This is a Class 1 exam

Lebanon Evangelical School
for Boys and Girls
Loueizeh - Baabda

Stage Exam 02

26MAR2025

Do NOT write in this box. Your MARK will be placed here.

Subject :	Physics
Class :	10A
Teacher :	Dr Ruth Brett
Duration :	1 hour

You should find any formulae you need on the last page, along with the value of g.

You are to answer the questions to this exam on : This exam paper

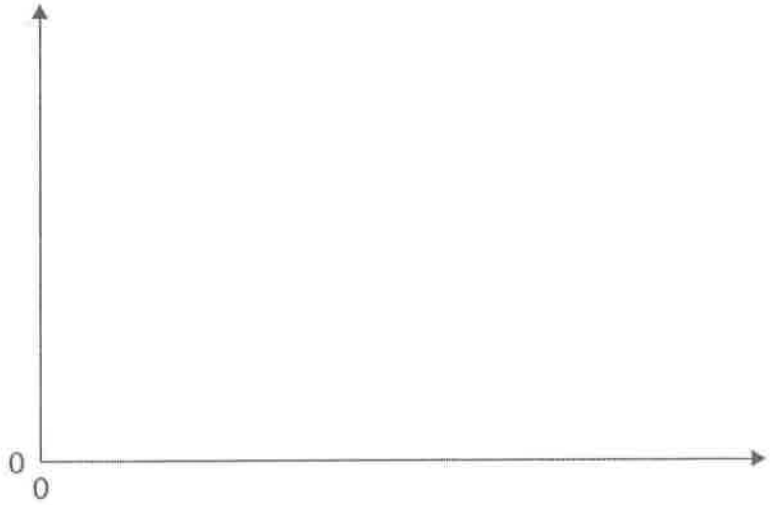
Your name :		*Time taken to complete exam*
Your Class :		
Exam Room :		
How many sheets, including cover sheet :		

- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

Q1.

(a) A metal spring obeys Hooke's law.
Sketch a graph to show that the spring obeys Hooke's law as it is stretched.
You should label both axes with appropriate physical quantities.

(3)



(b) Diagram 1 shows an object suspended from a support using a metal spring.
The object is initially at rest.

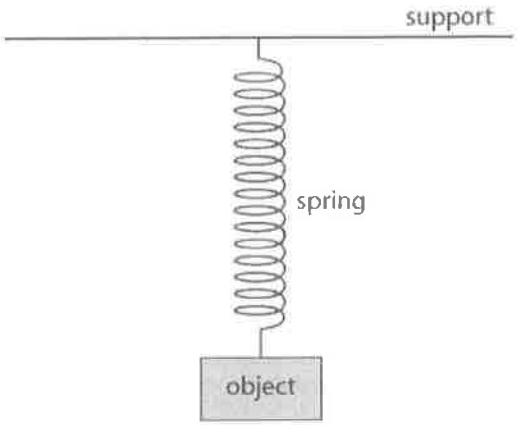


Diagram 1

This question continues on the next page...

(i) The object is pulled down and then released.
Diagram 2 shows the forces acting on the object at the instant it is released.

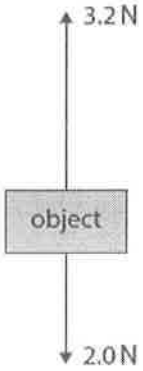


Diagram 2

Determine the magnitude and direction of the resultant force acting on the object.

(2)

magnitude of resultant force = ... N

direction of resultant force = ...

(ii) The object has a mass of 0.20 kg.
Calculate the acceleration of the object at the instant it is released.

(3)

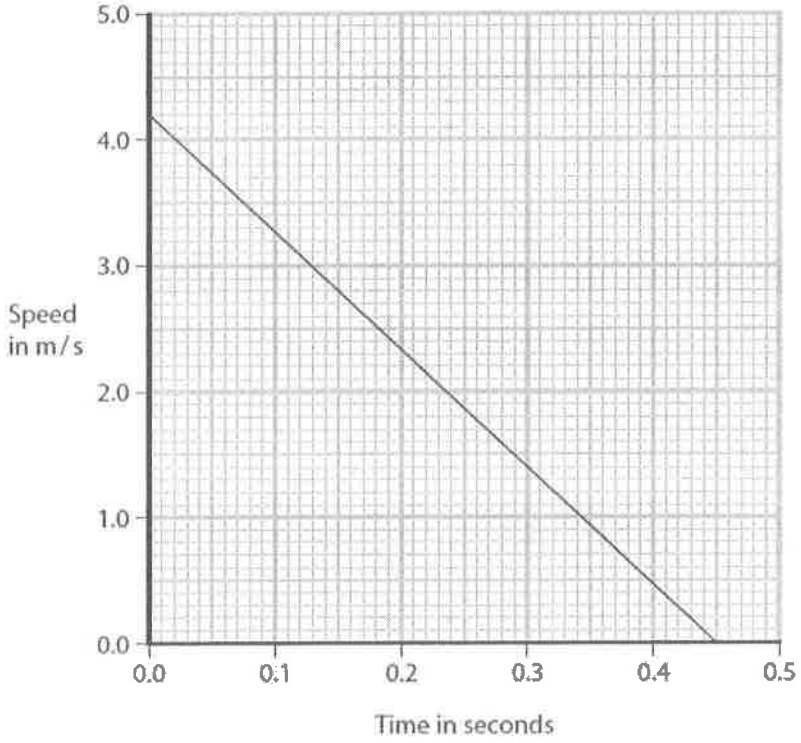
acceleration = ... m/s^2

(Total for question = 8 marks)

Q2.

(a) A person throws an object vertically upwards.

The speed-time graph shows how the speed of the object varies from the time it is thrown until reaching its maximum height.



(i) Calculate the acceleration of the object.

(3)

acceleration = ... m / s^2

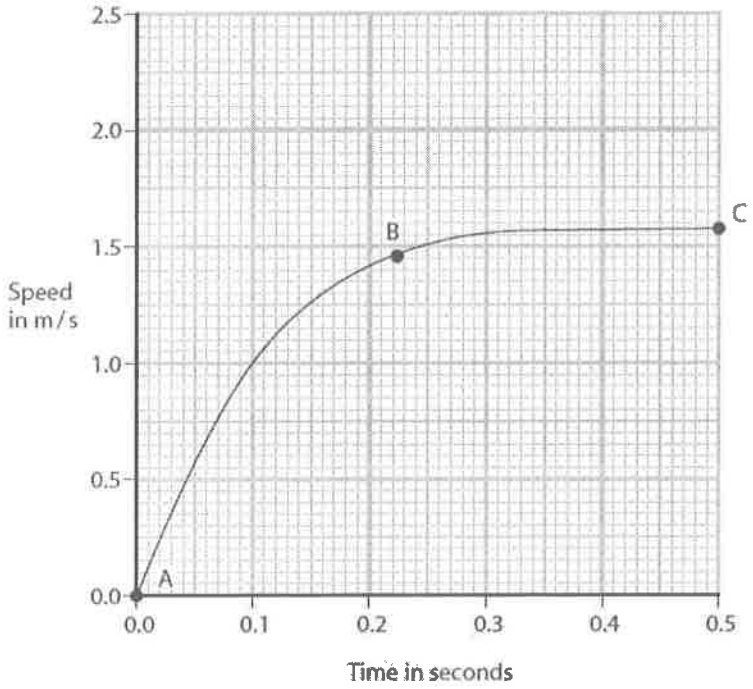
(ii) Calculate the distance the object travels to reach its maximum height.

(3)

distance = ... m

(b) A different object is dropped from rest and begins to fall.

The graph shows how the speed of this object varies with time.



(i) Give the name of the two forces acting on the object as it falls.

(2)

1 .....

2 .....

(ii) Draw arrows on the diagram to show the forces acting on the object at B.

(3)

object

(iii) Explain the shape of the graph from A to C.
You should use ideas about forces to help your answer.

(4)

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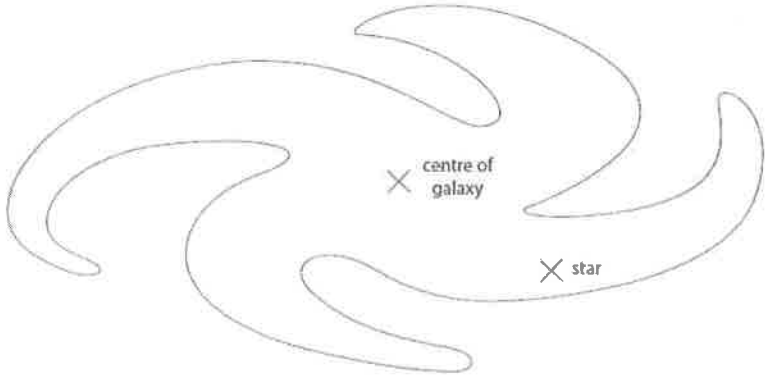
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(Total for question = 15 marks)

Q3. A star has a circular orbit around the centre of a galaxy.

(a) The diagram shows an outline of the galaxy and the star's position in the galaxy.



Draw an arrow on the diagram to show the force on the star that keeps the star in a circular orbit.

(1)

(b) (i) The speed of light is 3.0×10^8 m/s.

One light year is the distance light travels in one year.
Show that one light year is approximately 10^{16} m.
[one year = 3.2×10^7 s]

(2)

(ii) The star is 29 000 light years away from the centre of the galaxy and has an orbital speed of 220 km/s.

Calculate the time period of the star's orbit around the centre of the galaxy.
Give your answer in standard form.

(3)

time period = ... s

(Total for question = 6 marks)

Q4. A deioniser is a device used in rooms where workers build sensitive electronic circuits. The deioniser contains a small block of polonium-210.

(a) (i) Complete the equation that shows the alpha decay of polonium-210 into lead-206. (2)

$$^{210}_{84}Po \rightarrow {}^{206}_{82}Pb + \square\!\!\square\ \alpha$$

(ii) The alpha particle ionises air molecules in the room. What is meant by the term **ionisation?**

(1)

.....

.....

(iii) Explain why workers in the same room as the deioniser are not at risk from the alpha radiation it emits.

(2)

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(b) The half-life of polonium-210 is 140 days.

(i) State what is meant by the term **half-life**.

(2)

.....

.....

.....

(ii) The initial activity of the polonium-210 source in the deioniser is 70 kBq.
Calculate the activity of the source after 420 days.

(3)

activity = ... kBq

(Total for question = 10 marks)

Q5. Diagram 1 shows a wooden plank balanced horizontally on two supports, A and B.

A block is suspended from the plank between the supports by a cable of negligible weight.

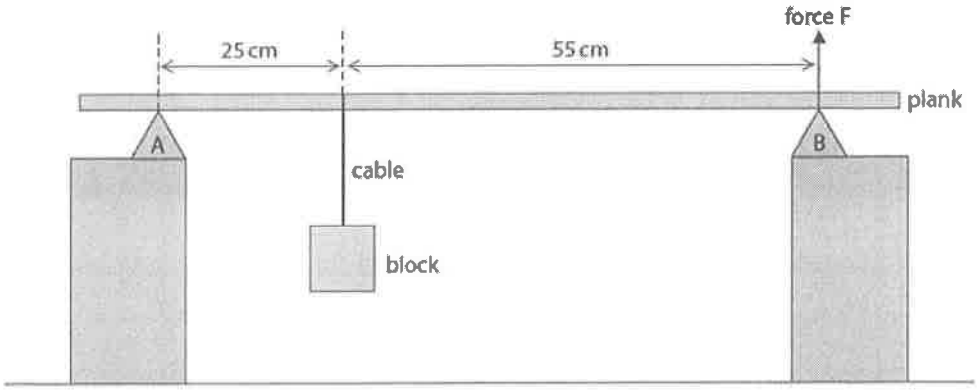


Diagram 1

(a) The weight of the block is 260 N.

(i) By taking moments about support A, calculate force F.
Assume the weight of the plank is negligible.

(3)

force F = ... N

(ii) Explain what will happen to the magnitude of force F if the block is moved towards support B.

(3)

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(Total for question = 6 marks)

Q6. This question is about nuclear fission and nuclear fusion.

(a) The table gives some statements about nuclear fission, or nuclear fusion, or both nuclear fission and nuclear fusion.

Place ticks (✓) in the table to show which statements are about nuclear fission and which statements are about nuclear fusion.

(3)

Statement	Nuclear fission	Nuclear fusion
requires high pressure and high temperature		
energy is released		
radioactive daughter nuclei are produced		

(b) Nuclear fission reactors use control rods and a moderator.

Describe the function of the control rods and the function of the moderator in a nuclear fission reactor.

(2)

control rods

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moderator

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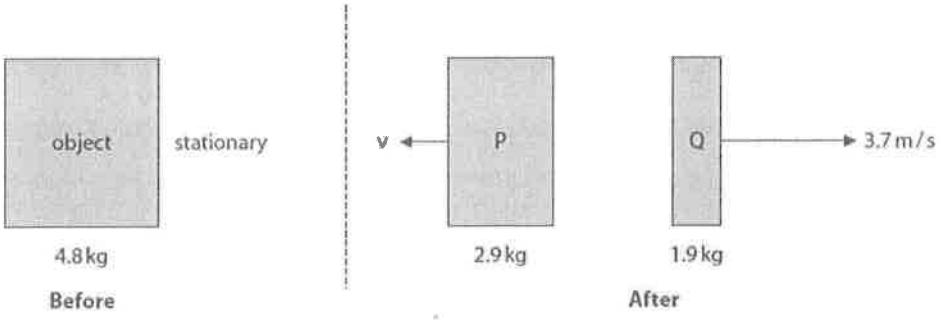
(Total for question = 5 marks)

Q7. This question is about momentum.

(a) The diagram shows an object before and after an explosion.

The object breaks into two parts, P and Q.

The parts move away from each other in opposite directions.



(i) State what is meant by the **principle of conservation of momentum**.

(1)

.....

.....

(ii) Calculate the magnitude of the velocity of part P after the explosion.

(3)

velocity = ... m / s

(b) A dummy is used to test the safety features of a car in a collision. In one test, the dummy has a momentum of 1100 kg m/s before the collision and is brought to rest by a mean force of 15 kN.

Calculate the time taken for the dummy to be brought to rest in the collision.

(3)

time taken = ... s

(c) A child drops an egg from a height of 10 cm and the egg lands on the floor.

Explain why the egg is less likely to break if the floor is covered with a thick carpet than if the floor were covered in hard tiles.

(3)

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(Total for question = 10 marks)

DATA AND EQUATIONS

You may remove this page. You don't have to hand it in with your paper.

Where necessary, assume the acceleration of freefall, $g = 10\ \text{m/s}^2$

1. Forces and Motion	
average speed = $\frac{\text{distance moved}}{\text{time taken}}$	
acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$	$a = \frac{(v-u)}{t}$
(final speed)^2 = (initial speed)^2 + (2 × acceleration × distance moved)	$v^2 = u^2 + (2 \times a \times s)$
force = mass × acceleration	$F = m \times a$
weight = mass × gravitational field strength	$W = m \times g$

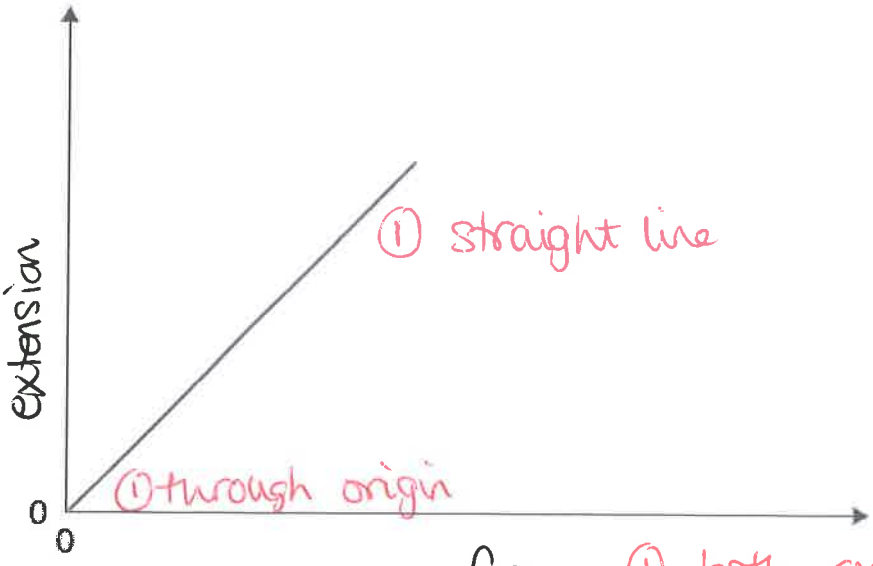
momentum = mass × velocity	$p = m \times v$
force = $\frac{\text{change in momentum}}{\text{time taken}}$	$F = \frac{(mv-mu)}{t}$
moment = force × perpendicular distance from the pivot	

8. Astrophysics	
orbital speed = $\frac{2 \times \pi \times \text{orbital radius}}{\text{time period}}$	$v = \frac{2 \times \pi \times r}{T}$

Q1.

(a) A metal spring obeys Hooke's law.
Sketch a graph to show that the spring obeys Hooke's law as it is stretched.
You should label both axes with appropriate physical quantities.

(3)



(b) Diagram 1 shows an object suspended from a support using a metal spring.
The object is initially at rest.

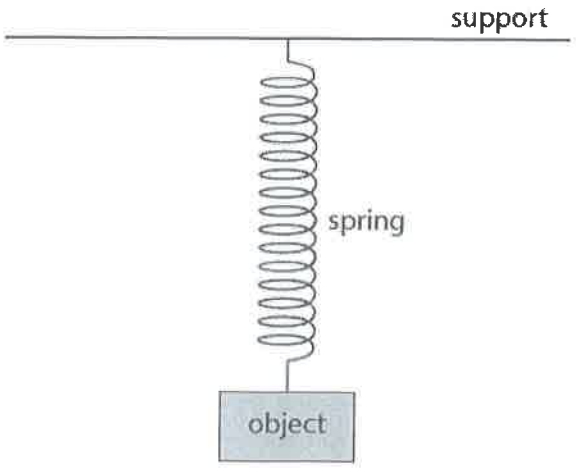


Diagram 1

This question continues on the next page...

(i) The object is pulled down and then released.
Diagram 2 shows the forces acting on the object at the instant it is released.

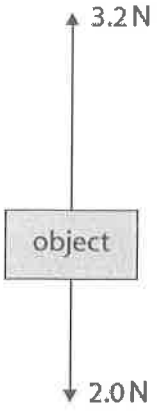


Diagram 2

Determine the magnitude and direction of the resultant force acting on the object.

$3 \cdot 2 - 2 = 1 \cdot 2$ **(2)**

magnitude of resultant force = ... 1·2 (1) ..... N

direction of resultant force = ... upwards (1) .....

(ii) The object has a mass of 0.20 kg.
Calculate the acceleration of the object at the instant it is released.

(3)

$F = m \times a$

$1 \cdot 2 = 0 \cdot 2 \times a$ (1)

$a = \frac{1 \cdot 2}{0 \cdot 2}$ (1) $= 6 \text{ m/s}^2$

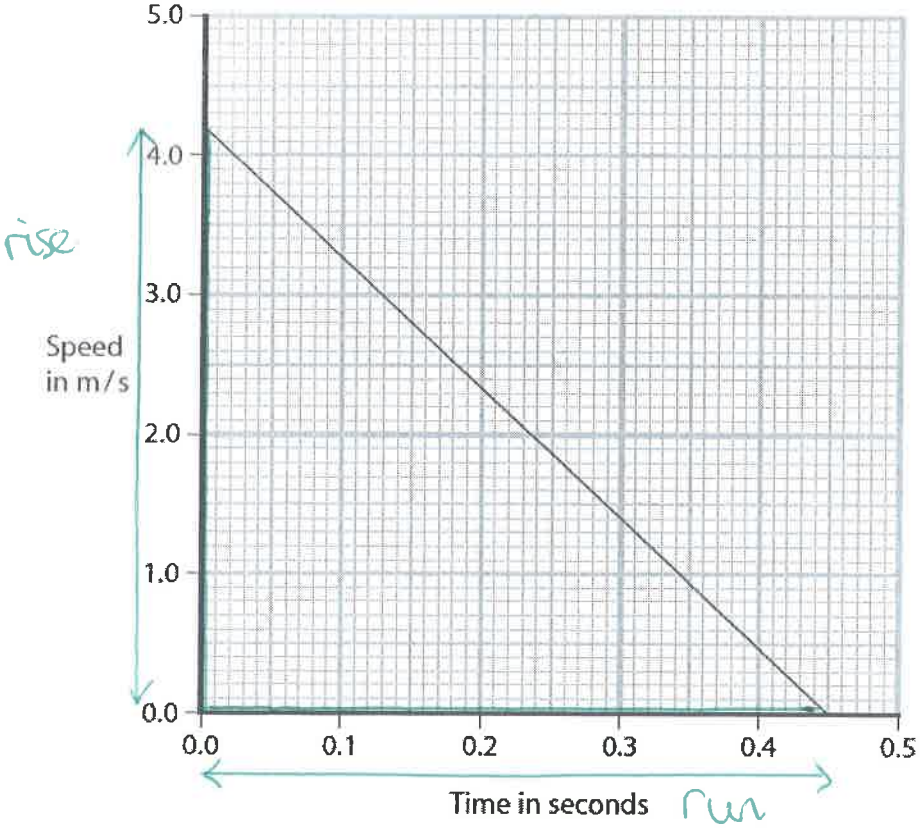
acceleration = ... 6·0 (1) ..... m/s^2

(Total for question = 8 marks)

Q2.

(a) A person throws an object vertically upwards.

The speed-time graph shows how the speed of the object varies from the time it is thrown until reaching its maximum height.



(i) Calculate the acceleration of the object.

(3)

acceleration = gradient

$a = \frac{(0 - 4.2)}{(0.45 - 0)} = \frac{-4.2}{0.45} = -9.33\ m/s^2$ (1) (1)

must be $-9.3 \rightarrow -9.4$

acceleration = −9.3 (1) ..... m / s^2

must be negative

(ii) Calculate the distance the object travels to reach its maximum height.

(3)

distance = area under the line (1)

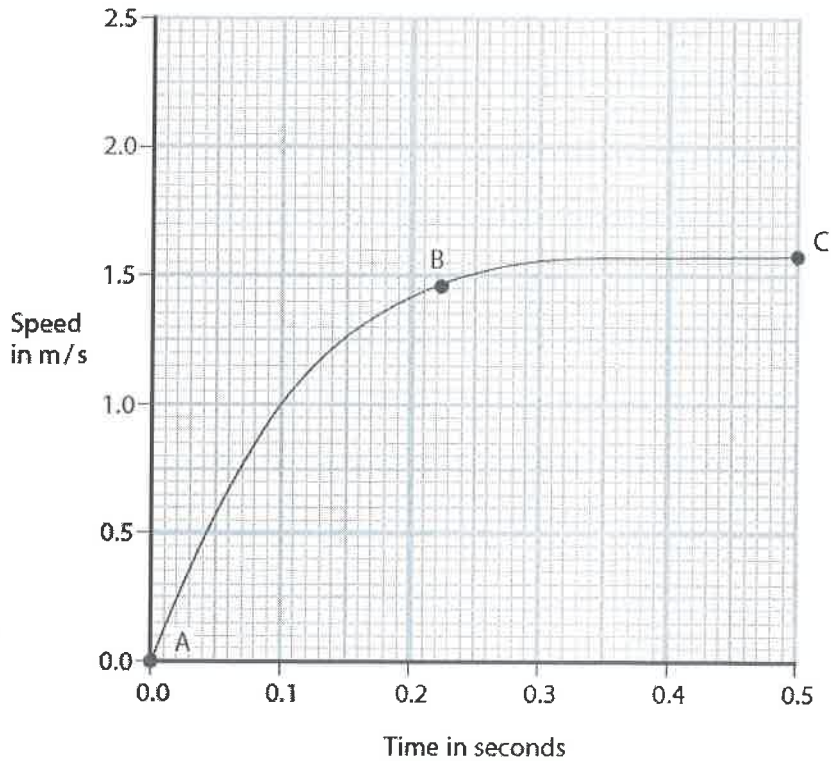
distance = $\frac{1}{2}(b \times h) = \frac{1}{2}(0.45 \times 4.2)$ (1)

distance = 0.945 m

distance = 0.95 (1) ..... m

(b) A different object is dropped from rest and begins to fall.

The graph shows how the speed of this object varies with time.



(i) Give the name of the two forces acting on the object as it falls.

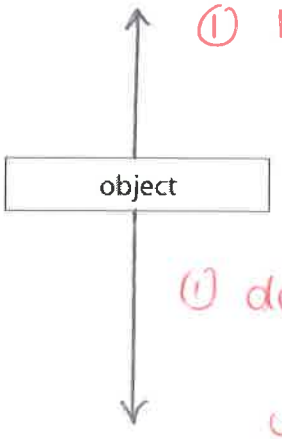
(2)

1 Weight (1) gravitational force is OK "granty" = 0

2 air resistance (1)

(ii) Draw arrows on the diagram to show the forces acting on the object at B.

(3)



(1) 1 upward + 1 downward arrow
Must touch the object

(1) downward arrow longer than upward arrow

(iii) Explain the shape of the graph from A to C.
You should use ideas about forces to help your answer.

(4)

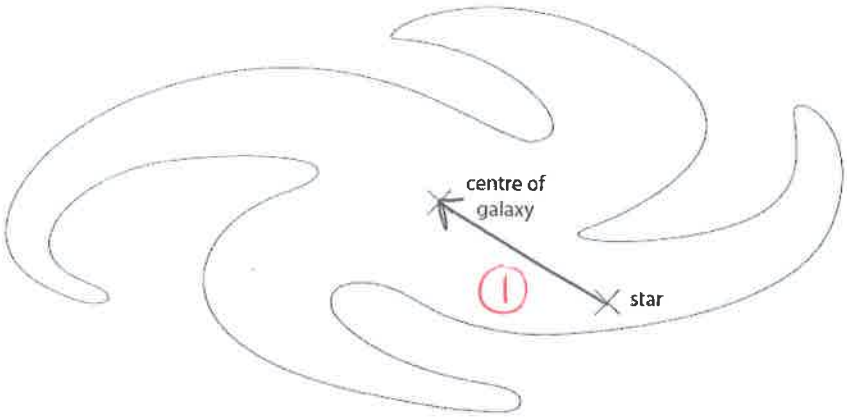
From A to B, the object is accelerating (1)
because the downward force is greater than the upward force. (1)
As the speed increases, the air resistance increases (1)
so the resultant force (and acceleration) decreases (1)
Between B and C, at about 0.35 s, the air resistance is equal to the weight (1). Therefore the resultant force is zero (1) and the object has reached its terminal velocity (1)

MAXIMUM 4 MARKS

(Total for question = 15 marks)

Q3. A star has a circular orbit around the centre of a galaxy.

(a) The diagram shows an outline of the galaxy and the star's position in the galaxy.



Draw an arrow on the diagram to show the force on the star that keeps the star in a circular orbit.

(1)

(b) (i) The speed of light is 3.0×10^8 m/s.

One light year is the distance light travels in one year.
Show that one light year is approximately 10^{16} m.
[one year = 3.2×10^7 s]

(2)

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

$$3 \times 10^8 = \frac{\text{distance}}{3.2 \times 10^7} \quad (1)$$

$$\text{distance} = 3 \times 10^8 \times 3.2 \times 10^7 = 9.6 \times 10^{15}\ \text{m} \quad (1)$$

(ii) The star is 29 000 light years away from the centre of the galaxy and has an orbital speed of 220 km/s.

Calculate the time period of the star's orbit around the centre of the galaxy.
Give your answer in standard form.

(3)

Distance in m is to centre of galaxy $9.6 \times 10^{15} \times 29\,000 = 2.784 \times 10^{20}$ m (1)

$r = 2.784 \times 10^{17}$ km

$$\text{Speed} = \frac{2\pi r}{T} \qquad 220\ \text{km/s} = \frac{2 \times \pi \times 2.784 \times 10^{17}}{T}$$

$$T = \frac{2 \times \pi \times 2.784 \times 10^{17}}{220} = 7.95 \times 10^{15}\ \text{s} \quad (1)$$

time period = 7.95×10^{15} s (1)

Must be in standard form

Using 1 light year $\approx 10^{16}$ s gives 8.28×10^{15} s

(Total for question = 6 marks)

Q4. A deioniser is a device used in rooms where workers build sensitive electronic circuits. The deioniser contains a small block of polonium-210.

(a) (i) Complete the equation that shows the alpha decay of polonium-210 into lead-206. **(2)**

$$^{210}_{84}Po \rightarrow {}^{206}_{82}Pb + \boxed{4}\,\alpha \quad (1)$$

$$\boxed{2} \quad (1)$$

(ii) The alpha particle ionises air molecules in the room. What is meant by the term **ionisation?** **(1)**

removal of electrons from an atom (1)

(iii) Explain why workers in the same room as the deioniser are not at risk from the alpha radiation it emits. **(2)**

α particles are stopped by a few cm of air (1)

so they cannot reach the workers (1)

(b) The half-life of polonium-210 is 140 days.

(i) State what is meant by the term **half-life**. **(2)**

The time taken (1) for the activity to halve (1)

(ii) The initial activity of the polonium-210 source in the deioniser is 70 kBq. Calculate the activity of the source after 420 days. **(3)**

70 kBq $\xrightarrow{140\text{ days}}$ (1) 35 kBq $\xrightarrow{280\text{ days}}$ 17.5 kBq $\xrightarrow{420\text{ days}}$ 8.75 kBq

or $\frac{420}{140} = 3$ so 3 half-lives

activity = 8.75 (1) kBq

(Total for question = 10 marks)

Q5. Diagram 1 shows a wooden plank balanced horizontally on two supports, A and B.

A block is suspended from the plank between the supports by a cable of negligible weight.

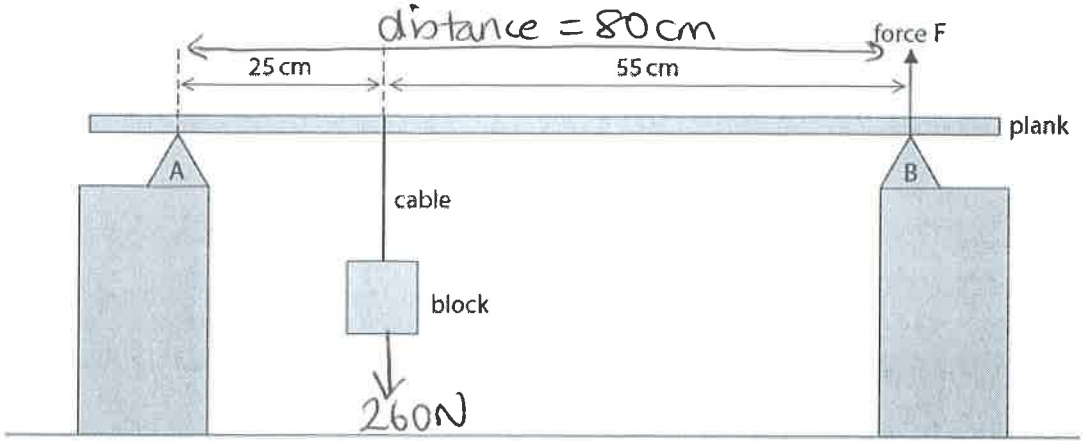


Diagram 1

(a) The weight of the block is 260 N.

(i) By taking moments about support A, calculate force F.
Assume the weight of the plank is negligible.

(3)

↻ moment = force × distance (1)

↻ moment = 260 × 25 = 6500 N cm

↺ moment = 6500 N cm = 80 × F (1)

$F = \frac{6500}{80} = 81.25\,N$

Can convert cm to m and get same answer

force F = 81 (1) N

(ii) Explain what will happen to the magnitude of force F if the block is moved towards support B.

(3)

As the block moves towards B, the clockwise moment increases (1). Therefore the anticlockwise moment must increase (1) to balance it. The distance to force F doesn't change, so force F must increase (1)

(Total for question = 6 marks)

Q6. This question is about nuclear fission and nuclear fusion.

(a) The table gives some statements about nuclear fission, or nuclear fusion, or both nuclear fission and nuclear fusion.

Place ticks (✓) in the table to show which statements are about nuclear fission and which statements are about nuclear fusion.

(3)

Statement	Nuclear fission	Nuclear fusion
requires high pressure and high temperature		✓
energy is released	✓	✓
radioactive daughter nuclei are produced	✓	

(1) (1) (1)

1 mark for each correct row

(b) Nuclear fission reactors use control rods and a moderator.

Describe the function of the control rods and the function of the moderator in a nuclear fission reactor.

(2)

control rods

Control rods absorb neutrons (1)

moderator

The moderator slows down the neutrons (1)

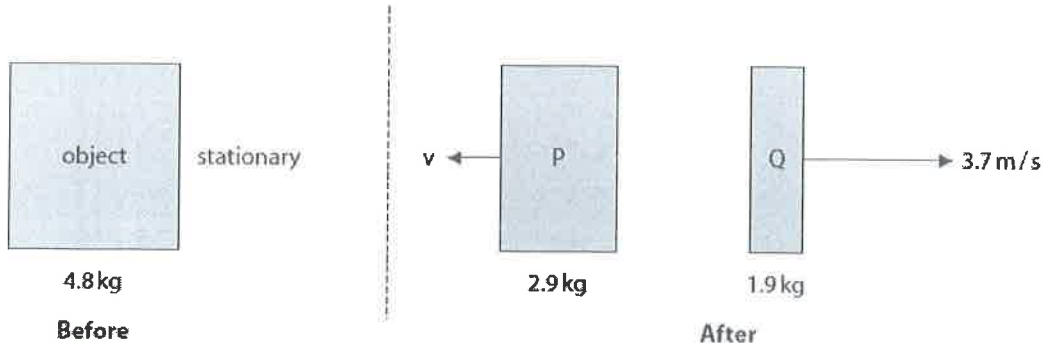
(Total for question = 5 marks)

Q7. This question is about momentum.

(a) The diagram shows an object before and after an explosion.

The object breaks into two parts, P and Q.

The parts move away from each other in opposite directions.



(i) State what is meant by the **principle of conservation of momentum**.

(1)

The total momentum before a collision is the same as the total momentum after a collision (1)

(ii) Calculate the magnitude of the velocity of part P after the explosion.

(3)

before

$0 \times 4.8 = (v \times 2.9) + (3.7 \times 1.9)$ (1)

$0 = 2.9v + 7.03$

$v = -\frac{7.03}{2.9} = -2.42$ (1)

velocity = 2.4 (1) m / s

no - sign need as we are asked for the magnitude

(b) A dummy is used to test the safety features of a car in a collision. In one test, the dummy has a momentum of 1100 kg m/s before the collision and is brought to rest by a mean force of 15 kN.

Calculate the time taken for the dummy to be brought to rest in the collision.

(3)

$F = \frac{\text{change in momentum}}{\text{time taken}}$

$15000 = \frac{(1100 - 0)}{t}$ (1)

$t = \frac{1100}{15000} = 0.0733\text{s}$

(1)

(1)

time taken = 0.073 s

(c) A child drops an egg from a height of 10 cm and the egg lands on the floor.

Explain why the egg is less likely to break if the floor is covered with a thick carpet than if the floor were covered in hard tiles.

(3)

Carpet increases (1) the time taken for the momentum to change.

The change in momentum is the same and the force, F, applied to the egg is:

$F = \frac{\text{change in momentum}}{\text{time taken}}$ (1)

Therefore if the time taken increases, the force applied will decrease (1) and so the egg is less likely to break.

(Total for question = 10 marks)