OXFORD
INTERNATIONAL
AQA EXAMINATIONS

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INTERNATIONAL AS
PHYSICS

Unit 1 Mechanics, materials and atoms

Monday 14 January 2019 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	
10–23	
TOTAL	

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Section A

Answer **all** questions in this section.

0 1 A single nucleus of $^{11}_{6}C$ decays into a nucleus of $^{11}_{5}B$.
During this decay two additional particles are emitted.

0 1 . 1 Identify this decay.

[1 mark]

_____

0 1 . 2 Identify the neutral particle emitted in this decay.

[1 mark]

_____

0 1 . 3 Identify the antiparticle of the neutral particle in question **01.2**.

[1 mark]

_____

3

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0 2 . 1 State the principle of moments.

[2 marks]

_____

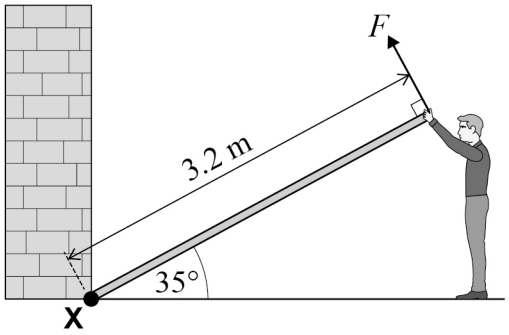
_____

_____

_____

0 2 . 2 **Figure 1** shows a uniform beam, of length $3.2\ \mathrm{m}$ and mass $27\ \mathrm{kg}$.
The beam is placed with one end against the bottom of a wall at **X**. A person holds the beam at $35°$ to the horizontal by applying a force F to the other end of the beam.
F is applied at right angles to the beam.

Figure 1



Determine F by taking moments about **X**.

[3 marks]

$F =$ _____ N

5

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0 3 A car has 280 kJ of kinetic energy when travelling at 80 km h^{-1}.

0 3 . 1 Calculate the mass of the car.

[3 marks]

mass = _____ kg

0 3 . 2 The car's brakes are applied. The car decelerates and comes to rest in a distance of 38 m.

Calculate the average resultant force acting on the car to bring it to rest.

[2 marks]

average resultant force = _____ N

5

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Turn over for the next question

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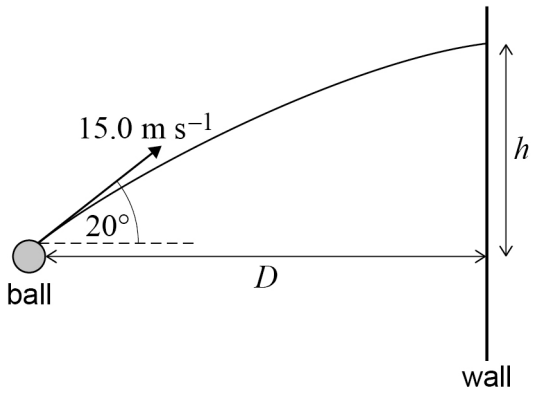
0 4 **Figure 2** shows a ball thrown with a velocity of $15.0\ \mathrm{m\ s^{-1}}$ at an angle of $20°$ to the horizontal. It reaches a wall $0.15\ \mathrm{s}$ after being thrown.
Throughout this question, assume that air resistance is negligible.

Figure 2



0 4 . 1 Calculate the horizontal distance D travelled by the ball.

[2 marks]

D = _____ m

Do not write outside the box

0 4 . 2 Calculate the height h gained by the ball.

[3 marks]

h = _____ m

0 4 . 3 Calculate the speed at which the ball hits the wall.

[3 marks]

speed = _____ m s^{-1}

8

Turn over ►

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0 5 A student has a source of gamma radiation and equipment that measures the radioactive count rate.

Describe the experiment the student can perform to verify the inverse-square law for gamma radiation.

In your answer you should include:

- the additional apparatus required
- the measurements to be taken
- how to ensure the accuracy of the results
- how the results are processed graphically to verify the law.

[5 marks]

Do not write outside the box

5

Turn over for the next question

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0 6 **Figure 3** shows a sphere that falls through distance h onto horizontal ground. The sphere hits the ground and rebounds.
Figure 4 shows the variation with time t of the velocity v of the sphere.

Figure 3

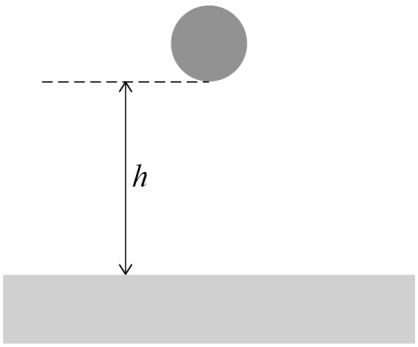
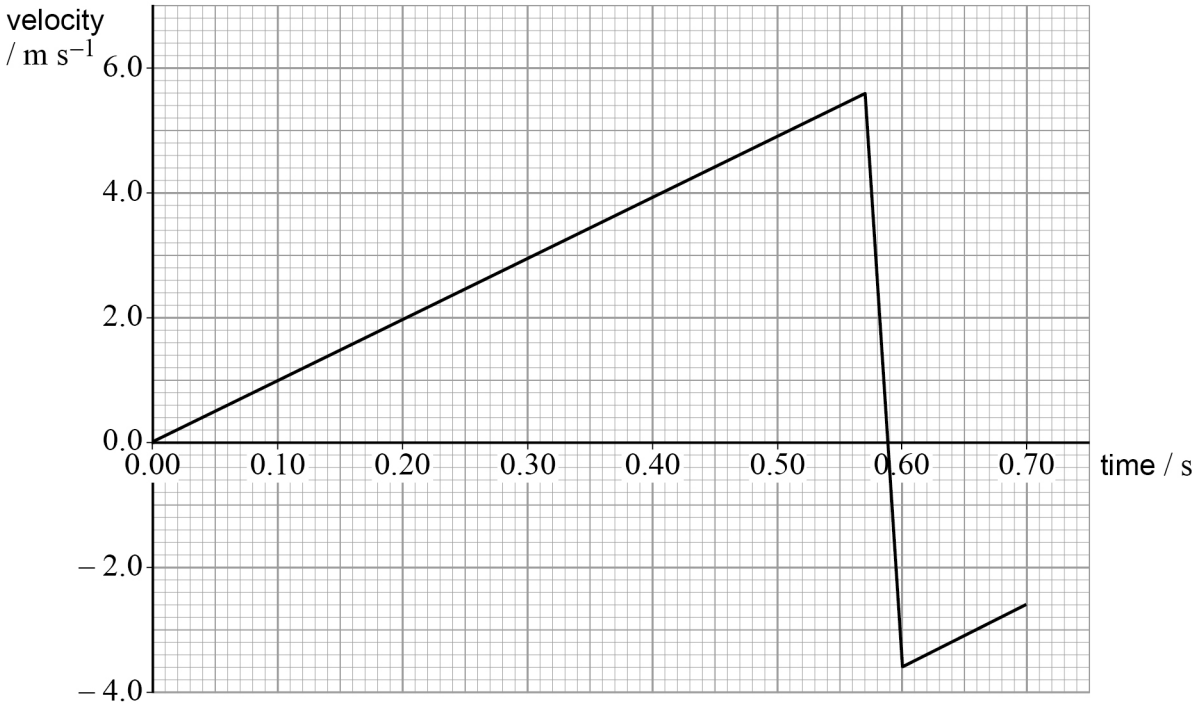


Figure 4



0 6 . 1 Calculate h.

[3 marks]

h = _____ m

Do not write outside the box

0 6 . 2 Calculate the magnitude of the acceleration of the sphere while it is in contact with the ground.

[3 marks]

acceleration = _____ $m\ s^{-2}$

0 6 . 3 The mass of the sphere is $58\ g$.

Calculate the force exerted by the ground on the sphere while it is in contact with the ground.

[3 marks]

force = _____ N

0 6 . 4 Another sphere of the same radius but much less mass is dropped in air from height h onto the ground. For this sphere, air resistance is significant during its descent.

Sketch onto **Figure 4** a velocity–time graph for this sphere from time $t = 0$ when it is dropped until it hits the ground for the first time.

[3 marks]

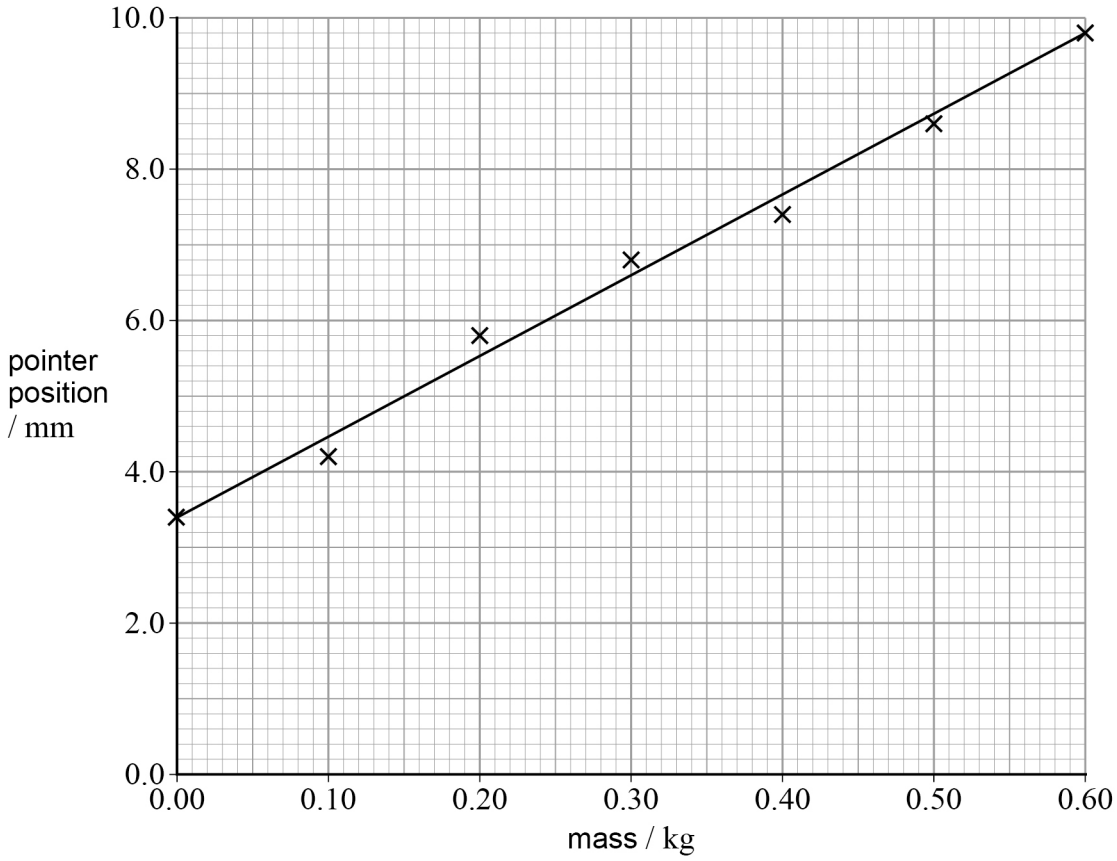
12

Turn over ►

Do not write outside the box

0 7 A wire hangs vertically from a fixed point with a mass attached to its bottom end.
A student varies the mass hanging on the wire and measures the position of a pointer attached to the end of the wire.
Figure 5 shows the variation of pointer position with mass at the end of the wire.

Figure 5



0 7 . 1 Show that the stiffness of the wire is approximately $0.9\ \text{kN m}^{-1}$.

[4 marks]

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0 7 . 2 The original unstretched length of the wire is $1.85\ \mathrm{m}$ and its cross-sectional area is $1.3 \times 10^{-5}\ \mathrm{m}^2$.

Calculate the Young modulus of the wire.
State an appropriate unit for your answer.

[3 marks]

Young modulus = _____

unit = _____

Question 7 continues on the next page

Do not write outside the box

The wire is cut into two pieces, **X** and **Y**. The unstretched length of **X** is twice the unstretched length of **Y**. Equal masses are suspended from each wire.

0 7 . 3 Explain how the Young modulus of **X** compares with the Young modulus of **Y**.

[1 mark]

0 7 . 4 Explain how the stiffness of **X** compares with the stiffness of **Y**.

[2 marks]

0 7 . 5 Explain how the energy stored in **X** compares with the energy stored in **Y**.

[2 marks]

12

END OF SECTION A

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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Section B

Answer **all** questions in this section.

0 8 **Figure 6** shows two identical dummies **A** and **B** in a moving car.
Dummy **A** has a seat belt. Dummy **B** does not have a seat belt.

Figure 6

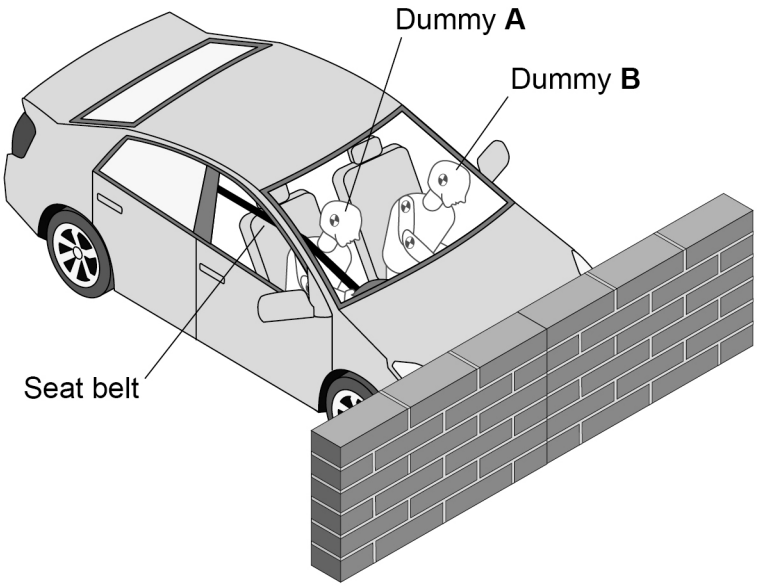
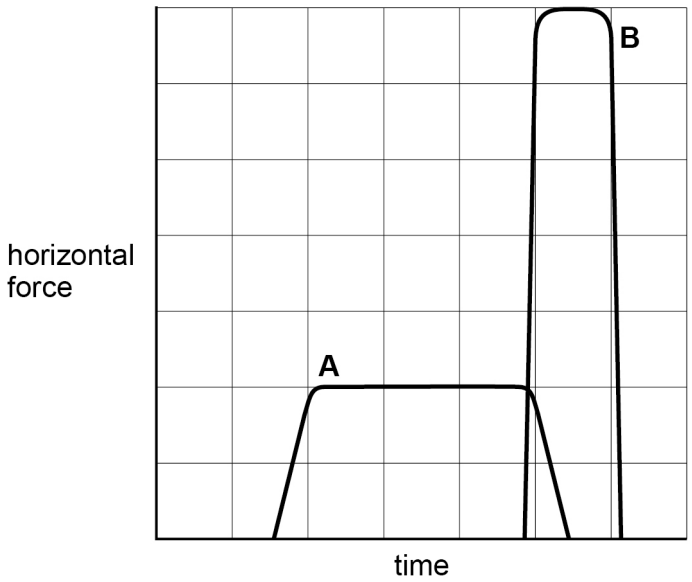


Figure 7 shows how the horizontal force on each dummy varies with time as the moving car is brought to rest.

Figure 7



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0 8 . 1 The area under curve **A** is equal to the area under curve **B**.

Explain why.

[3 marks]

0 8 . 2 Explain why the same work is done on both dummies even though the maximum force on dummy **A** is less than the maximum force on dummy **B**, as shown in **Figure 7**.

[3 marks]

0 8 . 3 State Newton's first law of motion.

[1 mark]

0 8 . 4 Explain how Newton's first law of motion applies to dummy **B** which does not have a seat belt.

[1 mark]

8

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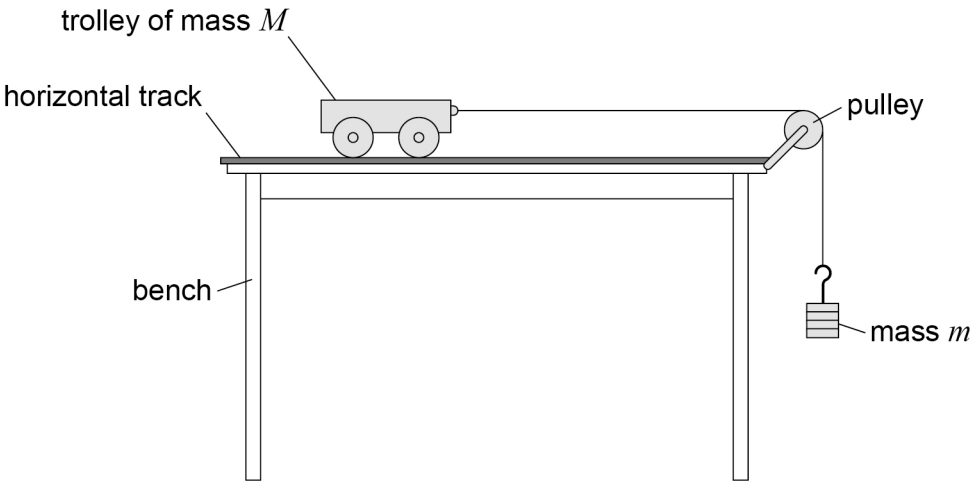
0 9 **Figure 8** shows the apparatus used in an experiment to illustrate Newton's second law of motion.
A trolley of mass M is accelerated by the weight of mass m.

Figure 8



The trolley and mass m are released from rest and travel a measured distance $s = 0.750$ m. The uncertainty in the measured distance $\Delta s = \pm 0.002$ m.

0 9 . 1 The time t taken for the trolley to travel distance s is measured five times.
Table 1 shows the results.

Table 1

t / s	0.81	0.77	0.80	0.79	0.78

Calculate the mean time t_{mean} and the uncertainty Δt_{mean} in these data.

[2 marks]

t_{mean} = _____ s

Δt_{mean} = _____ s

Do not write outside the box

0 9 . 2 The acceleration a of the trolley is given by

$$a = \frac{2s}{t^2}$$

Calculate a and its percentage uncertainty.

[4 marks]

$a =$ _____ $\mathrm{m\ s^{-2}}$

percentage uncertainty in $a = \pm$ _____

0 9 . 3 Newton's second law of motion when applied to the trolley and mass m gives

$$mg = (M + m)\,a$$

The mass of the connecting string is negligible.

Using this formula, a is predicted to be $2.56\ \mathrm{m\ s^{-2}}$.

Explain how friction acting on the trolley can account for the difference between the predicted and the measured value of a.

[1 mark]

_____

_____

_____

0 9 . 4 Suggest **one** improvement to the apparatus that could compensate for the friction acting on the trolley.

[1 mark]

_____

_____

_____

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 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.

1 0 Which is a unit for stiffness?

[1 mark]

A $J\ m^{-2}$

B $J\ m^{-1}$

C $J\ m$

D $J\ m^{2}$

1 1 Which is usually a physical quantity with a unit?

[1 mark]

A accuracy

B repeatability

C reproducibility

D resolution

Do not write outside the box

1 2 Which is a scalar quantity?

[1 mark]

A acceleration

B charge

C impulse

D momentum

1 3 What is the horizontal component of the resultant of these forces?

[1 mark]

A 51 N

B 27 N

C 19 N

D 17 N

Turn over for the next question

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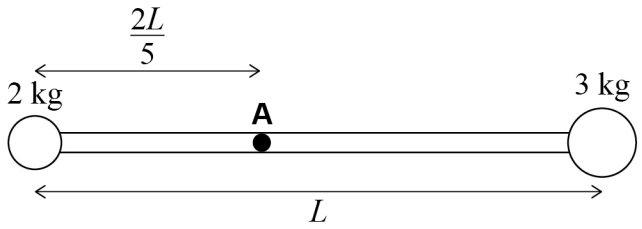
1 4 A 2 kg mass and a 3 kg mass are joined by a rod of negligible mass and length L.

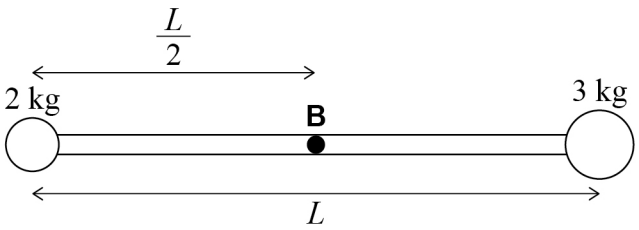
Which diagram shows the position of the centre of mass?

[1 mark]

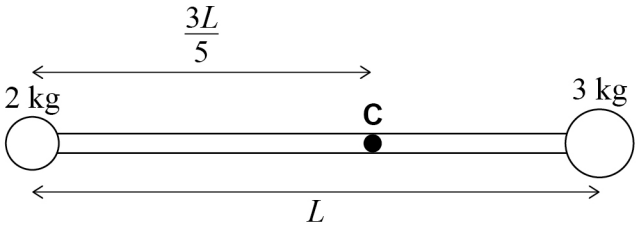
A



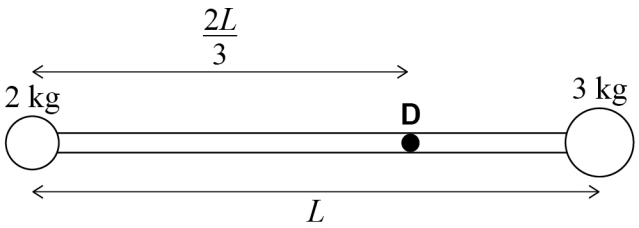
B



C



D



A ⬭

B ⬭

C ⬭

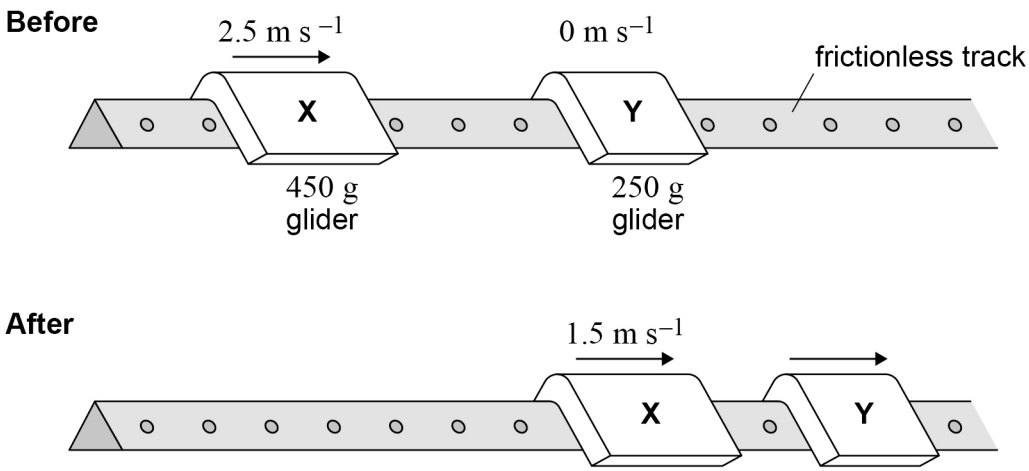
D ⬭

Do not write outside the box

1 5 A glider **X** of mass 450 g is travelling at $2.5\ \text{m s}^{-1}$ on a horizontal, frictionless air track. **X** collides with a stationary glider **Y** of mass 250 g. After the collision, **X** continues in the same direction with a speed of $1.5\ \text{m s}^{-1}$.

What is the speed of **Y** immediately after the collision?

[1 mark]



A $4.5\ \text{m s}^{-1}$ ⬭

B $1.8\ \text{m s}^{-1}$ ⬭

C $1.0\ \text{m s}^{-1}$ ⬭

D $0.9\ \text{m s}^{-1}$ ⬭

1 6 What does the area under a force–displacement graph represent?

[1 mark]

A acceleration ⬭

B energy transferred ⬭

C impulse ⬭

D spring constant ⬭

Do not write outside the box

1 7 A motor is 40% efficient and produces 96 W of useful output power.

What is the energy input to the motor in 2 minutes?

[1 mark]

A 240 J

B 480 J

C 4600 J

D 29 000 J

1 8 A car of mass m travels at a constant velocity v when its engine provides a useful output power P.

What is the resistive force acting on the car?

[1 mark]

A mv

B $\frac{P}{v}$

C Pmv

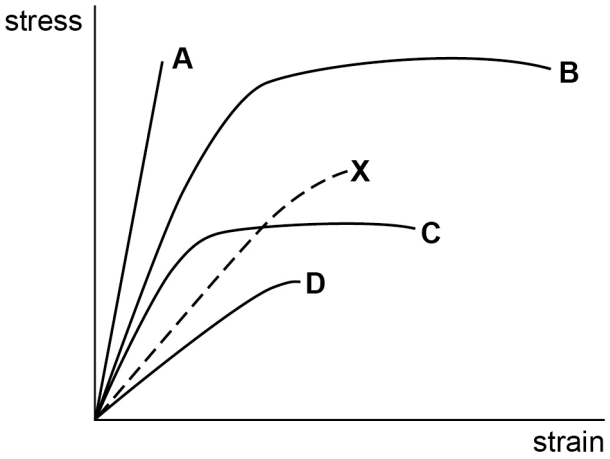
D $\frac{Pv}{m}$

Do not write outside the box

1 9 Two metal specimens **X** and **Y** are stretched until they break. **Y** has a greater Young modulus, a greater ultimate tensile stress, and is less brittle than **X**. The stress–strain curve for **X** is shown.

Which is the stress–strain curve for **Y**?

[1 mark]



A ⬭

B ⬭

C ⬭

D ⬭

2 0 Solid spheres **A** and **B** have the same mass but different densities. The diameter of sphere **A** is $2d$ and the diameter of sphere **B** is d.

What is $\frac{\text{density of sphere } \mathbf{A}}{\text{density of sphere } \mathbf{B}}$?

[1 mark]

A 1 ⬭

B $\frac{1}{2}$ ⬭

C $\frac{1}{4}$ ⬭

D $\frac{1}{8}$ ⬭

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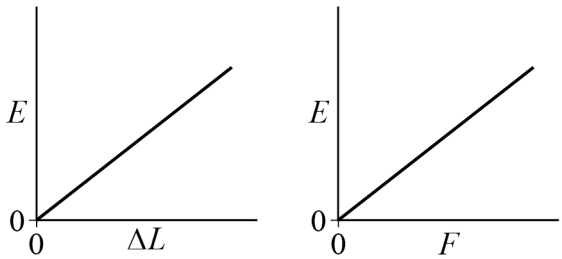
2 1 A spring that obeys Hooke's law is stretched.

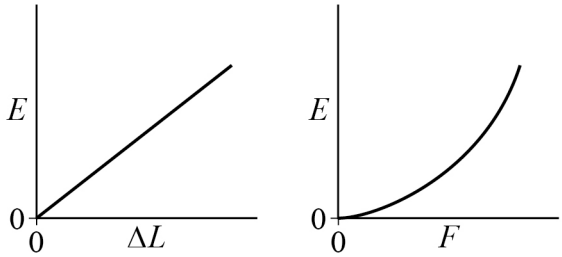
Which pair of graphs shows the variation of energy stored E with extension ΔL and the variation of E with force F?

[1 mark]

A



B



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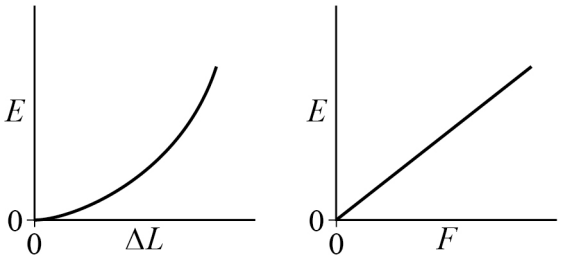

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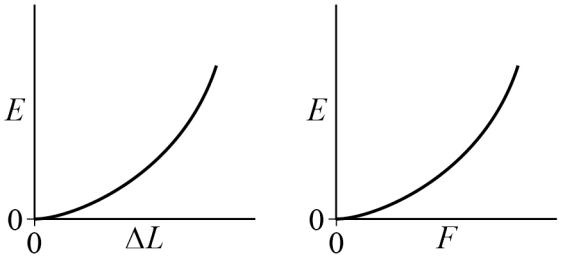

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A ⬭

B ⬭

C ⬭

D ⬭

2 2 What is the specific charge of a $^{9}_{4}Be^{2+}$ ion?

[1 mark]

A 2.1×10^{7} C kg^{-1} ⬭

B 4.3×10^{7} C kg^{-1} ⬭

C 9.6×10^{7} C kg^{-1} ⬭

D 2.2×10^{-1} C kg^{-1} ⬭

2 3 The initial activity of a radioactive source was 192 Bq. The activity of the source is 24 Bq after 12 days.

What was the activity of the radioactive source after 4 days?

[1 mark]

A 48 Bq ⬭

B 80 Bq ⬭

C 96 Bq ⬭

D 108 Bq ⬭

14

END OF QUESTIONS

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