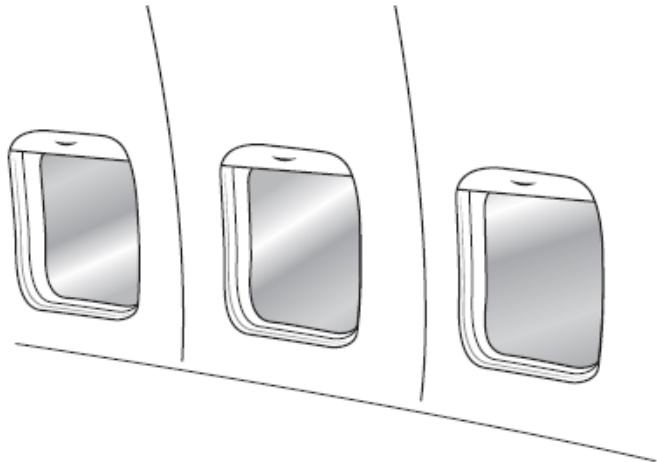


## Questions

Q1.

This question is about pressure.

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)

$$\text{pressure difference} = \dots \text{Pa}$$

(ii) The surface area of the window is 0.094 m<sup>2</sup>.

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)

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

(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)

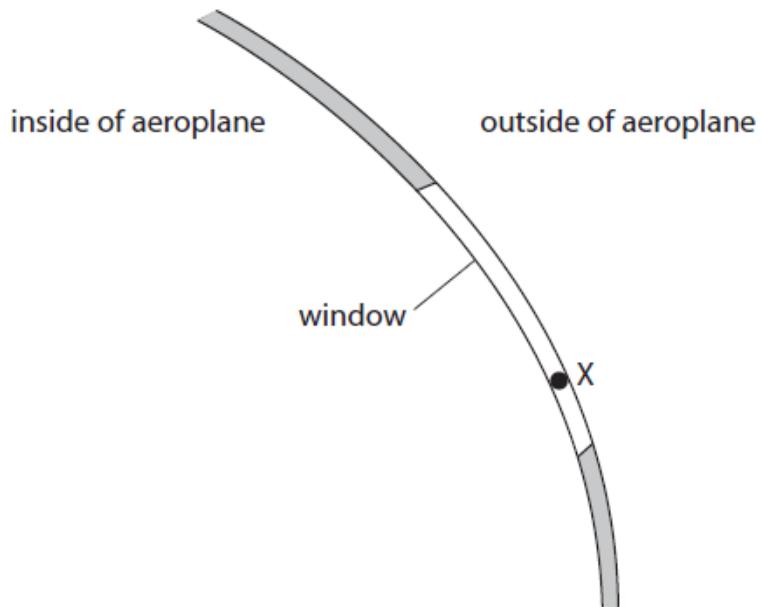
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- (iv) Figure 6 shows a cross-section through the aeroplane including one window.



**Figure 6**

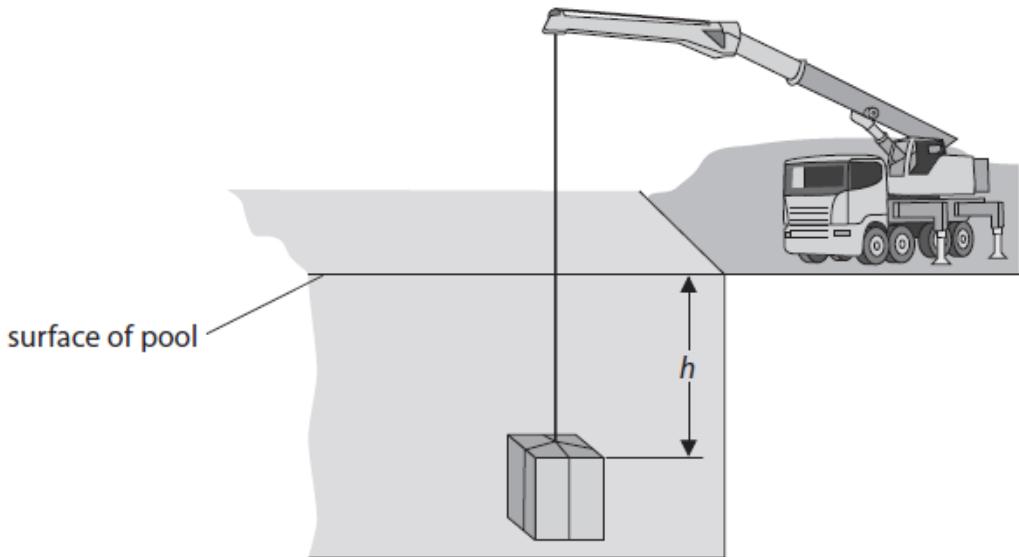
Draw an arrow on Figure 6 to show the direction of the resultant force due to the air pressure inside the cabin on the window at point X.

(2)

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

Q2.

Figure 17 shows a crane lifting a concrete block from the bottom of a deep pool of water. The top of the block is a distance,  $h$ , below the surface of the water.



**Figure 17**

The force on the top of the block due to the water above it is 41 000 N.

The pressure due to the water on the top surface of the block is 66 000 Pa.

- (i) Calculate the area of the top surface of the block.

(2)

$$\text{area of the top surface of the block} = \dots \text{m}^2$$

- (ii) The density of water is  $1000 \text{ kg/m}^3$ .

Calculate the distance,  $h$ , between the top of the block and the surface of the water.

Gravitational field strength,  $g$ , is  $10 \text{ N/kg}$ .

Use an equation selected from the list of equations at the end of this paper.

(2)

$$h = \dots \text{m}$$

- (iii) Explain why there is an upthrust produced by the water on the block.

(2)

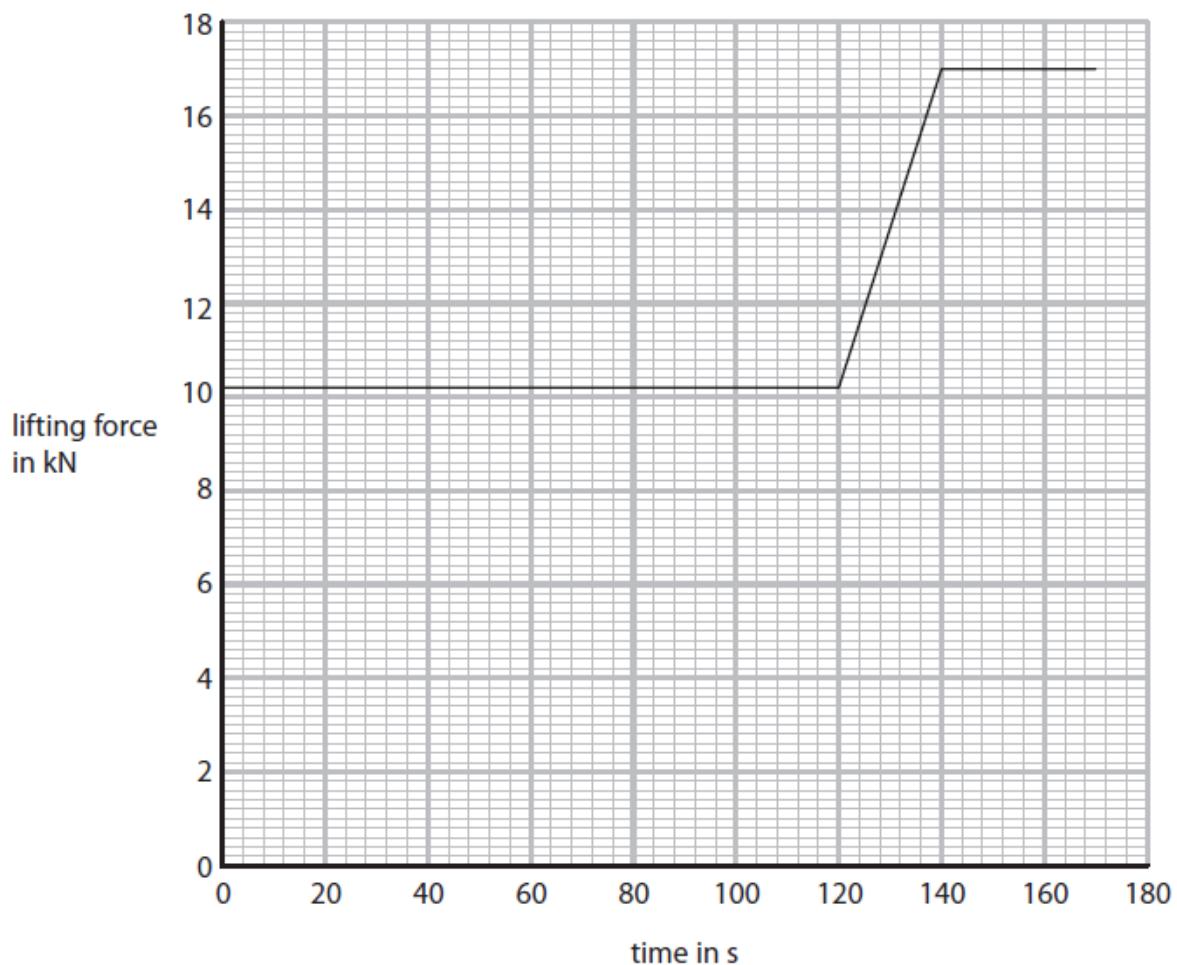
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- \* (iv) The crane raises the block until it is high enough out of the water to be loaded on to a lorry.

The block moves upwards at a constant speed even though the lifting force in

the cable changes.

Figure 18 shows the graph of how the lifting force changes while the block is being raised.



**Figure 18**

Explain why the lifting force changes as shown on the graph in Figure 18.  
Include calculation(s) in your answer.

(6)

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(Total for question = 12 marks)

Q3.

Figure 8 shows some water in a tank.



Figure 8

- (i) The bottom of the tank has an area of  $0.80 \text{ m}^2$ .

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)

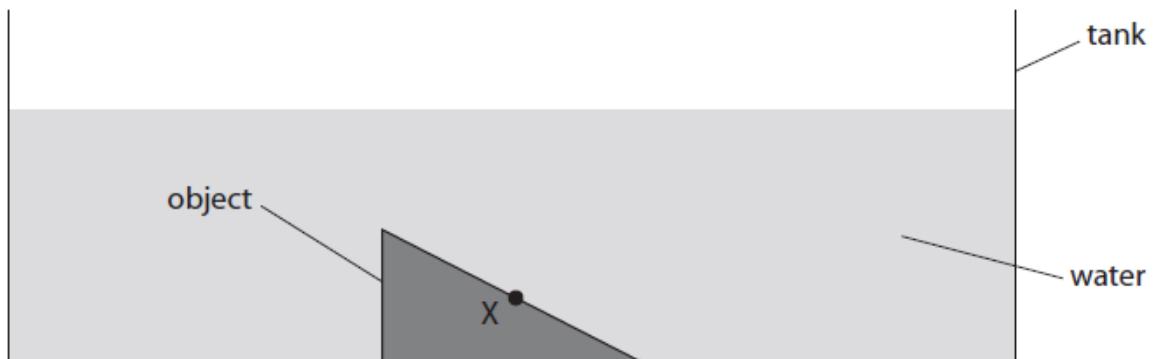
pressure = ..... Pa

- (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)

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



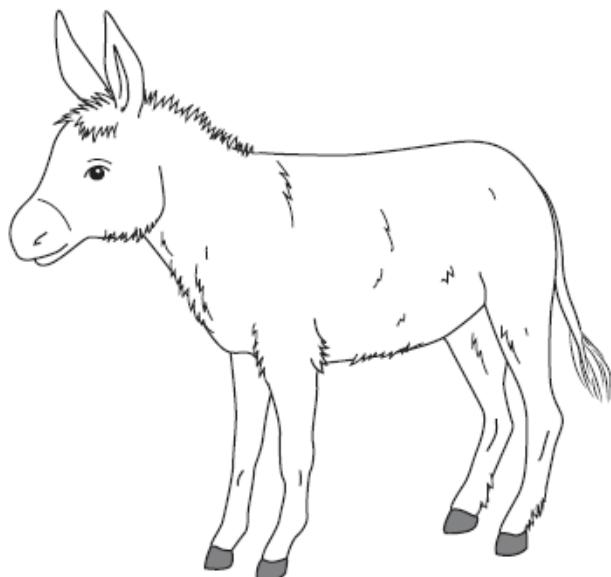
**Figure 9**

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)

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

Q4.



**Figure 6**

A donkey has a weight of 2500 N.

The area of each hoof is 0.022 m<sup>2</sup>.

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

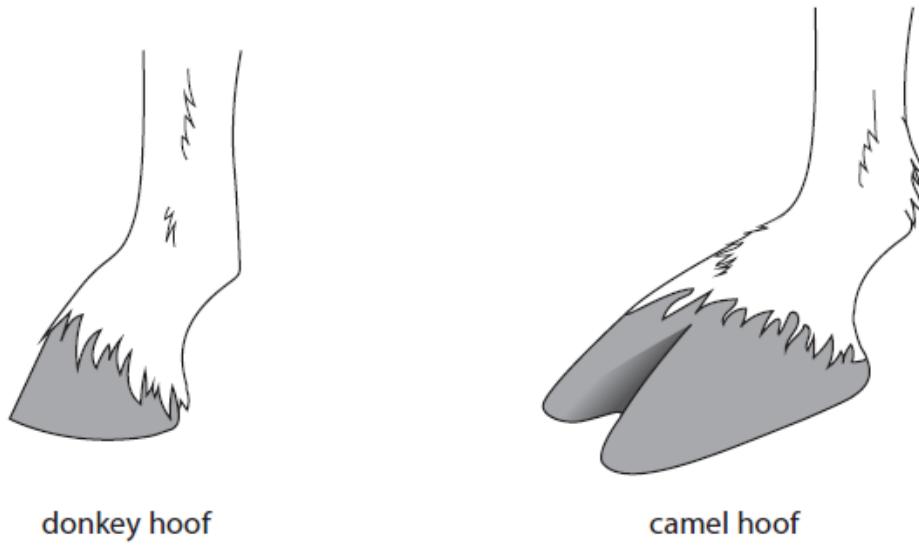
Use the equation

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

(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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.....  
.....  
**(Total for question = 4 marks)**

Q5.

Figure 1 shows a pool full of water.



(Source: © AnaKulagina/Shutterstock)

**Figure 1**

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

The density of water is  $10^3 \text{ kg/m}^3$ .

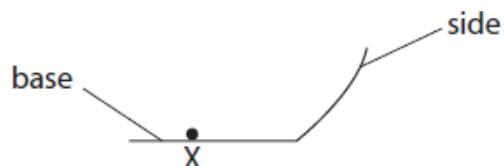
The gravitational field strength,  $g$ , = 10 N/kg.

Calculate the depth of the water in the pool.

(2)

$$\text{depth} = \dots \text{ m}$$

(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)

**(Total for question = 3 marks)**

Q6.

Figure 1 shows a pool full of water.



(Source: © AnaKulagina/Shutterstock)

**Figure 1**

A small hole is made in the base of the large pool shown in Figure 1.

The area of the hole is  $1.5 \text{ mm}^2$ . 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

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

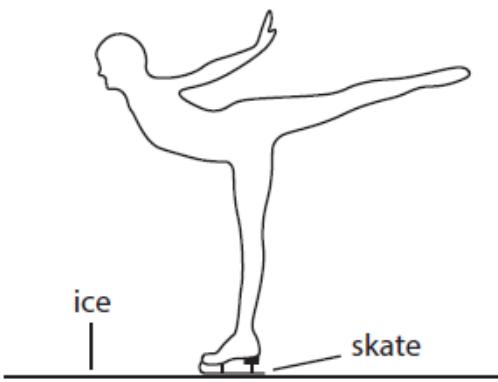
(2)

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

**(Total for question = 2 marks)**

Q7.

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 =  $4.8 \times 10^7$  Pa

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

force = pressure × area

Give your answer to 2 significant figures.

(3)

force = ..... N

**(Total for question = 3 marks)**

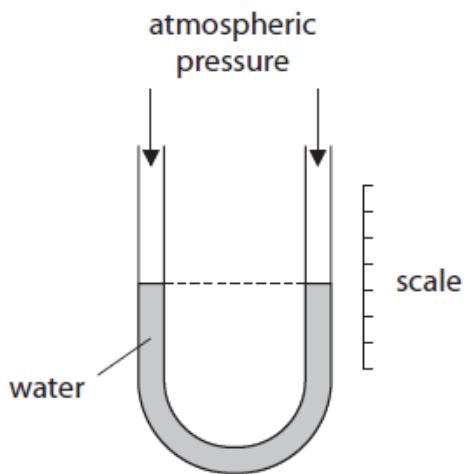
Q8.

Figure 26 shows a glass U-tube containing water of density 1000 kg/m<sup>3</sup>.

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

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

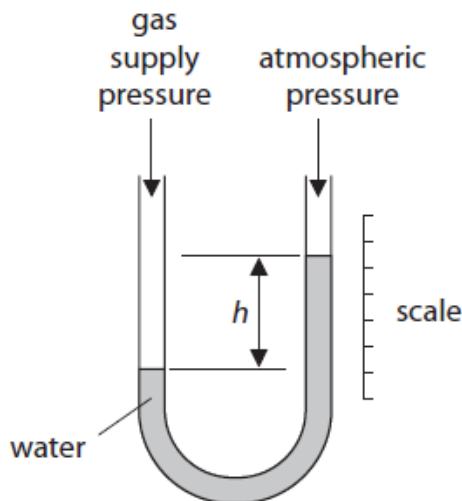
Atmospheric pressure is 101 000 N/m<sup>2</sup>.



**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)

$$\text{pressure of gas supply} = \dots \text{N/m}^2$$

(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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**(Total for question = 5 marks)**

Q9.

Figure 16 shows a beaker containing 150 g of water.



**Figure 16**

The cross-sectional area of the bottom of the beaker is  $3.3 \times 10^{-3} \text{ m}^{-2}$ .

Calculate the pressure at the bottom of the beaker due to the water.

Take gravitational field strength, g, to be 10 N/kg.

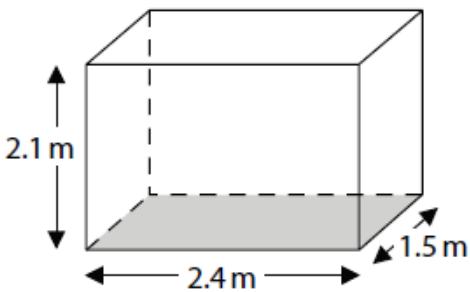
(2)

pressure = ..... Pa

**(Total for question = 2 marks)**

Q10.

Figure 2 shows a tank for holding water.



**Figure 2**

The tank has sides of 2.4 m, 2.1 m and 1.5 m.

The pressure at the bottom of the tank is 12 kPa.

- (i) State the equation relating pressure, force and area.

(1)

- (ii) Calculate the weight of water in the tank.

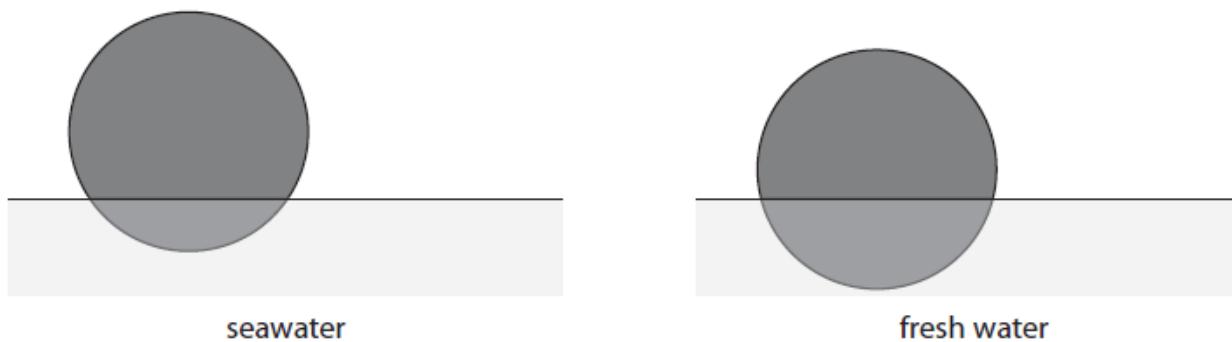
(4)

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

**(Total for question = 5 marks)**

Q11.

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)

(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 = 4 marks)**

Q12.

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 mark)**

Q13.

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.

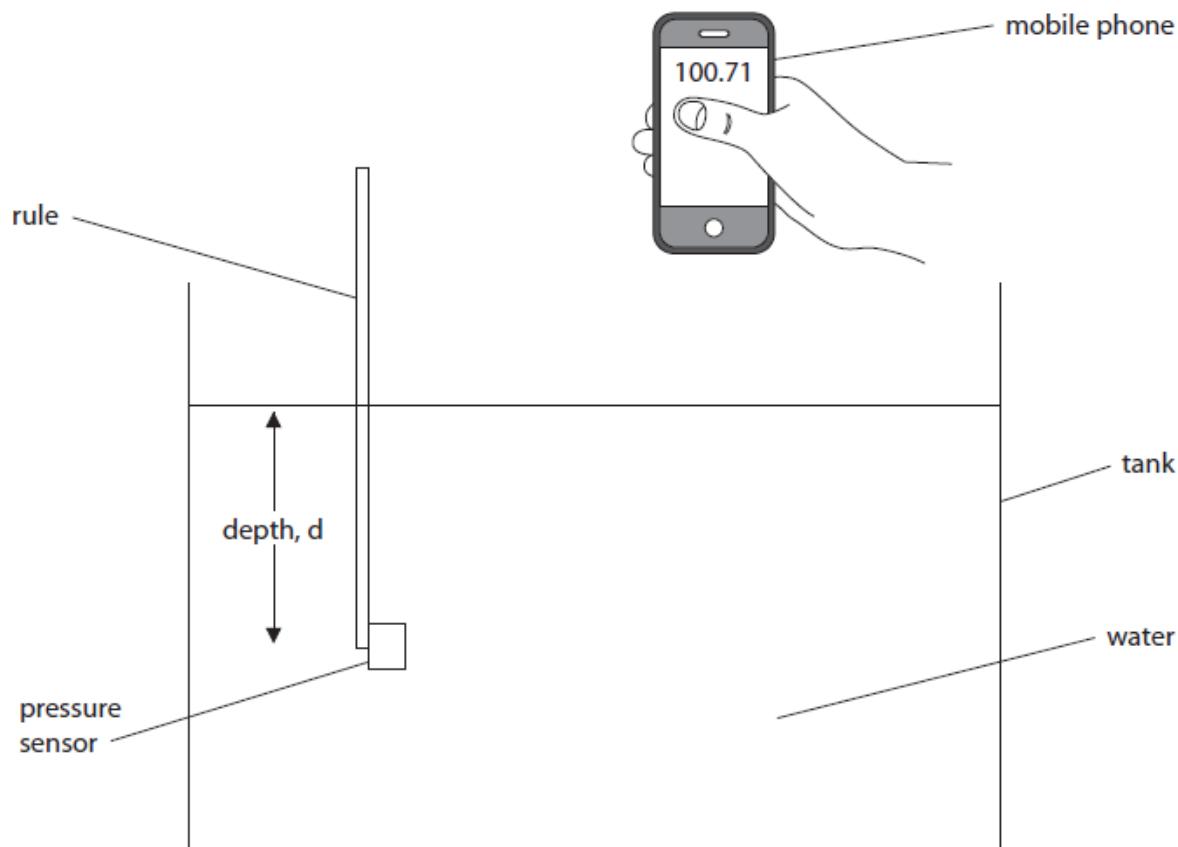


Figure 8

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

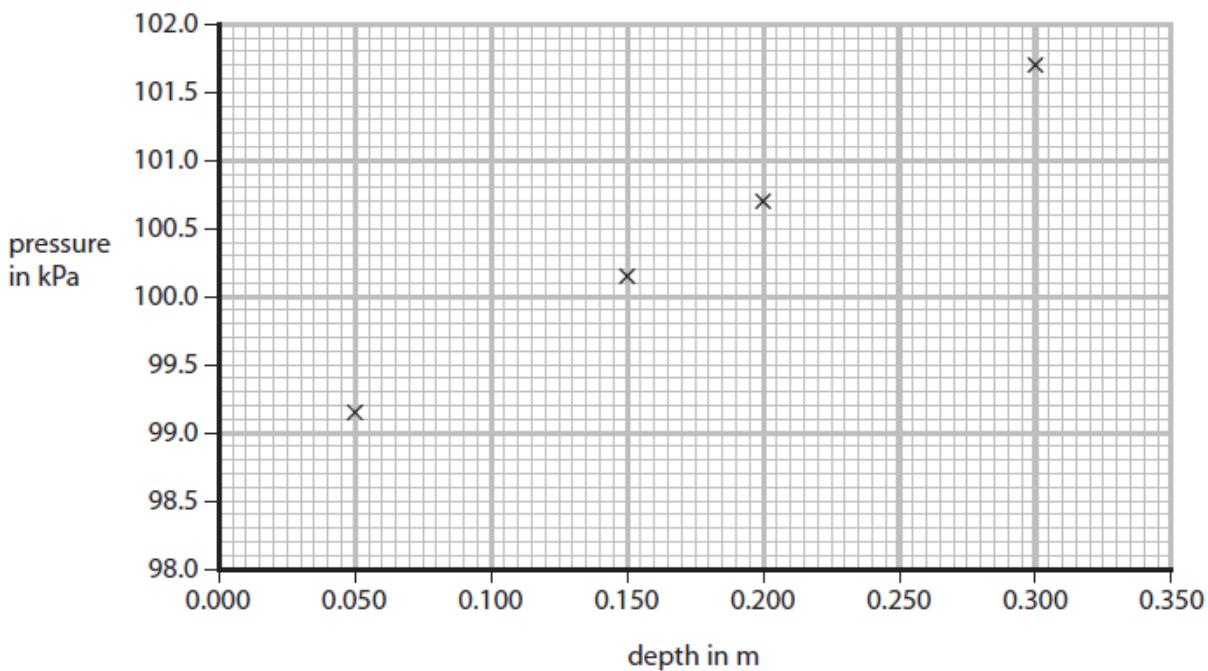
The pressure is displayed on the student's mobile phone which receives a signal from the pressure sensor.

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**

The student repeats the investigation using seawater and draws a graph of the results.

The seawater is more dense than the water used previously.

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

(2)

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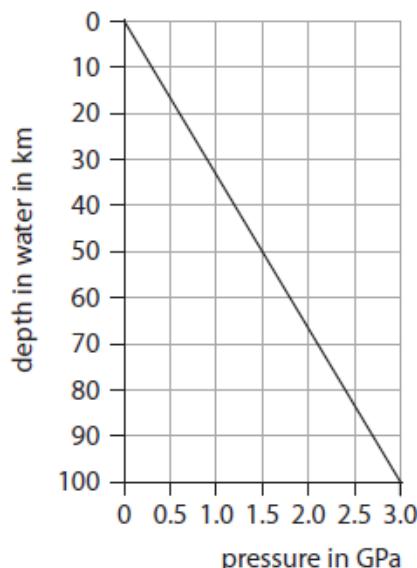
**(Total for question = 2 marks)**

Q14.

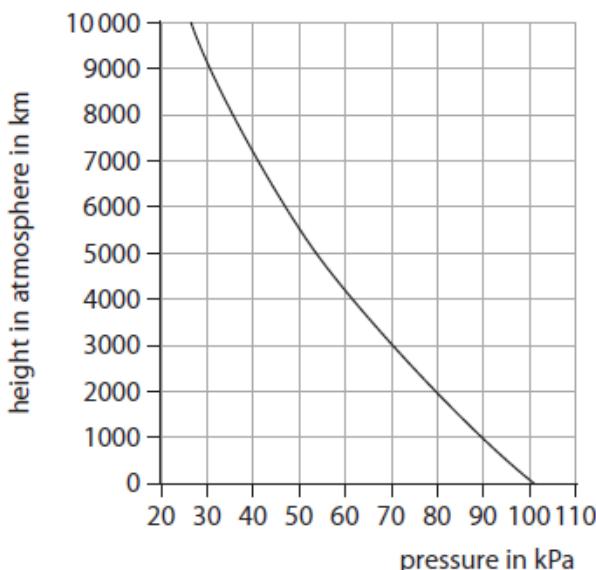
Figure 17 shows information about the pressures in the ocean and in the atmosphere of a distant planet.

Graph A shows the variation of pressure as the depth in the ocean increases.

Graph B shows the variation of pressure as the height in the atmosphere increases.



## Graph A



### Graph B

**Figure 17**

- (i) Use information from Graph A to obtain a value for the density of the ocean water.

Use an equation selected from the list of equations at the end of this paper.

(4)

density = ..... kg/m<sup>3</sup>

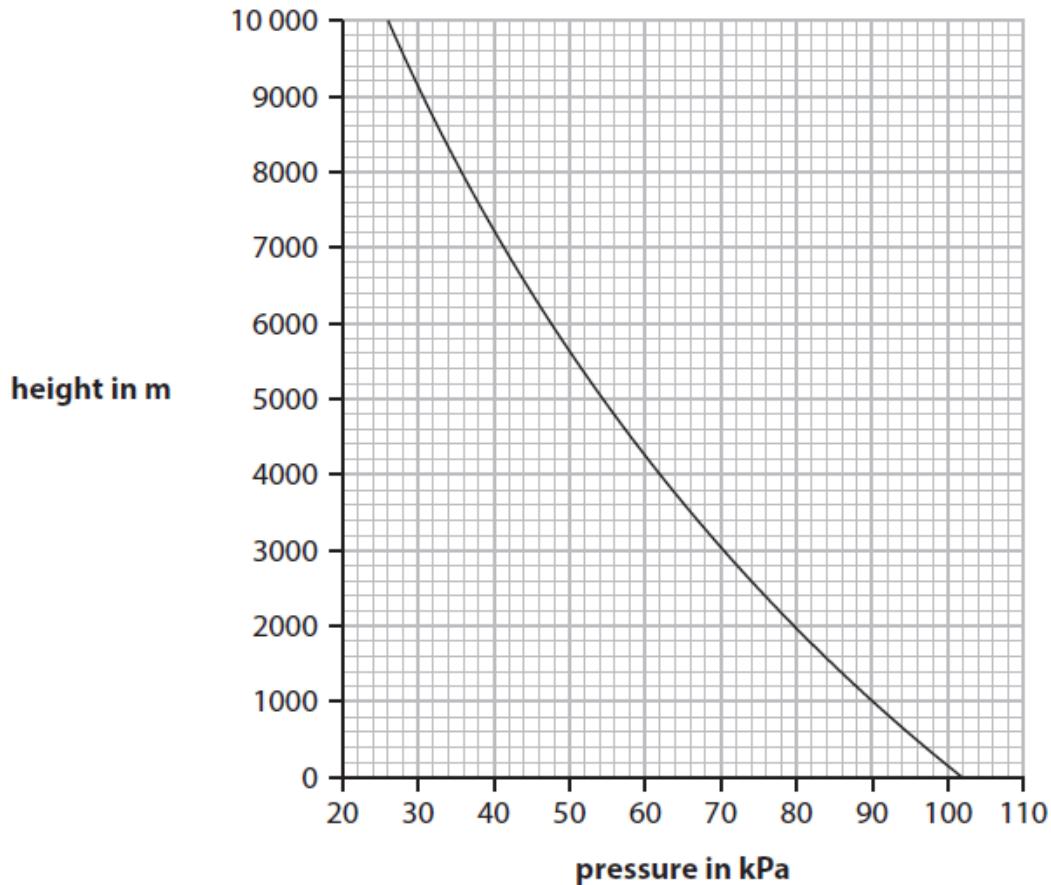
- \* (ii) Explain the similarities and differences in the pressure variations shown in graphs A and B.

Your answer should refer to both the particle model (kinetic theory) and to density.

(6)

Q15.

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)**

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.....  
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(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)

$$\text{pressure} = \dots \text{ kPa}$$

- (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)

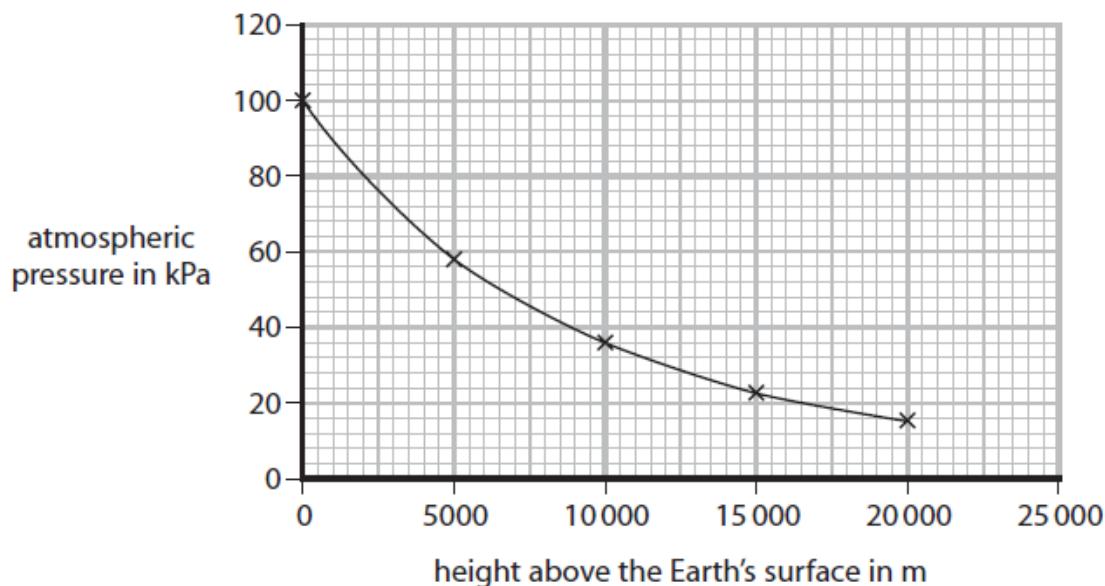
$$\text{percentage change} = \dots \% \quad$$

**(Total for question = 5 marks)**

Q16.

This question is about pressure.

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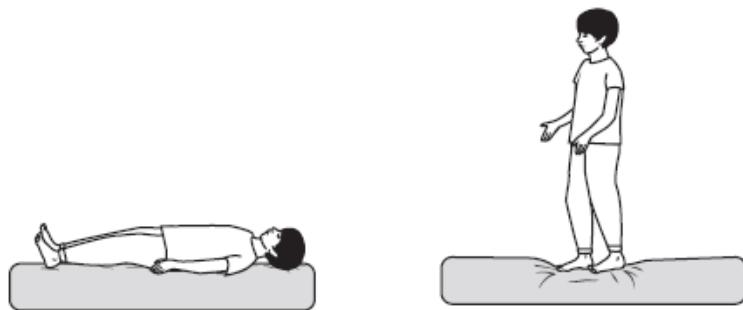
(ii) Suggest **one** reason why the atmospheric pressure changes with height above the Earth's surface.

(1)

**(Total for question = 4 marks)**

Q17.

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



**Figure 11**

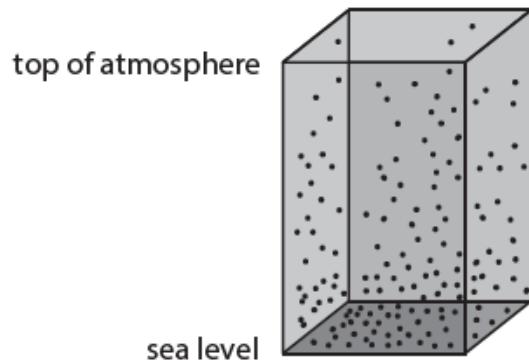
Explain why the person exerts a different pressure on the bed when standing up than when lying down.

(2)

**(Total for question = 2 marks)**

Q18.

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 = 2 marks)**

Q19.

Figure 3 shows three containers A, B, and C.

Each container contains a liquid, as shown.

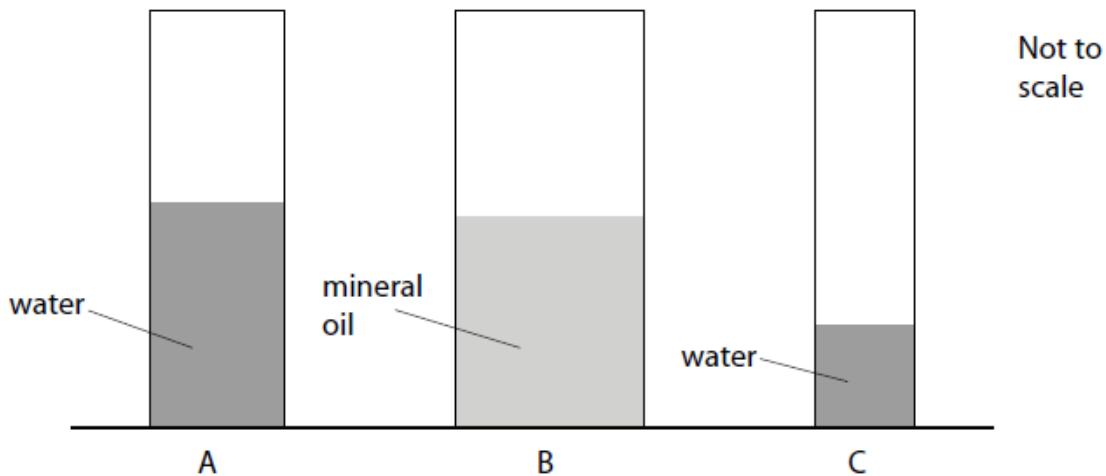


Figure 4 gives some data about the liquids and containers.

| container | area of base<br>(cm <sup>2</sup> ) | name of liquid | density of liquid<br>(g/cm <sup>3</sup> ) | depth of liquid<br>in container<br>(cm) |
|-----------|------------------------------------|----------------|---|---|
| A         | 16                                 | water          | 1.00                                      | 50.00                                   |
| B         | 32                                 | mineral oil    | 0.91                                      | 50.00                                   |
| C         | 12                                 | water          | 1.00                                      | 25.00                                   |

**Figure 4**

Explain which container has the highest pressure at the bottom, and which container has the lowest.

Use information from Figure 3 and Figure 4.

(3)

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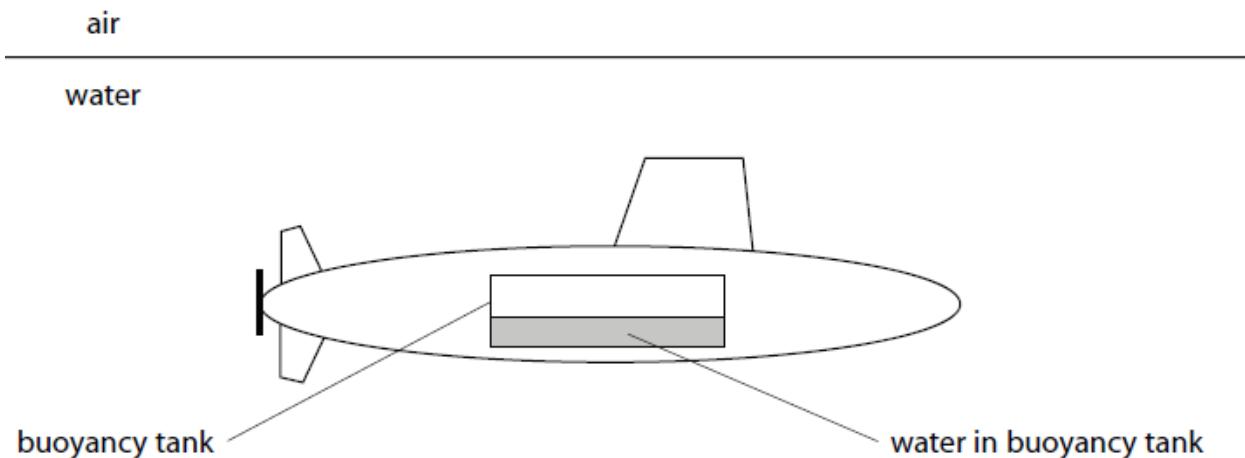
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**(Total for question = 3 marks)**

Q20.

\* Figure 26 shows the submarine stationary and submerged at a depth of 10 m.



**Figure 26**

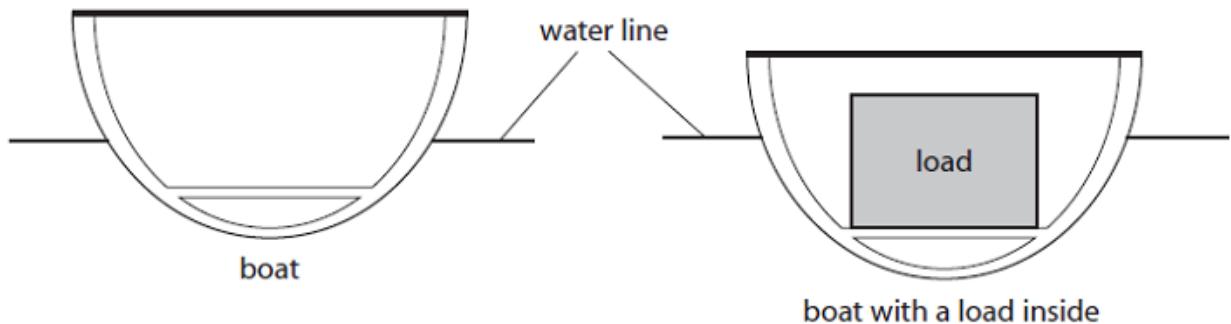
Explain how pumping water into and out of the buoyancy tank affects the depth of the submarine below the surface.

(6)

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

Q21.

\*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.

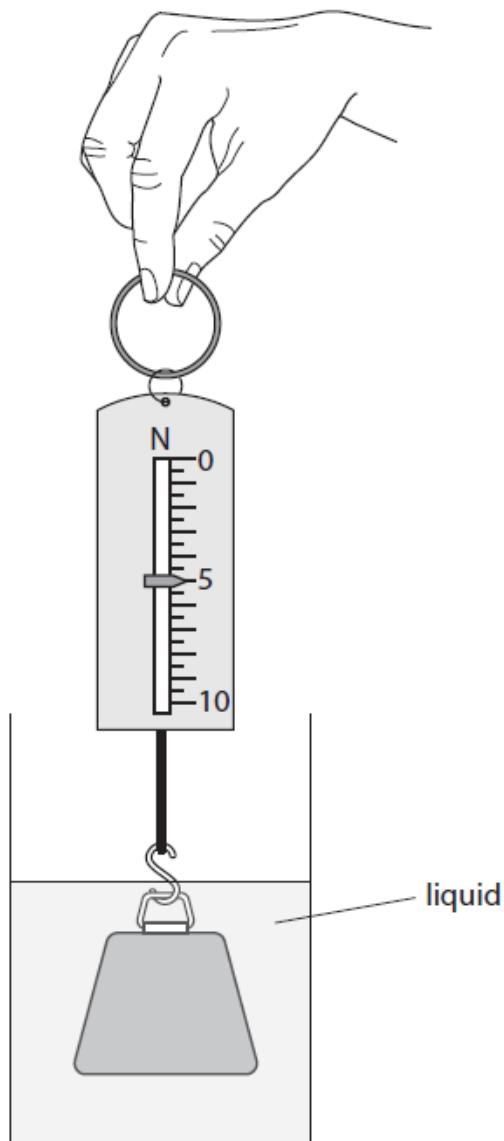
(6)

Q22.

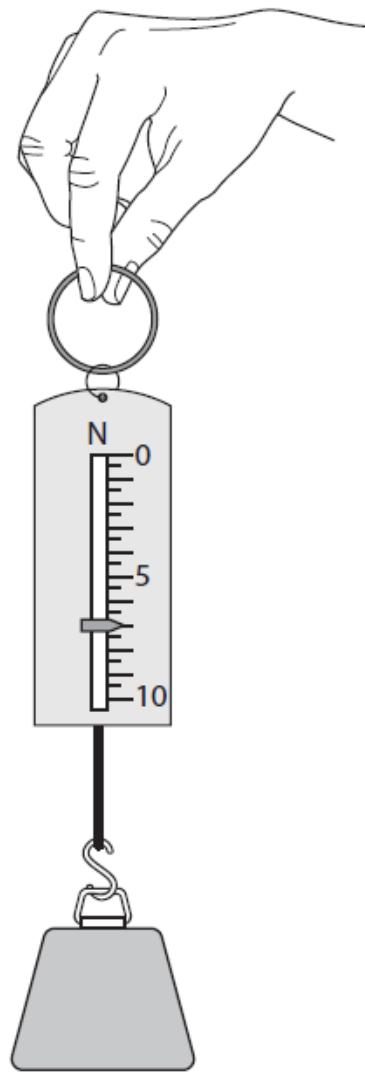
Figure 20 shows a metal block being weighed by a newton meter (force meter).

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

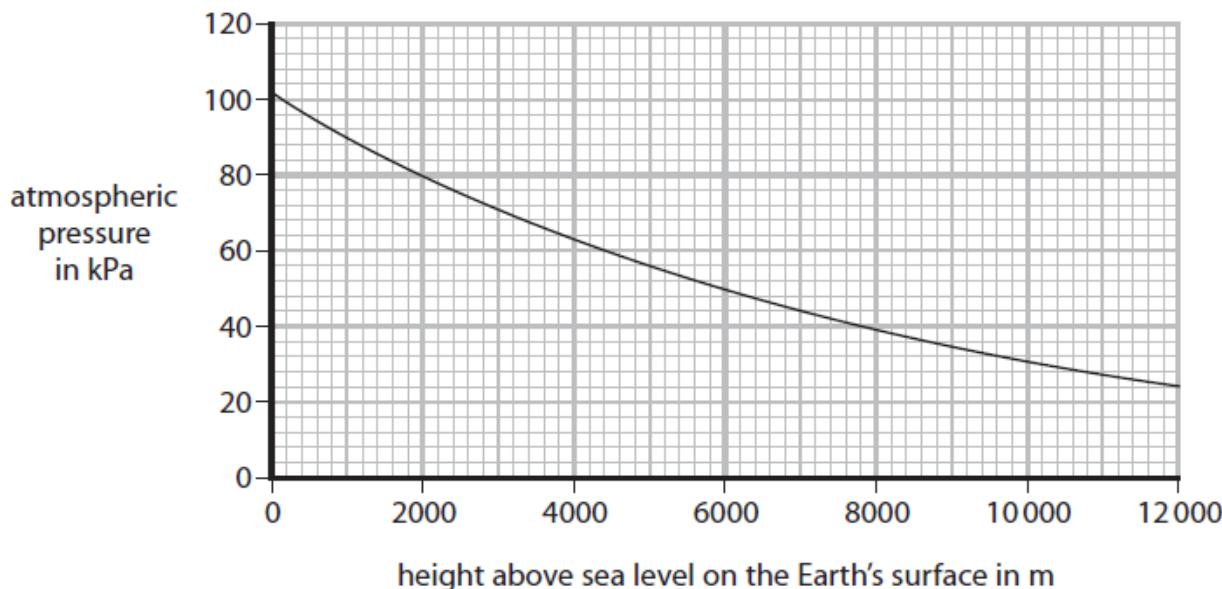
(4)

$$\text{density} = \dots \text{kg/m}^3$$

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

Q23.

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)

$$\text{change in pressure} = \dots \text{kPa}$$

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

(1)

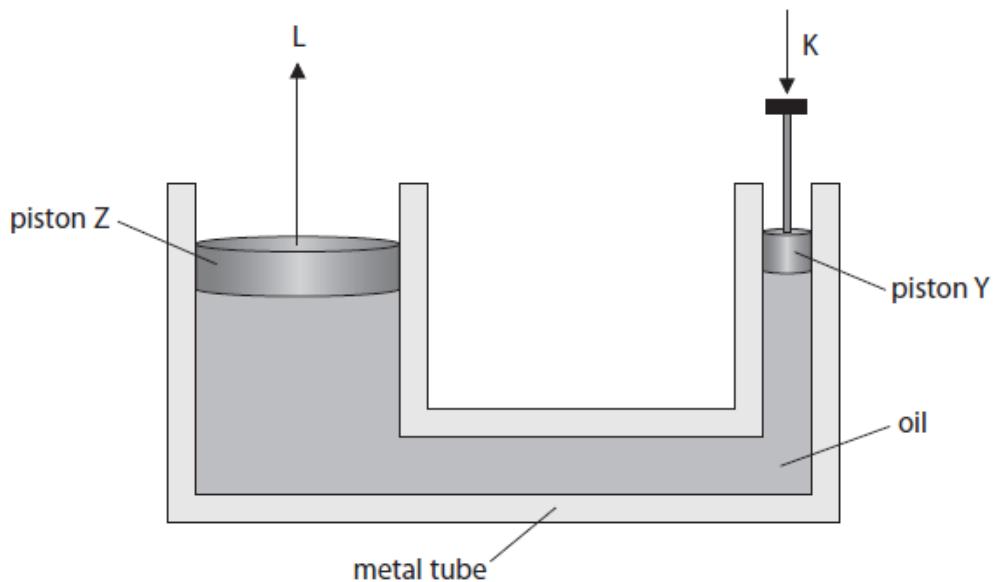
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**(Total for question = 3 marks)**

Q24.

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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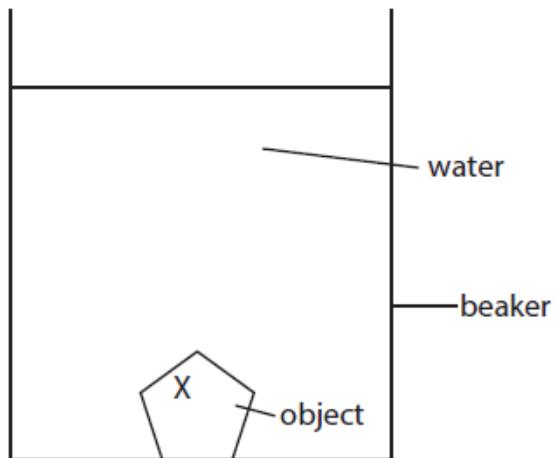
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(Total for question = 3 marks)

Q25.

**Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).**

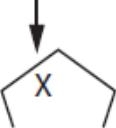
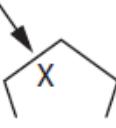
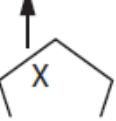
Figure 9 shows an object at the bottom of a beaker of water.



**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 

(Total for question = 1 mark)

Q26.

**Answer the question with a cross in the box you think is correct (). If you change your mind about an answer, put a line through the box () and then mark your new answer with a cross ().**

Figure 1 shows a pool full of water.



(Source: © AnaKulagina/Shutterstock)

**Figure 1**

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

**(Total for question = 1 mark)**

Q27.

**Answer the question with a cross in the box you think is correct  . If you change your mind about an answer, put a line through the box  and then mark your new answer with a cross  .**

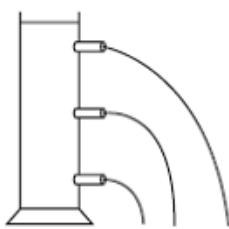
Figure 25 shows four identical metal cans, each filled with water to the same level.

Each can has three tubes.

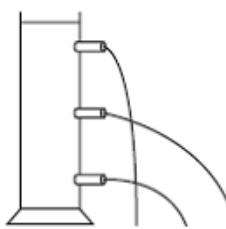
Water comes out of each tube.

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

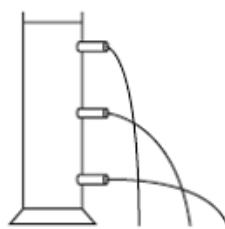
(1)



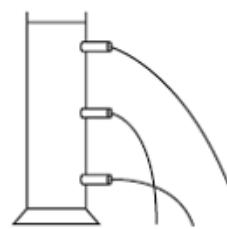
A



B



C



D

**(Total for question = 1 mark)**

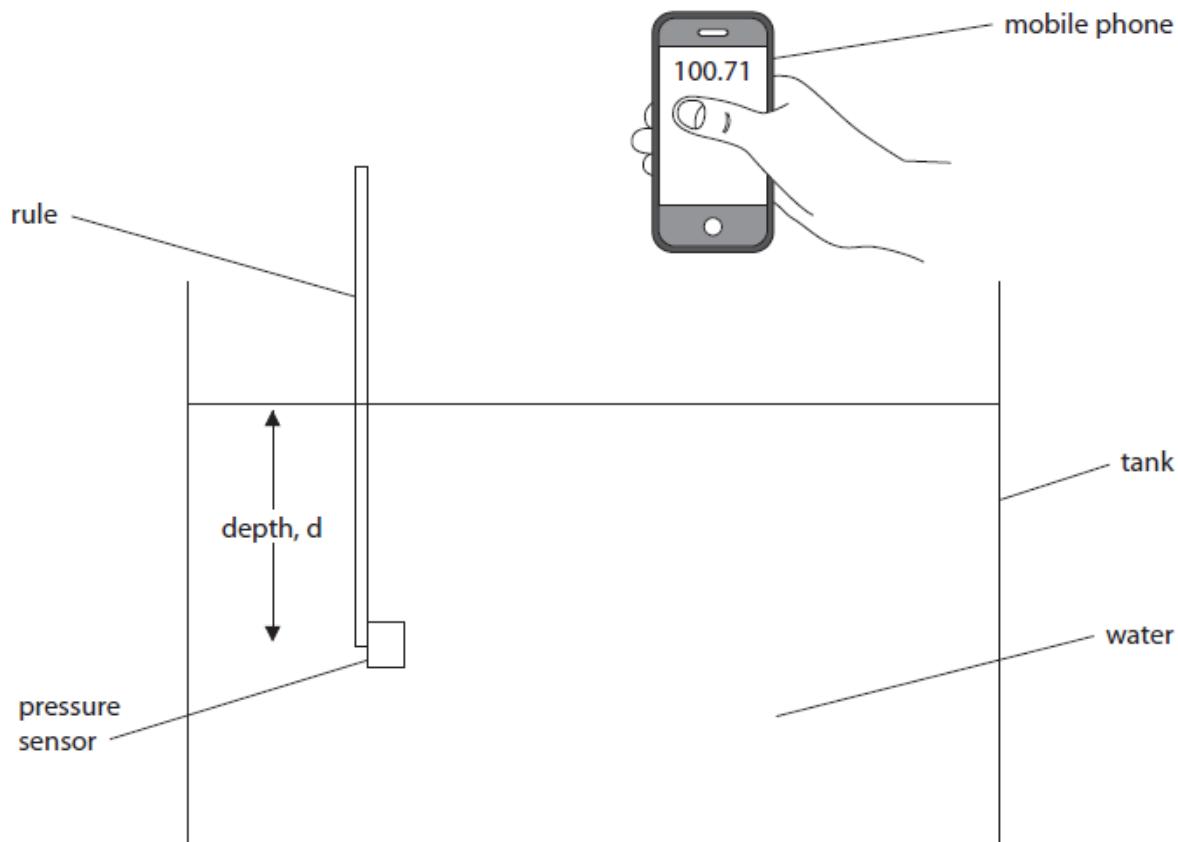
Q28.

**Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).**

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.

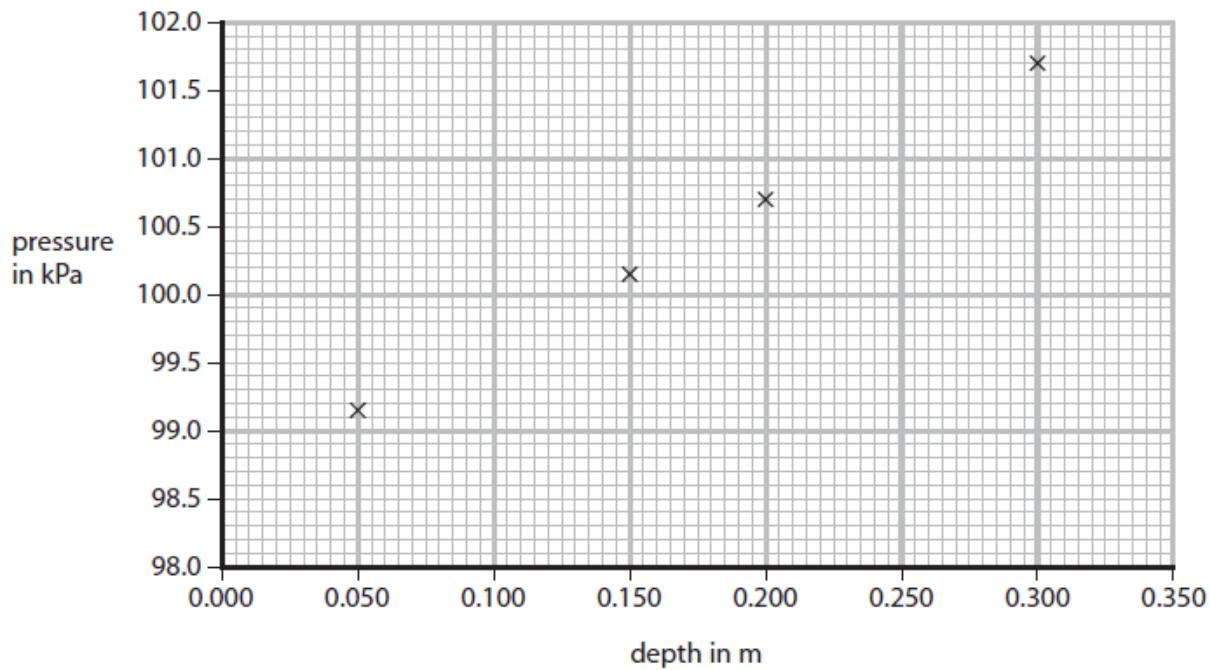
Figure 9 gives some of the readings.

| 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 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 sea water = ..... kPa

**(Total for question = 5 marks)**

Q29.

A student is interested in the way that submarines are controlled.

She has several regular wooden blocks, a set of weights and a tank of water. Wood floats in water.

The student plans to immerse the wooden blocks fully in the water and investigate the relationship between the upthrust and the weight of water displaced.

Describe how she should determine **one** of the variables in this investigation.

(2)

.....  
.....  
.....  
.....

**(Total for question = 2 marks)**

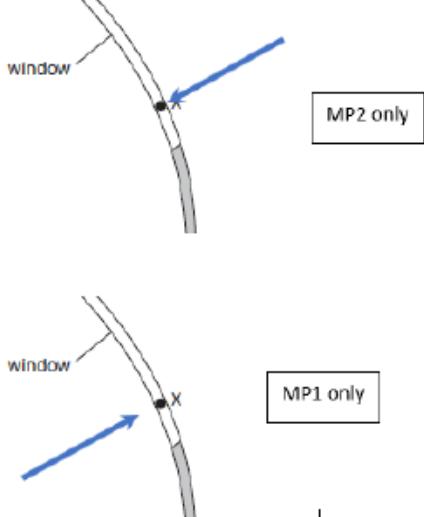
## Mark Scheme

Q1.

| Question number | Answer  | Additional guidance     | Mark              |
|-----------------|---|-------------------------|-------------------|
| (i)             | $(80\ 000 - 23\ 000)$<br>$57\ 000 \text{ (Pa)}$ (1) | $-57\ 000 \text{ (Pa)}$ | (1)<br><b>AO2</b> |

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

| Question number | Answer  | Additional guidance              | Mark              |
|-----------------|---|----------------------------------|-------------------|
| (iii)           | force is less (on small window) (1)<br><br>pressure is the same (1) | force is greater on large window | (2)<br><b>AO1</b> |

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

Q2.

| Question Number | Answer  | Additional guidance  | Mark |
|-----------------|---|--|------|
| (i)             | recall (1)<br>$(P =) \frac{F}{A}$<br><br>re-arrangement and evaluation (1)<br>$A = 0.62 \text{ (m}^2\text{)}$ | accept for recall<br>$66\ 000 = \frac{41\ 000}{A}$<br>or<br>$A = \frac{41\ 000}{66\ 000}$<br><br>allow values that round to 0.62 e.g. 0.621<br><br>award full marks for the correct answer without working | (2)  |

| Question Number | Answer  | Additional guidance   | Mark |
|-----------------|---|---|------|
| (ii)            | substitution into $P = h \times \rho \times g$ (1)<br>$66000 = h \times 1000 \times 10$<br><br>re-arrangement and evaluation (1)<br>$(h =) 6.6 \text{ (m)}$ | award substitution mark if it is clear that all values have been substituted<br>$(h = \frac{66\ 000}{1\ 000 \times 10})$<br><br>award full marks for the correct answer without working | (2)  |

| Question Number | Answer   | Additional guidance   | Mark |
|-----------------|--|---|------|
| (iii)           | <p>An explanation linking<br/>the pressure at the bottom of<br/>the block is greater than the<br/>pressure at the top of the block<br/>(for the same area) (1)</p> <p>the force on the bottom is<br/>greater than the force on the<br/>top (1)</p> | <p>accept in terms of<br/>weight of fluid<br/>displaced</p> <p>the block displaces<br/>some water</p> <p>weight of water<br/>displaced is less than<br/>weight of (same<br/>volume) of concrete<br/><b>or</b><br/>water is less dense<br/>than concrete</p> <p>allow<br/>the upthrust (of<br/>water) is equal to the<br/>weight of the water<br/>displaced<br/>for <b>2</b> marks</p> | (2)  |

| Question Number | Answer  | Mark |
|-----------------|---|------|
| (iv)            | <p>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.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant.</p> <p>Additional content included in the response must be scientific and relevant.</p> <p><b>Between 0 and 120 seconds</b></p> <ul style="list-style-type: none"> <li>the (apparent) weight of the block is less than in air (AO2)</li> <li>force in the cable is less (than weight of block) (AO3)</li> <li>force remains constant because upthrust is constant (AO3)</li> <li>upthrust is constant because submerged volume of block is constant (AO3)</li> <li>upthrust = <math>(17.0 - 10.2) = 6.8 \text{ kN}</math> (AO3)</li> <li>lifting speed = <math>(\text{distance for top to reach surface} / \text{time to start to emerge}) = 6.6 / 120 = 0.055 \text{ m/s}</math></li> </ul> <p><b>Between 120 and 140 seconds</b></p> <ul style="list-style-type: none"> <li>block is emerging from water (AO3)</li> <li>less volume of the block remaining submerged (AO2)</li> <li>upthrust is reducing (AO3)</li> <li>force in the cable is increasing (AO2)</li> <li>it takes 20 seconds to fully emerge from water (AO3)</li> <li>height of block = lifting speed x time for top emerge = <math>0.055 \times 20 = 1.1 \text{ m}</math> (AO3)</li> </ul> | (6)  |

|  |  |  |
|--|--|--|
|  | <p><b>140 seconds onwards</b></p> <ul style="list-style-type: none"> <li>block is clear of the water (AO3)</li> <li>no upthrust (from water) on the block (AO2)</li> <li>force in cable is equal to weight of block (AO2)</li> <li>force is constant because weight is constant (AO2)</li> <li>mass of block = weight in air / 10 = <math>17000 / 10 = 1700 \text{ kg}</math> (AO3)</li> <li>height of lorry = lifting speed x time to reach end of lift = <math>= 0.055 \times 30 \text{ s} = 1.7 \text{ m}</math> (AO3)</li> </ul> <p><b>At all times</b></p> <ul style="list-style-type: none"> <li>(speed is constant) so no force required to accelerate the block (AO2)</li> <li>so force is resultant of weight and upthrust (AO2)</li> </ul> <p><b>Other calculations are possible, eg:</b></p> <ul style="list-style-type: none"> <li>Volume of block = height x area = <math>1.1 \times 0.62 = 0.68 \text{ m}^3</math></li> <li>Density of block = <math>1700 / 0.68 = 2500 \text{ kg/m}^3</math></li> </ul> |  |
|--|--|--|

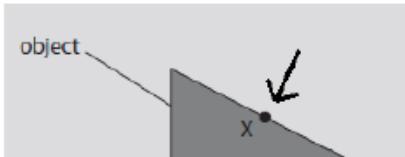
| Descriptor   |
|--|
| <ul style="list-style-type: none"> <li>• No awardable content</li> </ul>   |
| <ul style="list-style-type: none"> <li>• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3)</li> </ul>                              |
| <ul style="list-style-type: none"> <li>• 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. (AO2)</li> </ul>                     |
| <ul style="list-style-type: none"> <li>• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3)</li> </ul>  |
| <ul style="list-style-type: none"> <li>• 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. (AO2)</li> </ul> |
| <ul style="list-style-type: none"> <li>• Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3)</li> </ul>  |
| <ul style="list-style-type: none"> <li>• 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. (AO2)</li> </ul>       |

| Summary for guidance |      |  |  |
|----------------------|------|--|--|
| 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><br>Isolated facts with limited quantitative work e.g. identifies the change in lifting force and gives a reason why it changes.   | <u>Possible candidate responses</u><br>The lifting force increases because the block is being lifted out of the water  |
| Level 2              | 3-4  | <u>Additional guidance</u><br>Limited explanation that includes extracting data (from either one section of the graph or elsewhere in the question) to provide a reason why the force changes      | <u>Possible candidate responses</u><br>Between 120 and 140s the lifting force increases. This is because the block is being lifted out of the water and there is less upthrust.  |
| Level 3              | 5-6  | <u>Additional guidance</u><br>Detailed explanation that includes calculation(s) relevant to one section of the graph and correct explanation relevant to the middle section and one other section. | <u>Possible candidate responses</u><br>When underwater, the lifting force is smaller because of upthrust from the water.<br>$\text{The upthrust} = 17 - 10.2 = 6.8 \text{ kN}$ The lifting force increases after 120s because it is being lifted out of the water and the upthrust is getting smaller. |

Q3.

| Question number | Answer   | Additional guidance   | Mark              |
|-----------------|--|---|-------------------|
| i               | recall (1)<br>$P = \frac{F}{A}$<br>substitution (1)<br>$(p) = \frac{2400}{0.8}$<br>evaluation<br>$(P) = 3000 \text{ (Pa)} \quad (1)$ | may be implied by a correct substitution<br><br>award full marks for the correct answer without working | <b>(3)</b><br>AO2 |

| Question number | Answer  | Additional guidance   | Mark              |
|-----------------|---|---|-------------------|
| ii              | an explanation linking greater pressure (on bottom of tank) (1)<br><br>with<br><br>greater force <b>due to water</b> (above bottom of tank) (1) | more weight of water<br>more depth/height of water<br><br>ignore simply 'more water' or 'greater amount of water' | <b>(2)</b><br>AO1 |

| Question number | Answer  | Additional guidance | Mark              |
|-----------------|---|---------------------|-------------------|
| iii             | <br><br>an arrow perpendicular to the sloping side <b>and</b> pointing towards X | judge by eye        | <b>(1)</b><br>AO1 |

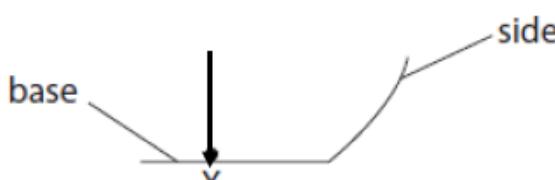
Q4.

| Question number | Answer  | Additional guidance   | Mark                |
|-----------------|---|---|---------------------|
| (i)             | <p>substitution (1)<br/>           (pressure =) <math>\frac{2500}{4 \times 0.022}</math></p> <p>evaluation (1)<br/>           28 000 (Pa)</p> | <p>any number rounding to 28 000 e.g. 28 400, 28 410, 28 409</p> <p>award full marks for the correct answer without working</p> <p>award <b>one</b> mark for numbers that round to 110 000 (Pa) (missing 4 in denominator)</p> <p>award 1 mark for 454 545 (times by 4)</p> | (2)<br><b>AO2.1</b> |

| Question number | Answer   | Additional guidance   | Mark                |
|-----------------|--|---|---------------------|
| (ii)            | <p>An explanation linking any <b>two</b> from</p> <p>camel is less likely to sink into the soft ground (1)</p> <p>(same) force / weight is distributed / spread out (1)</p> <p>camel's hoof has greater (surface) area (than donkey) (1)</p> <p>camel's hoof exerts less pressure (than it would if hoof were smaller) (1)</p> | <p>ORA for donkey</p> <p>ignore pressure is spread out</p> <p>wider</p> <p>if no other marks scored then allow 1 mark for split in camel hoof enables better grip (as it walks)</p> | (2)<br><b>AO3.1</b> |

Q5.

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

| Question number | Answer  | Additional guidance  | Mark                |
|-----------------|---|--|---------------------|
| (ii)            | <p>A straight, vertical, downwards arrow as shown</p>  | <p>Judge by eye.</p> <p>Arrow tip or tail (extended if necessary) must pass through point X.</p> | (1)<br><b>AO1.1</b> |

Q6.

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

Q7.

| Question number | Answer   | Additional guidance  | Mark         |
|-----------------|--|--|--------------|
|                 | <p>substitution (1)</p> <p>(force =) <math>4.8 \times 10^7 \times 1.2 \times 10^{-5}</math></p> <p>evaluation (1)</p> <p>576 (N)</p> <p>their evaluation rounded to 2sf (1)</p> <p>580 (N)</p> | <p>award full marks for the correct answer (580) without working</p> <p>award 1 mark for 5.76 to any other power of ten</p> <p>award 2 marks for 5.8 to any other power of ten</p> | (3)<br>AO2.1 |

Q8.

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

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

Q9.

| Question number | Answer   | Additional guidance   | Mark |
|-----------------|--|---|------|
|                 | <p>recall and use of <math>P = \frac{F}{A}</math> (1)</p> <p>evaluation (1)<br/>= 450 (Pa)</p> | $P = \frac{0.15 \times 10}{3.3 \times 10^{-3}}$<br>454 (Pa) | (2)  |

Q10.

| Question number | Answer                  | Mark |
|-----------------|-------------------------|------|
| (i)             | pressure = force ÷ area | (1)  |

| Question number | Answer  | Additional guidance  | Mark |
|-----------------|---|--|------|
| (ii)            | <p>rearrangement (1)<br/> <math>F = P \times A</math></p> <p>calculation of area (1)<br/> <math>2.4 \times 1.5 = 3.6</math></p> <p>substitution (1)<br/> <math>F = 12\,000 \times 3.6</math></p> <p>answer (1)<br/> <math>43\,200\text{ (N)}</math></p> | <p>award full marks for correct numerical answer without working</p> <p>maximum 3 marks if kPa not converted to Pa</p> | (4)  |

Q11.

| Question number | Answer                                 | Additional guidance | Mark       |
|-----------------|--|---------------------|------------|
| (i)             | (upthrusts in each case) are equal (1) |                     | (1)<br>AO3 |

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

Q12.

| Question number | Answer                                      | Additional guidance                         | Mark                 |
|-----------------|---|---|----------------------|
|                 | (force below the bigger hole is) larger (1) | accept force below original hole is smaller | <b>(1)<br/>AO1.1</b> |

Q13.

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

Q14.

| Question number | Answer   | Additional guidance  | Mark |
|-----------------|--|--|------|
| (i)             | <p>rearrange <math>p = \rho g h</math><br/>to give <math>\rho = p / (g h)</math> (1)</p> <p>substitution using any point from graph (1)</p> <p>e.g. depth = 50km and pressure = 1.5 GPa<br/> <math>\rho = p / (g h)</math><br/> <math>= 1.5 \times 10^9 / (10 \times 50 \times 10^3)</math></p> <p>Evaluation (2)<br/> <math>= 3000 \text{ (kg/m}^3\text{)}</math></p> | <p>rearrangement and substitution in any order</p> <p>allow any combination from the graph and ignore 'pot' error here</p> <p>'pot' error scores 2 marks maximum</p> | (4)  |

| Question number | Indicative content  | Mark |
|-----------------|---|------|
| (ii)            | <p>Answers will be credited according to the candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all of the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;"><b>A02 (3 marks) A03 (3 marks)</b></p> <p><b>A03 Interpretation and evaluation from the graph</b></p> <p><b>Similarities:</b></p> <ul style="list-style-type: none"> <li>• both show increasing pressure with depth</li> <li>• both show a range of pressures over kilometre depths / heights</li> </ul> <p><b>Differences:</b></p> <ul style="list-style-type: none"> <li>• ocean water shows a linear relationship (straight line) but atmosphere gives a non-linear (curved) relationship</li> <li>• density of ocean water not changing with depth but density of atmosphere changes as you go higher</li> <li>• The pressures in the ocean recorded are much bigger (GPA compared with kPa)</li> </ul> <p>The depth of the ocean shown is up to 100km whereas the height of the atmosphere involved is only up to 10km</p> <p><b>A02 Link between graph shapes and underlying physics</b></p> <p><b>Similarities:</b></p> <ul style="list-style-type: none"> <li>• pressure is due to (increasing) weight of fluid (liquid / gas) above</li> <li>• more molecules above</li> </ul> <p><b>Differences:</b></p> <ul style="list-style-type: none"> <li>• atmosphere becomes thinner the higher you go molecules in the ocean stay (on average) the same distance apart but in the atmosphere they get further apart (on average) as you go higher up</li> </ul> | (6)  |

| Level   | Mark | Descriptor  |
|---------|------|---|
|         | 0    | <ul style="list-style-type: none"> <li>No awardable content</li> </ul>  |
| Level 1 | 1–2  | <ul style="list-style-type: none"> <li>Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3)</li> <li>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. (AO2)</li> </ul> |
| Level 2 | 3–4  | <ul style="list-style-type: none"> <li>Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3)</li> <li>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. (AO2)</li> </ul>                                       |
| Level 3 | 5–6  | <ul style="list-style-type: none"> <li>Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3)</li> <li>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. (AO2)</li> </ul>                               |

Q15.

| Question number | Answer  | Additional guidance  | Mark         |
|-----------------|---|----------------------|--------------|
| (i)             | a description including<br>pressure increases as height decreases (1)<br>OR<br>as height increases pressure decreases (1) | negative correlation | (2)<br>AO3.2 |

|  |                |   |  |
|--|----------------|---|--|
|  | non-linear (1) | implication of non-linear e.g.<br>curved OR not proportional OR<br>gradient increases as height increases OR gradient decreases as pressure increases |  |
|--|----------------|---|--|

| Question number | Answer                                       | Additional guidance | Mark         |
|-----------------|--|---------------------|--------------|
| (ii)            | accept any answer from 30 to 34 (kPa)<br>(1) |                     | (1)<br>AO3.2 |

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

Q16.

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

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

Q17.

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

Q18.

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

Q19.

| Question number | Answer   | Additional guidance  | Mark |
|-----------------|--|--|------|
|                 | <p>An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (2 marks):</p> <ul style="list-style-type: none"> <li>• pressure in A is the highest and pressure in C is the lowest (pressure in B is between them) (1)</li> <li>• pressure depends on depth of liquid (so) can compare A and C because same liquid (hence) pressure in A is twice that of C (1)</li> <li>• pressure depends on density of liquid (so) can compare A and B since same depth hence pressure in A greater than pressure in B (1)</li> </ul> | allow a mathematical approach, i.e. calculating all three pressures from the relevant data | (3)  |

Q20.

| Question number | Indicative content   | Mark |
|-----------------|--|------|
| *               | <p>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.</p> <p>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.</p> <p style="text-align: center;"><b>AO1 (3 marks)</b></p> <ul style="list-style-type: none"> <li>• upthrust is the force on the submarine in the water (submerged) in a fluid</li> <li>• upthrust on the submarine and its weight act in opposite directions</li> <li>• upthrust is equal to the weight of water displaced by the submarine</li> <li>• the difference in pressures on the upper and lower surfaces of the submarine causes the upthrust</li> </ul> <p style="text-align: center;"><b>AO2 (3 marks)</b></p> <ul style="list-style-type: none"> <li>• the volume of the submarine is fixed so the upthrust on the submarine is constant</li> <li>• increasing/decreasing volume of water in tanks increases/ decreases weight of submarine but does not affect upthrust</li> <li>• if weight increases to become greater than upthrust there is a resultant downward force on the submarine so the submarine sinks</li> <li>• if weight decreases to become less than upthrust there is a resultant upward force on the submarine so the submarine rises</li> </ul> | (6)  |

| <b>Level</b> | <b>Mark</b> | <b>Descriptor</b>   |
|--------------|-------------|---|
|              | 0           | No awardable content.   |
| Level 1      | 1–2         | <ul style="list-style-type: none"> <li>Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1)</li> <li>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. (AO2)</li> </ul>  |
| Level 2      | 3–4         | <ul style="list-style-type: none"> <li>Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1)</li> <li>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. (AO2)</li> </ul> |
| Level 3      | 5–6         | <ul style="list-style-type: none"> <li>Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1)</li> <li>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. (AO2)</li> </ul>                                     |

Q21.

| Question number | Indicative content  | Mark |
|-----------------|---|------|
|                 | <p>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.</p> <p>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.</p> <p style="text-align: center;">AO2</p> <p><b>Pressure</b></p> <ul style="list-style-type: none"> <li>difference in pressure between top and bottom of boat</li> <li>top pressure is atmospheric</li> <li>pressure on bottom of boat atmospheric plus that due to depth of water.</li> </ul> <p><b>Unloaded boat</b></p> <ul style="list-style-type: none"> <li>density of boat less than density of water</li> <li>floating objects are partially immersed</li> <li>floating objects displace fluid / water</li> <li>upthrust is due to the difference in pressure</li> <li>upthrust is equal to the weight of the boat</li> <li>upthrust is equal to the weight of fluid / water displaced</li> </ul> <p><b>Boat with load</b></p> <ul style="list-style-type: none"> <li>the weight/density of the boat increases because of the load added</li> <li>more upthrust is needed to balance the extra weight of the boat</li> <li>more water has to be displaced to provide the upthrust</li> <li>when the boat floats lower in the water it displaces more water</li> <li>the weight of water displaced is the upthrust and is equal to the weight of the boat</li> </ul> | (6)  |

| <b>Level</b> | <b>Mark</b> | <b>Descriptor</b>   |
|--------------|-------------|---|
|              | 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.<br>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.<br>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.<br>Lines of reasoning are supported by sustained application of relevant evidence. (AO2)         |

| <b>Level</b> | <b>Mark</b> | <b>Additional Guidance</b>  | <b>General additional guidance – the decision within levels</b>  |
|--------------|-------------|---|--|
|              | 0           | No rewardable material.   |  |
| Level 1      | 1-2         | <u>Additional guidance</u><br>Elements of physics present i.e. isolated knowledge of principles<br><b>two unconnected statements from any section</b> | <u>Possible candidate responses</u><br>pressure difference<br>upthrust<br>water displaced<br>displacement<br>floating  |
| Level 2      | 3-4         | <u>Additional guidance</u><br>Some knowledge of principles with a logical connection made in one section and statement from one other section         | <u>Possible candidate responses</u><br>upthrust and weight are balanced<br>/upthrust is equal to the weight of the boat<br><br>when load added upthrust increases<br><br>difference in pressure between the top and bottom of the boat |
| Level 3      | 5-6         | <u>Additional guidance</u><br>Detailed knowledge of principles with logical connections made in two sections.   | <u>Possible candidate responses</u><br>upthrust is equal to the weight of water displaced.<br><br>when load is added, weight increases more water is displaced   |

Q22.

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

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

|  |  |  |  |
|--|--|--|--|
|  |  | (wrong rearrangement)<br><br>250 000 scores 2 marks<br>250 000 to any other power of ten scores 1 mark<br>(used wrong weight of liquid and wrong rearrangement)<br><br>award full marks for the correct answer without working |  |
|--|--|--|--|

| Question number | Answer   | Additional guidance   | Mark       |
|-----------------|--|---|------------|
| i               | <p>data points correctly identified<br/>(1)</p> <p><math>50 \pm 2</math></p> <p><math>80 \pm 2</math></p> <p>evaluation (1)<br/><math>(-30 \pm 4 \text{ kPa})</math></p> | <p>award 1 mark if 80 and 50 seen<br/>ignore the lack of minus sign</p> <p>allow ecf from incorrect reading of either pressure at 2000m or pressure at 6000m for one mark</p> | (2)<br>AO3 |

| Question number | Answer  | Additional guidance   | Mark       |
|-----------------|---|---|------------|
|                 | <p>any <b>one</b> suggestion of greater density of atmosphere (1)</p> <p>greater depth of atmosphere (above the aeroplane) (1)</p> <p>greater temperature (of the atmosphere) (1)</p> | <p>accept reverse argument</p> <p>more particles (per cubic metre)<br/>the air gets thicker</p> <p>greater weight of the atmosphere</p> | (1)<br>AO1 |

Q24.

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

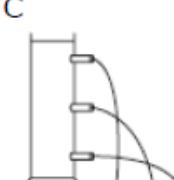
Q25.

| Question number | Answer   | Mark       |
|-----------------|--|------------|
|                 |  <p>This shows the only direction normal to surface, acting towards surface</p> | 1<br>AO3.1 |

Q26.

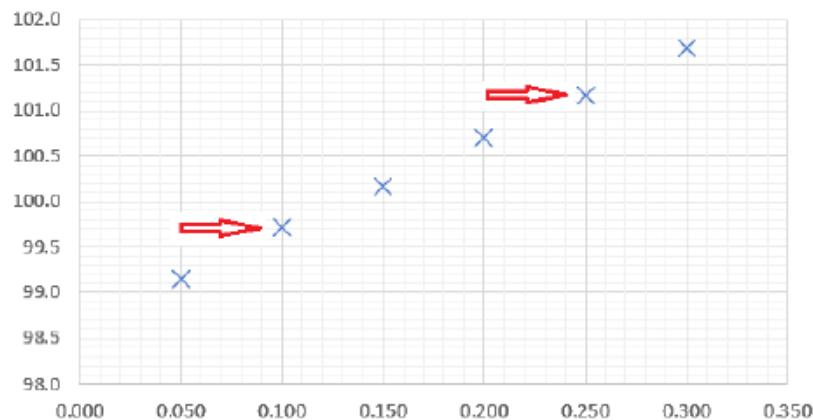
| Question number | Answer  | Additional guidance | Mark         |
|-----------------|---|---------------------|--------------|
|                 | D the same as the pressure underneath the large pool<br><br>A, B and C are all incorrect because the pressure is the same |                     | (1)<br>AO2.2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

Q27.

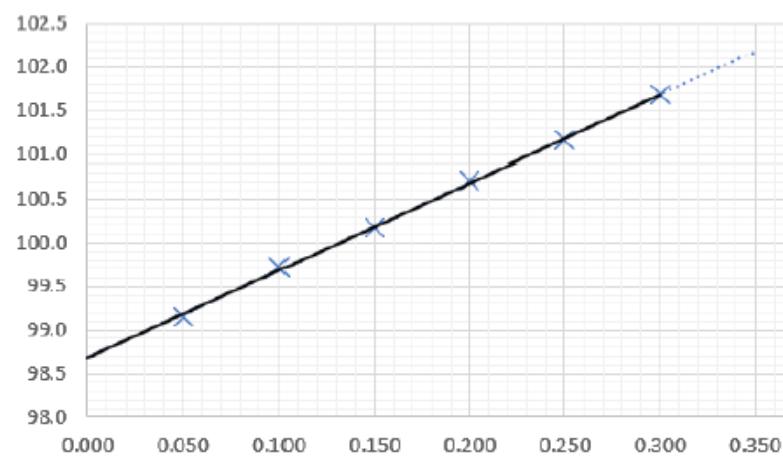
| Question number | Answer   | Mark |
|-----------------|--|------|
|                 | C<br> <p>A, B and D are incorrect because pressure increases with depth</p> | (1)  |

Q28.

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



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



| Question number | Answer   | Mark                |
|-----------------|--|---------------------|
| (iii)           | $D\ y = mx + c$<br>Figure 10 shows a linear graph with a positive gradient and intercept | (1)<br><b>AO1.1</b> |

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

Q29.

| Question number | Answer  | Mark |
|-----------------|---|------|
|                 | <p>An answer that combines the following points to provide a logical description of the plan:</p> <p>EITHER</p> <ul style="list-style-type: none"> <li>• (determine upthrust) by adding weights until the block of wood is fully immersed and recording the load required (1)</li> <li>• calculate upthrust by adding load and weight of block (1)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• (determine the weight of water displaced) by using a ruler to measure the dimensions of the block and multiplying them together to find the volume (1)</li> <li>• calculate the weight of water from volume <math>\times</math> density <math>\times g</math> (1)</li> </ul> | (2)  |