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EDEXCEL GCSE PHYSICS: QUESTIONS BY TOPIC

Forces and Their Effects (9)

GCSE Physics (Higher) Topic 9

16 questions · 160 marks · Mark schemes included

Pearson Edexcel GCSE (9-1) Physics 1PH0, Higher Tier, June 2018 - June 2025

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HOW TO USE THIS BOOKLET

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any row below to jump straight to that question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

16 questions · 160 marks · lowest tariff first



6-MARK QUESTIONS

1 question in this booklet



- 1 (a) Figure 1 shows some forces acting on a seesaw.

The forces shown have the same magnitude but act in different directions.

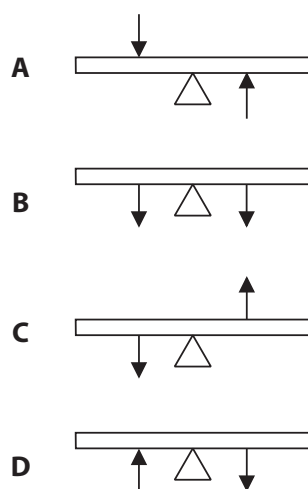


Figure 1

In which of these could the forces acting on a seesaw be in equilibrium?

(1)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(b) Figure 2 shows an open door.

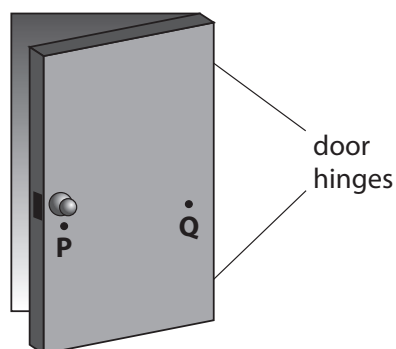


Figure 2

Explain why it is easier to close the door by pushing at point **P** rather than pushing at point **Q**.

(2)

(c) Figure 3 is a diagram of the forces acting on a swing.

The swing is not moving.

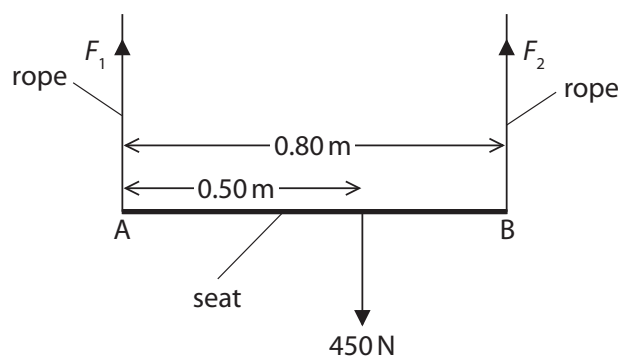


Figure 3

The seat of the swing, AB, is 0.80 m long.

A person of weight 450 N sits on the seat.

The person's weight acts at a distance of 0.50 m from A as shown in Figure 3.

Ignore the weight of the seat.

The upward forces exerted by the ropes on the seat are F_1 and F_2 .

Calculate the force F_2 by taking moments about A.

(3)

force F_2 = ... N

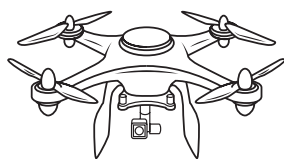
(Total for Question 1 = 6 marks)

7-MARK QUESTIONS

2 questions in this booklet



3 (a) Figure 7 shows a drone.



© Liubov Kotliar/123RF

Figure 7

The drone has four spinning blades.

The upward force produced enables the drone to rise in the air.

The speed at which the blades spin is measured in turns per minute.

Figure 8 shows how the upward force produced by the four blades depends on the speed at which the blades spin.

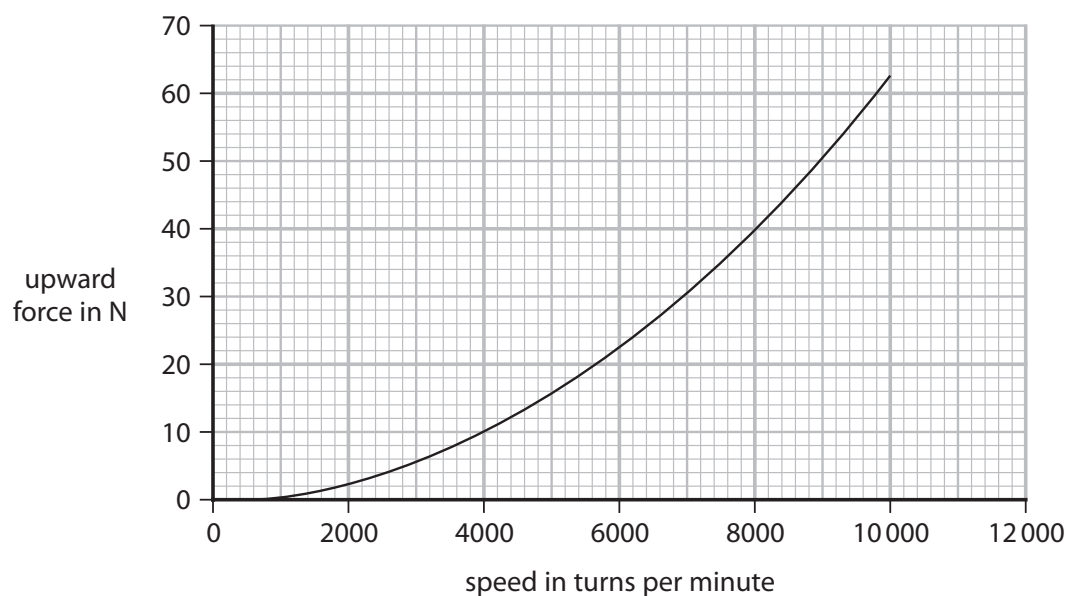


Figure 8

Describe the relationship between upward force and speed shown by this graph.

(2)

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.....

(b) A different drone has a mass of 4.5 kg.

This drone rises from the ground to a height of 20 m.

- (i) Calculate the change in gravitational potential energy when the drone rises through a height of 20 m.

The gravitational field strength $g = 10 \text{ N/kg}$.

(2)

change in gravitational potential energy = ... J

- (ii) State the amount of useful work done by the blades as the drone rises through 20 m.

(1)

useful work done = ... J

- (iii) It takes 4 s for the drone to rise through 20 m.

Calculate the useful power developed by the blades in this time of 4 s.

(2)

useful power developed = ... W

(Total for Question 3 = 7 marks)



- 1 Figure 1 shows a pool full of water.



(Source: © AnaKulagina/Shutterstock)

Figure 1

- (a) (i) The pressure on the ground due to the water in the pool is 3500 Pa.

The density of water is 10^3 kg/m^3 .

The gravitational field strength, g , = 10 N/kg.

Calculate the depth of the water in the pool.

(2)

depth = ... m

- (ii) Figure 2 shows part of the side and base of the pool.

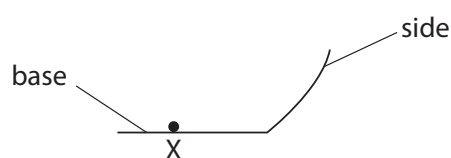


Figure 2

The water in the pool causes a force on the base of the pool.

Draw an arrow on Figure 2 to show the direction of this force at point X.

(1)

- (b) A smaller pool has the same depth of water but has only half the area in contact with the ground.

The pressure on the ground underneath the smaller pool is

(1)

- ☐ **A** twice the pressure underneath the larger pool
- ☐ **B** ten times the pressure underneath the larger pool
- ☐ **C** half the pressure underneath the larger pool
- ☐ **D** the same as the pressure underneath the larger pool

- (c) A small hole is made in the base of the large pool shown in Figure 1.

The area of the hole is 1.5 mm^2 . The pressure at the base of the pool due to the water is 3500 Pa .

Calculate the force on the ground directly below the hole due to the water in the pool.

Use the equation

$$P = \frac{F}{A}$$

(2)

force = ... N

- (d) A bigger hole is made in the base of the same pool.

Compare the force on the ground directly below the bigger hole with the force on the ground directly below the original hole.

(1)

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(Total for Question 1 = 7 marks)



10-MARK QUESTIONS

5 questions in this booklet



- 6 (a) Figure 10 shows an arrangement of gears.
- Each gear turns around a fixed axle.

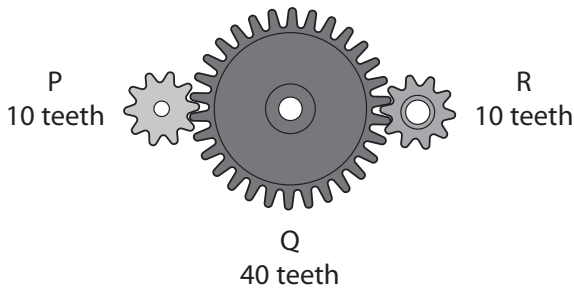


Figure 10

Gear P is turned through one complete revolution per second.

- (i) Which of the following describes the motion of gear R?

(1)

	speed (revolutions per second)	direction of rotation
☐ A	4	same as P
☐ B	1	same as P
☐ C	4	opposite to P
☐ D	1	opposite to P

(ii) Figure 11 shows the same arrangement with gear R replaced by a rack.

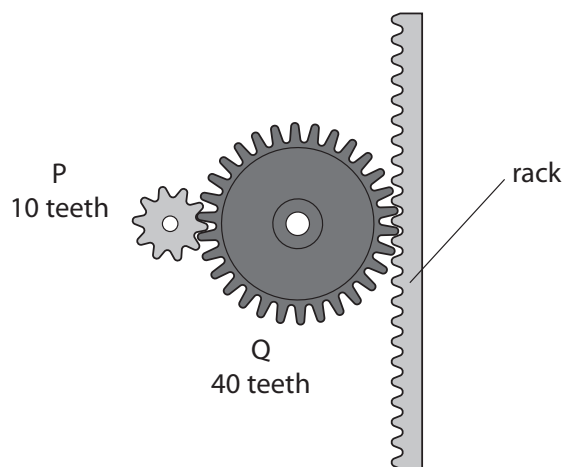


Figure 11

The rack can move up or down when the gears turn.

The teeth on the rack are 2 mm apart.

Calculate how far the rack moves when P turns through to one complete revolution.

(2)

distance = ... mm

(b) Figure 12 shows three toy animals hanging from a rod.

The rod hangs from the ceiling by a string tied to the centre of the rod.

The system is in equilibrium.

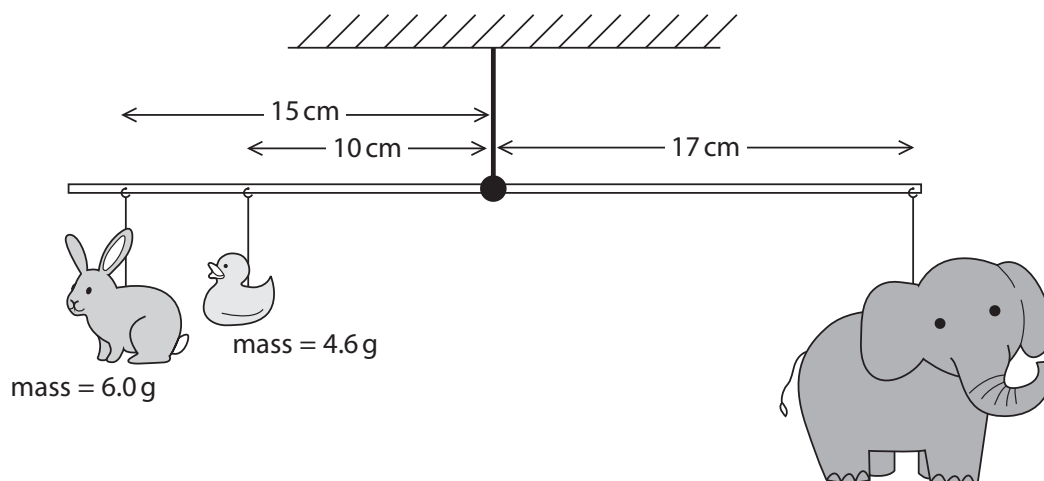


Figure 12

Use the principle of moments to calculate the mass of the toy elephant.

(4)

mass = ... g

(c) Figure 13 shows a diagram of a device for lifting heavy loads.

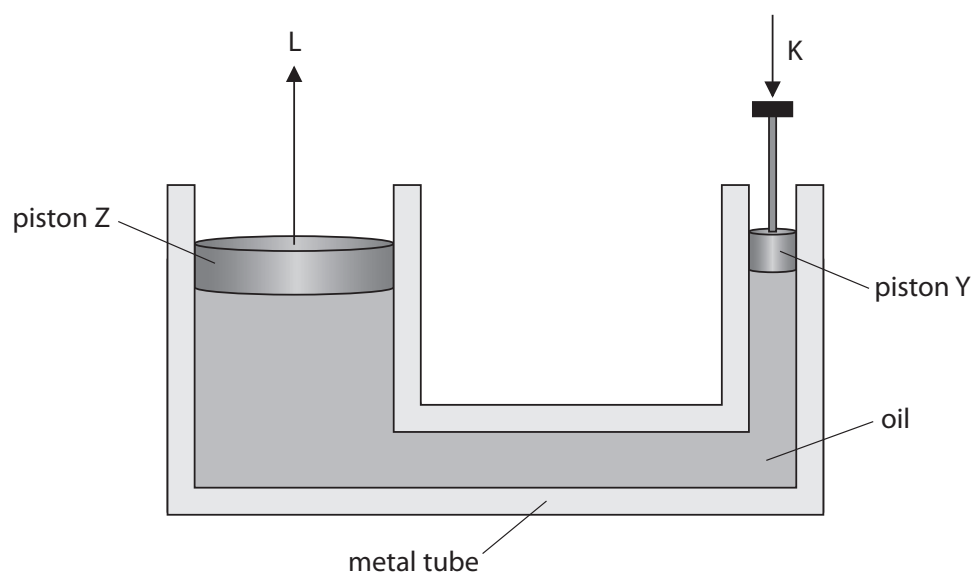


Figure 13

The metal tube is filled with oil.

The piston Y is pushed down with a force K.

This produces a force L on piston Z.

The pressure exerted on the oil by piston Y is the same as the pressure exerted by the oil on piston Z.

Explain the difference between the size of force K and the size of force L.

(3)

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(Total for Question 6 = 10 marks)

6 A student investigates moments of forces.

Figure 14 shows the apparatus used.

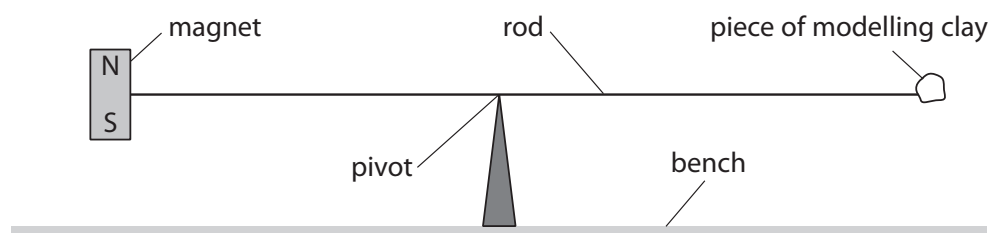


Figure 14

The pivot is under the centre of the rod.

A magnet is fixed to one end of the rod.

A piece of modelling clay is fixed to the other end of the rod.

The system is in equilibrium.

- (a) State the relationship between the moment of the weight of the magnet and the moment of the weight of the piece of modelling clay about the pivot.

(1)

(b) The student fixes a coil to the bench under the magnet as shown in Figure 15.

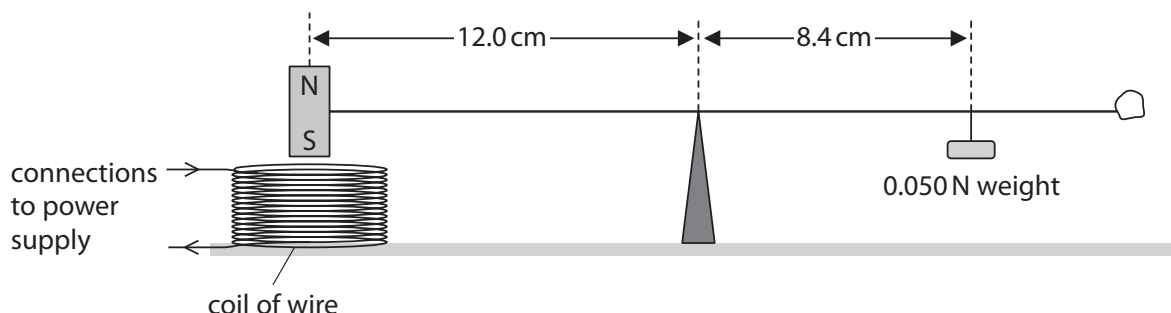


Figure 15

The coil of wire is connected to a d.c. power supply so that there is a current in the coil.

To bring the system back into equilibrium, the student hangs a 0.050 N weight on the rod, 8.4 cm away from the pivot, as shown in Figure 15.

Calculate the size of the force between the magnet and the coil.

(3)

force = ... N

(c) Describe how the student could develop the investigation to determine if the size of the force between the magnet and the coil is directly proportional to the size of the current in the coil.

(4)

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- (d) The student reverses the direction of the current in the coil.
Describe how the student can bring the system back into equilibrium without making any changes to the magnet.

(2)

(Total for Question 6 = 10 marks)



6 (a) Which of these is a vector quantity?

(1)

- ☐ A acceleration
- ☐ B speed
- ☐ C time
- ☐ D distance

(b) Figure 13 shows a toy that a student makes for a nursery school.

The rod hangs by a string from the ceiling.

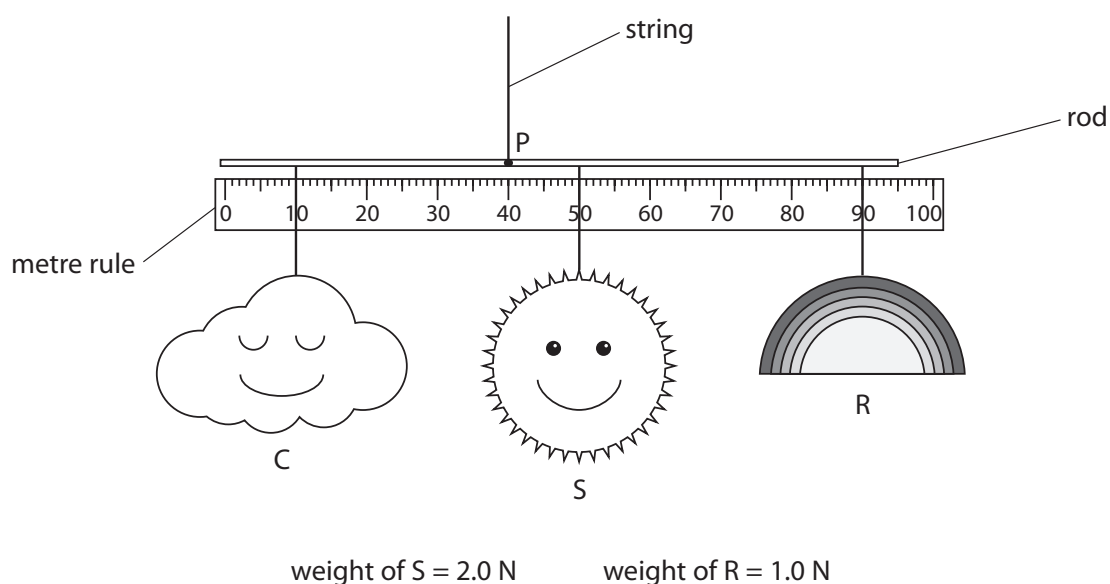


Figure 13

(i) The moment of C about point P is 0.60 Nm.

Calculate the weight of C.

Use the equation

$$\text{moment} = F \times d$$

(2)

weight of C N

(ii) Show that the total moment of S and R about P is 0.70 N m .

(2)

(iii) Using the data in the question and the principle of moments, determine if the toy shown in Figure 13 is in equilibrium.

The rod is very light so its weight can be ignored.

(3)

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(c) Figure 14 show a rack and pinion system, used on a mountain railway.

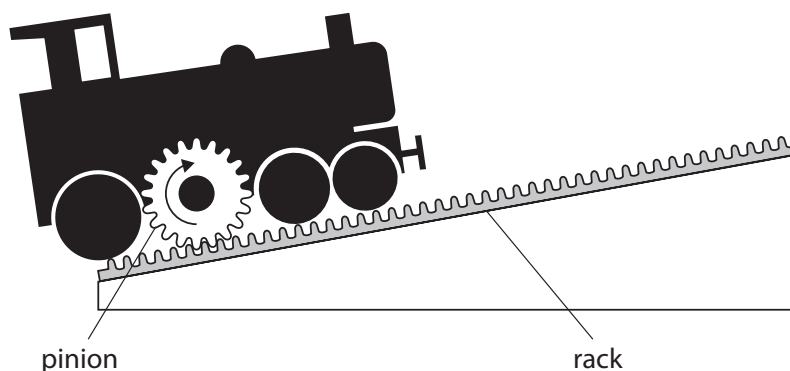


Figure 14

The teeth on the rack are 8.0 cm apart.

Calculate how far along the rack the train moves when the pinion turns through one complete revolution.

(2)

distance = ... m

(Total for Question 6 = 10 marks)

6 (a) Figure 11 shows a person doing a push-up exercise.



Figure 11

An upward force is used to cause rotation about a pivot.

Which row of the table is correct for this rotation?

(1)

	provide the upward force	act as a pivot
☒ A	arms	hands
☒ B	arms	feet
☒ C	legs	hands
☒ D	legs	feet

(b) Figure 12 shows some of the bones and muscles in an arm.

The arrows show the forces on the forearm when the arm is bent.

The hand is empty.

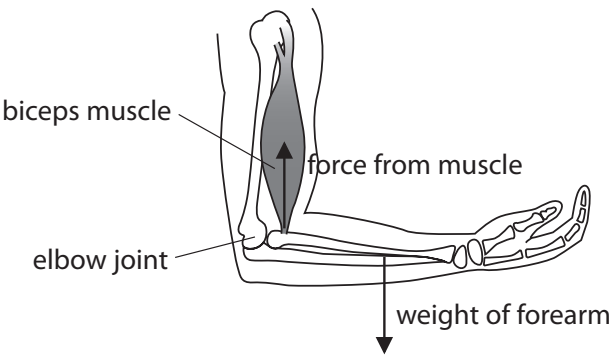


Figure 12

The biceps muscle provides a force to balance the weight of the forearm.

The weight of the forearm can be represented as a single force.

Figure 13 shows a diagram representing the forces and distances involved.

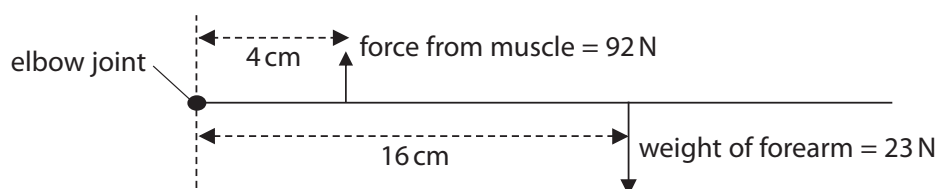


Figure 13

- (i) Use the principle of moments to show that the system shown in Figure 13 is in equilibrium.

(2)

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- (ii) The person then holds a ball weighing 15 N in their hand.

Figure 14 shows the forces on the forearm and their distances from the elbow joint.

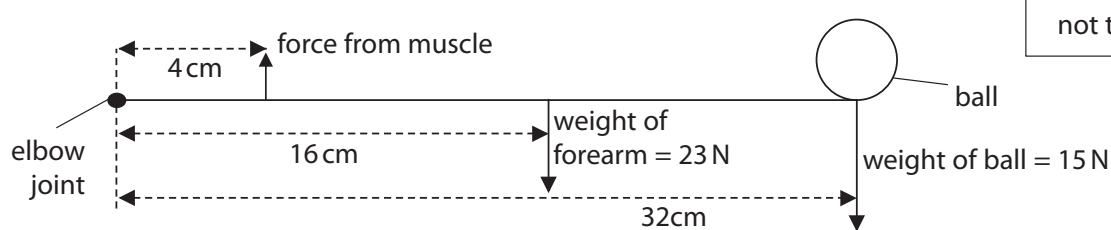


Figure 14

Calculate the force from the muscle that is needed to keep the system in Figure 14 in equilibrium.

(3)

force = ... N

- (c) Figure 15 shows a ball floating in seawater and the same ball floating in fresh water.

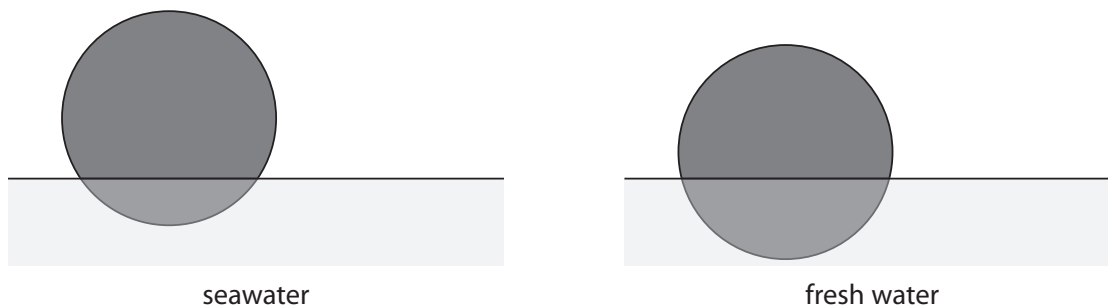


Figure 15

- (i) Compare the upthrust on the ball in seawater with the upthrust on the same ball in fresh water.

(1)

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- (ii) Explain why there is less of the ball below the surface of the seawater than below the surface of the fresh water.

(3)

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.....

(Total for Question 6 = 10 marks)

6 (a) Which of these is a unit for the moment of a force?

(1)

- ☐ A N/m^2
- ☐ B N/m
- ☐ C N m
- ☐ D N m^2

(b) Figure 15 shows a claw hammer about to remove a nail from a piece of wood.

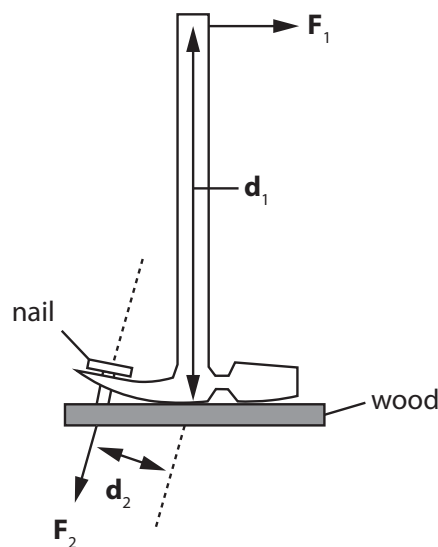


Figure 15

(i) State the principle of moments.

(2)

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(ii) Calculate the force F_2 shown in Figure 15.

Use the following data

- $F_1 = 11.4 \text{ N}$
- $d_1 = 24.5 \text{ cm}$
- $d_2 = 3.7 \text{ cm}$

(3)

$F_2 = \dots\dots\dots \text{ N}$

(c) Figure 16 shows a system of gears used in a clock.

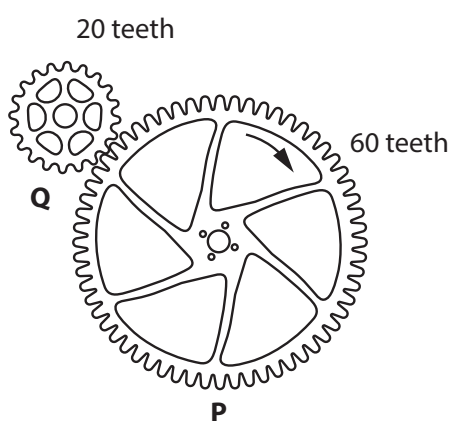


Figure 16

(i) Gear wheel **P** rotates clockwise at a rate of 1.0 revolution per **minute**.

Calculate the rotation rate of gear wheel **Q** in revolutions per **hour**.

(2)

rotation rate of **Q** = $\dots\dots\dots$ revolutions per hour

- (ii) Describe how a gear wheel could be added to the system to give a clockwise rotation with **double** the rotation rate of gear wheel **Q**.

Your answer should refer to

- the position of the gear wheel
- the number of teeth in the gear wheel.

(2)

(Total for Question 6 = 10 marks)



11-MARK QUESTIONS

6 questions in this booklet



- 7 (a) (i) Figure 14 shows the vertical forces on an aeroplane.

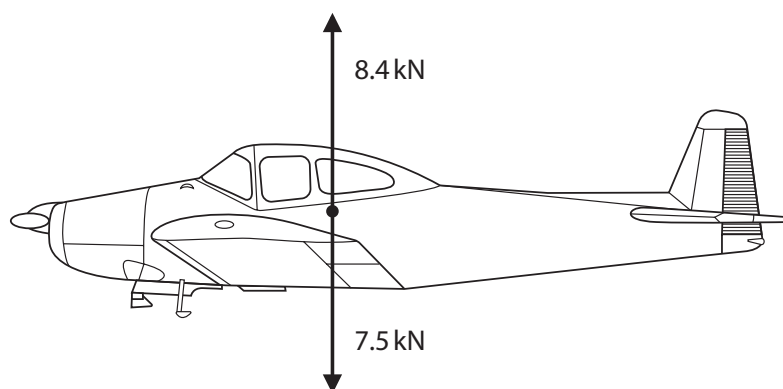


Figure 14

Use information from the diagram to determine the size and direction of the resultant vertical force on the aeroplane.

(2)

size = ... kN, direction is

- (ii) The aeroplane is descending.

Figure 15 shows a diagram of the resultant vertical and horizontal forces on the aeroplane as it is descending.

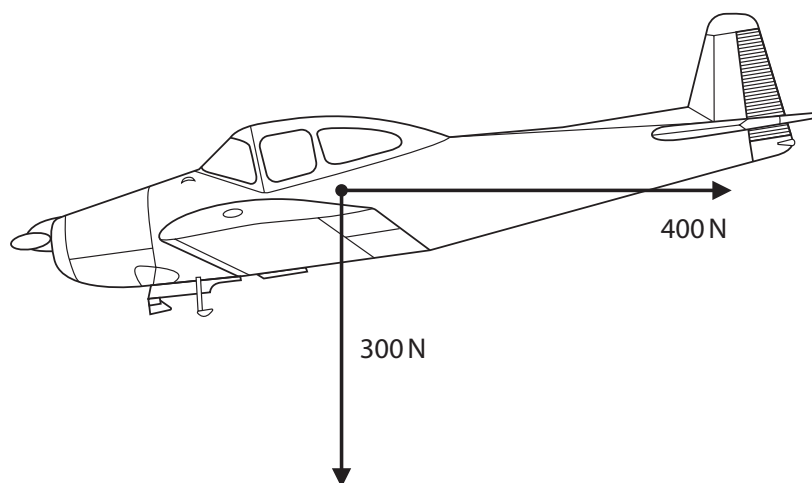


Figure 15

Complete the diagram to show the resultant of these two forces.

(1)

(iii) The mass of the aeroplane is 750 kg.

Calculate the change in gravitational potential energy of the aeroplane as it descends from 1300 m to the ground.

Gravitational field strength (g) = 10 N/kg

(2)

energy = ... J



(b) The aeroplane is powered by an engine that burns fuel.

The fuel supplies a total of 6500 kJ of energy every minute.

The efficiency of the engine is 0.70 (70%).

(i) Calculate the power output of the engine.

Give your answer in kW.

(4)

power = ... kW

(ii) Explain why the efficiency of the engine is less than 1 (100%).

(2)

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(Total for Question 7 = 11 marks)



- 9 (a) The magnitude and direction of a force can be represented by a vector.
Figure 22 shows the forces acting on four identical trolleys. The arrows show the magnitude and direction of the forces.

Which diagram shows a pair of forces that will produce zero acceleration?

(1)

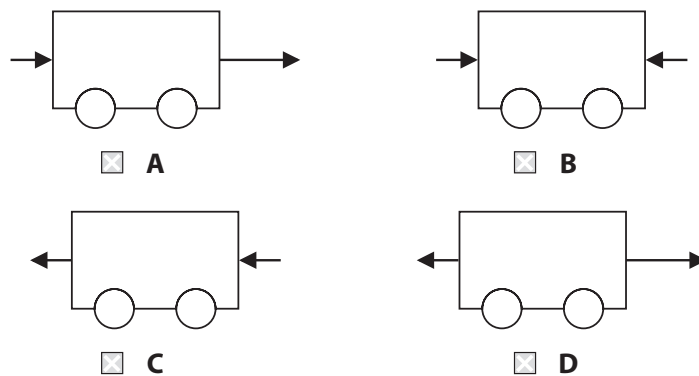


Figure 22

(b) Figure 23 shows two small boats pulling a much larger ship.

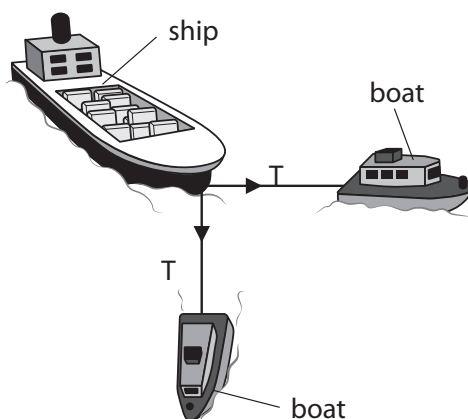


Figure 23

The ship is connected to the boats with ropes.

The tension, T , in each of the ropes has a magnitude of 20 kN.

The ropes are at right angles to each other.

Draw a vector diagram and use it to determine the resultant force that the boats exert on the ship.

(4)

magnitude of resultant force on the ship = ... kN

- 4 (a) Figure 8 shows some water in a tank.



Figure 8

- (i) The bottom of the tank has an area of 0.80 m^2 .

The force on the bottom of the tank, due to the water, is 2400 N .

Calculate the pressure, due to the water, on the bottom of the tank.

(3)

pressure = ... Pa

- (ii) More water is added to the tank.

Explain how the pressure on the bottom of the tank changes when more water is added to the tank.

(2)

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(iii) Figure 9 shows an object on the bottom of the tank of water.

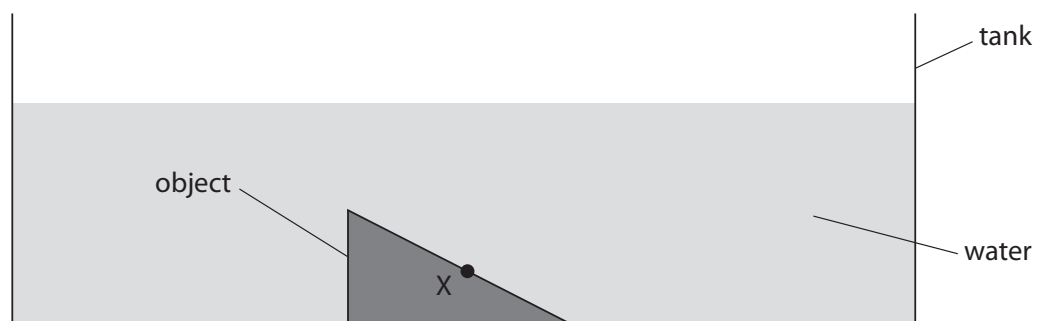


Figure 9

Draw an arrow on Figure 9 to show the direction of the force exerted by the water on the surface of the object at point X.

(1)

- (b) Figure 10 is a graph showing how the atmospheric pressure changes with the height above sea level on the Earth's surface.

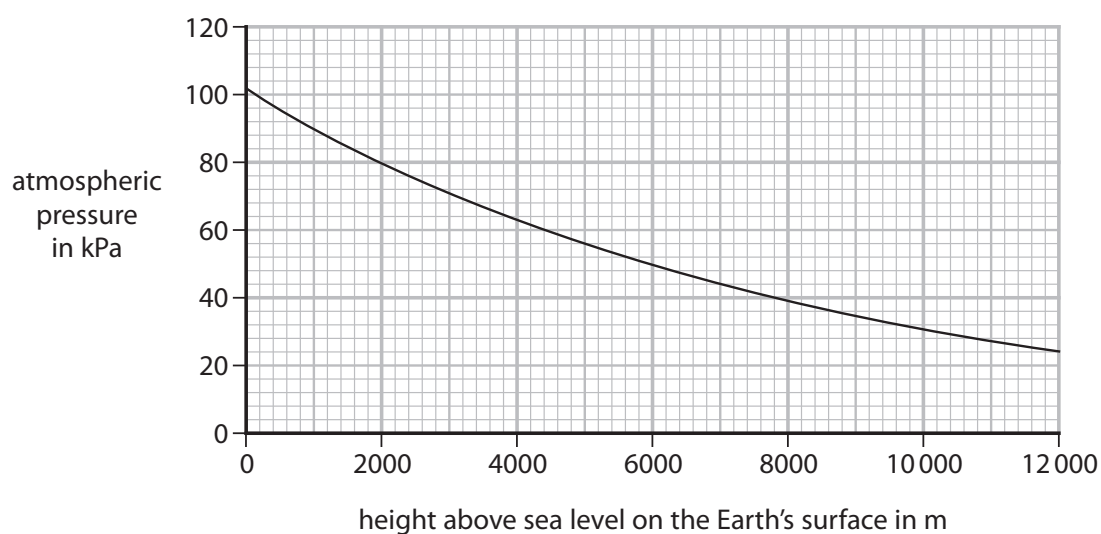


Figure 10

- (i) An aeroplane descends from 6000 m to 2000 m.

Use the graph to find the change in atmospheric pressure as the aeroplane descends.

(2)

change in pressure = ... kPa

- (ii) Suggest **one** reason why the atmospheric pressure is greater at 2000 m than at 6000 m.

(1)

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.....

(c) Figure 11 shows two drawings of the same person on a bed.

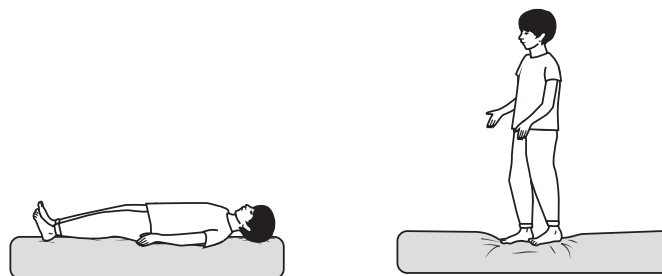


Figure 11

Explain why the person exerts a different pressure on the bed when standing up than when lying down.

(2)

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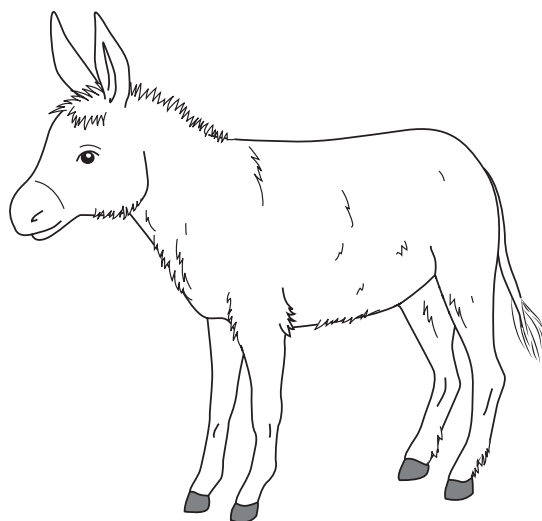
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(Total for Question 4 = 11 marks)

4 (a)

**Figure 6**

A donkey has a weight of 2500 N.

The area of each hoof is 0.022 m².

- (i) Calculate the average pressure that the donkey exerts on the ground.

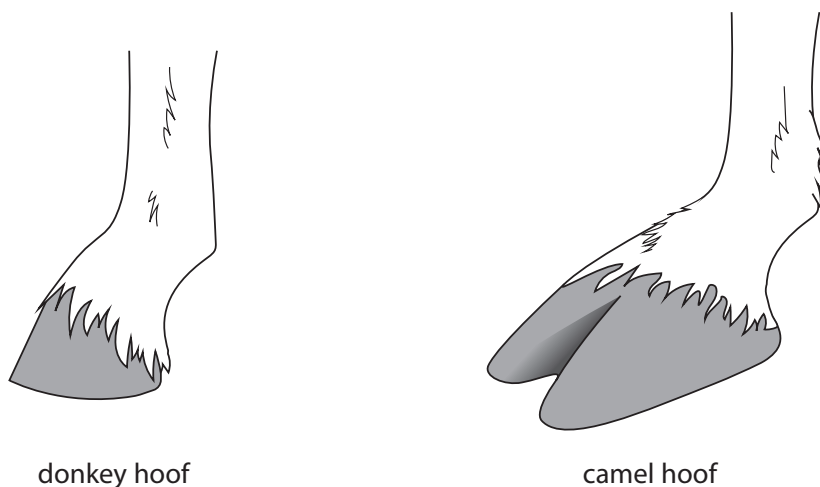
Use the equation

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

(2)

average pressure = ... Pa

- (ii) Figure 7 shows how the shape of a camel's hoof is different from the shape of a donkey's hoof.



Both diagrams are drawn to the same scale.

Figure 7

The camel and the donkey have the same mass.

Explain how a camel's hoof is a more suitable shape than a donkey's hoof for walking on soft ground.

(2)

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- (b) A student carries out an investigation to show how pressure varies with depth in water.

A pressure sensor is attached to a rule.

The rule and pressure sensor are lowered into the water in a tank, as shown in Figure 8.

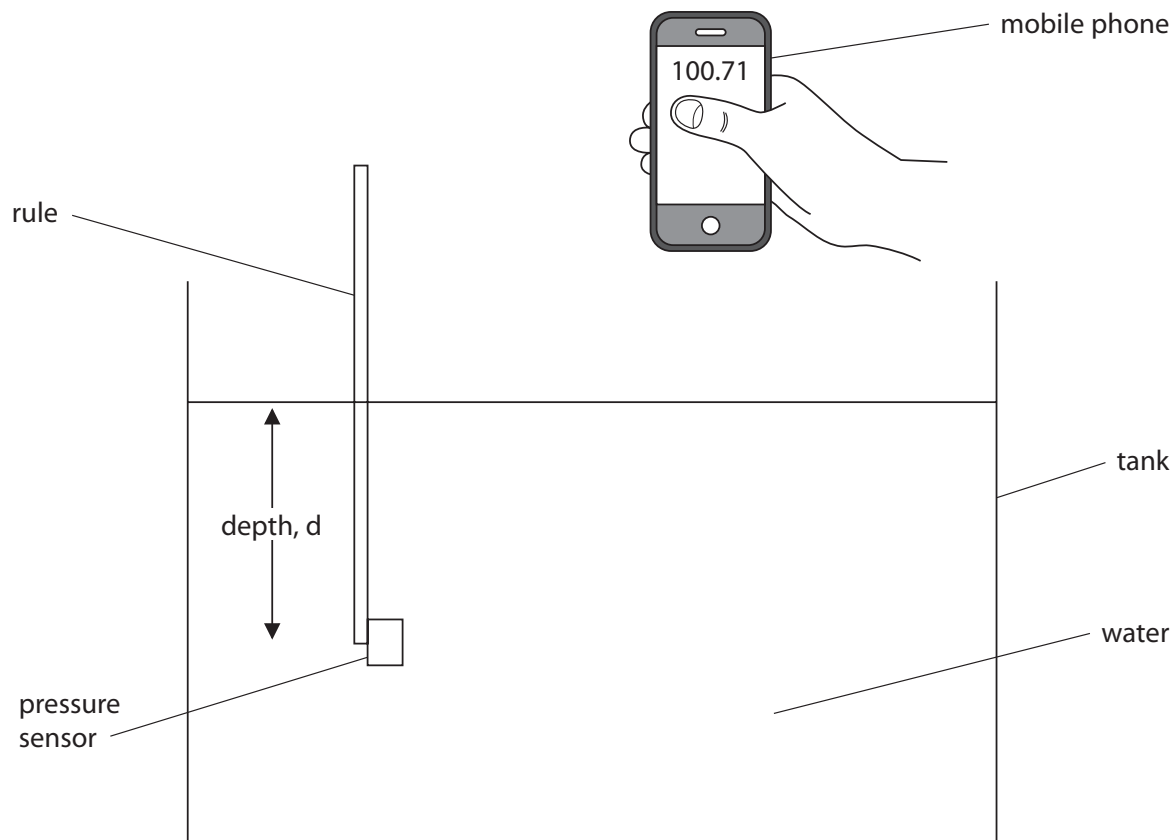


Figure 8

The depth of the pressure sensor below the surface of the water is read from the scale on the rule.

The pressure is displayed on the student's mobile phone which receives a signal from the pressure sensor.

Figure 9 gives some of the readings.

depth in m	pressure in kPa
0.050	99.15
0.100	99.70
0.150	100.15
0.200	100.70
0.250	101.15
0.300	101.70

Figure 9

Figure 10 shows a graph with some of the results plotted, but two of the points are missing.

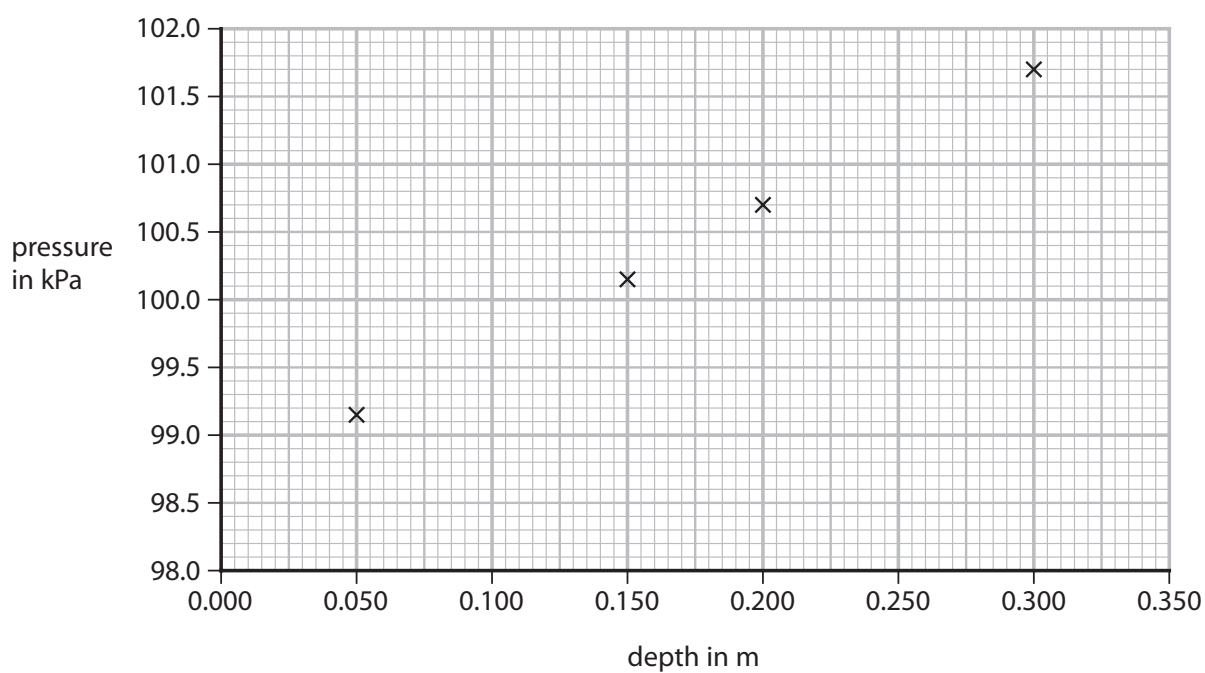


Figure 10

(i) Plot the two missing points on the graph.

(2)

(ii) Draw a line of best fit through the points on the graph.

(1)



(iii) Which of the following equations represents the variation of pressure with depth of water below the surface?

(1)

☐ **A** $y = ax^2 + b$

☐ **B** $y = mx$

☐ **C** $Y = mc - x$

☐ **D** $y = mx + c$

(iv) Use the graph in Figure 10 to predict the pressure at the surface of the water.

(1)

pressure at the surface of the water = ... kPa

(c) The student repeats the investigation in part (b) using seawater and draws a graph of the results.

The seawater is more dense than the water used in part (b).

Compare the graph for seawater with the graph in Figure 10.

(2)

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(Total for Question 4 = 11 marks)

4 This question is about pressure.

(a) Figure 5 shows windows in an aeroplane.

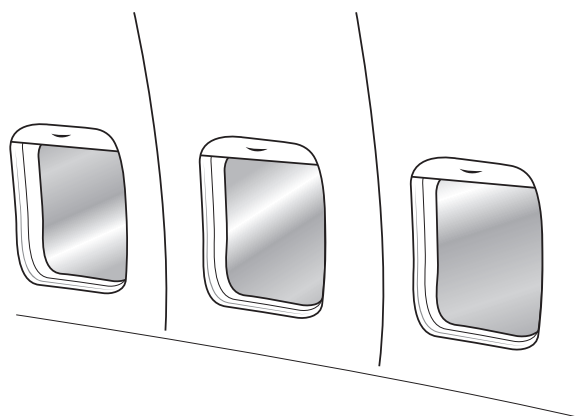


Figure 5

The aeroplane is high above the Earth's surface.

The atmospheric pressure outside the aeroplane is 23 000 Pa.

The air pressure inside the aeroplane is 80 000 Pa.

- (i) Calculate the pressure difference between inside and outside of the aeroplane.

(1)

pressure difference = ... Pa

- (ii) The surface area of the window is 0.094 m².

Calculate the size of the force on the window due to the cabin air pressure of 80 000 Pa.

Use the equation

$$P = \frac{F}{A}$$

(2)

force = ... N

- (iii) On the same aeroplane, a different window has a smaller surface area.

Explain how the force due to the air pressure inside the cabin on the small window differs from the force on the larger window.

(2)

- (iv) Figure 6 shows a cross-section through the aeroplane including one window.

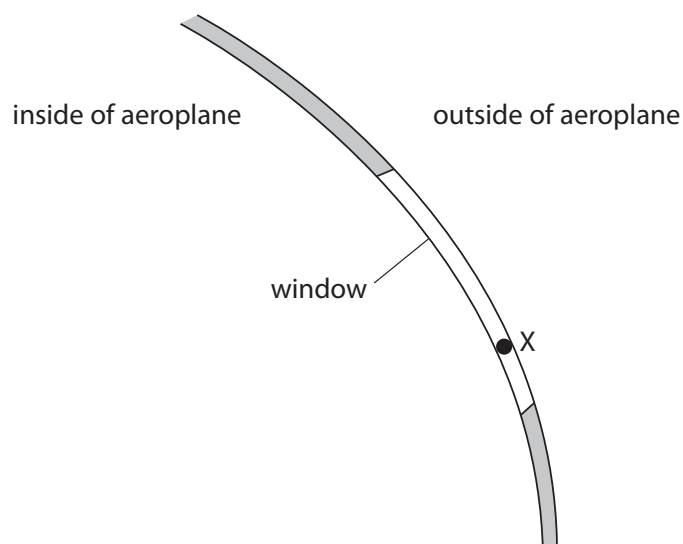


Figure 6

Draw an arrow on Figure 6 to show the direction of the resultant force due to the air pressure inside the cabin on the window at point X.

(2)

- (b) Figure 7 shows the atmospheric pressure at different heights above the Earth's surface.

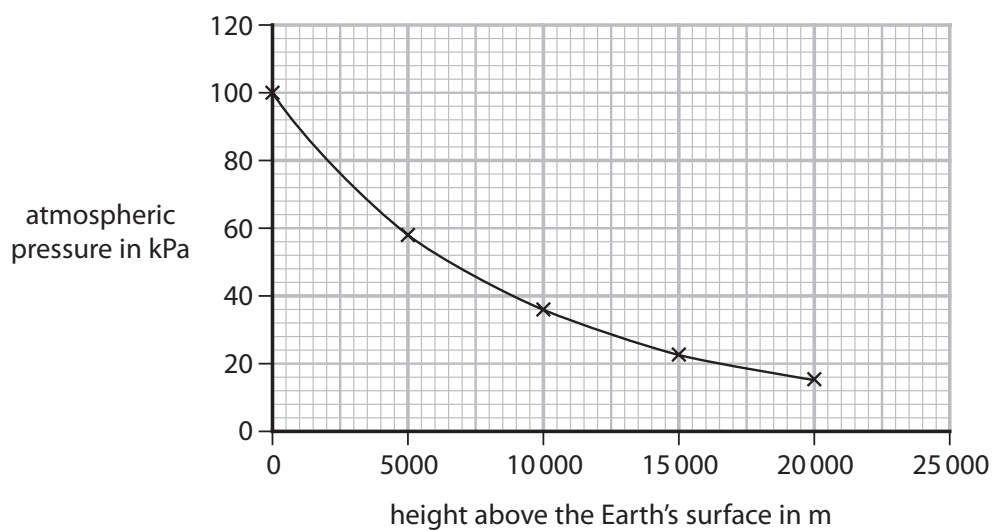


Figure 7

- (i) Describe how the atmospheric pressure changes with height above the Earth's surface.

Use data from Figure 7 to support your answer.

(3)

.....

.....

.....

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.....

- (ii) Suggest **one** reason why the atmospheric pressure changes with height above the Earth's surface.

(1)

.....

.....

(Total for Question 4 = 11 marks)

- 4 (a) Figure 9 shows an object at the bottom of a beaker of water.

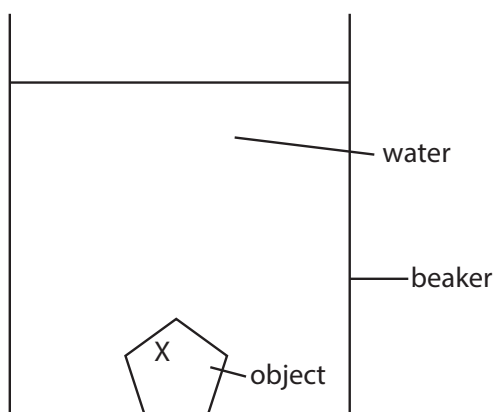


Figure 9

Which diagram shows the direction of the force exerted by the water on the object at point X?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(b) Figure 10 shows an ice skater standing on one skate.

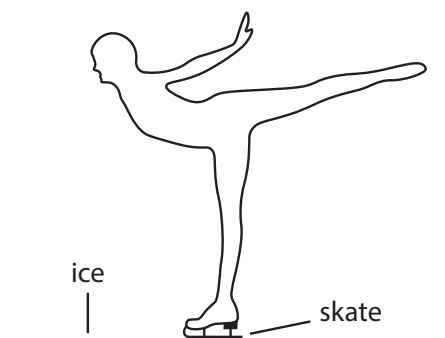


Figure 10

Calculate the force the skate exerts on the ice

pressure of skate on ice = $4.8 \times 10^7 \text{ Pa}$

area of blade in contact with ice = $1.2 \times 10^{-5} \text{ m}^2$

Use the equation

$$\text{force} = \text{pressure} \times \text{area}$$

Give your answer to 2 significant figures.

(3)

force = ... N

(c) Figure 11 shows how atmospheric pressure changes with height above sea level.

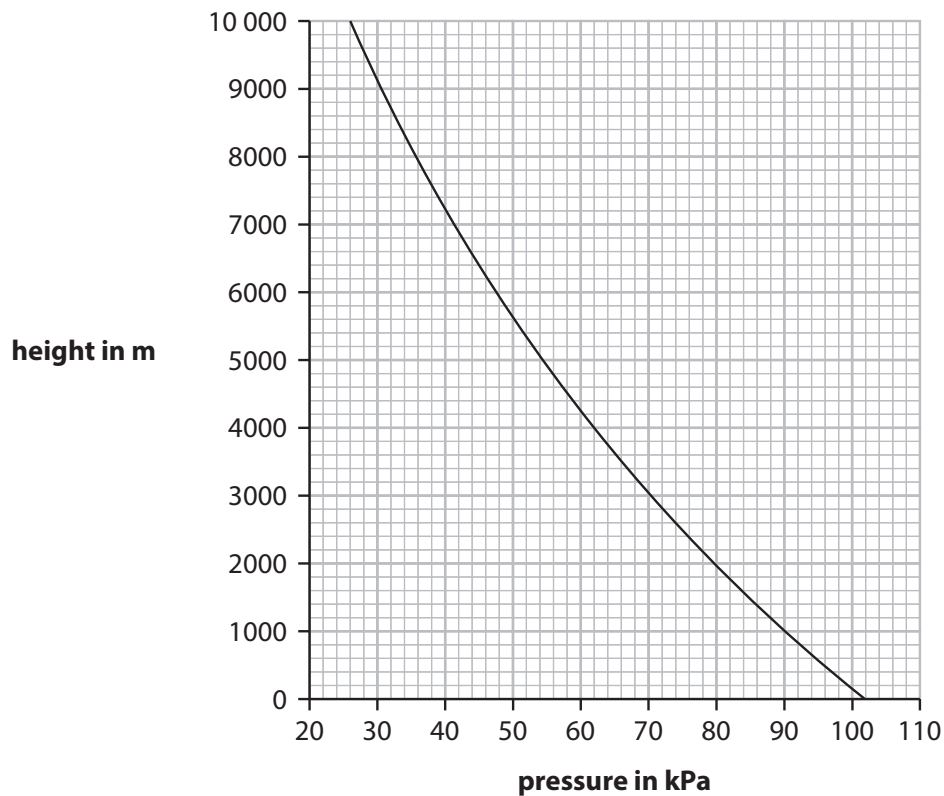


Figure 11

- (i) Using the graph, describe how atmospheric pressure changes with height above sea level.

(2)

.....

.....

.....

.....

- (ii) The top of Mount Everest is 8850 m above sea level.
Using the graph, estimate the atmospheric pressure at the top of Mount Everest.

(1)

pressure = ... kPa

- (iii) On a different day, the pressure at sea level is 104 kPa and the pressure at a height of 2500 m is 74 kPa.

Calculate the percentage change in pressure from sea level to the height of 2500 m.

(2)

percentage change = ... %

- (d) Figure 12 is a model representing molecules of the Earth's atmosphere.

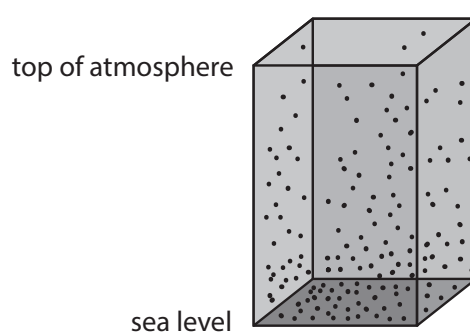


Figure 12

Use Figure 12 to explain how the density of the air varies with height above sea level.

(2)

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.....

.....

.....

(Total for Question 4 = 11 marks)

12-MARK QUESTIONS

2 questions in this booklet



10 (a) Figure 25 shows four identical metal cans, each filled with water to the same level.

Each can has three tubes.

Water comes out of each tube.

Which of these shows the correct pattern of water coming out of the tubes?

(1)

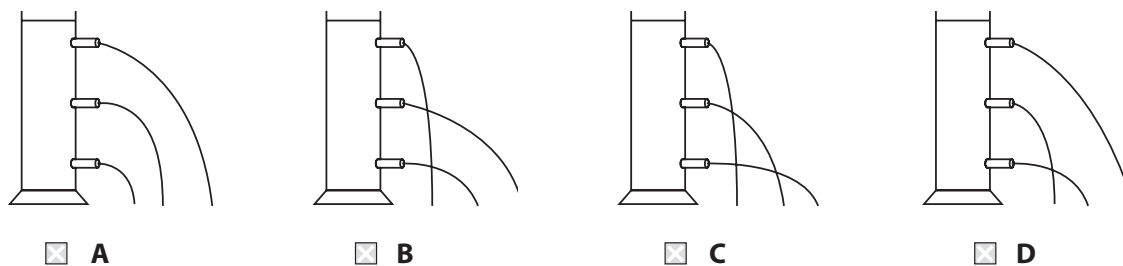


Figure 25

(b) Figure 26 shows a glass U-tube containing water of density 1000 kg/m^3 .

The water levels are the same on both sides of the U-tube.

Both ends of the U-tube are open to the atmosphere.

Atmospheric pressure is $101\,000 \text{ N/m}^2$.

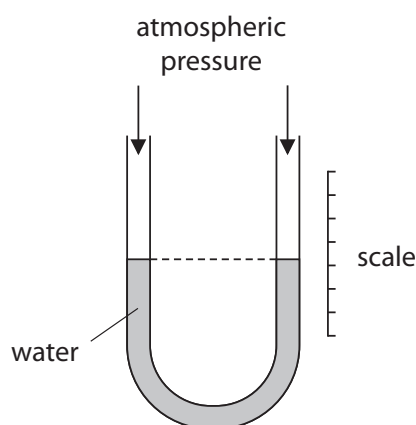


Figure 26

Figure 27 shows the U-tube with one side connected to a gas supply.

The difference in the levels of water, h , is 0.200 m .

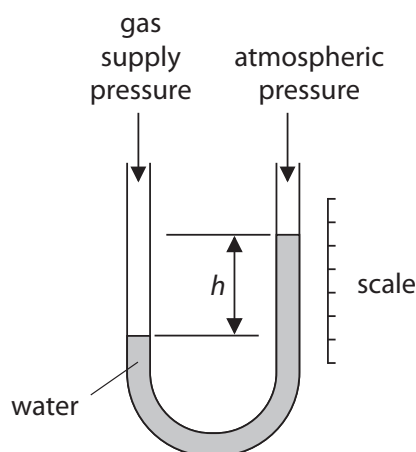


Figure 27

- (i) Calculate the gas supply pressure.
Use an equation selected from the list of equations at the end of the paper.

(3)

pressure of gas supply = ... N/m^2

- (ii) The measurement is repeated using a U-tube of larger cross-sectional area.
Explain why the value of h does not change.

(2)

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*(c) Figure 28 shows a cross-section of a boat floating in water and the same boat with a load inside.

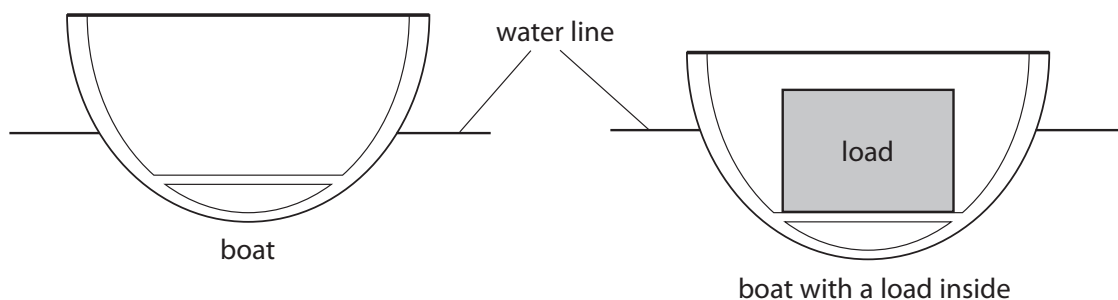


Figure 28

The boat floats lower in the water when there is a load inside the boat.

Explain why the boat floats in water and why the boat floats lower in the water when there is a load inside the boat.

You may add to the diagram to help with your answer.

(6)

(Total for Question 10 = 12 marks)

- 9 (a) Figure 20 shows a metal block being weighed by a newton meter (force meter).

In Figure 20a the block is hanging in a liquid.

In Figure 20b the **same** block is hanging in air.

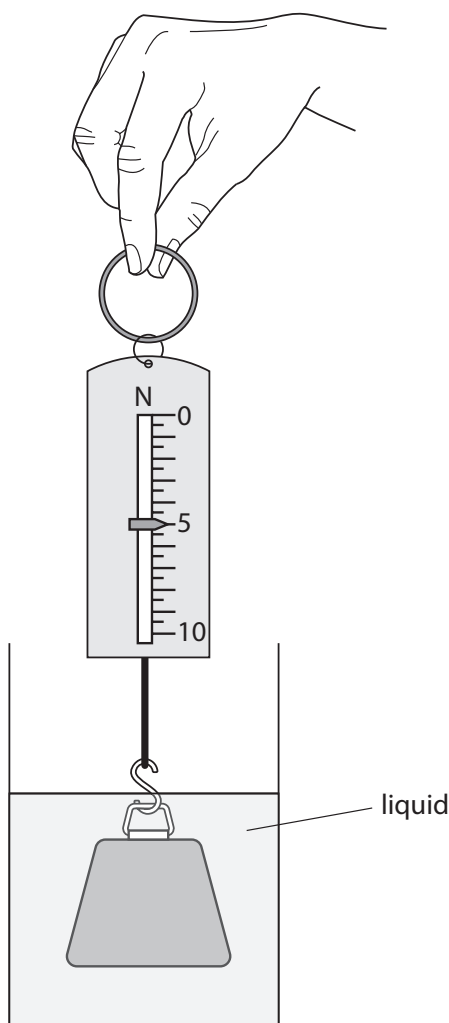


Figure 20a

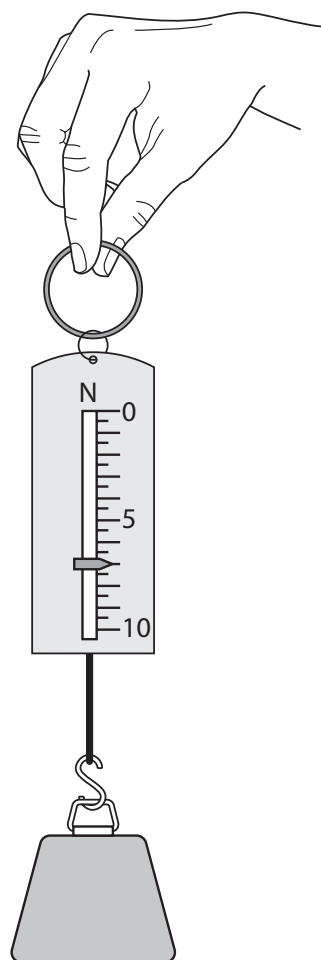


Figure 20b

- (i) Explain why the reading on the newton meter is different in Figures 20a and 20b.

(2)

.....

.....

.....

.....

- (ii) The density of the liquid is $1.4 \times 10^3 \text{ kg/m}^3$.

Calculate the density of the block.

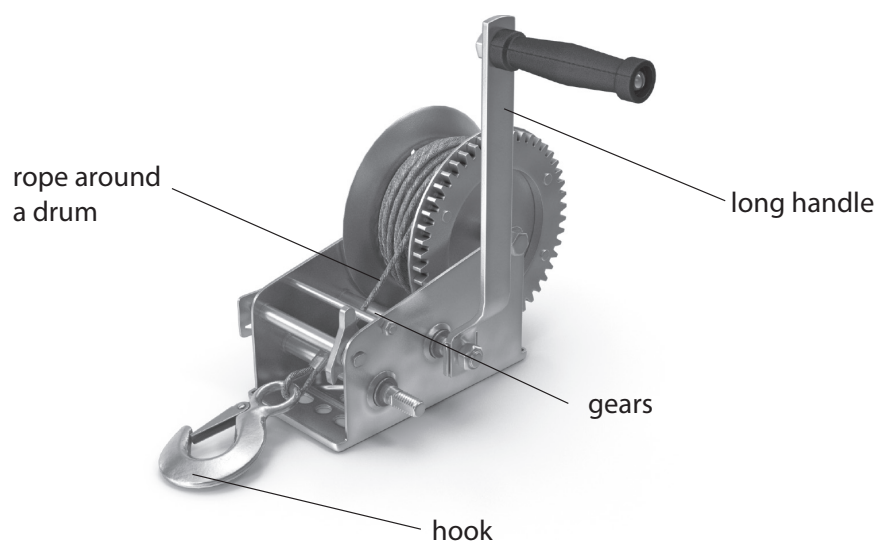
Gravitational field strength, g , = 10 N/kg

(4)

density = ... kg/m^3



*(b) Figure 21 shows a device that a person can use to lift a large load with a smaller effort force.



(Source: © Shutterstock-Pixelsquid/Shutterstock)

Figure 21

Figure 22 shows the important parts of the device. The curved arrows show the directions of rotation of the handle, the gears and the drum.

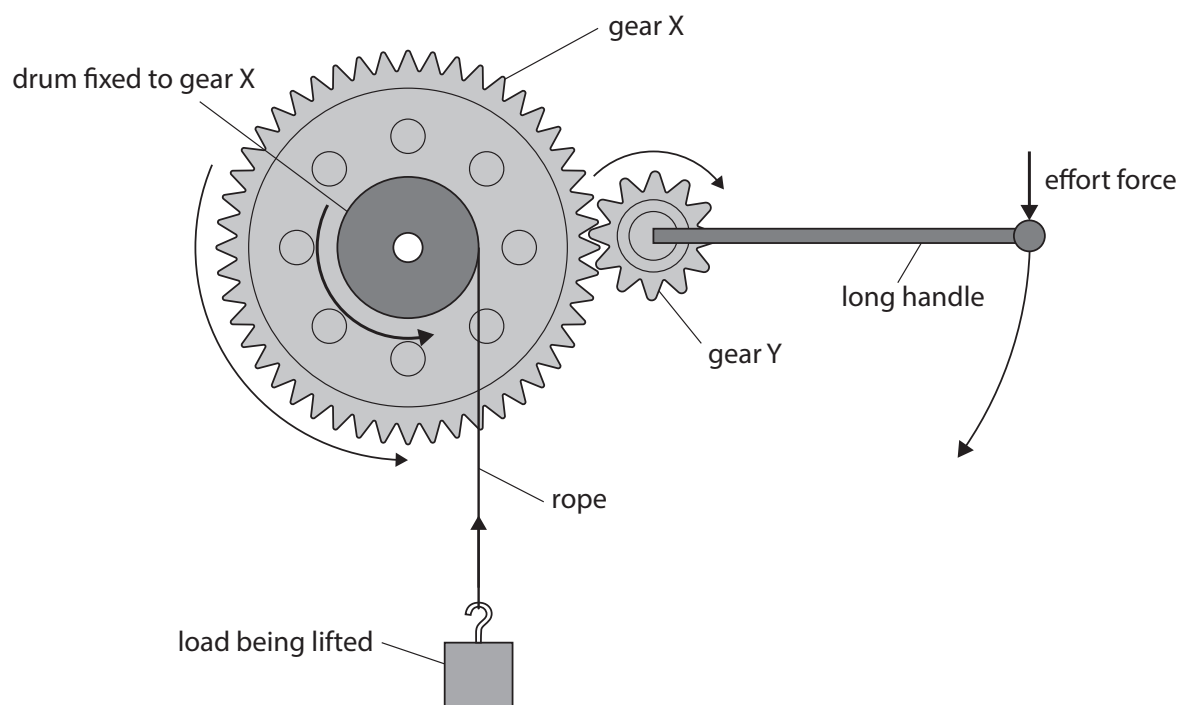


Figure 22

The size of the effort force needed to lift the load is determined by the sizes of the parts of the device.

Explain why this is the case.

Your answer should refer to

- the sizes of the different parts of the device
- how these sizes are used in relevant calculations

(6)

(Total for Question 9 = 12 marks)



MARK SCHEMES

official Pearson Edexcel mark schemes



Question number	Answer	Mark
1(a)	B  A,C and D are incorrect as the forces would cause the seesaw to turn	(1)

Question number	Answer	Additional guidance	Mark
1(b)	an explanation linking distance from hinge/pivot increased (1) (therefore) smaller force needed (to close door)	P further from hinge than Q accept the greater distance gives greater moment for 2 marks	(2)

Question number	Answer	Additional guidance	Mark
1(c)	any correct moment (1) 450×0.50 or 225 or $0.80 \times F_2$ substitution into prin. of moment equation (1) $450 \times 0.50 = 0.80 \times F_2$ evaluation (1) 280 (N) (for question at end)	allow 450×0.3 moment taken about B allow statement of prin. of moments accept numbers which round to 280 such as 281.25 award full marks for correct answer without working.	(3)

Question number	Answer	Additional guidance	Mark
3(a)	(upward) force increases with speed (1) relationship is non-linear (1)	allow reverse argument changing rate / increases exponentially / initially no upward force (until 1000 turns per minute)	(2)

Question number	Answer	Additional guidance	Mark
3(bi)	recall and substitution into (1) $\text{gpe} = m \times g \times h$ $(\text{gpe}) = 4.5 \times 10 \times 20$ evaluation (1) 900(J)	allow 90(J) for 1 mark award full marks for the correct answer without working	(2)

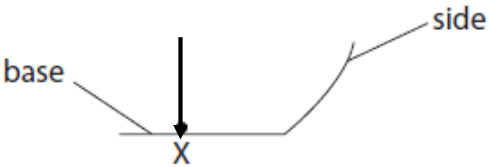
Question number	Answer	Additional guidance	Mark
3bii	900(J)	allow ecf from bi	(1)

Question number	Answer	Additional guidance	Mark
3biii	recall and substitution (1) power = work done / time taken (power =) $900 / 4$ evaluation (1) 200 (W)	allow ecf from bi or bii accept 230(W), 225(W) award full marks for the correct answer without working	(2)

Total marks for question 3 = 7



Question number	Answer	Additional guidance	Mark
1(a)(i)	substitution into $P = h \times \rho \times g$ (1) $3500 = h \times 10^3 \times 10$ rearrangement and evaluation (1) $(h =) 0.35 \text{ (m)}$ OR ALTERNATIVE METHOD rearrangement (1) $h = \frac{P}{\rho \times g}$ substitution and evaluation (1) $(h =) 0.35 \text{ (m)}$	35 <u>cm</u> 35 <u>cm</u> accept 35 (m) for 1 mark award full marks for correct answer without working	(2) AO2.1

Question number	Answer	Additional guidance	Mark
1 (a)(ii)	A straight, vertical, downwards arrow as shown 	Judge by eye. Arrow tip or tail (extended if necessary) must pass through point X.	(1) AO1.1

Question number	Answer	Additional guidance	Mark
1 (b)	D the same as the pressure underneath the large pool A, B and C are all incorrect because the pressure is the same		(1) AO2.2

Question number	Answer	Additional guidance	Mark
1(c)	substitution into $P = \frac{F}{A}$ (1) $3500 = \frac{F}{1.5 \times 10^{-6}}$ rearrangement and evaluation (1) $(F =) 0.0053 \text{ (N)}$ OR ALTERNATIVE METHOD rearrangement (1) $F = P \times A$ substitution and evaluation (1) $(F =) 0.0053 \text{ (N)}$	$5.3 \times 10^{-3} \text{ (N)}$ accept 0.0052(5) (N) or $5.2(5) \times 10^{-3} \text{ (N)}$ $5.3 \times 10^{-3} \text{ (N)}$ accept 0.0052(5) (N) or $5.2(5) \times 10^{-3} \text{ (N)}$ 0.0053 or 0.0052(5) to any other power of ten scores 1 mark award full marks for correct answer without working	(2) AO2.1

Question number	Answer	Additional guidance	Mark
1 (d)	(force below the bigger hole is) larger (1)	accept force below original hole is smaller	(1) AO1.1

Total for Question 1 = 7 marks

Question number	Answer			Mark
6(a)(i)	B	1	same as P	(1) AO 1 1
	The only correct answer is B A is incorrect because the number of teeth on P and R are equal C is incorrect because Q reverses the rotation of P and then R reverses the rotation of Q D is incorrect because Q reverses the rotation of P and then R reverses the rotation of Q			

Question Number:	Answer	Additional Guidance	Mark
6(a)(ii)	use of distance = pitch x number of teeth (moved) (1) evaluation (1) (distance =) 20 (mm)	allow first mark if 2 x 4 (=8) or 2 x 40 (=80) seen award full marks for correct answer without working	(2) AO 1 1

Question Number:	Answer	Additional Guidance	Mark
6(b)	recall clockwise moment = anticlockwise moment (1) moment = force x (perpendicular) distance (1) substitution (1) $m \times 17 = (6 \times 15) + (4.6 \times 10)$ rearrangement and evaluation (1) $m = 8.0$ (g)	calculations need not include g (which cancels out from all terms) substitution and rearrangement in either order $m \times 17 = 90 + 46$ $m = \frac{(6 \times 15) + (4.6 \times 10)}{17}$ $m = 136 / 17$ award full marks for correct answer without working	(4) AO 1 1 AO 2 1

Question Number:	Answer	Additional Guidance	Mark
6(c)	an explanation linking: use of $P = \frac{F}{A}$ (1) area of piston Y is less than area of piston Z (1) (therefore) force K is less than force L (1)	accept answers in terms of work = force x distance accept reverse arguments accept K for piston Y and L for piston Z	(3) AO 3 2a AO 3 2b

(Total for Question 6 = 10 marks)



Question number	Answer	Additional guidance	Mark
6 a	(sum of) the clockwise moments = (sum of) the anticlockwise moments	moment of magnet = moment of modelling clay moments are equal (size)	(1) AO1

Question number	Answer	Additional guidance	Mark
6 b	recall and substitution (1) (force x 12.0 =) 0.050 x 8.4 rearrangement (1) (force =) $\frac{0.050 \times 8.4}{12.0}$ evaluation (1) (force =) 0.035 (N)	allow substitution and rearrangement in either order award full marks for the correct answer without working. if no other marks scored then award 1 mark for answers that round to 29 (eg 28.57) (substitution mark)	(3) AO2

Question number	Answer	Additional guidance	Mark
6 c	a description to include four of the following measure the value of current (1) measure force or distance (1) vary the current (1) restore equilibrium of system (1) calculate ratio between force and current or distance and current (1) if ratio is the same then they are proportional (1)	accept calculate for measure increase weight or move (existing) weight to new position plot a graph of force / distance against current graph would be a straight line (through the origin)	(4) AO3

Question number	Answer	Additional guidance	Mark
6 d	move the (position of) the (0.050 N) weight (1) to the other side of the pivot/3.6 cm from the magnet (1)	adjust mass of modelling clay reduce (mass of modelling clay) by taking some away add (additional) weight between pivot and magnet scores 2 marks	(2) AO3

Total for question 6 = 10 marks

Question number	Answer	Mark
6 (a)	☒ A acceleration This is the only vector quantity from the options given	(1) AO1.1

Question number	Answer	Additional guidance	Mark
6(b) (i)	substitution and rearrangement (1) $(\text{force} = \frac{\text{moment}}{\text{distance}})$ $= \frac{0.6}{3(\times 10^{-1})}$ evaluation (1) 2(.0) (N)	reject $0.6 \times 3 = 1.8$ award full marks for the correct answer without working ignore significant figures 2(.0) to any other power of ten scores 1 mark maximum	(2) AO2.1

Question number	Answer	Additional guidance	Mark
6(b) (ii)	correct calculation of one moment (1) correct calculation of second moment and adding of moments seen (1)	show that question either 2×0.1 or 1×0.5 seen $2(.0) \times 0.1(0) + 1(.0) \times 0.5$ scores 2 marks $0.2 + 0.5$ scores 2 marks accept calculations in alternative units (e.g. N cm) if correct conversion(s) seen if no other marks scored, the addition of two other moments can score 1 mark maximum	(2) AO2.1

Question number	Answer	Additional guidance	Mark
6 (b) (iii)	explanation linking three from: {sum of / total } clockwise moments = {sum of / total } anticlockwise moments (1) for a system in equilibrium / balance (1) clockwise and anticlockwise moments compared (1) so rod not in equilibrium (1)	about the same point / about a point e.g. clockwise moment > anticlockwise moment or reverse argument $0.7 > 0.6$ $0.7 \neq 0.6$ rod will rotate clockwise MP4 can only be scored if MP3 awarded	(3) A03.2

Question number	Answer	Additional guidance	Mark
6(c)	counting teeth on the pinion (1) evaluation (1) 1.6 (m)	allow between 18 and 22 inclusive 20×0.08 ecf number of teeth answer in range 1.44 to 1.76 scores 2 marks award full marks for the correct answer without working power of 10 error scores 1 mark maximum	(2) A03.1

Total 10 marks

Question number	Answer	Additional guidance	Mark
6 (a)	B arms provide an upward force and feet act as a pivot A and C are incorrect because the rotation is not around the hands. D is incorrect because the legs are not providing an upward force that causes rotation		(1) AO3

Question number	Answer	Additional guidance	Mark
6 (b) (i)	calculation of both moments (1) moments are equal (size) and opposite direction (1)	4 x 92 and 16 x 23 seen comparison of both moments 368 (=) 368 or $4 \times 92 = 16 \times 23$ or $16 = \frac{4 \times 92}{23}$ or $4 = \frac{16 \times 23}{92}$ accept calculations in Nm	(2) AO1, AO2

Question number	Answer	Additional guidance	Mark
6 (b) (ii)	calculation of moment of ball (1)		(3) AO2
	480 (Ncm)	15 x 32 seen	
	calculation of total clockwise moment (1)		
	848 (Ncm)	368 + 480 seen	
	calculation of bicep force needed (1)		
	212 (N)	848/4 seen	
	OR		
	calculation of moment of ball (1)		
	480 (Ncm)	15 x 32 seen	
	calculation of additional force from bicep (1)		
	120 (N)	480/4 seen	
	calculation of total bicep force (1)		
	212 (N)	120 + 92 seen	
		award full marks for correct answer without working. accept conversion of cm to m throughout	

Question number	Answer	Additional guidance	Mark
6 (c) (i)	(upthrusts in each case) are equal (1)		(1) AO3

Question number	Answer	Additional guidance	Mark
6 (c) (ii)	an explanation linking any three of weight of ball = weight of water displaced (1) seawater more dense than fresh water (1) smaller volume of seawater (needs to be) displaced (1) to produce same weight of water (displaced) (1)	accept reverse arguments accept saltwater for seawater upthrust = weight of water displaced accept less seawater displaced to produce same upthrust	(3) AO1

Total 10 marks

Question number	Answer	Mark
6 (a)	the correct answer is C N m A, B and D are incorrect because they do not match the expression moment of a force = force x distance	(1) AO1.1

Question number	Answer	Additional guidance	Mark
6 (b) i	sum of the clockwise moments = sum of anticlockwise moments (about the same point) (1) for (a system in) equilibrium (1)	allow 'total' in place of 'sum'	(2) AO1.1

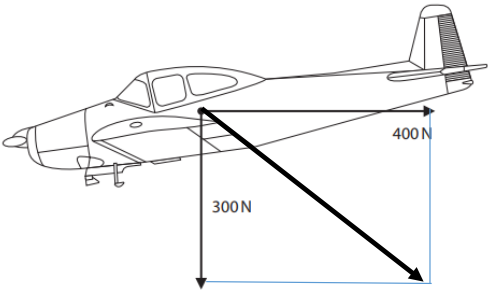
Question number	Answer	Additional guidance	Mark
6 (b)ii	choice of equation and rearrangement (1) $F_2 = \frac{F_1 \times d_1}{d_2}$ substitution (1) ($F_2 =$) $\frac{11.4 \times 24.5}{3.7}$ evaluation (1) 75 (N)	allow substitution and rearrangement in either order $F_2 \times 3.7 = 11.4 \times 24.5$ any number rounding to 75(.5) (N) e.g. 75.486... (N) award full marks for the correct answer without working if no other mark scored, award one mark for idea of moment = force x distance	(3) AO2.1

Question number	Answer	Additional guidance	Mark
6 (c)i	calculation of rate in revs /min (1) $= 3 \times 1.0$ evaluation (1) 180 (revs / hr)	uses gear ratio (3 x) award full marks for the correct answer without working allow 1 mark for answer of 20 (revs/hour) (from inverse ratio)	(2) AO2.1

Question number	Answer	Additional guidance	Mark
6 (c) ii	an answer that provides a description by making reference to idea of linking with Q (only) (1) add a gearwheel with 10 teeth (1)	may be shown in diagram add / next to Q half the number of teeth of gearwheel Q	(2) AO1.1

Question 6 total 10 marks

Question Number:	Answer	Additional guidance	Mark
7(a)(i)	0.9 (k N) (1) up / upwards / ascending (1)	accept .9 or 0.90 north N ↑	(2) AO 3 2a AO 3 2b

Question Number:	Answer	Additional guidance	Mark
7(a)(ii)		judge length and direction by eye construction lines need not be shown magnitude need not be stated allow missing arrowhead if direction and length are correct reject answers which have any additional vectors drawn	(1) AO 3 2b

Question Number:	Answer	Additional Guidance	Mark
7(a)(iii)	recall and substitution (1) $GPE = 750 \times 10 \times 1300$ evaluation (1) (energy =) 9 800 000 (J)	no POT error (could have missed out g) allow answers in standard form 9.8×10^6 allow answers that round to 9 800 000 e.g. 9 750 000 J allow 9800 kJ or 9.8MJ allow 9 555 000 J allow negative values award full marks for correct answer without working	(2) AO 2 1

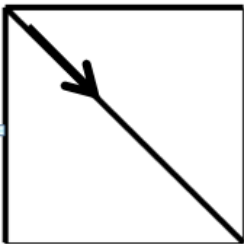
Question Number:	Answer	Additional Guidance	Mark
7(b)(i)	recall efficiency equation (1) $\text{efficiency} = \frac{\text{useful output}}{\text{input}}$ rearrangement (1) output energy = 0.70 x 6500 recall power equation (1) $\text{power} = \frac{\text{energy}}{\text{time}}$ evaluation (1) (power =) 76 (kW)	$\text{efficiency} = \frac{\text{power output}}{\text{power input}}$ 4550 (kJ) seen scores 2 marks (from 0.7 x 6500 (kJ)) $\frac{4550}{60}$ accept ecf from output energy accept values that round up to 76 (kW) e.g. 75.8 award full marks for correct answer without working	(4) AO 1 1 AO 2 1

Question Number:	Answer	Additional Guidance	Mark
7(b)(ii)	an explanation linking: (useful) output energy is less than input energy (1) some energy is transferred to less useful forms (1)	input energy is greater than output energy (only) 70% of the input energy is useful energy is dissipated / wasted / lost (to surroundings) energy is lost / transferred as thermal / heat 30% is lost /dissipated / wasted / lost for 2 marks	(2) AO 1 1

(Total for Question 7 = 11 marks)



Question number	Answer	Mark
9(a)	B  A, C and D are incorrect because they all show a resultant force which would cause the trolley to accelerate	(1)

Question number	Answer	Additional guidance	Mark
9(b)	Scale drawing two lines at right angles (1) a correct scaling (for example 10kN equivalent to 1 cm) / a completed square or triangle(1) diagonal in correct direction (1) 28 kN (1)	 judge by eye accept answers from 25 kN to 30 kN accept use of Pythagoras award full marks for correct answer without working.	(4)

Question number	Indicative content	Mark
9c*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive, and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. A01 Horizontal forces • tension in the string/pull of the string • tension is one of the horizontal forces acting on the wooden block • friction between the table and the wooden block • friction acts in the opposite direction to the tension • friction opposes motion • the force due to friction is equal to the force provided by the tension • the forces are balanced /equal and opposite • no resultant force, so the block moves at a constant (horizontal) velocity Vertical forces • (normal) reaction (force) upwards between the table and the wooden block • contact force • weight of block downwards • the weight (force of gravity) and the (normal) reaction are equal and opposite / balanced • the block does not move up or down • tension caused by the force due to gravity on the weight • vertical forces on the block do not affect horizontal velocity. labels on the diagram should be considered when marking candidates do not have to indicate the forces as horizontal and vertical	(6)



Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	- Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) - Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	- Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) - Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	- Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) - Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

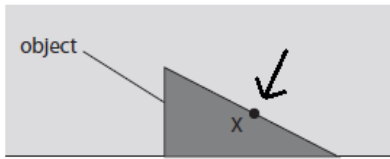
Level	Mark	Additional Guidance	General additional guidance – the decision within levels
	0	No rewardable material.	e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
Level 1	1–2	<u>Additional guidance</u> Elements of physics present i.e. isolated knowledge of principles two unconnected statements from any section	<u>Possible candidate responses</u> contact force weight pulls block friction tension in string weight acts downward reaction
Level 2	3–4	<u>Additional guidance</u> Some knowledge of principles with a logical connection made in one section and statement from the other section OR Detailed knowledge of principles with logical connections made in one section	<u>Possible candidate responses</u> There is friction between the table and the block and this opposes motion weight of block acts downwards
Level 3	5–6	<u>Additional guidance</u> Detailed knowledge of principles with logical connections made in one section and statement from the other section	<u>Possible candidate responses</u> Friction and tension are equal and opposite there is no resultant /no acceleration The weight (of the block) and the(normal) reaction are equal and opposite

Total marks for question 9 = 11



Question number	Answer	Additional guidance	Mark
4 (H) 10(F) (ai)	recall (1) $P = \frac{F}{A}$ substitution (1) $(p) = \frac{2400}{0.8}$ evaluation $(P) = 3000 \text{ (Pa)}$ (1)	may be implied by a correct substitution award full marks for the correct answer without working	(3) AO2

Question number	Answer	Additional guidance	Mark
4 (H) 10(F) (aii)	an explanation linking greater pressure (on bottom of tank) (1) with greater force due to water (above bottom of tank) (1)	 more weight of water more depth/height of water ignore simply 'more water' or 'greater amount of water'	(2) AO1

Question number	Answer	Additional guidance	Mark
10 aiii (F) 4(aiii) (H)	 an arrow perpendicular to the sloping side and pointing towards X	judge by eye	(1) AO1

Question number	Answer	Additional guidance	Mark
10 bi (F) 4 bi (H)	data points correctly identified (1) 50 ± 2 80 ± 2 evaluation (1) (-)30 ± 4 kPa	award 1 mark if 80 and 50 seen ignore the lack of minus sign allow ecf from incorrect reading of either pressure at 2000m or pressure at 6000m for one mark	(2) AO3

Question number	Answer	Additional guidance	Mark
10 bii (F) 4 bii (H)	any one suggestion of greater density of atmosphere (1) greater depth of atmosphere (above the aeroplane) (1) greater temperature (of the atmosphere) (1)	accept reverse argument more particles (per cubic metre) the air gets thicker greater weight of the atmosphere	(1) AO1

Question number	Answer	Additional guidance	Mark
10 (c) (F) 4 (c) (H)	an explanation linking the area (of contact between person and bed) is smaller when standing up (1) same weight (over smaller area) so the pressure is greater when standing up (1)	accept reverse arguments weight is more concentrated / not distributed / not spread across bed (when standing up) uses $p = F/A$ argument (as a consequence of the smaller area, pressure is bigger)	(2) AO2

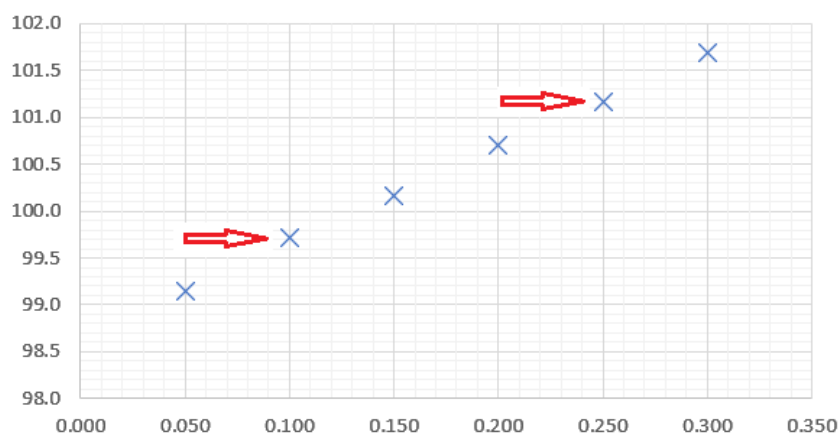
Total for question 4(h), 10(F) = 11 marks



Question number	Answer	Additional guidance	Mark
4 (a) (i)	substitution (1) (pressure =) $\frac{2500}{4 \times 0.022}$ evaluation (1) 28 000 (Pa)	any number rounding to 28 000 e.g. 28 400, 28 410, 28 409 award full marks for the correct answer without working award one mark for numbers that round to 110 000 (Pa) (missing 4 in denominator) award 1 mark for 454 545 (times by 4)	(2) A02.1

Question number	Answer	Additional guidance	Mark
4 (a) (ii)	An explanation linking any two from camel is less likely to sink into the soft ground (1) (same) force / weight is distributed / spread out (1) camel's hoof has greater (surface) area (than donkey) (1) camel's hoof exerts less pressure (than it would if hoof were smaller) (1)	ORA for donkey ignore pressure is spread out wider if no other marks scored then allow 1 mark for split in camel hoof enables better grip (as it walks)	(2) A03.1

Question number	Answer	Additional guidance	Mark
4 (b)(i)	points plotted to within $\pm$ 1 small square (0.100, 99.7) (1) (0.250, 101.15) (1)		(2) AO2.1



Question number	Answer	Additional guidance	Mark
4 (b)(ii)	best fit straight line passing through at least four of the points (1)	do not accept tramlining (multiple lines / curves) ignore slight shakiness in drawing	(1) AO2.1

Question number	Answer	Mark
4 (b)(iii)	D $y = mx + c$ Figure 10 shows a linear graph with a positive gradient and intercept	(1) AO1.1

Question number	Answer	Additional guidance	Mark
4 (b)(iv)	answer between 98.6 and 98.8 (kPa)	allow ecf from their line of best fit in b(ii)	(1) AO3.2

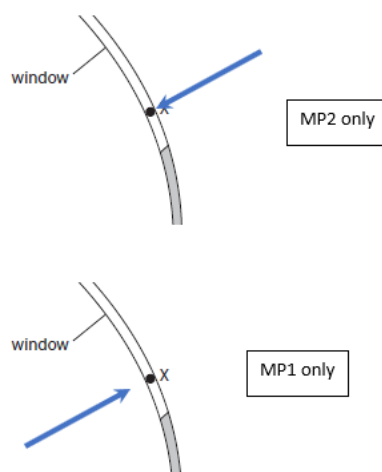
Question number	Answer	Additional guidance	Mark
4 (c)	any two from pressure(s) would be greater (values) (1) steeper gradient of graph (1) both straight lines (1) intercept (on pressure axis) the same (1)	credit mark points seen on graph bigger gradient / steeper line (of best fit) both linear pressure at surface is the same	(2) AO3.2

 Question 4 11 marks


Question number	Answer	Additional guidance	Mark
4 (a) (i)	(80 000 – 23 000) 57 000 (Pa) (1)	-57 000 (Pa)	(1) AO2

Question number	Answer	Additional guidance	Mark
4 (a) (ii)	substitution (1) $80\,000 = \frac{F}{0.094}$ rearrangement and evaluation (1) (F=) 7500 (N)	alternative method re-arrangement (1) (F =) P x A or (F=) 80 000 x 0.094 (substitution and) evaluation accept 7520 (N), award full marks for correct answer without working. allow 1 mark max for substitution using pressure of 57 000 or an answer that rounds to 5400 e.g. 5358 (calculated net force)	(2) AO2

Question number	Answer	Additional guidance	Mark
4 (a) (iii)	force is less (on small window) (1) pressure is the same (1)	force is greater on large window	(2) AO1

Question number	Answer	Additional guidance	Mark
4 (a) (iv)	arrow pointing towards outside of aeroplane (1) arrow is normal to surface at X (judge by eye) (1) Examples: 	may be inside or outside of aeroplane. need not touch X do not award if two or more conflicting arrows drawn must touch X or dot at X independent marks	(2) AO1

Question number	Answer	Additional guidance	Mark
4 (b) (i)	increase in height results in decrease in pressure (1) non-linear relationship (1) use of numerical data (1) at least two different pressure and height values from the graph	pressure decreases with height accept inversely proportional in this context accept negative correlation double the height does not result in half the pressure pressure not does change evenly description of graph e.g. curved / not straight calculation of change in pressure e.g. 5000m to 10000 m pressure went down by 22	(3) AO3

Question number	Answer	Additional guidance	Mark
4 (b) (ii)	any one from air becomes less dense (1) smaller weight (of air) above (1) lower temperature (1)	accept oxygen / atmosphere for air air gets thinner / (air) particles further apart / fewer particles / less particles less air above / smaller height of air above ignore change in value of g with height	(1) AO1

Total 11 marks

Question number	Answer	Additional guidance	Mark
4 (c)(ii)	accept any answer from 30 to 34 (kPa) (1)		(1) AO3.2

Question number	Answer	Additional guidance	Mark
4 (c)(iii)	substitute into % calculation (1) $\frac{74 - 104}{104} \times 100$ evaluation (1) (-) 29 (%)	$\frac{104 - 74}{104} \times 100$ any number rounding to (-)29(%) e.g. (-)28.8(%) award full marks for the correct answer without working award 1 mark for (-)0.29 OR (-)0.288 award 1 mark for (-)40(.54) (%) or (-)41 (%) award 1 mark for 71 (%)	(2) AO2.1

Question number	Answer	Additional guidance	Mark
4 (d)	an explanation linking: density decreases as height increases (1) with (because) particles are further apart (higher up) (1)	ignore gravity accept reverse arguments density decreases as you go higher accept fewer particles per unit volume accept particles more spaced out	(2) AO3.2

Total for question 4 -11 marks



Question number	Answer	Mark
10(a)	C  A,B and D are incorrect because pressure increases with depth	(1)

Question number	Answer	Additional guidance	Mark
(b) (i)	substitution (1) $(p) = 1000 \times 10 \times 0.200$ evaluation of pressure difference (1) 2000 final evaluation (1) 103000 (Pa)	accept e.c.f for addition of atmospheric pressure seen for 1mark award 1 mark for selecting correct equation if no other mark awarded award full marks for correct answer without working.	(3)

Question number	Answer	Additional guidance	Mark
10(b)(ii)	an explanation linking use of $P = h \times \rho \times g$ (1) no area in the equation (1)	P /pressure, ρ /density (and g /gravitational field strength) are constant/the same Area does not affect result h /height of water is independent of area P, ρ, and g are all constant gains 2 marks	(2)

Question number	Indicative content	Mark
10(c) *	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative (example) content below is not prescriptive and candidates are not required to include the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. AO2 Pressure • difference in pressure between top and bottom of boat • top pressure is atmospheric • pressure on bottom of boat atmospheric plus that due to depth of water. Unloaded boat • density of boat less than density of water • floating objects are partially immersed • floating objects displace fluid / water • upthrust is due to the difference in pressure • upthrust is equal to the weight of the boat • upthrust is equal to the weight of fluid / water displaced Boat with load • the weight/density of the boat increases because of the load added • more upthrust is needed to balance the extra weight of the boat • more water has to be displaced to provide the upthrust • when the boat floats lower in the water it displaces more water • the weight of water displaced is the upthrust and is equal to the weight of the boat	(6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. Lines of reasoning are supported by sustained application of relevant evidence. (AO2)



Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> Elements of physics present i.e. isolated knowledge of principles two unconnected statements from any section	<u>Possible candidate responses</u> pressure difference upthrust water displaced displacement floating
Level 2	3–4	<u>Additional guidance</u> Some knowledge of principles with a logical connection made in one section and statement from one other section	<u>Possible candidate responses</u> upthrust and weight are balanced /upthrust is equal to the weight of the boat when load added upthrust increases difference in pressure between the top and bottom of the boat
Level 3	5–6	<u>Additional guidance</u> Detailed knowledge of principles with logical connections made in two sections.	<u>Possible candidate responses</u> upthrust is equal to the weight of water displaced. when load is added, weight increases more water is displaced

Total marks for question 10 =12



Question number	Answer	Additional guidance	Mark
9(a) (i)	an explanation linking (apparent) loss in weight of block in liquid(1) (equal to) weight of liquid displaced (1)	upthrust /buoyant force on block liquid more dense than air	(2) AO1

Question number	Answer	Additional guidance	Mark
9(a) (ii)	calculation of weight lost (1) 2 (N) attempt to determine volume of block (1) (V=) 1.43×10^{-4} substitution to determine density of block (1) (ρ =) $\frac{7 \times 10^{-1}}{1.43 \times 10^{-4}}$ evaluation (1) (ρ =) 4900 (kg/m³)	accept (7 – 5) accept 0.2 (kg) accept (V =) $\frac{2 \times 10^{-1}}{1.4 \times 10^3}$ or (V =) $\frac{5 \times 10^{-1}}{1.4 \times 10^3}$ or 3.6 ($\times 10^{-4}$) (weight of 5 N used) accept $\frac{7 \times 10^{-1}}{3.6 \times 10^{-4}}$ accept values that round to 4900 e.g. 4895 4900 to any other power of ten scores 3 marks (incorrect unit conversion) 1960 scores 3 marks 1960 to any other power of ten scores 2 marks (used wrong weight of liquid) 100 000 scores 3 marks 100 000 to any other power of ten scores 2 marks	(4) AO2

Question number	Indicative content	Mark
*9(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Relevant sizes of components • Length of bar • Number of teeth on gear(s) • Size / circumference / radius / diameter of gear(s) • Size / circumference radius / diameter of drum Equations • Work done = force x distance moved • Moment of force = force x (perpendicular) distance (normal to the direction of the force) • Efficiency = useful energy transferred / total energy supplied • Speed = distance travelled / time taken • Gear ratio determines relative rotational speed of gears • Power = work done ÷ time taken Links between equations and sizes of components • Work done by effort = force x distance moved by (end of) handle around rotations • Work done on load = force x distance moved/raised • Moment of effort = effort x length of handle • Moment of force of gear Y on gear X = force x radius of Y • Moment of load on drum = load x radius of drum	(6) A01 A03

Level	Mark	Descriptor
	0	No awardable content
Level 1	1–2	- Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) - Analyses the scientific information but understanding and connections are flawed. (AO3)
Level 2	3–4	- Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) - Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. (AO3)
Level 3	5–6	- Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) - Analyses the scientific information and provide logical connections between scientific enquiry, techniques and procedures. (AO3)



Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> Isolated sizes or equations	<u>Possible candidate responses</u> How long the handle is and how big the gears are.
Level 2	3–4	<u>Additional guidance</u> Size linked to a relevant equation	<u>Possible candidate responses</u> Moment of = force x distance so a long handle makes it easier to turn
Level 3	5–6	<u>Additional guidance</u> Use of size in a calculation	<u>Possible candidate responses</u> A long bar means that the distance moved by the effort in one turn of the handle is bigger than the distance moved by the load. Because work done = force x distance, the effort is less than the load for the same amount of work done.

Total for Question 9 = 12 marks

