

- 1: A cube of volume V is placed in a liquid of density ρ . The cube displaces a weight W of the liquid.

Which of the following gives the magnitude of the upthrust acting on the cube?

- ☐ A $V \times W$
- ☐ B V
- ☐ C $V \times \rho$
- ☐ D W

(Total for Question 1 = 1 mark)

- 3 A sphere of weight 2.5 N floats in water with $\frac{1}{2}$ of its volume beneath the surface.
- A force F is applied to the sphere, completely immersing it in the water as shown.



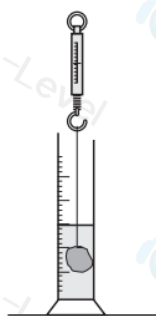
Which of the following is the minimum value of F ?

- ☐ A $2 \times 2.5\text{ N}$
- ☐ B $1 \times 2.5\text{ N}$
- ☐ C $\frac{1}{2} \times 2.5\text{ N}$
- ☐ D $\frac{1}{4} \times 2.5\text{ N}$

(Total for Question 3 = 1 mark)

- 7 An object of volume $2.4 \times 10^{-5} \text{ m}^3$ was suspended from a spring balance in air and its weight, in newtons, was read from the scale.

The object was then placed in a measuring cylinder containing water of density 1000 kg m^{-3} .



The reading on the spring balance

- ☒ A decreased by $(2.4 \times 10^{-5}) \times (1000)$
- ☒ B decreased by $(2.4 \times 10^{-5}) \times (1000) \times (9.81)$
- ☒ C increased by $(2.4 \times 10^{-5}) \times (1000)$
- ☒ D increased by $(2.4 \times 10^{-5}) \times (1000) \times (9.81)$

(Total for Question 7 = 1 mark)



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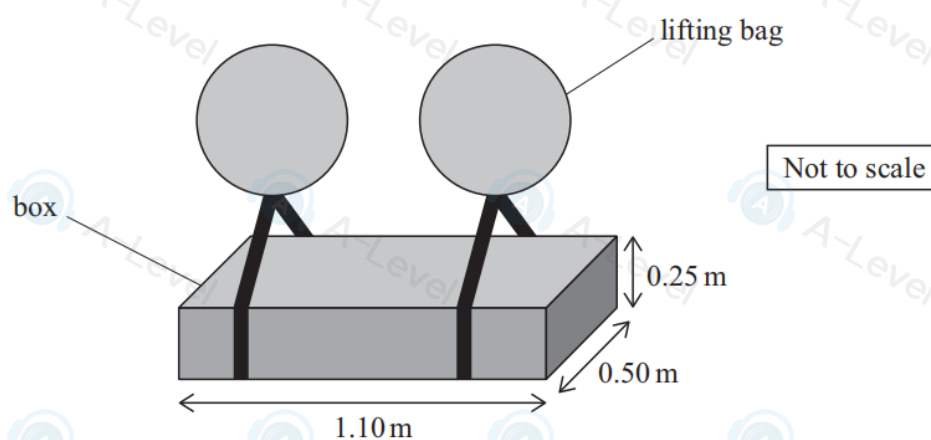
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- 17 A 'lifting bag' is a bag that can be filled with air and used to lift heavy objects from the bottom of the sea.

Lifting bags are attached to an object and then filled with air.

- (a) A person attaches two spherical lifting bags to a box at the bottom of the sea, as shown.



The total weight of the box and two lifting bags filled with air is 2500 N. The diameter of each spherical lifting bag is 50 cm.

Deduce whether the box will lift from the bottom of the sea.

density of seawater = 1020 kg m^{-3}

(6)

- (b) As the person filled the lifting bags, a small bubble of air escaped and moved upwards through the seawater.

- (i) Calculate the terminal velocity of the bubble of air predicted by Stokes' law.

weight of air in bubble = $1.82 \times 10^{-6} \text{ N}$

upthrust on bubble = $4.77 \times 10^{-4} \text{ N}$

viscosity of seawater = $8.60 \times 10^{-4} \text{ Pa s}$

radius of bubble = $2.25 \times 10^{-3} \text{ m}$

(3)

Terminal velocity =

- (ii) Give two reasons why the terminal velocity of the bubble may be different from the value predicted by Stokes' law.

(2)

(Total for Question 17 = 11 marks)

13 A crane is used to remove an object from the bottom of a lake.

The object is a cylinder of height h and the depth of the lake is D , as shown in Figure 1.

The cylinder is moved vertically through the water at a slow and steady speed. The cylinder comes to rest in a position where it is completely above the surface of the water, as shown in Figure 2.

The diagrams are not to scale.

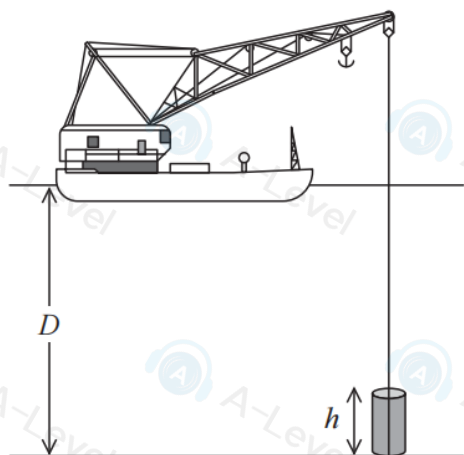


Figure 1

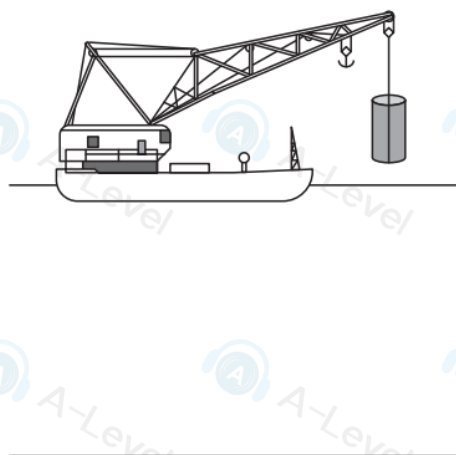
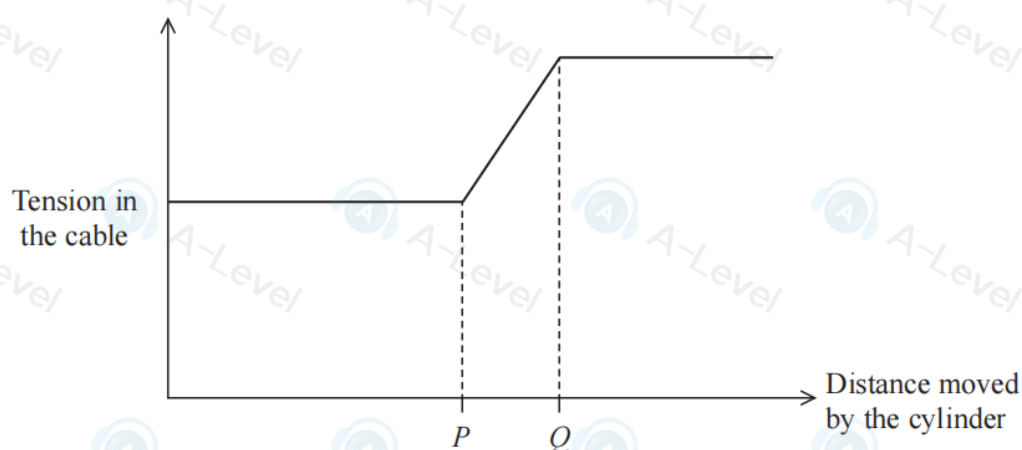


Figure 2

The graph shows how the tension in the cable varies with distance as the cylinder is lifted from the bottom of the lake to its position in Figure 2.



(a) State expressions for the distances P and Q .

(2)

Distance P =

Distance Q =

* (b) Explain the shape of the graph.

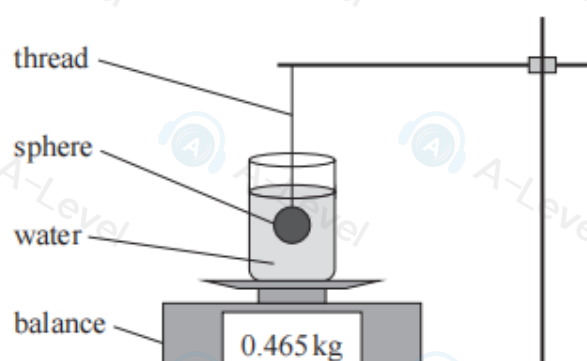
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(Total for Question 13 = 7 marks)

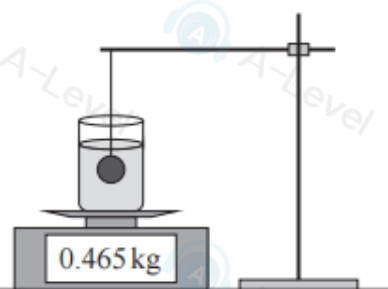
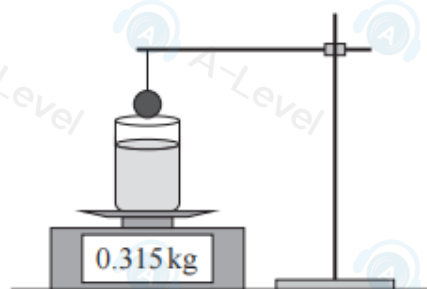
- 19 A student used the apparatus shown to investigate the forces acting on a uniform, solid sphere placed in water.



- (a) Draw a free-body force diagram for the sphere when it is suspended in water as shown. (3)



- (b) As the sphere was lowered into the water, the reading on the balance increased from 315 g to 465 g as shown.



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- (i) Explain the increase in the reading on the balance. Your answer should include a reference to Newton's third law.

(3)

- (ii) Determine the mass of the sphere.

density of water = 1000 kg m^{-3}

density of sphere = 2000 kg m^{-3}

(4)

Mass of sphere =

- (iii) The water was replaced with the same mass of oil and the experiment repeated. The density of the oil is less than the density of water.

Explain what happens to the final reading on the balance.

(2)