OXFORD AQA

INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

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

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Candidate signature _____
I declare this is my own work.

INTERNATIONAL AS
PHYSICS

Unit 1 Mechanics, materials and atoms

Tuesday 6 May 2025 | 07:00 GMT | 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	
11–24	
TOTAL	

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Section A

Answer **all** questions in this section.

0 1 . 1 Describe plastic behaviour in a material.

[1 mark]

0 1 . 2 Describe the behaviour of a brittle material.

[1 mark]

2

0 2 Two forces act on an object to form a couple.

State the conditions necessary for the two forces to form a couple.

[2 marks]

2

Do not write outside the box

0 3 . 1 State the fundamental (base) units of the stiffness of a spring.

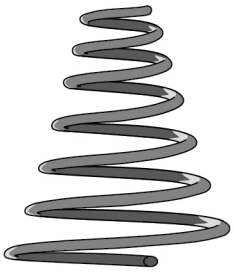
[1 mark]

fundamental (base) units of stiffness = _____

Figure 1 shows a spring **S** at its natural length. **S** does not obey Hooke's law.

Figure 2 shows **S** when it is compressed.

Figure 1



natural length

Figure 2

compressed

Question 3 continues on the next page

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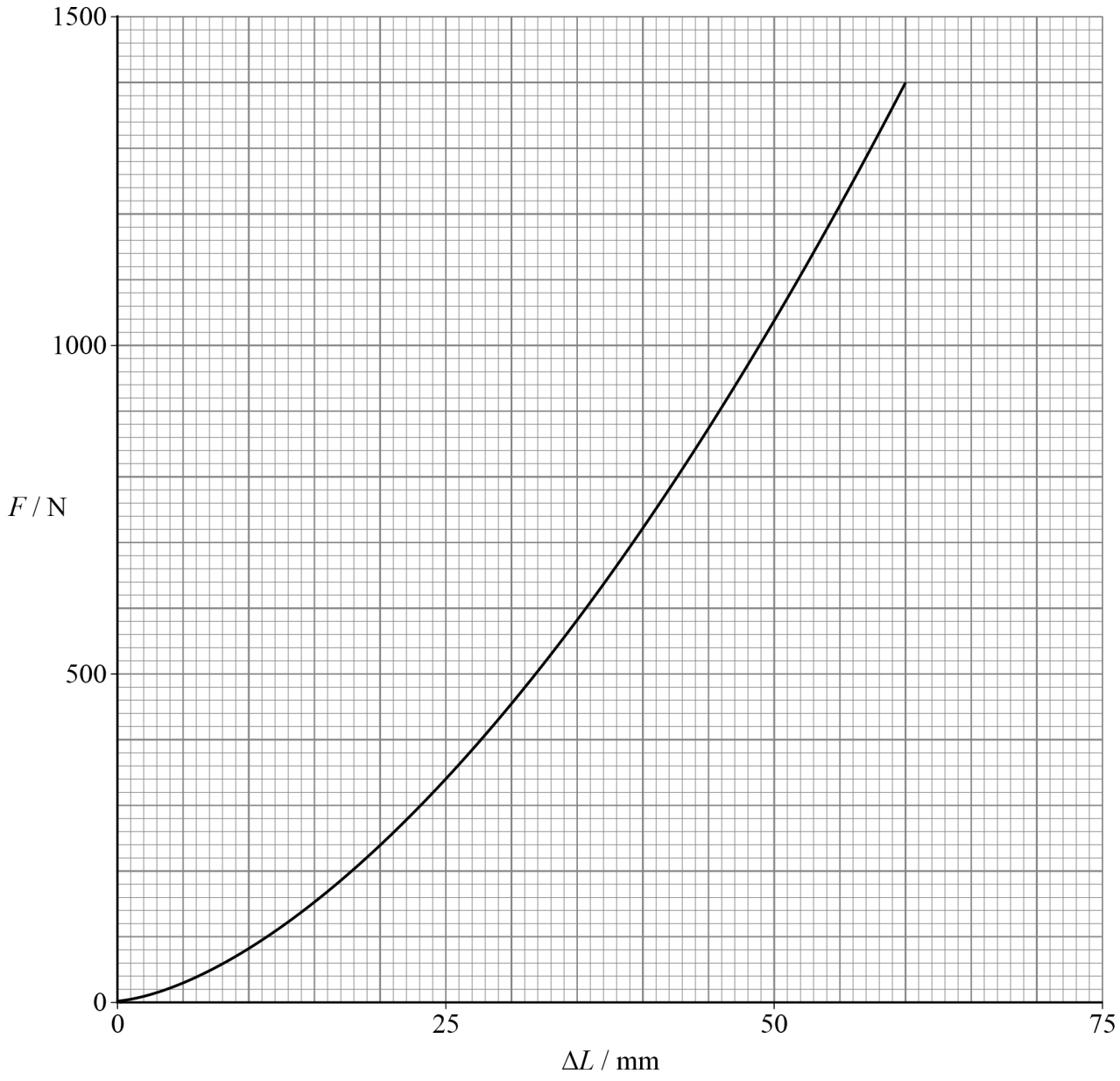
A force F is applied to compress **S**.
F and the change in length ΔL of **S** are measured.

Figure 3 shows the variation of ΔL with F.

Figure 3



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0 3 . 2 **S** is compressed until $F = 1400$ N.

Determine the work done.

[3 marks]

work done = _____ J

0 3 . 3 Explain how **Figure 3** shows how the stiffness of **S** changes as **S** is compressed.

[2 marks]

_____

_____

_____

_____

_____

_____

6

Turn over for the next question

Do not write outside the box

0 4 . 1 A free neutron decays.

State the names of the particles created in the decay.

[1 mark]

0 4 . 2 Describe what happens when a free neutron collides with an antineutron.

[2 marks]

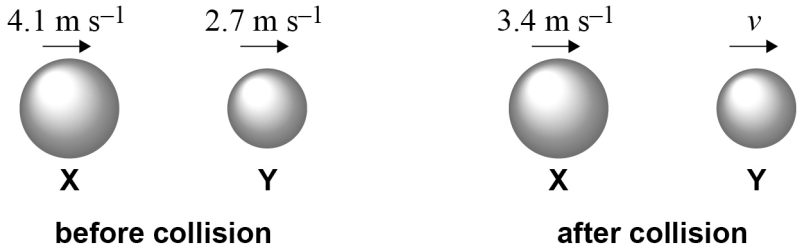
3

Do not write outside the box

0 5 **Figure 4** shows two objects **X** and **Y** immediately before and immediately after they collide.

The velocities of **X** and **Y** before and after the collision are shown on **Figure 4**.

Figure 4



The mass of **X** is 8.4 kg and the mass of **Y** is 6.3 kg.
The total kinetic energy immediately before the collision is 94 J.

Determine the velocity v of **Y** immediately after the collision.
Go on to determine whether the collision is elastic or inelastic.

[4 marks]

v = _____ m s^{-1}

_____

_____

4

Turn over ►

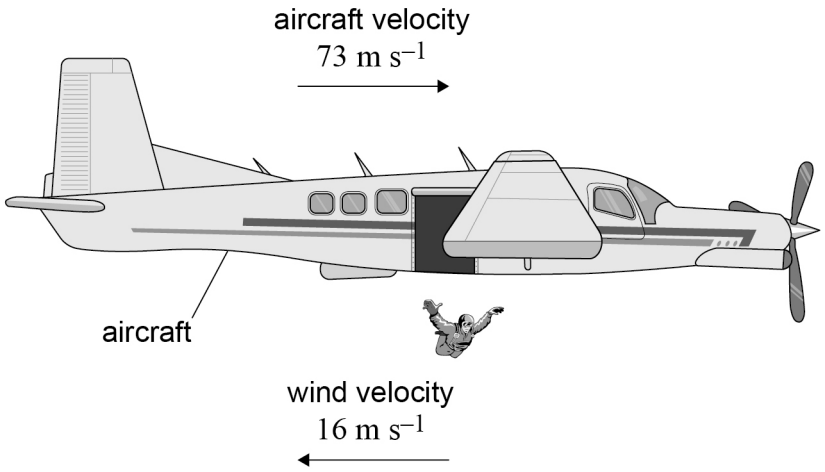
Do not write outside the box

0 6 This question is about a person wearing a parachute.

A parachute is a device that, when open, allows the person to fall slowly through the air.

0 6 . 1 **Figure 5** shows the person wearing a closed parachute as she jumps from a moving aircraft.

Figure 5



The aircraft is travelling horizontally with a velocity of $73\ \mathrm{m\ s^{-1}}$ relative to the ground. A wind is moving horizontally in the opposite direction to the motion of the aircraft. The wind has a constant velocity of $16\ \mathrm{m\ s^{-1}}$ relative to the ground.

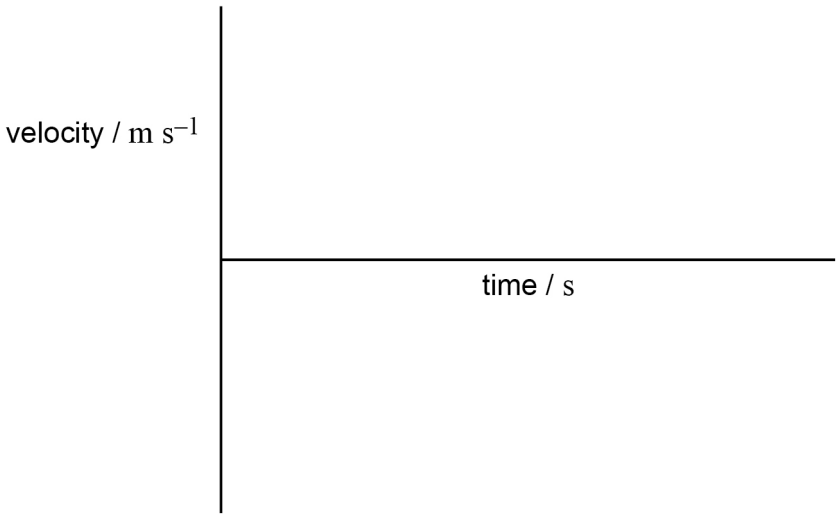
Sketch, on **Figure 6**, a velocity–time graph for the horizontal component of the person's velocity relative to the ground.

You should:
- label the velocity axis with the values of the initial and final horizontal components of the person's velocity
- continue your graph to the point where the person's horizontal acceleration is zero.

[3 marks]

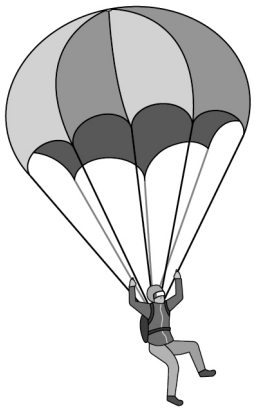
Do not write outside the box

Figure 6



0 6 . 2 The person opens the parachute as shown in **Figure 7**.

Figure 7



The person then reaches a constant velocity of $18\ \mathrm{m\ s^{-1}}$ at an angle of $29°$ to the horizontal.

Calculate the time taken for the person to fall a vertical distance of $250\ \mathrm{m}$ when at this constant velocity.

[2 marks]

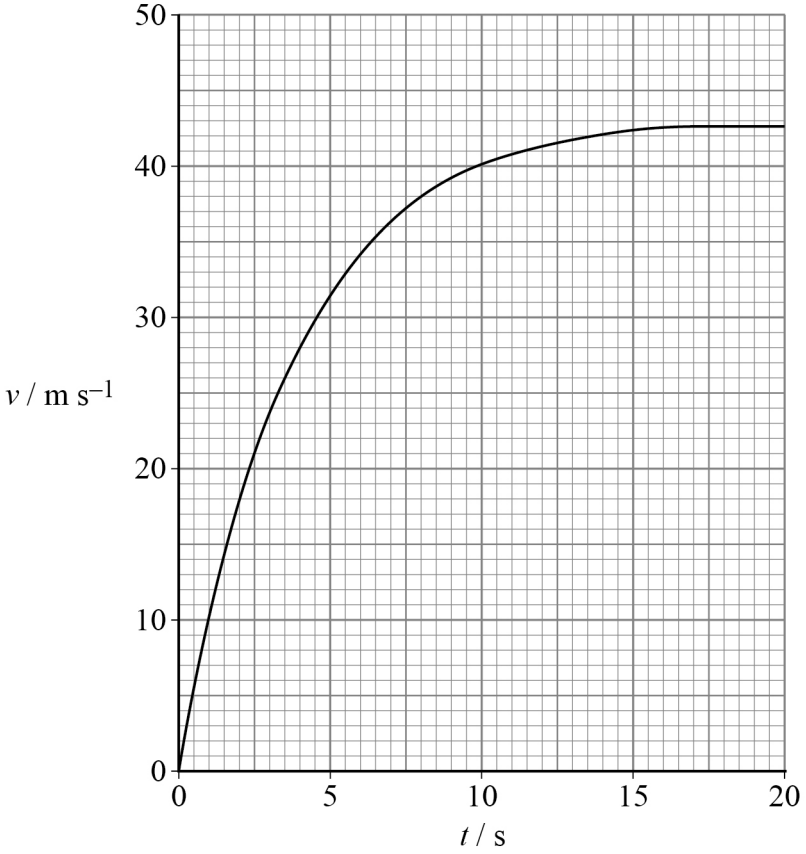
time = _____ s

Do not write outside the box

The person now jumps from the top of a tall building, wearing a parachute.
The parachute is not opened for the first 20 s of the jump.

Figure 8 shows the variation of velocity v with time t for the first 20 s of the jump.

Figure 8



0 6 . 3 The total mass of the person and the parachute is 85 kg.

Calculate the magnitude of the air resistance acting when $t = 5.0$ s.

[4 marks]

air resistance = _____ N

Do not write outside the box

0 6 . 4 Explain the shape of the graph in **Figure 8**.

[4 marks]

13

Turn over for the next question

Do not write outside the box

0 7 A teacher uses a radium-226 source to demonstrate the properties of alpha radiation.

0 7 . 1 Calculate the specific charge of an alpha particle.

[3 marks]

specific charge = _____ $C\ kg^{-1}$

0 7 . 2 Radium-226 has a half-life of 1600 years.

Suggest **one** reason why this half-life means that radium-226 is suitable for use in school laboratories.

[1 mark]

_____

_____

_____

The maximum range of alpha particles in air is about 50 mm.

0 7 . 3 Explain why the momentum of an alpha particle decreases as it travels through air.

[1 mark]

_____

_____

_____

Do not write outside the box

The nuclide radium-226:
- emits only alpha radiation
- undergoes a series of decays to become the stable nuclide lead-206.

The teacher places the source at different distances from a detector and records the corrected count rate as shown in **Table 1**.

Table 1

Distance / mm	**Corrected count rate / count s^{-1}**
25	4502
75	151

0 7 . 4 Describe a procedure the teacher can use to determine the corrected count rate.

[2 marks]

0 7 . 5 Explain why the corrected count rate shown for a distance of 75 mm in **Table 1** is not zero.

[2 marks]

9

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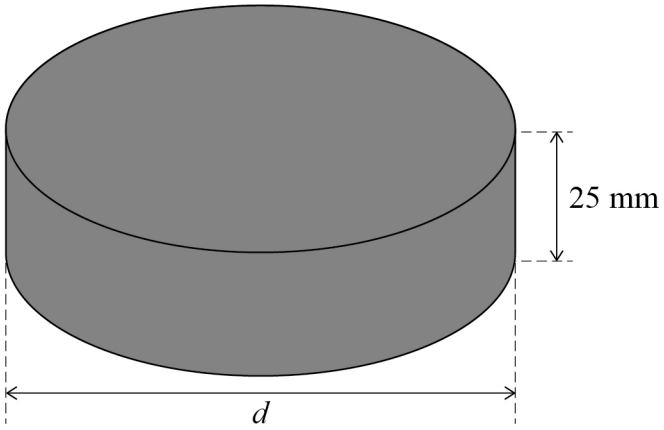
0 8 This question is about a procedure to test the friction of an ice surface where a game will be played.

Figure 9 shows a rubber disc used in the procedure.

Figure 9

not to scale



The mass of the disc is $0.17\ \text{kg}$.

0 8 . 1 The density of the rubber is $1500\ \text{kg m}^{-3}$.
The height of the disc is $25\ \text{mm}$ and the diameter is d.

Calculate d in mm.

[3 marks]

$d =$ _____ mm

Do not write outside the box

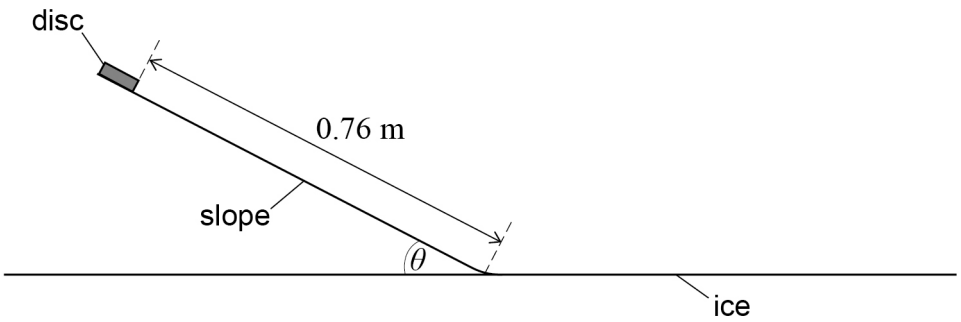
The procedure to test the friction of an ice surface measures the distance that the disc will travel across a horizontal ice surface for a given initial speed.

The disc is placed at the top of a slope. The angle between the ice and the slope is increased. The disc starts to slide down the slope when the angle is θ.

Figure 10 shows the disc at the instant that it starts to slide.

Figure 10

not to scale



The distance that the disc travels down the slope is $0.76\ \mathrm{m}$.
A constant frictional force of $0.41\ \mathrm{N}$ acts on the disc as it moves down the slope.
The slope is designed so that the disc always reaches the end of the slope at a speed of $2.1\ \mathrm{m\ s^{-1}}$.

0 8 . 2 Calculate θ.

[4 marks]

$\theta =$ _____ °

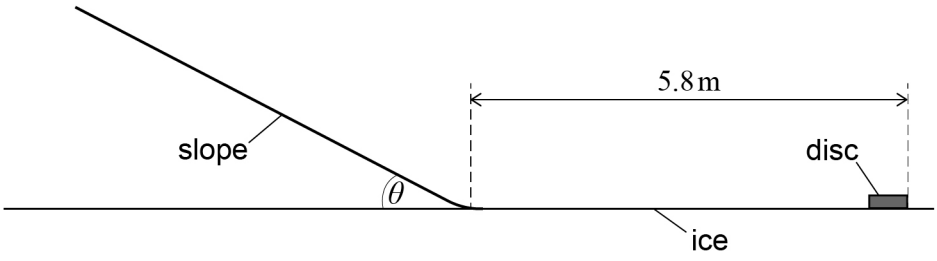
Question 8 continues on the next page

Do not write outside the box

Figure 11 shows the disc when it has travelled across the ice and come to rest.
The horizontal distance travelled by the disc along the ice is measured as $5.8\ \mathrm{m}$.

Figure 11

not to scale



0 8 . 3 The deceleration of the disc is uniform.
The initial speed of the disc on the ice is $2.1\ \mathrm{m\ s^{-1}}$.

Calculate the time taken for the disc to travel along the ice before coming to rest.

[2 marks]

time = _____ s

Do not write outside the box

0 8 . 4 The procedure tests the friction between the ice and the disc for a game played on ice.
The procedure is repeated three times in the same location and then done in different locations across the area where the game is to be played.

Explain why the measurement is:
- repeated three times in the same location
- done in different locations.

[2 marks]

11

END OF SECTION A

Do not write outside the box

Section B

Answer **all** questions in this section.

0 9 A student does an experiment to determine a value for g, the acceleration due to gravity. A ball is dropped from rest.

The time t taken for the ball to fall a vertical distance s is measured for a range of values of s. The student uses sensors connected to a data logger to measure t.

Table 2 shows the data collected by the student.

Table 2

s / m	t / s
0.300	0.246
0.500	0.322
0.700	0.381
0.900	0.432

0 9 . 1 Explain **one** advantage of using a data logger rather than a stopwatch to measure t.

[2 marks]

_____

_____

_____

_____

0 9 . 2 Suggest **two** ways in which the student's data could be improved.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

Table 3 shows the data collected by the student and the student's calculated values for t^2.

Table 3

s / m	t / s	t^2 / s^2
0.300	0.246	0.06
0.500	0.322	0.10
0.700	0.381	0.15
0.900	0.432	0.19

0 9 . 3 Describe how the recording of t^2 can be improved.

[1 mark]

0 9 . 4 Explain a graphical method to determine g using the data in **Table 3**.

[3 marks]

8

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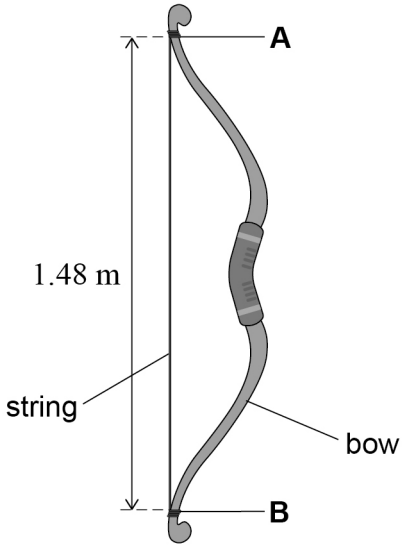
1 0 **Figure 12** shows a bow that is used to shoot an arrow at a target.

A string is attached to the bow at points **A** and **B**.
The string is in tension.
The string obeys Hooke's law.

Figure 12



The distance between **A** and **B** is 1.48 m.
The tension in the string is 450 N and the tensile strain is 0.072
The diameter of the string is 1.64 mm.

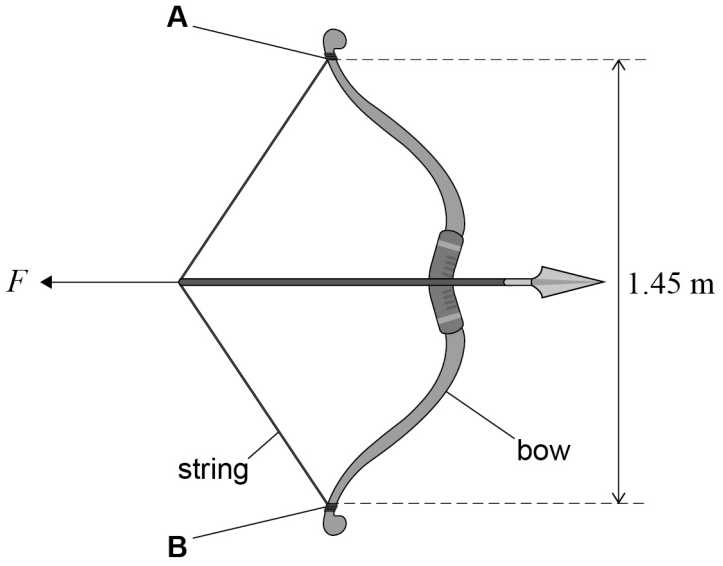
1 0 . 1 Show that the Young modulus of the material of the string is approximately 3.0 GPa.
[3 marks]

Do not write outside the box

An arrow is placed in the bow and a force F is applied to pull the string.

Figure 13 shows the string and arrow in a new equilibrium position.

Figure 13



1 0 . 2 The distance between **A** and **B** is now $1.45\ \mathrm{m}$.
The tension in the string is now $930\ \mathrm{N}$ and the new length of the string is $1.60\ \mathrm{m}$.

Calculate F.

[2 marks]

$F =$ _____ N

Question 10 continues on the next page

Do not write outside the box

1 0 . 3 F is removed so that the bow accelerates the arrow.

Explain how the acceleration of the arrow varies as the length of the string decreases from $1.60\ \mathrm{m}$ to $1.48\ \mathrm{m}$.

[3 marks]

8

END OF SECTION B

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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 1 Carbon-14 has a half-life of approximately 5700 years and can be used to date an old piece of wood.

1.0 g of the wood originally contained 6.5×10^{10} atoms of carbon-14.

A 0.30 g sample of the wood now contains 2.4×10^{9} atoms of carbon-14.

What is the best estimate for the age of the 0.30 g sample?

[1 mark]

A 5700 years

B 12 000 years

C 17 000 years

D 34 000 years

Do not write outside the box

1 2 When a technetium-99m nucleus decays, it emits a gamma ray with an energy of 140 keV.

How many nuclei in a sample of technetium-99m must decay in one second to produce a power output of 2.2 nW?

[1 mark]

A 9.8×10^{4}

B 9.8×10^{7}

C 9.8×10^{10}

D 9.8×10^{13}

1 3 Which shows only vectors?

[1 mark]

A acceleration, displacement, work

B acceleration, distance, force

C displacement, force, momentum

D force, kinetic energy, mass

1 4 A ball of mass 2.7 g is released from a height of 0.30 m above a surface. It bounces on the surface to reach a height of 0.23 m.

What is the change in momentum of the ball at the surface?

[1 mark]

A 8.2×10^{-4} kg m s^{-1}

B 5.7×10^{-3} kg m s^{-1}

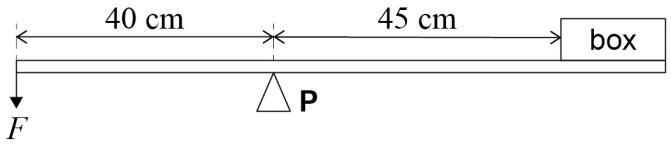
C 6.6×10^{-3} kg m s^{-1}

D 1.2×10^{-2} kg m s^{-1}

Do not write outside the box

1 5 A uniform ruler of mass 75 g and length 100 cm rests on a pivot **P**.

A uniform box of mass 25 g is at one end of the ruler.
A force F acts vertically on the other end of the ruler so that the system is in equilibrium.



What is the magnitude of F?

[1 mark]

A 0.052 N ⬭

B 0.32 N ⬭

C 0.46 N ⬭

D 0.51 N ⬭

1 6 A car is driven at a constant speed of 60 km hour^{-1} for 15 minutes. A constant resistive force of 180 N acts.

What is the work done against the resistive force?

[1 mark]

A 1.6 MJ ⬭

B 2.7 MJ ⬭

C 9.7 MJ ⬭

D 11 MJ ⬭

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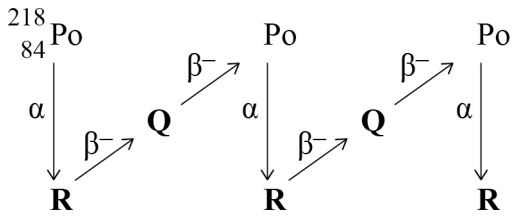
1 7 A possible decay chain for the nuclide polonium-218 is shown.



unstable **unstable** **stable**

Which row gives the nucleon number and proton number for the stable nuclide of element **R**?

[1 mark]

	Nucleon number	Proton number
A	202	79
B	212	76
C	206	82
D	212	82

1 8 A particle has the following properties:

charge = $+1.6 \times 10^{-19}$ C
mass = 9.11×10^{-31} kg

What is the particle?

[1 mark]

A electron

B neutrino

C positron

D proton

Do not write outside the box

1 9 A ball is thrown vertically upwards from point **P**. It is caught at **P** as it descends. The ball is in the air for time t.

What quantity is zero at $\frac{t}{2}$?

[1 mark]

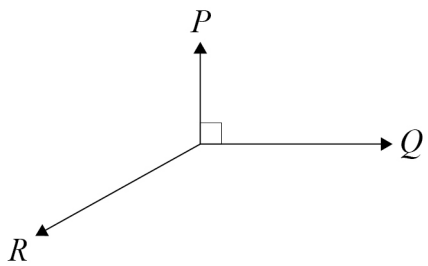
A acceleration ⬭

B displacement ⬭

C distance travelled ⬭

D velocity ⬭

2 0 An object in equilibrium is acted on by three coplanar forces P, Q and R as shown.



Which row gives possible magnitudes for P, Q and R?

[1 mark]

	P	***Q***	***R***	
A	5 N	6 N	7 N	⬭
B	8 N	10 N	18 N	⬭
C	12 N	16 N	20 N	⬭
D	20 N	25 N	34 N	⬭

Turn over ►

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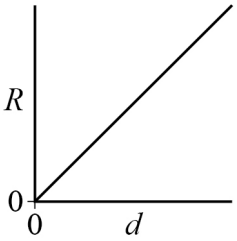
2 1 The corrected count rate R from a gamma source is measured at different distances d between the source and a detector.

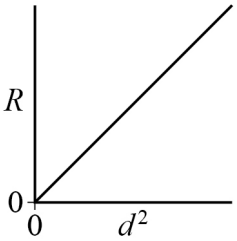
Which graph is correct?

[1 mark]

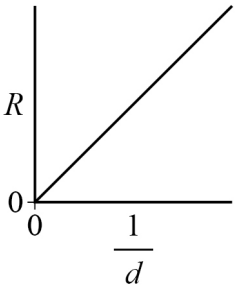
A



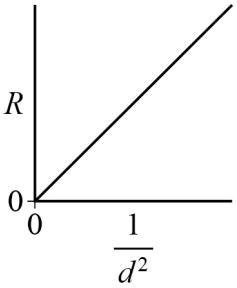
B



C



D



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2 2 A person stands on a weighing scale in a lift. When the lift is stationary, the scale reads W.

Which movement of the lift will cause the reading on the scale to be less than W?

[1 mark]

A downwards at a constant speed ⬭

B downwards with an increasing speed ⬭

C upwards at a constant speed ⬭

D upwards with an increasing speed ⬭

2 3 The area under a force–time graph gives the change in:

[1 mark]

A displacement. ⬭

B momentum. ⬭

C velocity. ⬭

D work done. ⬭

2 4 A crane lifts a large steel bar of mass m at a constant speed v through a height h. The crane's motor has an efficiency η.

What is the input power to the crane's motor?

[1 mark]

A $\frac{mgvh}{\eta}$ ⬭

B $\frac{mgv}{\eta}$ ⬭

C $mgvh\eta$ ⬭

D $mgv\eta$ ⬭

14

END OF QUESTIONS

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There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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