PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

# PHYSICS



EXAM QUESTION PACK

## SECTION 1: FORCES AND MOTION (PACK 1)

| SCORE | PERCENTAGE |
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STEMUP

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Q1.

This is a question about alpha particles.

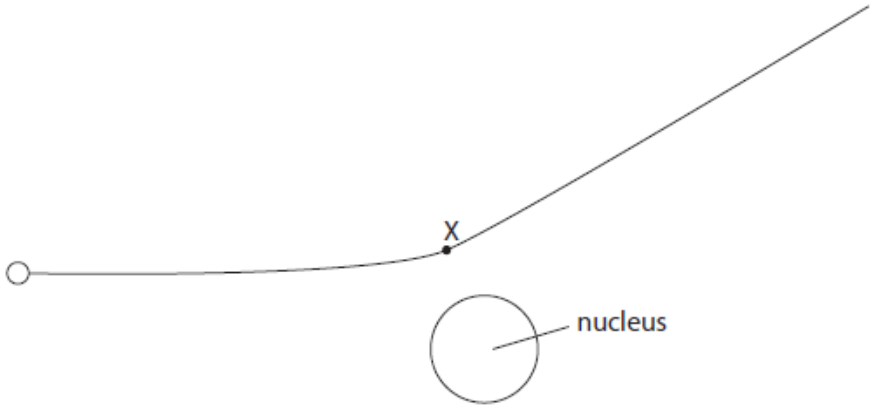
(a) Describe the nature of an alpha particle.

**(1)**

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(b) The diagram shows the path of an alpha particle as it passes close to a nucleus.




(i) Draw an arrow from point X to show the force on the alpha particle due to the nucleus.

Label this force Y.

**(2)**

(ii) Draw an arrow to show the force on the nucleus due to the alpha particle.

Label this force Z.

**(2)**

(iii) Explain how the path of the alpha particle shows whether the nucleus is positive, negative or neutral.

**(3)**

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(c) The alpha particle experiences a resultant force of 3.6 N and has a mass of $6.6 \times 10^{-27}$ kg.

Calculate the acceleration of the alpha particle.

**(3)**

acceleration = ..... $m/s^2$

**(Total for question = 11 marks)**

Q2.

A tennis racket is used to hit a tennis ball.

The ball is in contact with the racket for 0.20 seconds and leaves the racket with a horizontal velocity of 46 m/s.






(a) (i) State the equation relating acceleration, change in velocity and time taken.

**(1)**

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(ii) Calculate the acceleration of the tennis ball assuming it is at rest when it is hit.

Give the unit.

**(3)**

acceleration = .....unit.....

(b) The tennis ball has a mass of 57 grams.

(i) State the equation relating momentum, mass and velocity.

**(1)**

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(ii) Calculate the momentum of the tennis ball when its velocity is 46 m/s.

**(3)**

momentum = ..... kg m/s

(c) The bottom of a tennis player's shoes are thick and made from a material that compresses when the player's feet land on the ground.

Explain why these shoes reduce the risk of injury to the tennis player.

**(3)**

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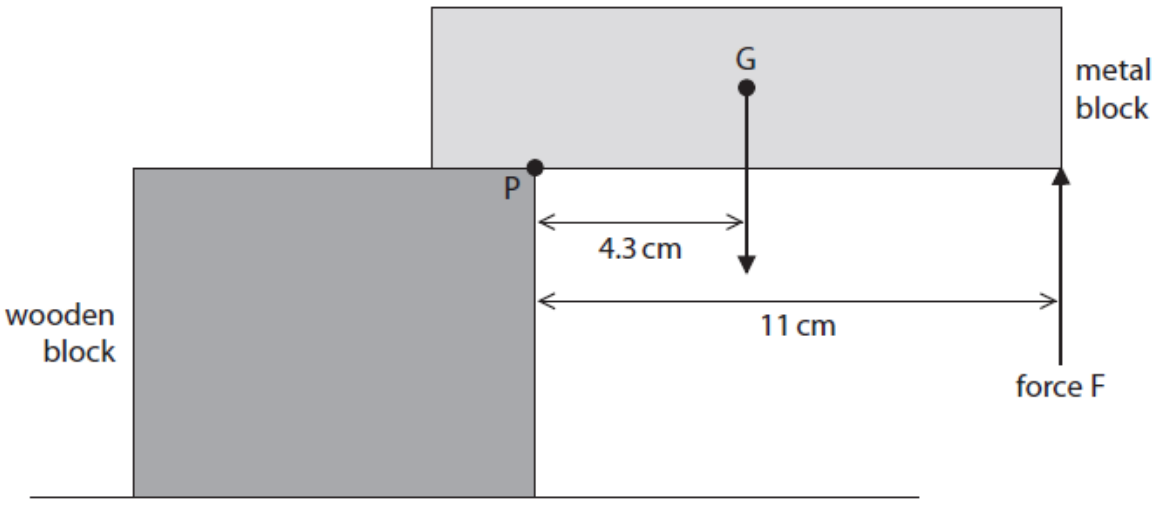
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**(Total for question = 11 marks)**

Q3.

The diagram shows a metal block on top of a wooden block.

The metal block is held stationary by force F.




(a) (i) The weight of the metal block acts through point G.

Give the name of point G.

**(1)**

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(ii) Name a piece of apparatus that could be used to measure the weight of the metal block.

**(1)**

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(b) (i) State the formula linking moment, force and perpendicular distance from the pivot.

**(1)**

(ii) The weight of the metal block is 0.68 N.

Show that the moment of the weight of the metal block about point P is approximately 2.9 N cm.

**(1)**

(iii) Force F is applied to the metal block to stop it from moving.

Calculate the magnitude of force F.

**(3)**

force F = ..... N

**(Total for question = 7 marks)**

Q4.

A builder needs to lift a large stone block.

(a) Diagram 1 shows the stone block.

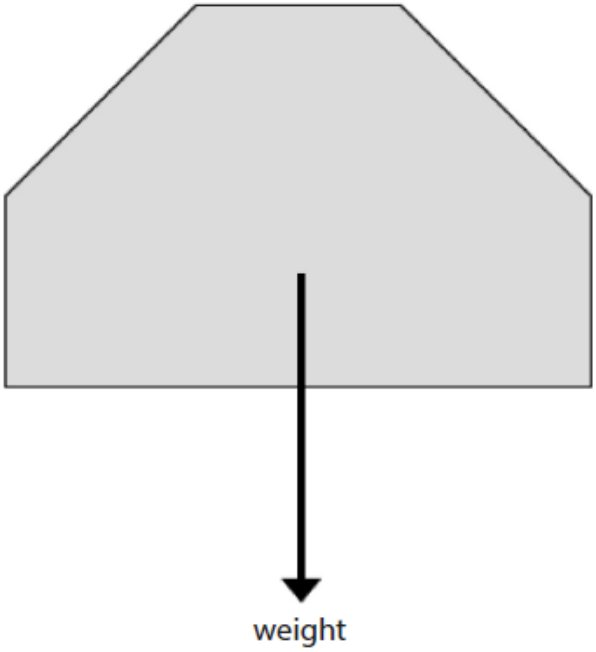



**Diagram 1**

(i) Draw an X on diagram 1 at the centre of gravity of the stone block.

**(1)**

(ii) State the formula linking weight, mass and gravitational field strength.

**(1)**

(iii) The mass of the stone block is 130 kg.

Calculate the weight of the stone block.

**(2)**

weight = ..... N

(b) The builder uses a wooden plank to lift the large stone block.

The plank is uniform and pivoted at its centre.

The builder pushes down on one end of the plank to lift the stone block.

Diagram 2 shows the plank when it is horizontal and stationary.

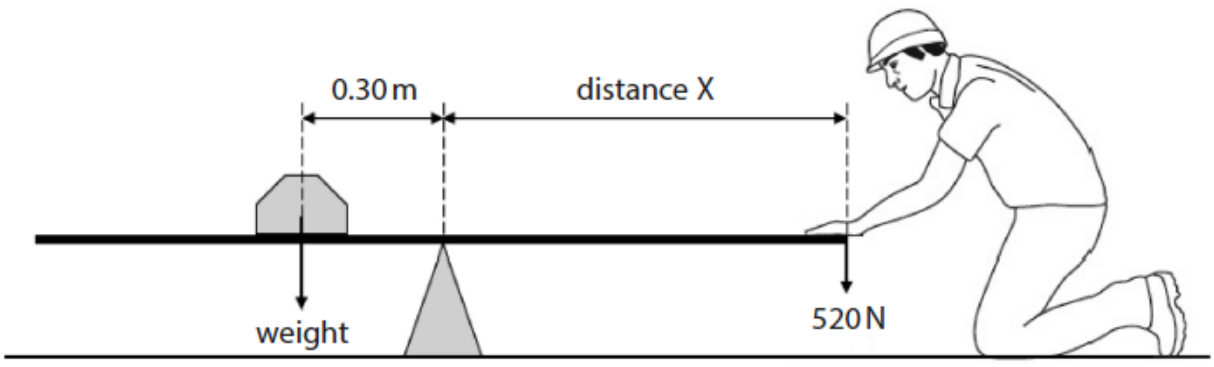



**Diagram 2**

(i) State the principle of moments.

**(2)**

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(ii) The builder is pushing down with a force of 520 N to keep the plank horizontal.

Calculate distance X.

**(3)**

distance X = ..... m

(iii) Calculate the length of the plank.

**(1)**

length of plank = ..... m

**(Total for question = 10 marks)**

Q5.

An aircraft travels along a runway.

(a) The aircraft starts from rest and has a constant acceleration of 4.1 $m/s^2$.

Calculate the distance required to reach take-off speed of 75 m/s.

**(3)**

distance = ..... m

(b) The aircraft takes off and reaches its maximum height above the ground.

At maximum height, the background radiation count rate is higher than on the ground.

(i) Explain what is meant by background radiation.

**(2)**

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(ii) Suggest why there is a limit to the number of hours that an airline pilot can fly at maximum height.

**(3)**

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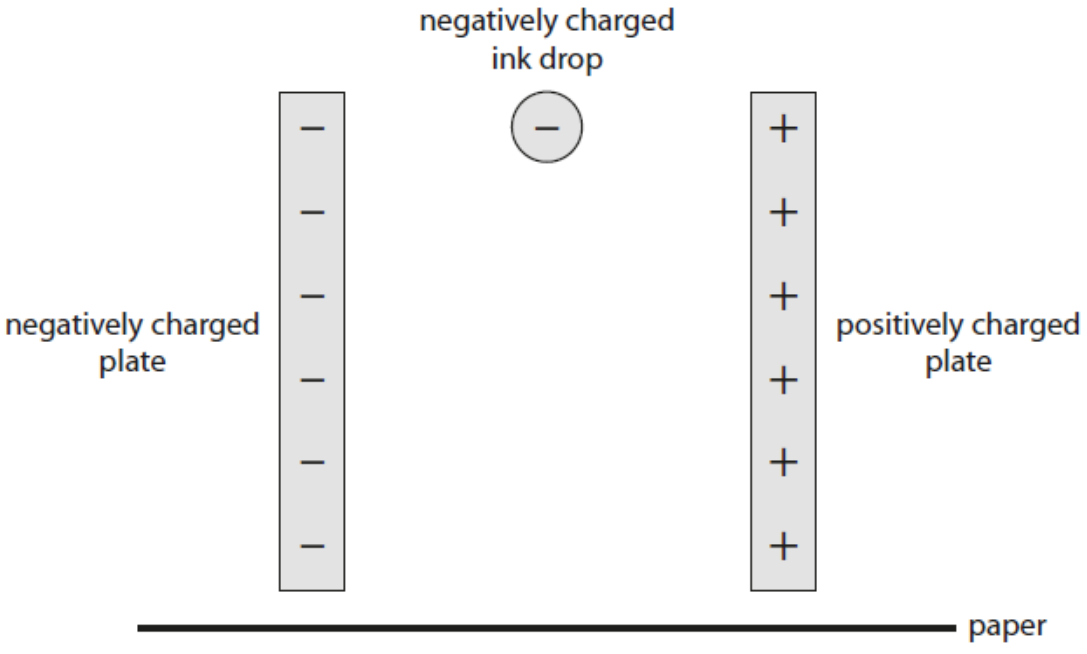
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**(Total for question = 8 marks)**

Q6.

The diagram shows a simplified view of part of an inkjet printer.




A negatively charged ink drop falls vertically between a pair of charged plates.

(a) The ink drop experiences a horizontal electrostatic force as it falls.

Explain the direction of the electrostatic force exerted on the ink drop by the charged plates.

**(2)**

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(b) On the diagram, draw the path of the ink drop as it falls between the charged plates until it hits the paper.

**(2)**

(c) (i) The ink drop experiences a horizontal force of $8.5 \times 10^{-7}$ N when it is between the charged plates.

The mass of the ink drop is $1.1 \times 10^{-10}$ kg.

Calculate the horizontal acceleration of the ink drop when it is between the charged plates.

**(3)**

acceleration = ..... $m/s^2$

(ii) The ink drop has no initial horizontal velocity before it passes between the charged plates.

After passing between the charged plates, the horizontal velocity of the ink drop is 3.9 m/s.

Calculate the horizontal distance travelled by the ink drop as it passes between the charged plates.

Give your answer in mm.

**(4)**

distance = ..... mm

(d) Explain how another ink drop could be deflected in the opposite direction by a greater distance using the charged plates in the inkjet printer.

**(2)**

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**(Total for question = 13 marks)**

Q7.

Diagram 1 shows a machine used for demonstrating electrostatics.

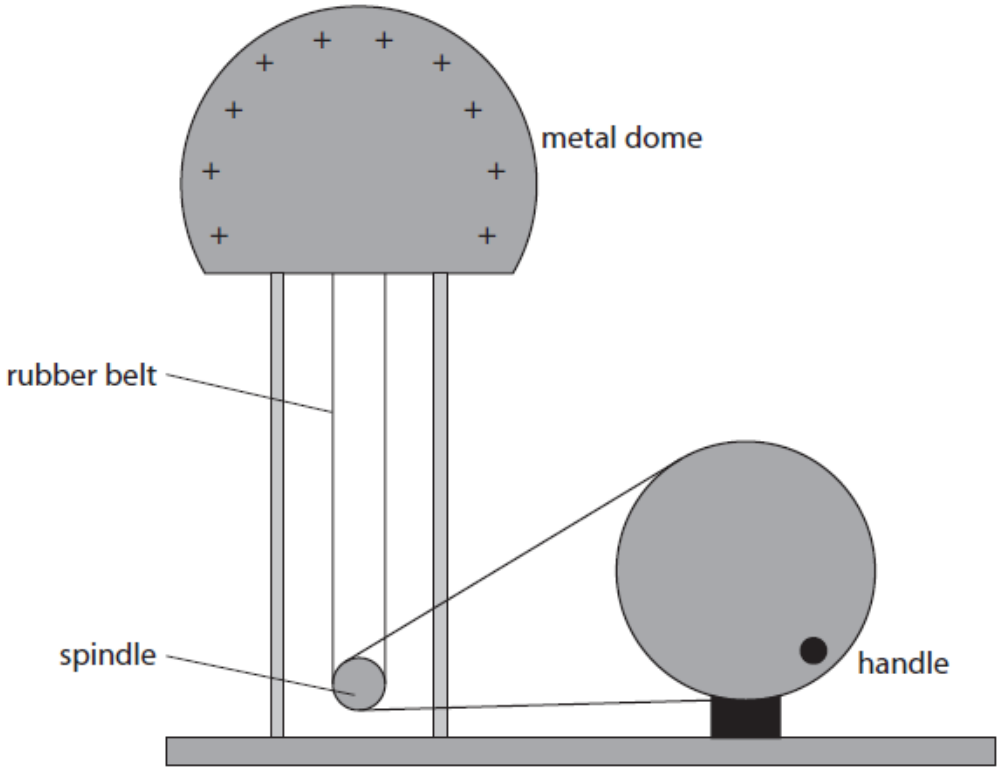



**Diagram 1**

(a) When the handle is turned, the dome becomes positively charged.

(i) In terms of electron movement, give a reason why the metal dome becomes positively charged.

**(1)**

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(ii) When the handle is turned for 15 s the dome gains 0.50 J of energy in its electrostatic store as it becomes charged.

The voltage between the dome and the earth is 120 kV.

Calculate the mean charging current during this time.

**(3)**

mean charging current = ..... A

(b) The metal dome is discharged.

A thin metal case is then placed on top of the metal dome, as shown in Diagram 2.

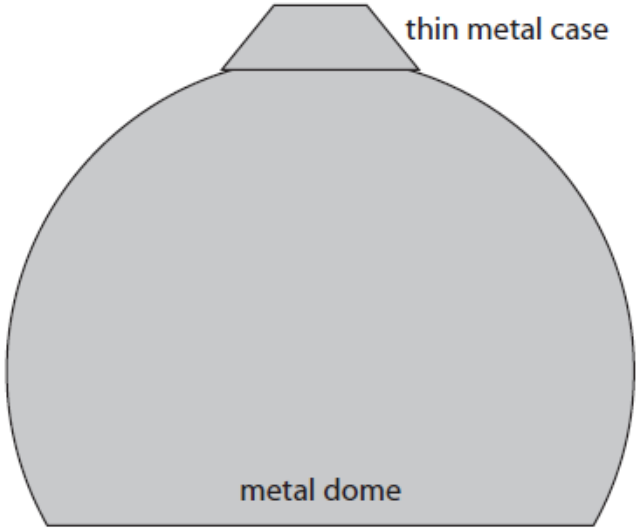



**Diagram 2**

(i) When the handle is turned, the thin metal case moves upwards away from the dome.

Explain why the thin metal case starts to move upwards.

**(3)**

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(ii) Explain why the metal case reaches a maximum height above the metal dome.

**(4)**

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**(Total for question = 11 marks)**

Q8.

(a) Which of these is a device used to measure force?

**(1)**

☒ **A** newton meter

☒ **B** ruler

☒ **C** thermometer

☒ **D** voltmeter

(b) Airbags are safety devices used in cars to protect the driver if there is a crash.

(i) State the formula linking momentum, mass and velocity.

**(1)**

(ii) A person inside a car has a mass of 72 kg and a velocity of 13 m/s.

Show that the momentum of the person is about 900 kg m/s.

**(1)**

(iii) The person experiences a crash and comes to rest in 0.29 s.

Calculate the force on the person.

**(2)**

force = ..... N

(iv) Which statement explains how airbags protect the driver?

**(1)**

☒ **A** increase the force acting on the driver

☒ **B** increase the time taken for the driver to stop

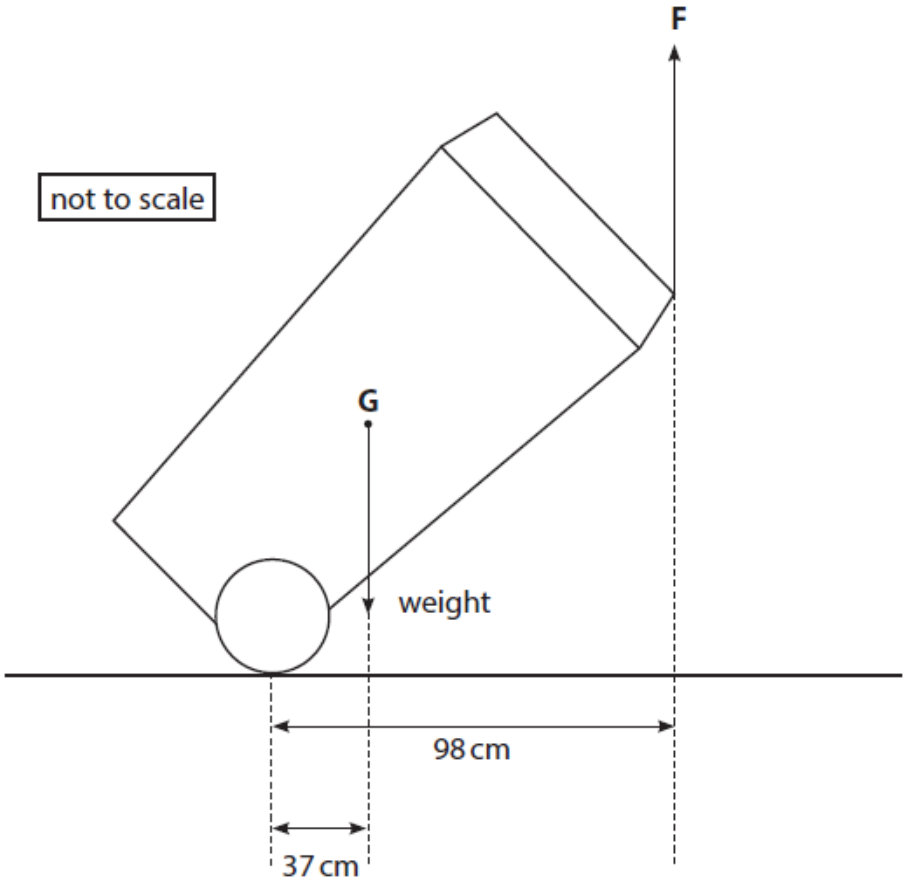
☒ **C** increase the kinetic energy store of the driver

☒ **D** increase the momentum of the driver

**(Total for question = 6 marks)**

Q9.

The diagram shows some of the forces acting on a large rubbish bin on wheels.




(a) The weight of the bin acts through point G.

Give the name of point G.

**(1)**

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(b) The mass of the bin is 23 kg.

(i) What is the weight of the bin?

**(1)**

☒ **A** 23 kg

☒ **B** 230 kg

☒ **C** 230 N

☒ **D** 23 000 N

(ii) State the principle of moments.

**(1)**

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(iii) A person applies force F to the bin to keep it stationary.

Calculate the magnitude of force F.

**(4)**

magnitude of force F = ..... N

(iv) State the magnitude and direction of the force applied to the person by the bin.

**(2)**

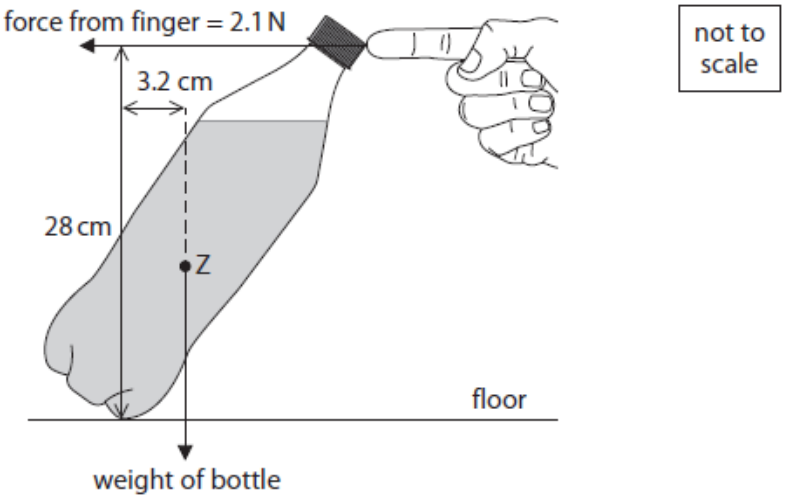
magnitude = ..... N

direction = .....

**(Total for question = 9 marks)**

Q10.

The diagram shows a bottle supported by a finger.




(a) State the name of point Z.

**(1)**

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(b) (i) State the formula linking moment, force and perpendicular distance from the pivot.

**(1)**

(ii) The bottle does not move.

Calculate the weight of the bottle.

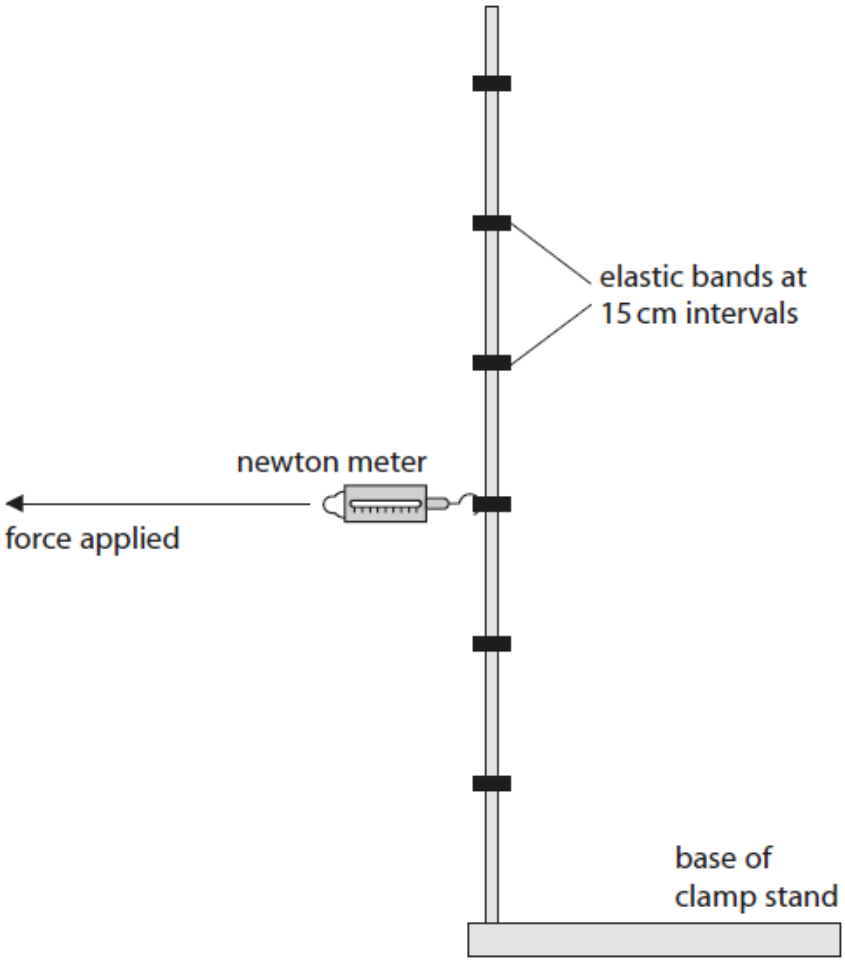
**(4)**

weight of bottle = ..... N

**(Total for question = 6 marks)**

Q11.

A student uses this apparatus to investigate moments.




This is the student's method.

- attach elastic bands at 15 cm intervals on a one metre tall clamp stand
- attach a newton meter to the highest elastic band and measure the horizontal force required to tilt the stand
- repeat the method at each 15 cm interval

(a) Name an instrument that the student should use to accurately measure the distances on the clamp stand.

**(1)**

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(b) The table shows the student's results.

| Distance in cm | Force applied in N |
|---|---|
| 15.0 | 10.0 |
| 30.0 | 5.6 |
| 45.0 | |
| 60.0 | 2.6 |
| 75.0 | 2.2 |
| 90.0 | 1.8 |

(i) The photograph shows the reading on the newton meter when the distance is 45.0 cm.




Use the photograph to determine the force required to tilt the stand when the distance is 45.0 cm.

**(1)**

force = ..... N

(ii) Give a reason why this newton meter is unsuitable for measuring the force for distances less than 15.0 cm.

**(1)**

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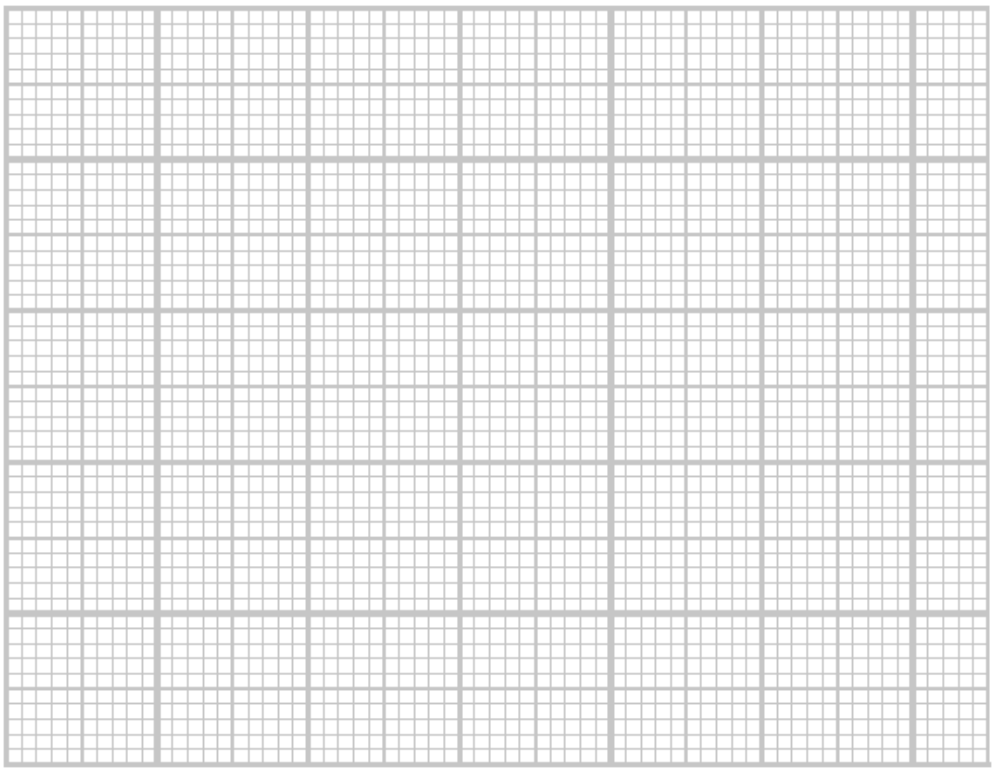
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(c) (i) Plot a graph of the student's results on the grid.

**(3)**

(ii) Draw the curve of best fit.

**(1)**



(d) The student concludes that the moment required to tilt the clamp stand does not change when the distance is varied.

Use data from the table or the graph to evaluate the student's conclusion.

**(4)**

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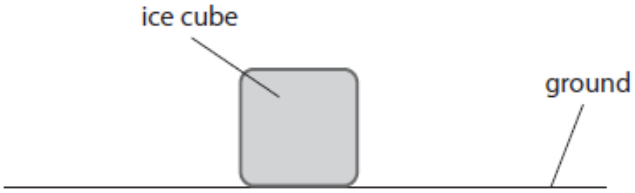
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**(Total for question = 11 marks)**

Q12.

This is a question about a melting ice cube.

(a) The diagram shows an ice cube placed on the ground.




(i) The mass of the ice cube is 3.7 g and its area of contact with the ground is $2.6 \times 10^{-4}$ $m^2$.

Calculate the pressure the ice cube exerts on the ground.

**(4)**

pressure = ..... Pa

(ii) The ice cube melts and becomes a puddle with a larger cross-sectional area.

Explain how the pressure of the ice cube on the ground changes when it melts.

**(2)**

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(b) Ice melts at a temperature of 0 °C.

On the axes, sketch how the temperature of the ice cube changes as it rises from a temperature of –10 °C to a temperature of 20 °C.

**(3)**



(c) Explain the changes that occur when a solid melts.

Refer to particles in your answer.

**(2)**

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**(Total for question = 11 marks)**

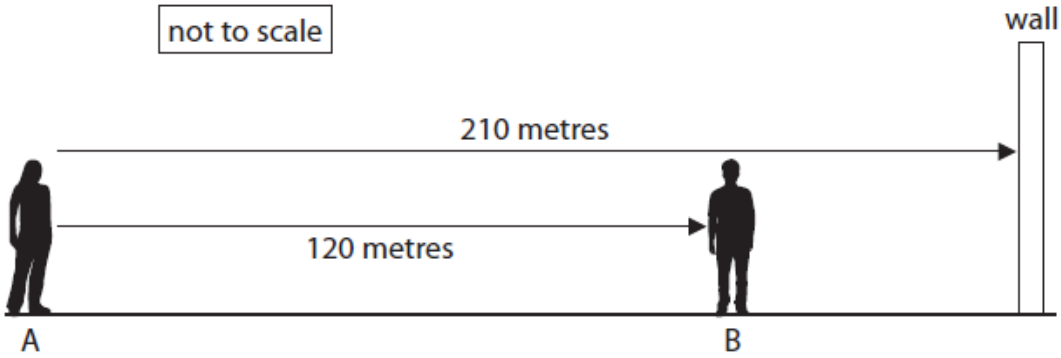
Q13.

Two students investigate the speed of sound.

Student A has a device that makes a loud sound.

Student B has a stopwatch.

A sound wave travels from student A to the wall and is reflected back to student B.




(a) Calculate the total distance the sound wave travels from student A to the wall and back to student B.

**(1)**

distance = ..... m

(b) Student B hears the sound before and after the sound wave reflects from the wall.

When student B hears the sound before reflection, he starts the stopwatch.

When student B hears the sound after reflection, he stops the stopwatch.

The students repeat this experiment five times.

The table shows the students' results.

| Time in s | | | | |
|---|---|---|---|---|
| 0.50 | 0.62 | 0.52 | 0.58 | 0.55 |

Calculate the mean (average) time.

Give your answer to 2 significant figures.

**(2)**

mean time = ..... s

(c) Calculate the speed of sound for this investigation.

**(4)**

speed = ..... m/s

(d) Suggest a reason why the students' results are not always the same.

**(1)**

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**(Total for question = 8 marks)**

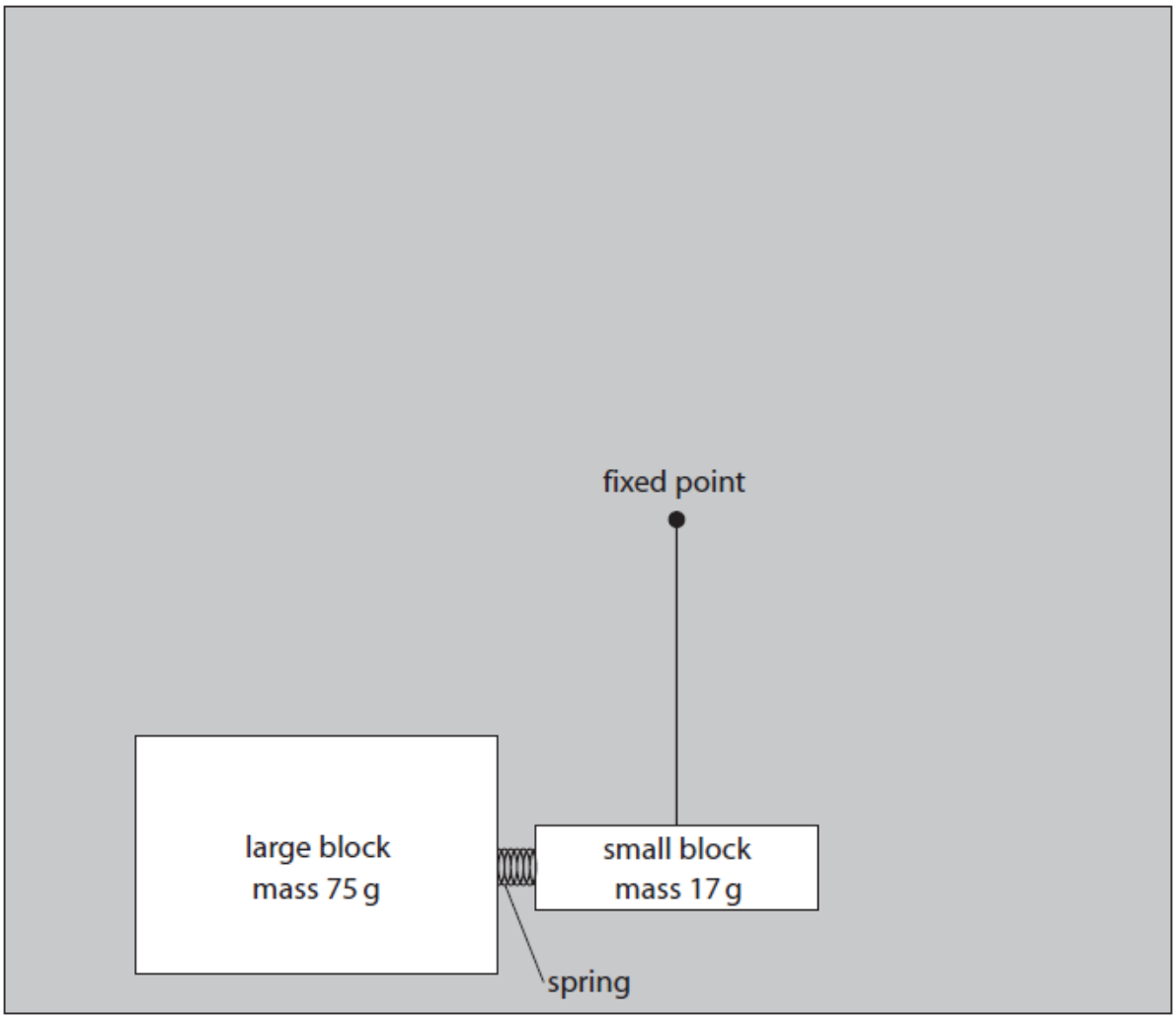
Q14.

The diagram shows two blocks at rest on a table, viewed from above.

A spring is attached to the large block.

The small block is attached by a piece of string to a fixed point on the table.

A student pushes the two blocks together so that the spring is compressed.




(a) The student releases the blocks.

The kinetic energy (KE) store of the small block is 0.29 J when the blocks are no longer in contact.

Show that the speed of the small block is about 6 m/s.

**(3)**

(b) Using ideas about momentum, show that the speed of the large block is about 1 m/s after the blocks are no longer
in contact.

**(4)**

(c) The small block takes 0.11 s to reach 6 m/s.

Calculate the mean force exerted on the small block by the spring.

**(3)**

mean force = ..... N

(d) The small block then moves around the fixed point on the table.

The block moves in a circular orbit of radius 17.6 cm at a constant orbital speed of 6 m/s.

The time period of the orbit can be found using the formula

$$\text{orbital speed} = \frac{2\pi \times \text{orbital radius}}{\text{time period}}$$

Calculate the time period of the orbit.

**(3)**

time period = ..... s

**(Total for question = 13 marks)**

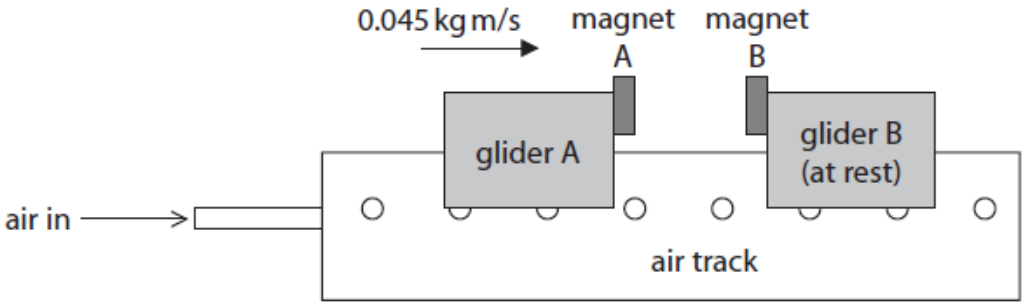
Q15.

The diagram shows an air track that can be used to investigate motion without friction.

Air comes out through a series of small holes in the air track, which lifts the gliders slightly above the track.

There are two gliders on the track.

Each glider has a magnet.




The poles of the magnets nearest each other are alike.

(a) Explain the direction of the force acting on magnet A from magnet B.

**(2)**

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(b) The gliders collide and the magnets cause them to rebound.

Before the collision, the momentum of glider A is 0.045 kg m/s to the right and glider B is at rest.

(i) State the total momentum of glider A and glider B after the collision.

**(1)**

total momentum = ..... kg m/s

(ii) After the collision, the momentum of glider A is 0.021 kg m/s to the left.

Calculate the momentum of glider B after the collision.

**(2)**

momentum of glider B = ..... kg m/s

(iii) The time taken for glider B to change its momentum is 0.19 seconds.

Calculate the average force on glider B that causes this change in momentum.

**(2)**

average force = ..... N

(iv) Give the direction of the force on glider B from glider A.

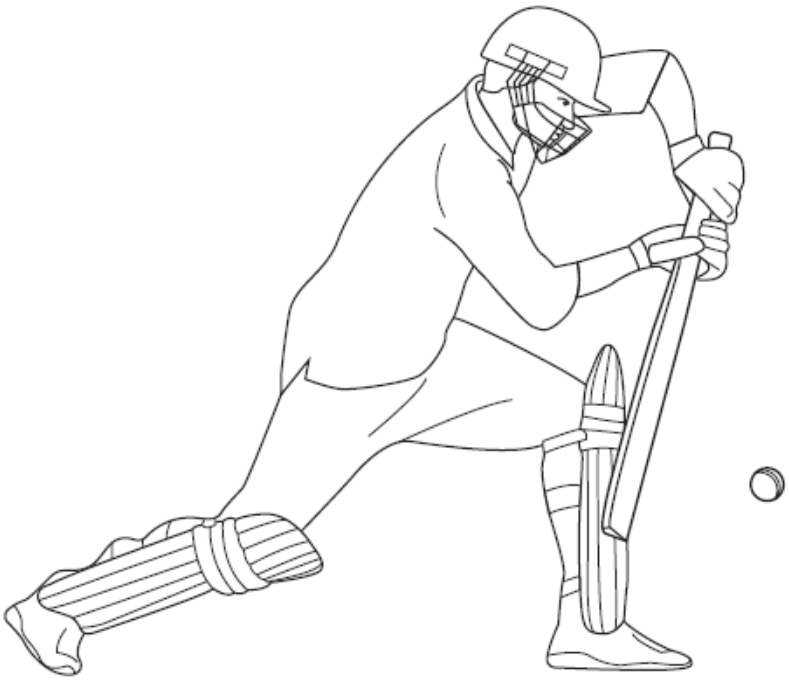
**(1)**

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**(Total for question = 8 marks)**

Q16.

Cricket is a sport played with bats and balls.



(a) (i) A cricket player hits a ball with a bat. Before the ball is hit, it is moving to the **left** with a momentum of 4.2 kg m/s.

The bat is in contact with the ball for 0.012 s.

After the ball is hit, it moves to the **right** with a momentum of 6.7 kg m/s.

Calculate the mean force the bat exerts on the ball and state the direction of the force.

**(3)**

mean force = ..... N

direction = .....

(ii) State the magnitude and direction of the mean force the **ball** exerts on the **bat**.

**(1)**

magnitude of mean force = ..... N

direction of force .....

(b) The cricket player wears padded protective equipment.

This protective equipment reduces the risk of injury to the player if they are struck by the cricket ball.

Explain how this protective equipment reduces the risk of injury to the player.

Use ideas about momentum in your answer.

**(3)**

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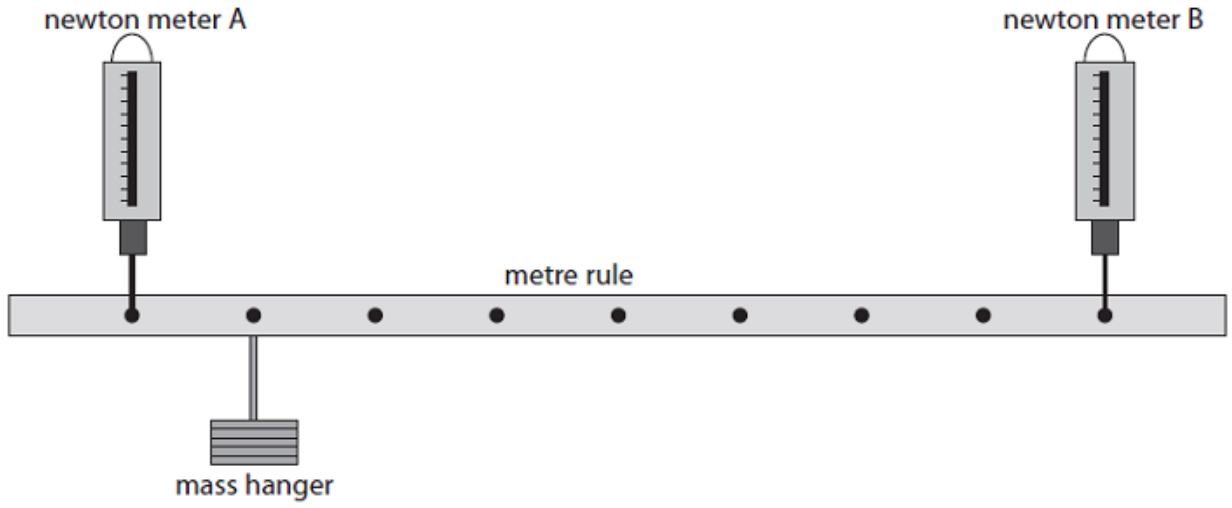
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**(Total for question = 7 marks)**

Q17.

A student investigates how the support forces acting on a metre rule are affected by the position of a mass hanger.

He uses this apparatus.




This is the student's method.

- suspend a metre rule from its 10 cm and 90 cm marks using two newton meters
- place a mass hanger with a weight of 5 N at the 20 cm mark on the metre rule
- adjust the heights of the newton meters until the metre rule is horizontal
- record the readings on both newton meters

The student repeats the method, moving the mass hanger to a different position on the metre rule each time.

(a) (i) State the independent variable in the student's investigation.

**(1)**

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(ii) State two control variables in the student's investigation.

**(2)**

1 .....

2 .....

(iii) Suggest how the student could improve the quality of his data.

**(1)**

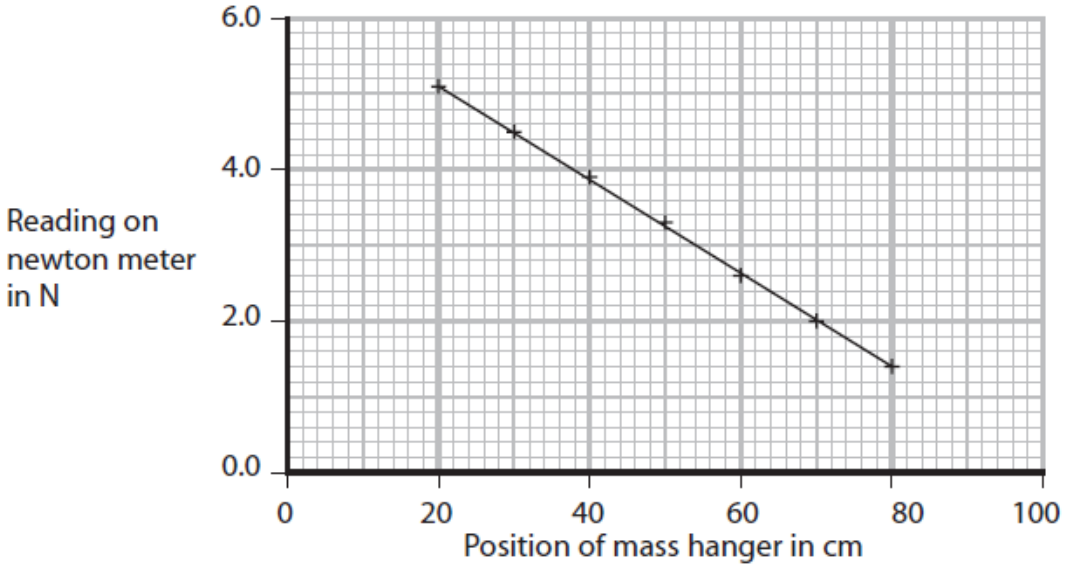
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(b) The table shows the student's results.

| Position of mass hanger in cm | Reading on newton meter A in N | Reading on newton meter B in N |
|---|---|---|
| 20 | 5.1 | 1.4 |
| 30 | 4.5 | 2.0 |
| 40 | 3.9 | 2.6 |
| 50 | 3.3 | 3.3 |
| 60 | 2.6 | 3.9 |
| 70 | 2.0 | 4.5 |
| 80 | 1.4 | 5.1 |

The graph shows the results for newton meter A.




(i) Plot the results for newton meter B.

**(1)**

(ii) Draw the line of best fit for newton meter B.

**(1)**

(iii) Describe the relationships shown by the graph.

**(4)**

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(c) Using ideas about moments, explain why the reading on newton meter A decreases as the mass hanger is moved towards newton meter B.

**(3)**

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**(Total for question = 13 marks)**

Q18.

This question is about momentum.

(a) Which of these is the correct unit for momentum?

**(1)**

☒ **A** kg / m / s

☒ **B** $kg^2$ m / s

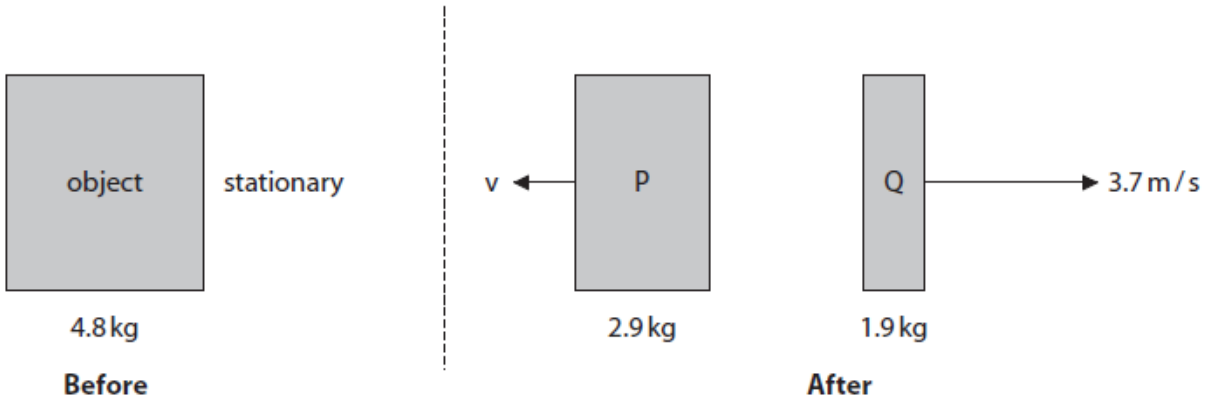
☒ **C** kg m / $s^2$

☒ **D** kg m / s

(b) 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)**

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

**(3)**

velocity = ..... m / 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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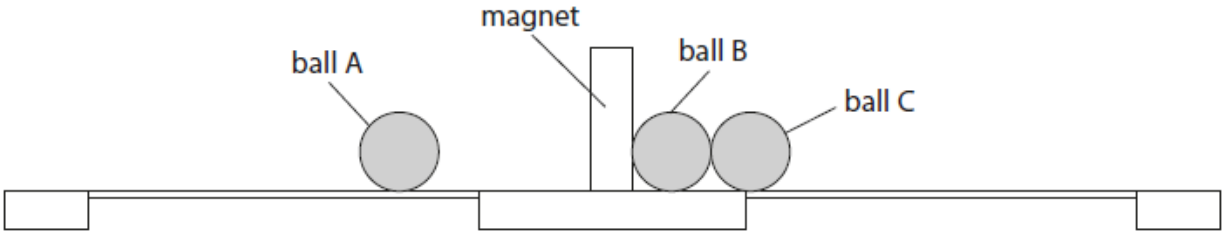
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**(Total for question = 8 marks)**

Q19.

The diagram shows a child's toy for accelerating steel balls.



This is how the toy works.

- the toy uses three identical steel balls, each with a mass of 4.1 g
- ball A moves towards the magnet
- ball B is in contact with the magnet
- balls B and C are initially at rest and are in contact with each other
- when ball A collides with the magnet, ball C moves away from the magnet

(a) Ball A moves towards the magnet with an initial velocity of 0.15 m/s.

Calculate the initial momentum of ball A.

**(2)**

initial momentum = ..... kg m/s

(b) Ball A is attracted to the magnet.

Explain how this attraction affects the momentum of ball A as it approaches the magnet.

**(2)**

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(c) When ball A collides with the magnet, a force of 1.3 N is exerted on ball C for a time of 0.0025 s.

This causes ball C to move away from the magnet.

Calculate the change in velocity of ball C due to this force.

**(3)**

change in velocity = ..... m/s

**(Total for question = 7 marks)**

Q20.

Curling is a sport played on ice.

A player slides stone A across the ice towards a scoring zone.

The ice reduces friction so that there is negligible friction when the stone is sliding.




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(a) Stone A leaves the player's hand with a velocity of 2.90 m/s.

The mass of stone A is 17 kg.

(i) State the formula linking momentum, mass and velocity.

**(1)**

(ii) Show that the momentum of stone A is approximately 50 kg m/s.

**(2)**

(b) Stone A slides towards the scoring zone.

In the scoring zone, stone A collides with a stationary stone, B.



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(i) After the collision, both stones move in the same direction as the initial direction of stone A.

The velocity of stone A after the collision is 0.40 m/s.

Calculate the velocity of stone B after the collision.

[mass of stone B = 19 kg]

**(4)**

velocity of stone B = ..... m/s

(ii) When the stones collided, they were in contact for a time of 25 ms.

Calculate the magnitude of the force stone A exerted on stone B in this collision.

**(3)**

force = ..... N

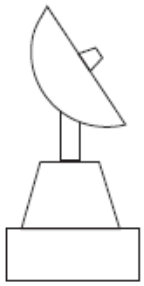
**(Total for question = 10 marks)**

Q21.

This question is about using radio waves to track an aeroplane.



aeroplane



aerial at airport

(a) Radio waves are emitted from an aerial at an airport, and are then reflected back to the aerial from an aeroplane.

The time taken between emitting the radio waves and receiving the waves back at the aerial is 1.9 milliseconds.

Show that the aeroplane is approximately 300 km away from the aerial.

[speed of radio waves = $3.0 \times 10^5$ km/s]

**(3)**

(b) As the aeroplane travels away from the airport, it sends a signal to the airport using radio waves with a wavelength of 1.2 m.

When the signal is received at the airport, the wavelength is $1.1 \times 10^{-6}$ m longer than when it is

emitted by the aeroplane.

Calculate the speed of the aeroplane using the formula

$$\frac{\text{change of wavelength}}{\text{wavelength}} = \frac{\text{speed of aeroplane}}{\text{speed of radio wave}}$$

[speed of radio waves = $3.0 \times 10^8$ m/s]

**(3)**

speed of aeroplane = ..... m/s

**(Total for question = 6 marks)**

Q22.

Diagram 1 shows a gate fitted with a spring mechanism.

The spring mechanism shuts the gate automatically.

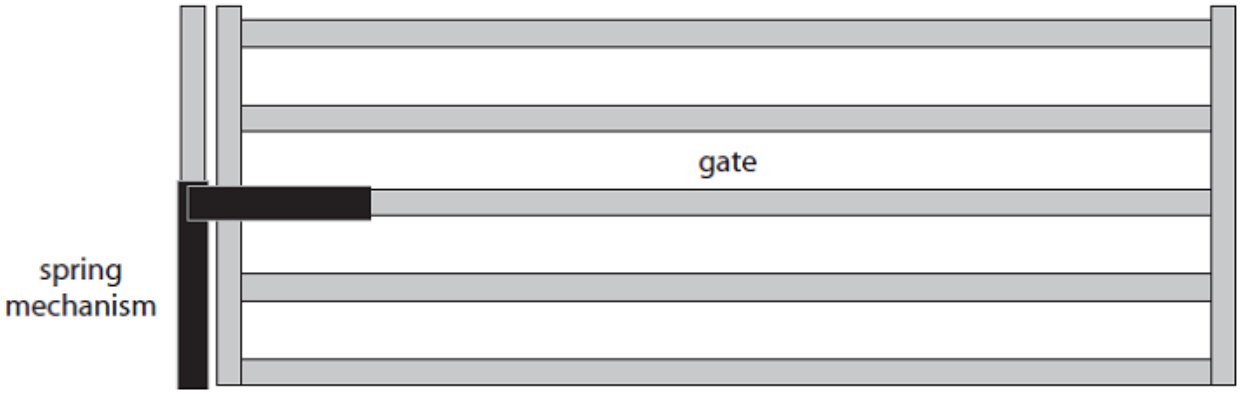
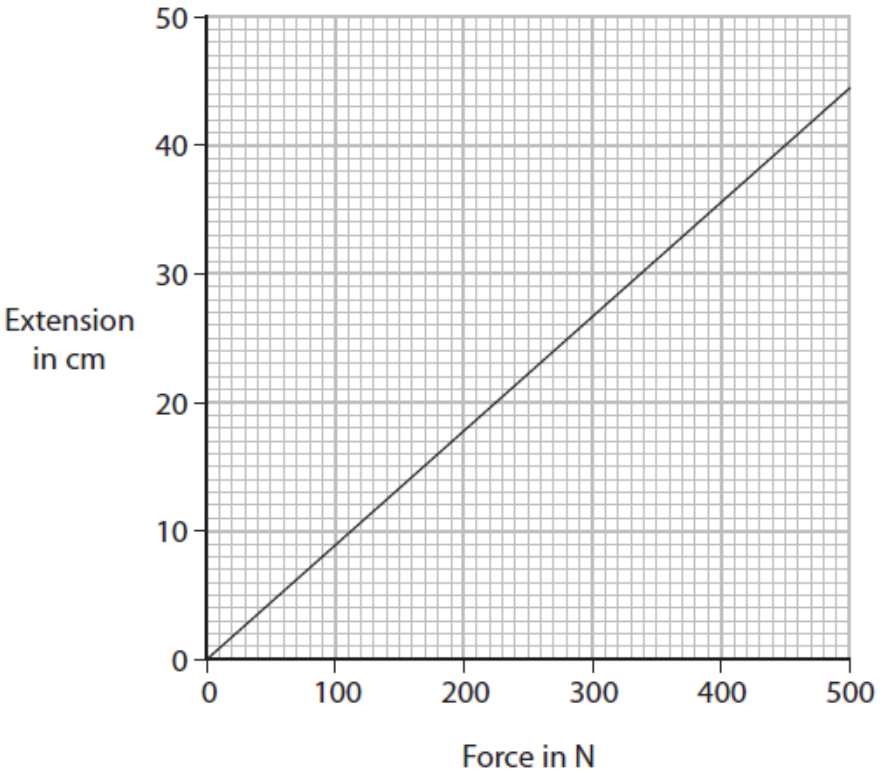



**Diagram 1**

(a) The graph shows some data from an investigation into how the extension of the spring changes with an increasing force.




Describe the relationship shown by the graph.

**(2)**

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(b) Diagram 2 shows the gate viewed from above.

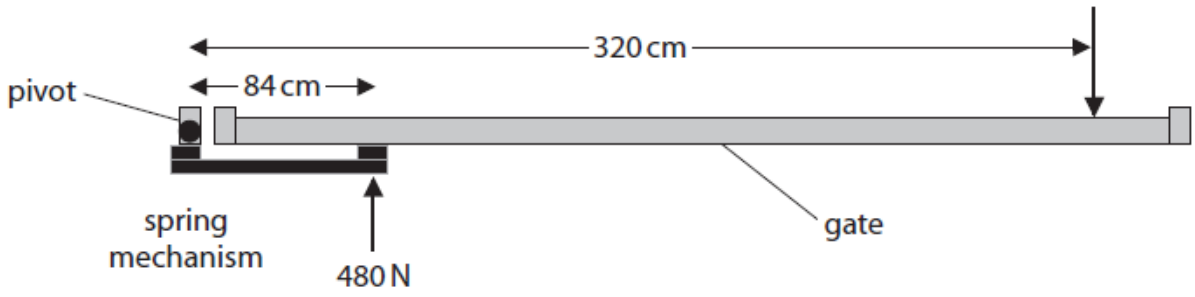



**Diagram 2**

The force the spring exerts on the gate is 480 N.

Show that the moment of the force the spring exerts on the gate is about 400 Nm.

**(2)**

(c) The force, F, is the minimum force needed to start opening the gate.

Calculate the magnitude of force F.

**(4)**

force F = ..... N

(d) The spring is removed for testing.

Explain what will happen to the spring if the force applied to extend the spring is too large.

**(2)**

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**(Total for question = 10 marks)**