answer you should:

- draw a labelled diagram of the apparatus used
- describe the observations made
- explain what Rutherford deduced about the structure of the atom from these observations.

[6 marks]

Do not write outside the box

6

Turn over for the next question

Do not write outside the box

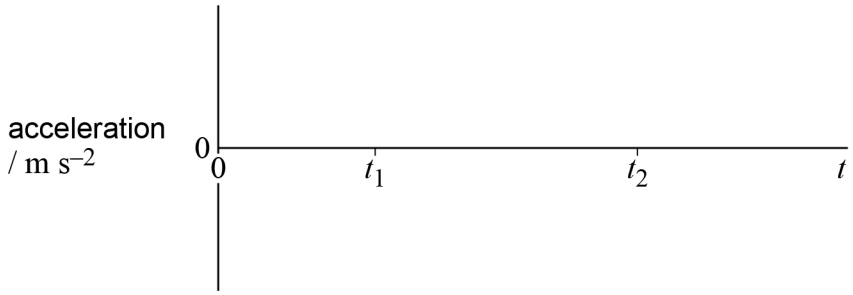
0 6 A ball is thrown vertically upwards from an initial height of $1.5\ \text{m}$ above horizontal ground. Assume that air resistance is negligible.

0 6 . 1 The ball is thrown at time $t = 0$
It reaches the top of its path when $t = t_1$. It hits the ground at $t = t_2$ and bounces.

Sketch on **Figure 2** an acceleration–time graph for the ball.
You should provide the initial value of the acceleration on the acceleration axis.

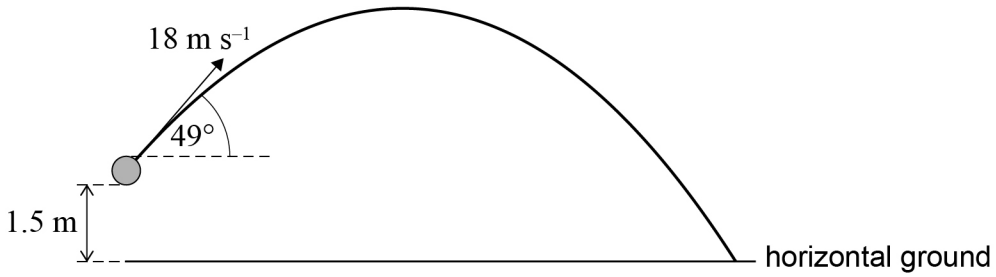
[3 marks]

Figure 2



0 6 . 2 The ball is now thrown from the same initial height with a velocity of $18\ \text{m s}^{-1}$ at an angle of $49°$ to the horizontal. **Figure 3** shows the path of the ball.

Figure 3



Calculate the maximum height of the ball above the ground.

[3 marks]

maximum height = _____ m

Do not write outside the box

At one point in its motion, the ball has a minimum speed v_{min}.

0 6 . 3 State and explain the position of the ball when its speed is v_{min}.

[2 marks]

0 6 . 4 Determine v_{min}.

[1 mark]

v_{min} = _____ m s^{-1}

9

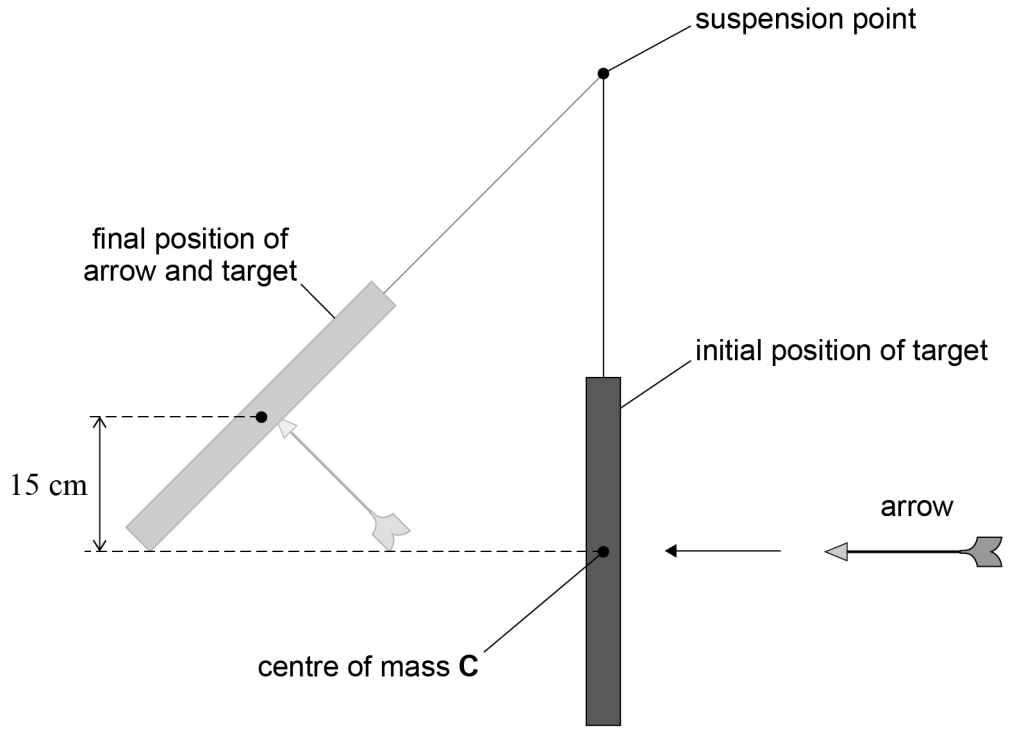
Turn over for the next question

Do not write outside the box

0 7 A target is suspended by a string. The string does not stretch, and the target can swing freely. The centre of mass **C** of the target is in the middle of the target.

An arrow is fired at the target.
The arrow strikes the target horizontally with a velocity u. The arrow sticks into the centre of the target. The maximum change in height of **C** is $15\ \text{cm}$, as shown in **Figure 4**.

Figure 4



0 7 . 1 Calculate u.

mass of arrow = $95\ \text{g}$
mass of target = $1.2\ \text{kg}$

[3 marks]

$u =$ _____ m s^{-1}

Do not write outside the box

0 7 . 2 On another occasion the arrow strikes the centre of the target at the same velocity u. This time the arrow does **not** stick into the target but bounces backwards.

Deduce how the maximum change in height of **C** compares with the value of $15\ \text{cm}$ shown in **Figure 4**.
Calculations are **not** required.

[3 marks]

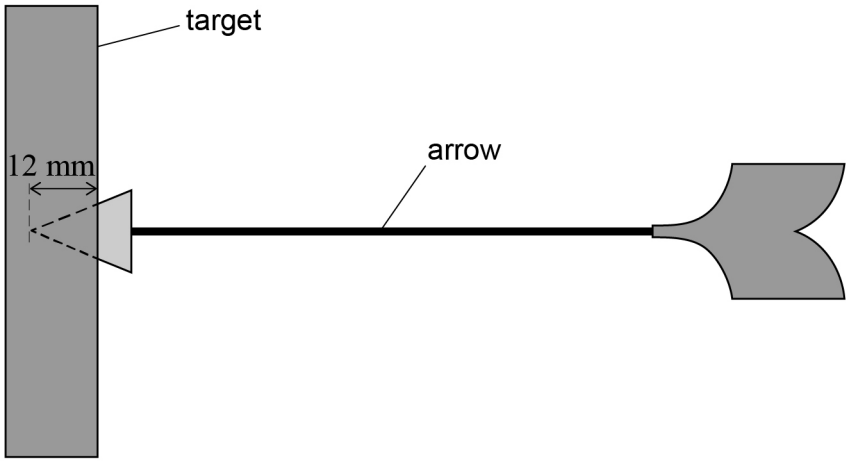
Question 7 continues on the next page

Do not write outside the box

0 7 . 3 The target is now placed on a fixed stand.
The arrow strikes the centre of the target horizontally at a speed of $44\ \text{m s}^{-1}$.
The arrow comes to rest with $12\ \text{mm}$ of its length inside the target, as shown in **Figure 5**.

The target does not move.

Figure 5



Calculate the average force that the target applies to the arrow.

[3 marks]

average force = _____ N

9

Do not write outside the box

0 8 A teacher provides a student with a radioactive source and asks the student to identify the type of radiation that it emits.

0 8 . 1 Describe an experiment that the student could do to identify which type of radiation is emitted.

You may wish to include a diagram in your answer.

[3 marks]

Question 8 continues on the next page

Do not write outside the box

0 8 . 2 State **two** ways to reduce the hazards of exposure to ionising radiation when using the radioactive source.

[1 mark]

1 _____

_____

_____

2 _____

_____

_____

A radioactive source used in a school contains caesium-137.
Caesium-137 decays by β emission to form barium-137m.

0 8 . 3 Barium-137m is a metastable isotope with a half-life of 153 s.

Explain what is meant by this statement.

[3 marks]

_____

_____

_____

_____

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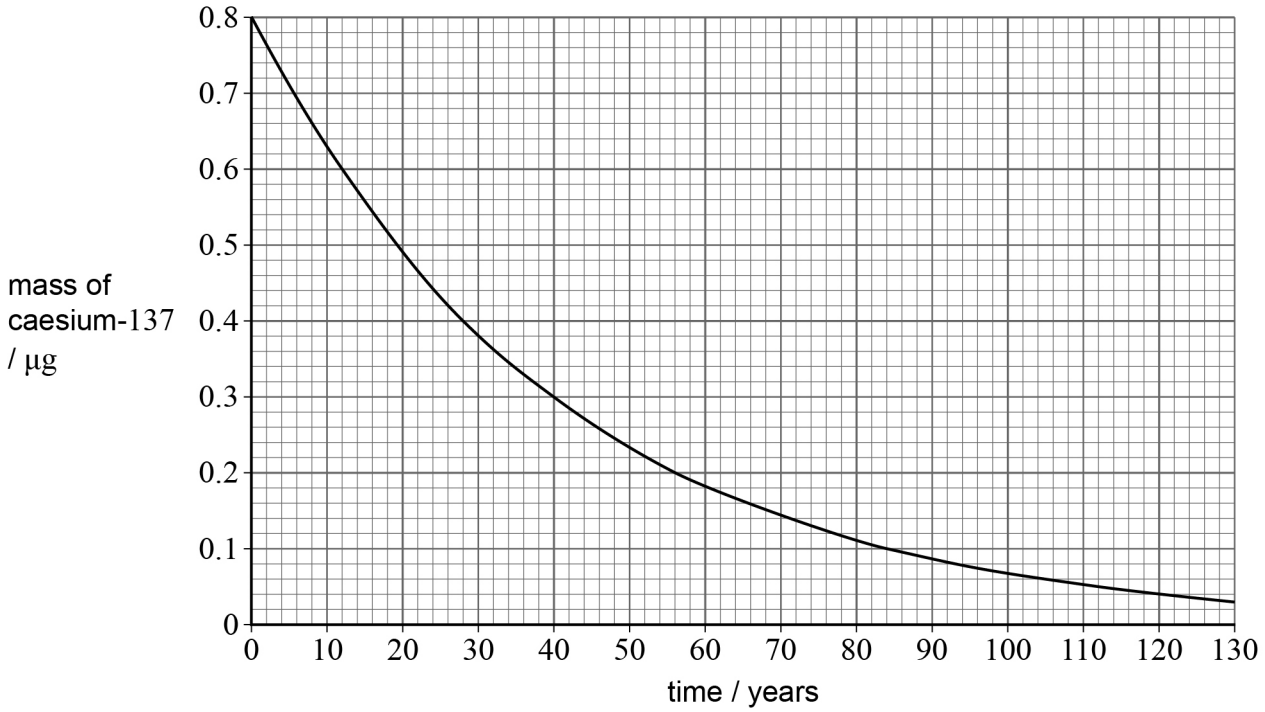
0 8 . 4 **Figure 6** shows the variation of the mass of caesium-137 in the source with time.

Figure 6



Determine, using **Figure 6**, a value for the half-life of caesium-137 in years.

[1 mark]

half-life = _____ years

8

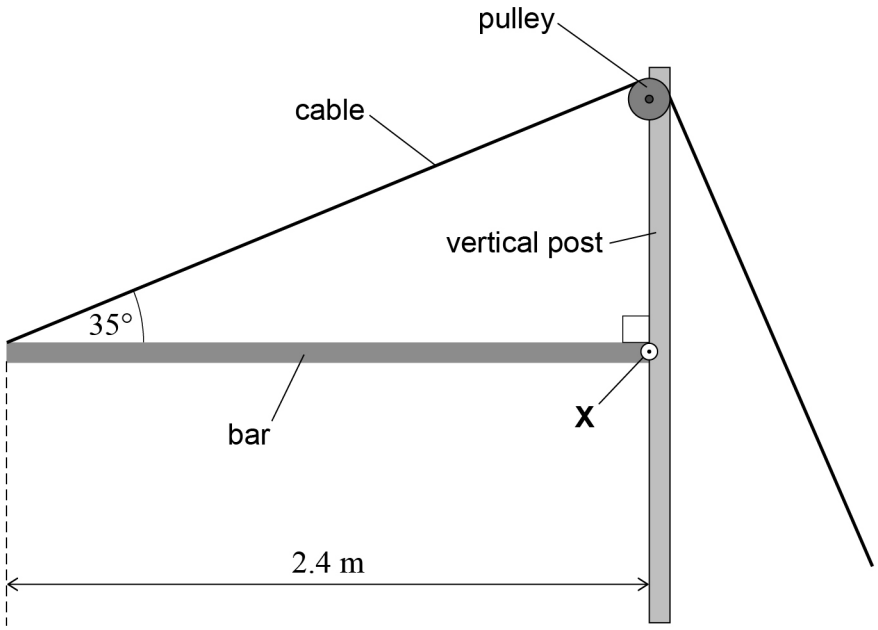
Turn over for the next question

Do not write outside the box

0 9 **Figure 7** shows a system used to stop cars from entering a car park.

A uniform horizontal bar of length $2.4\ \text{m}$ is attached by a pivot to a vertical post at point **X**.
A cable is attached to the left-hand end of the bar and passes over a pulley. The cable makes an angle of $35°$ with the bar. The tension in the cable is $230\ \text{N}$.

Figure 7



0 9 . 1 Calculate the mass of the bar.

[3 marks]

mass = _____ kg

Do not write outside the box

0 9 . 2 The cable has a diameter of $11\ \text{mm}$ and an unstretched length of $5.2\ \text{m}$.
The Young modulus of the material used to make the cable is $205\ \text{GPa}$.

Determine the extension of the cable in **Figure 7**.

[2 marks]

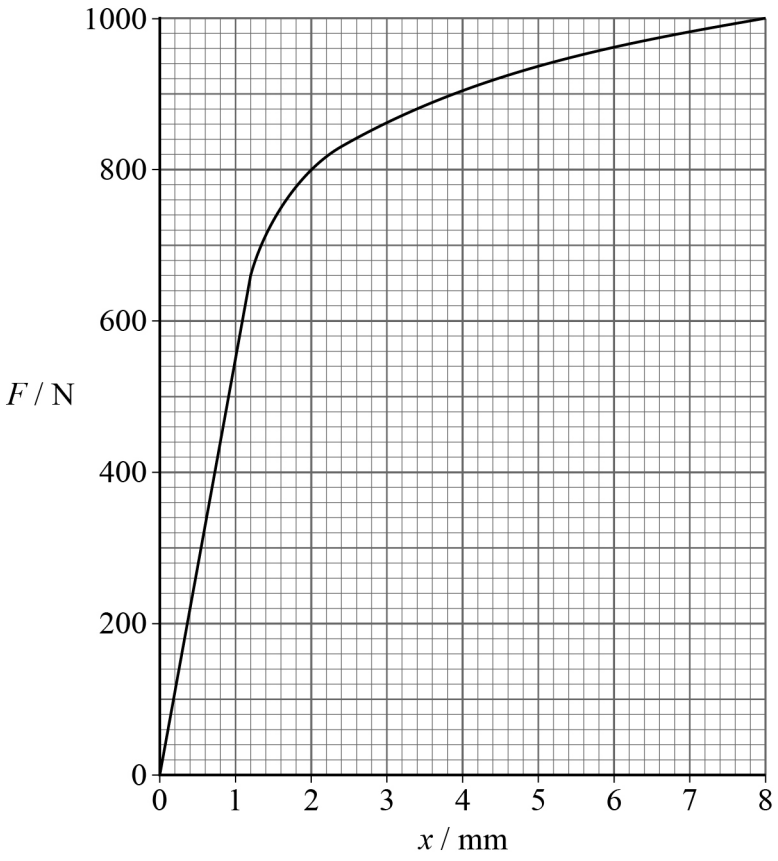
extension = _____ m

Question 9 continues on the next page

Do not write outside the box

A new cable is tested as a possible replacement for the cable in **Figure 7**.
Figure 8 shows how the extension x varies with the force F applied to the new cable as it is loaded to a maximum of 1000 N.

Figure 8



0 9 . 3 Determine the force applied to the cable at the limit of proportionality.

[1 mark]

force = _____ N

Do not write outside the box

0 9 . 4 The cable is loaded to $1000\ \text{N}$ and is then unloaded. The cable is found to have undergone plastic deformation.
When the cable is unloaded, some of the work done in stretching the cable cannot be recovered. The amount of work that cannot be recovered is W.

Deduce W using **Figure 8**.

[3 marks]

$W =$ _____ J

9

END OF SECTION A

Do not write outside the box

Section B

Answer **all** questions in this section.

1 0 **Figure 9** shows a system consisting of a pair of identical springs and a rod of negligible mass.

The upper end of each spring is fixed. The rod is attached to the bottom of the springs so that the springs are parallel to each another.

The length L_0 of each unstretched spring is measured using a ruler with millimetre divisions.

Figure 9

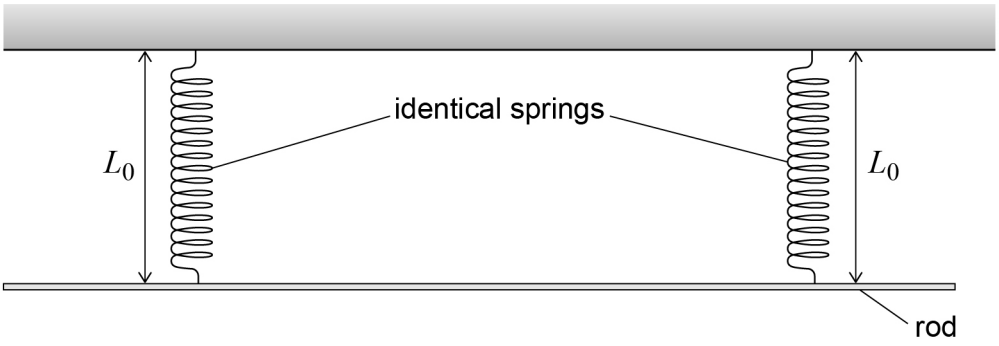
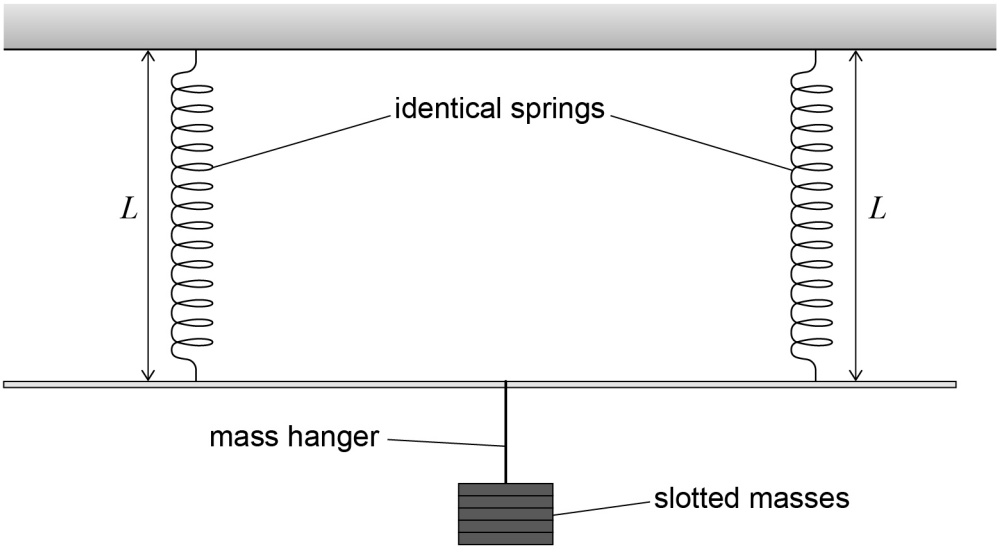


Figure 10 shows a mass hanger and slotted masses suspended from the rod at the mid-point between the springs.

Figure 10



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Known masses are added to gradually increase the force F applied to the springs. For each value of F, the length L is measured and the extension ΔL is calculated.

1 0 . 1 Explain why the minimum uncertainty in ΔL is $2\ \text{mm}$.

[2 marks]

Question 10 continues on the next page

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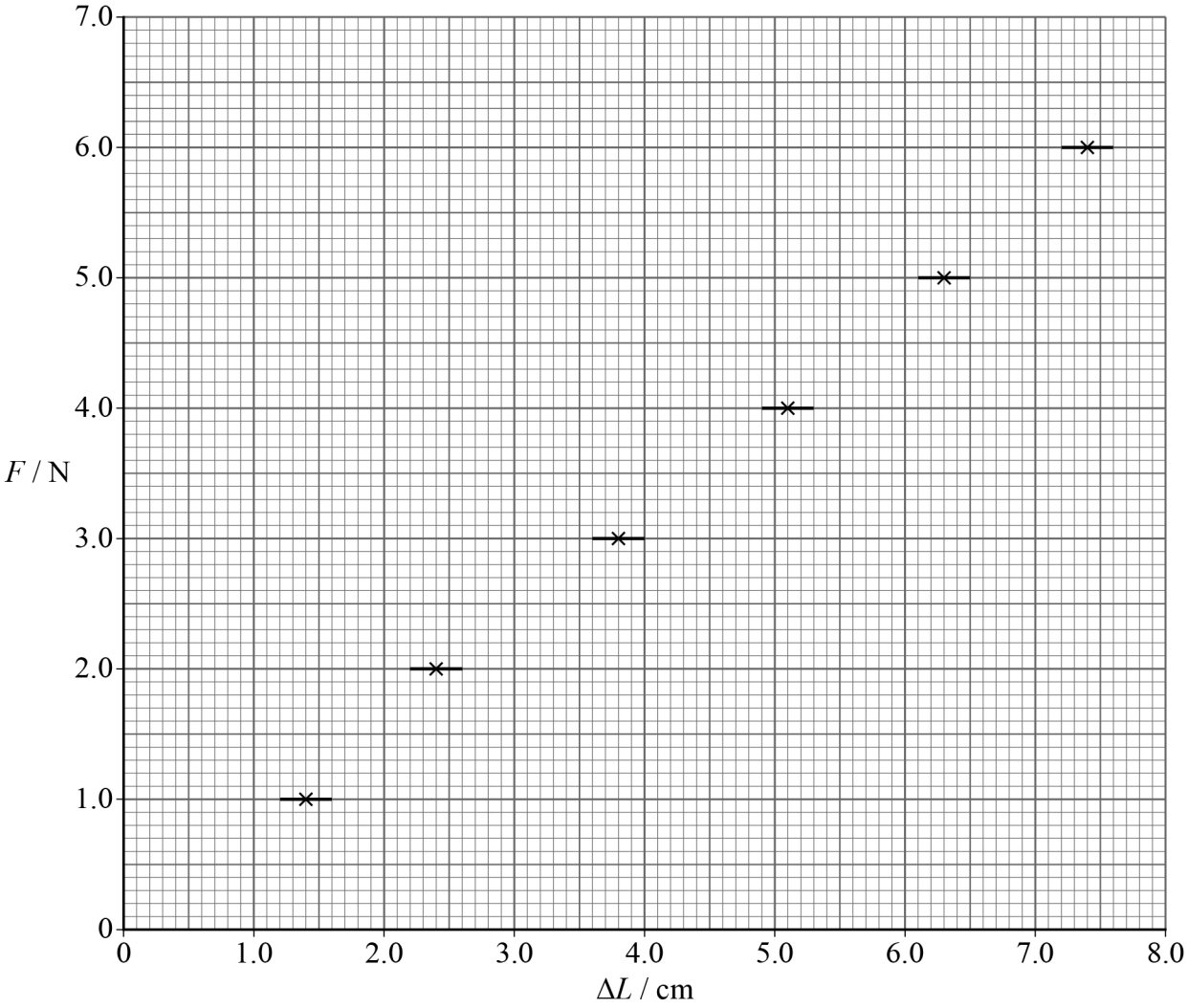
Figure 11 shows data points with error bars plotted on a graph of F against ΔL.

Figure 11



1 0 . 2 Draw, on **Figure 11**, the two best-fit lines that show the maximum and minimum gradients for the graph.

[1 mark]

Do not write outside the box

k_t is the total spring constant of the system.

1 0 . 3 Use **Figure 11** to determine a value, in $\mathrm{N\ cm^{-1}}$, for k_t.

[3 marks]

$k_t =$ _____ $\mathrm{N\ cm^{-1}}$

1 0 . 4 Determine, in $\mathrm{N\ cm^{-1}}$, the uncertainty in k_t.

[1 mark]

uncertainty = _____ $\mathrm{N\ cm^{-1}}$

1 0 . 5 The experiment is repeated using a different pair of identical springs. Each new spring has a larger spring constant than each original spring.

State and explain the effect of this change on the value for the uncertainty in k_t.

[2 marks]

_____

_____

_____

_____

_____

9

Turn over ►

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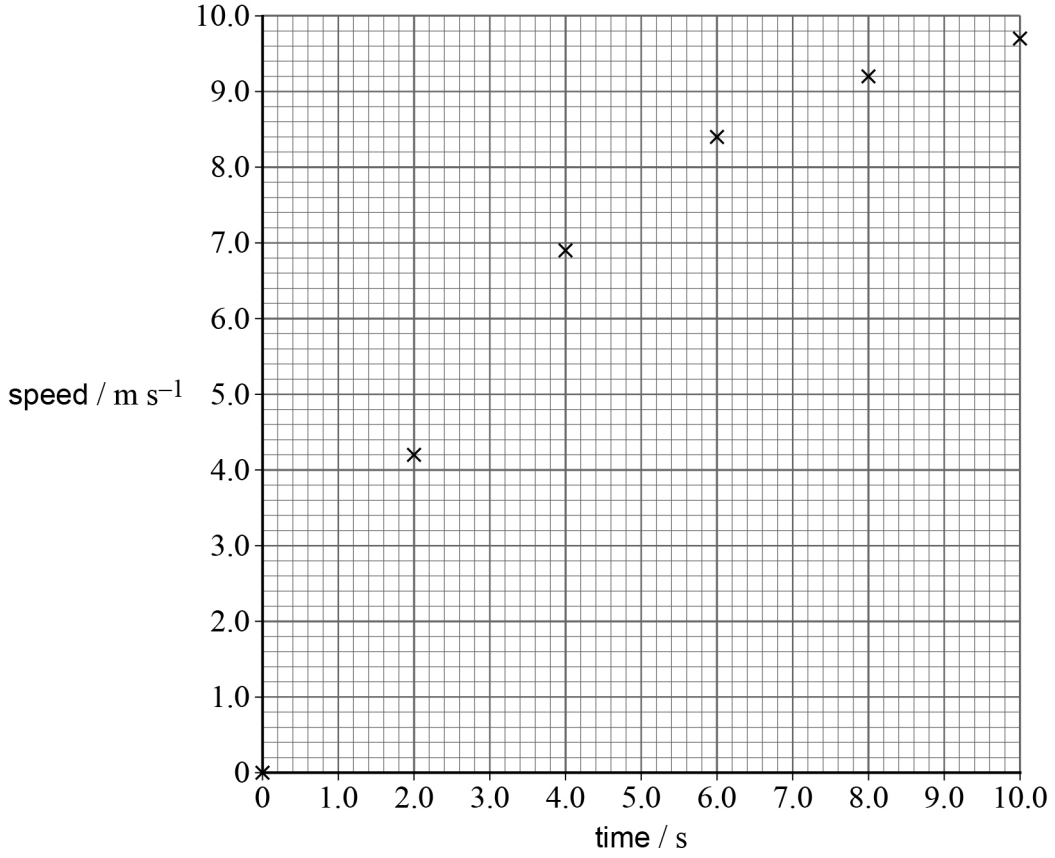
1 1 A bike rider accelerates from rest along a straight horizontal road.

Figure 12 shows the variation of the rider's speed with time.

Figure 12



1 1 . 1 Draw, on **Figure 12**, a line of best fit.

[1 mark]

1 1 . 2 The total mass of the bike and rider is 95 kg.

Determine, using **Figure 12**, the maximum resultant force on the bike and rider.

[3 marks]

maximum resultant force = _____ N

Do not write outside the box

1 1 . 3 The force exerted by the rider on the bike is constant.

Explain the shape of the graph in **Figure 12**.
No calculations are required.

[3 marks]

7

END OF SECTION B

Do not write outside the box

Section C

Each of the questions in this section 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 question, 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 pages for this working.

1 2 Which particle has the greatest magnitude of $\frac{\text{charge}}{\text{mass}}$?

[1 mark]

A alpha particle ⬭

B electron ⬭

C neutron ⬭

D proton ⬭

1 3 A radioactive nucleus **X** decays into nucleus **Y** by emitting two β^- particles and an α particle.

Which statement is correct?

[1 mark]

A **X** and **Y** are isotopes. ⬭

B **X** and **Y** have the same nucleon number. ⬭

C **Y** has a larger proton number than **X**. ⬭

D **Y** has a larger nucleon number than **X**. ⬭

Do not write outside the box

1 4 An average force of $42\ \text{kN}$ acts on the air that is passing through a jet engine. This force causes the speed of the air to increase by $540\ \text{m s}^{-1}$.

What mass of air passes through the engine in one minute?

[1 mark]

A $7.7 \times 10^{-2}\ \text{kg}$ ⬭

B $4.7\ \text{kg}$ ⬭

C $78\ \text{kg}$ ⬭

D $4.7 \times 10^{3}\ \text{kg}$ ⬭

1 5 What is the order of magnitude of the ratio $\frac{\text{proton rest mass}}{\text{electron rest mass}}$?

[1 mark]

A -3 ⬭

B 1 ⬭

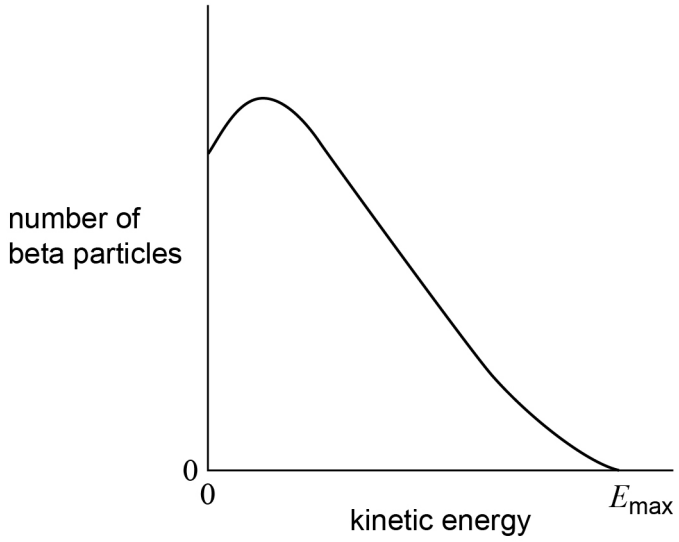
C 3 ⬭

D 1800 ⬭

Turn over for the next question

Do not write outside the box

1 6 The graph shows the distribution of kinetic energies of beta minus particles from the decay of carbon-14.



What can be deduced from this graph?

[1 mark]

A A gamma photon is also released to conserve energy. ⬭

B A neutron turns into a proton. ⬭

C Each emitted beta particle shares the released energy with another particle. ⬭

D The emitted beta particles all have the same speed. ⬭

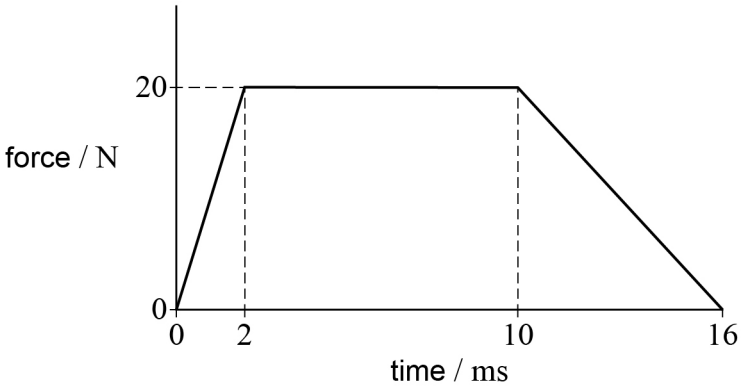
1 7 Which row is true for an inelastic collision?

[1 mark]

	Momentum	**Kinetic energy**	
A	conserved	not conserved	⬭
B	conserved	conserved	⬭
C	not conserved	conserved	⬭
D	not conserved	not conserved	⬭

Do not write outside the box

1 8 A force is applied to a ball. The graph shows the variation of force with time.



What is the change in momentum of the ball between 0 and 16 ms?

[1 mark]

A 240×10^{-3} N s ⬭

B 320×10^{-3} N s ⬭

C 240 N s ⬭

D 320 N s ⬭

1 9 A metal wire has initial length L and diameter d. An extension e is produced in the wire when a force is applied.

A second wire of the same material has initial length $\frac{L}{2}$ and diameter $\frac{d}{2}$.

What is the extension of the second wire when the same force is applied?

[1 mark]

A $\frac{e}{4}$ ⬭

B $\frac{e}{2}$ ⬭

C e ⬭

D $2e$ ⬭

Turn over ►

Do not write outside the box

2 0 A motorbike has an engine that is 27% efficient.
The motorbike does 14.6 MJ of useful work in a time of one hour.

What is the average input power?

[1 mark]

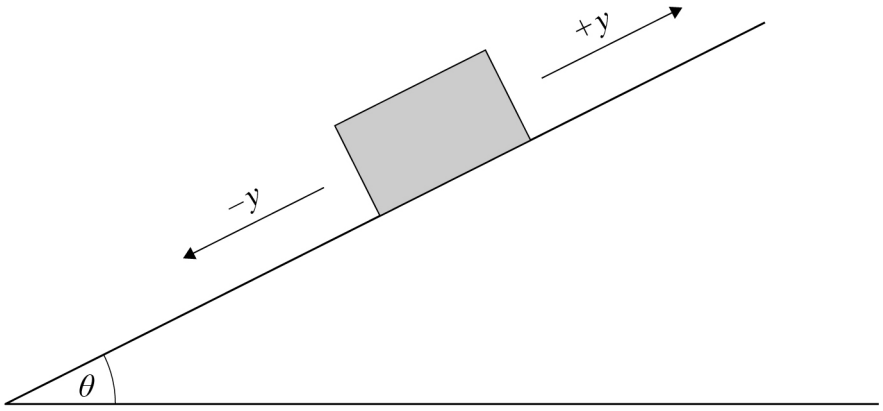
A 54 MW ⬭

B 0.90 MW ⬭

C 15 kW ⬭

D 4.1 kW ⬭

2 1 A block of mass m is stationary on a slope.



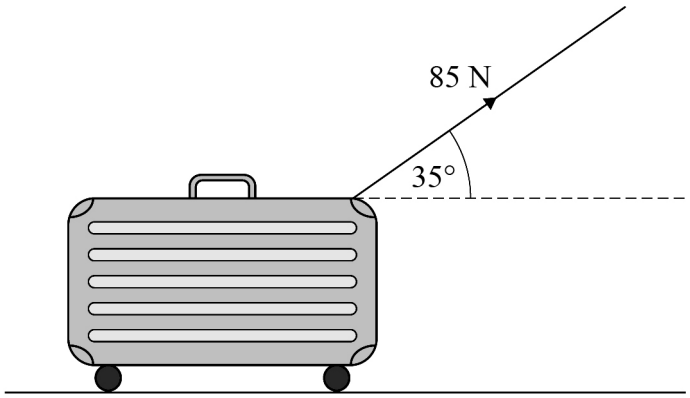
Which row shows the magnitude and direction of the frictional force acting on the block?

[1 mark]

	Magnitude	Direction	
A	$mg \cos \theta$	$+y$	⬭
B	$mg \cos \theta$	$-y$	⬭
C	$mg \sin \theta$	$+y$	⬭
D	$mg \sin \theta$	$-y$	⬭

Do not write outside the box

2 2 A suitcase is pulled across a horizontal surface using a rope at an angle of $35°$ to the horizontal. The tension in the rope is $85\ \text{N}$. The suitcase is moved a distance of $100\ \text{m}$ in a time of 1.5 minutes.



What is the average rate at which work is done?

[1 mark]

A 54 W ⬭

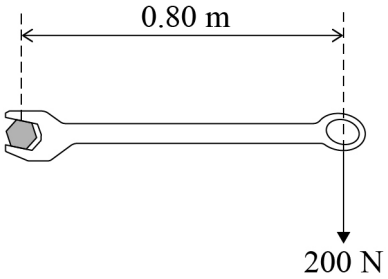
B 77 W ⬭

C 6010 W ⬭

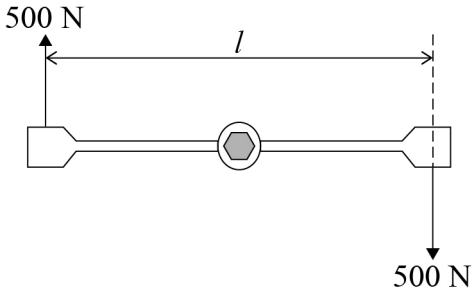
D 6900 W ⬭

Turn over for the next question

2 3 Tool **X** can be used to loosen a bolt by applying a minimum force of 200 N.



Tool **Y** can be used to loosen the same bolt by applying two forces a perpendicular distance l apart. The minimum value of each force is 500 N.



What is l?

[1 mark]

A 0.16 m ⬭

B 0.32 m ⬭

C 0.48 m ⬭

D 0.64 m ⬭

Do not write outside the box

2 4 The intensity of gamma radiation at a point 45 cm away from a source is 62 W m^{-2}.

What is the intensity at a point an additional 75 cm further away from the source?

[1 mark]

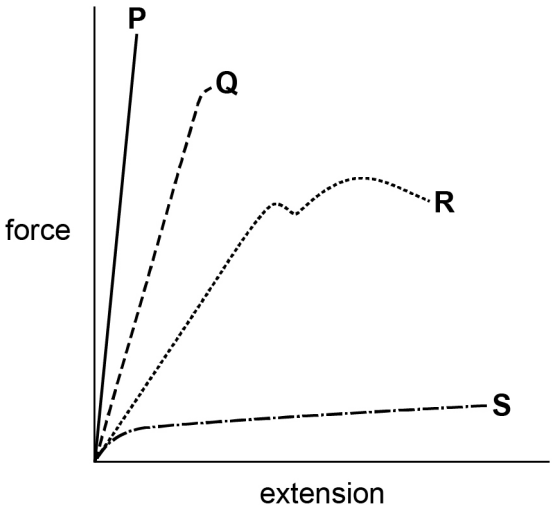
A 8.7 W m^{-2} ⬭

B 22 W m^{-2} ⬭

C 23 W m^{-2} ⬭

D 37 W m^{-2} ⬭

2 5 The graph shows the variation of extension with force for four wires **P**, **Q**, **R** and **S**, up to the points at which they break.



Which is **not** correct?

[1 mark]

A **S** is less brittle than **Q**. ⬭

B **P** is brittle. ⬭

C **S** has the largest spring constant. ⬭

D **R** behaves plastically. ⬭

14

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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