



Questions

Q1.

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 ☐.

A cylinder of aluminium has a weight of 35.0 N and a volume of $1.32 \times 10^{-3} \text{ m}^3$.

Which of the following calculations gives the density of aluminium in kg m^{-3} ? RocketRevise

☐ A $\frac{9.81 \times 1.32 \times 10^{-3}}{35.0}$

☐ B $\frac{1.32 \times 10^{-3}}{35.0 \times 9.81}$

☐ C $\frac{35.0}{9.81 \times 1.32 \times 10^{-3}}$

☐ D $\frac{35.0 \times 9.81}{1.32 \times 10^{-3}}$



(Total for question = 1 mark)

Q2.

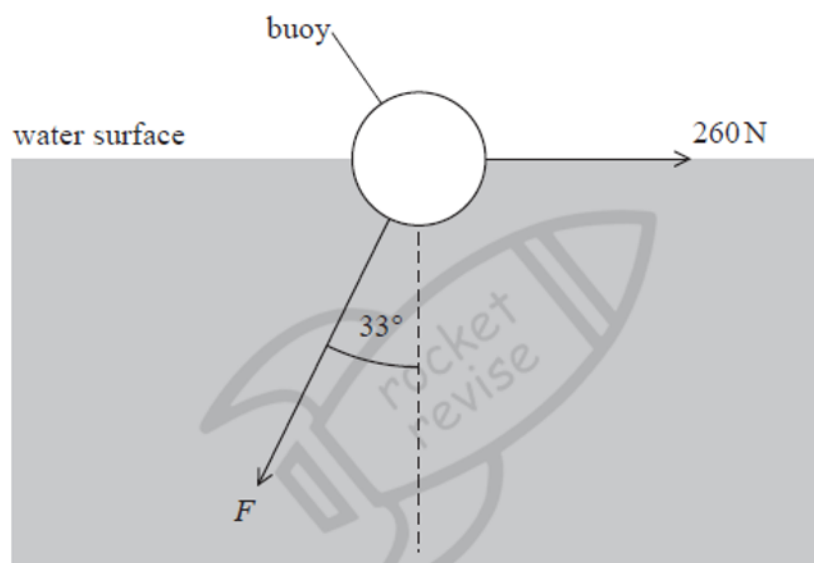
The photograph shows a floating object called a buoy. A long chain attaches the buoy to a very large mass at the bottom of the sea so that the buoy remains stationary. www.RocketRevise.com



(Source: © EThamPhoto/Alamy Stock Photo)

Water flowing past the buoy causes a horizontal force of 260 N on the buoy. The chain exerts a force F on the buoy at an angle of 33° to the vertical as shown.

RocketRevise



(a) (i) Show that F is about 500 N.

(2)

.....

.....

.....

.....

www.RocketRevise.com

(ii) The buoy floats due to the upthrust from the water.

The weight of water displaced by the buoy is 2.9 kN.

Determine the weight of the buoy.

(3)

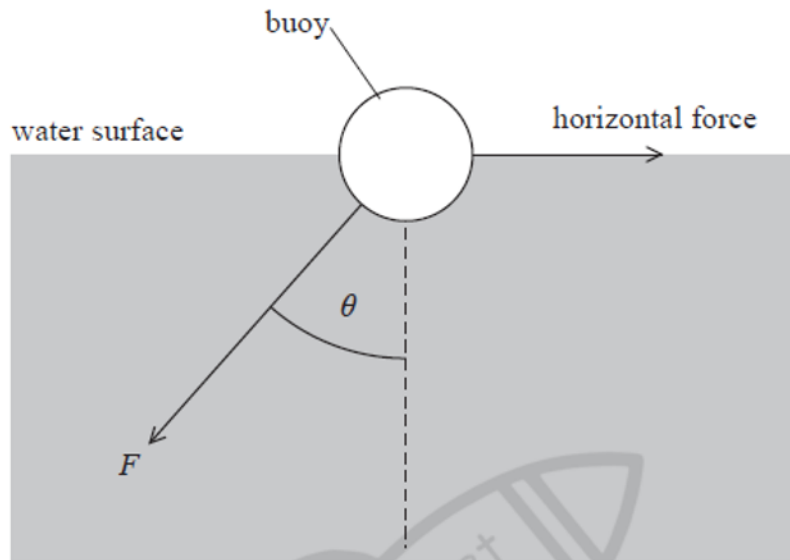
.....

.....



Weight of buoy =

(b) The speed of the water flowing past the buoy increases, so the horizontal force increases. Assume that the weight of water displaced by the buoy does not change.



RocketRevise

Explain how F and θ change when the horizontal force increases.

(3)

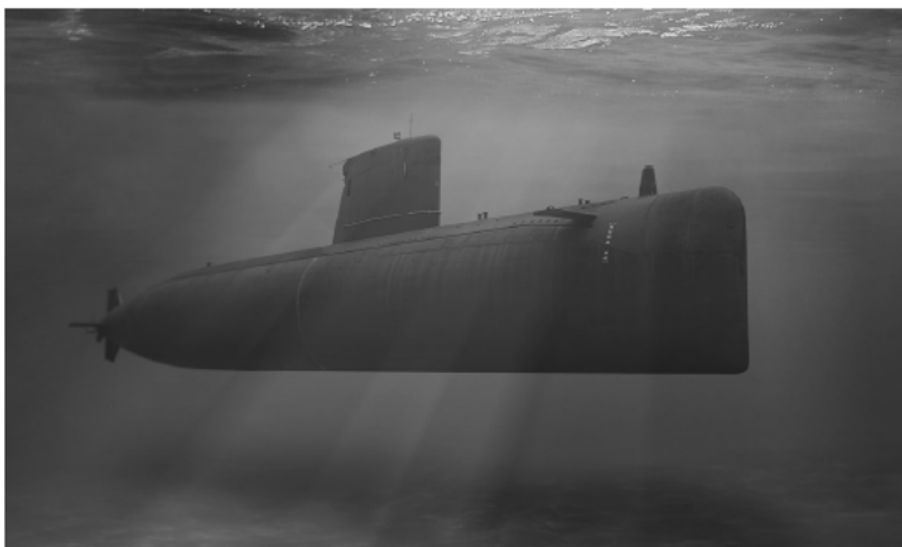
www.RocketRevise.com

(Total for question = 8 marks)



Q3.

The photograph shows a submarine below the surface of the sea.



RocketRevise

(Source: noraismail/Shutterstock)

(a) The submarine has a volume of $5.83 \times 10^3 \text{ m}^3$.

The submarine is stationary in a region of the sea where the density of the seawater is $1.03 \times 10^3 \text{ kg m}^{-3}$.

(i) Calculate the upthrust exerted on the submarine by the seawater.

(2)

.....

.....

.....

.....

Upthrust =

(ii) Explain why the mass of the submarine must be $6.0 \times 10^6 \text{ kg}$.

www.RocketRevise.com

(2)

.....

.....

.....

.....

(b) The submarine now moves into a region of the sea where the water is less salty, and the density of the water reduces



to $1.01 \times 10^3 \text{ kg m}^{-3}$.

(i) Explain what would happen to the submarine as it moves into this region of lower density seawater.

(3)

.....

.....

.....

.....

(ii) The submarine alters its weight by pumping water in or out of its internal tanks.

RocketRevise

Determine the mass of water that the submarine should pump, in or out of its tanks, to maintain its depth below the surface of the sea.

(2)

.....

.....

.....

.....

Mass of water =

(Total for question = 9 marks)

Q4.

www.RocketRevise.com

The photograph shows a fireboat used to put out fires on ships at sea. A pump, fixed to the boat, pumps water from the sea. The seawater is projected at high speed out of a pipe connected to the pump.



.....

.....

.....



(b) Projecting water from the pipe causes a force to be exerted on the pump.

Explain the direction of the force on the pump.

(2)

.....

.....

.....

.....

RocketRevise

(c) Initially the pump is turned off and the fireboat moves forwards through the water at a constant speed. The boat's engine provides a constant forward force.

When the pump is turned on, water is projected forwards and the fireboat slows to a lower constant speed.

Explain why the boat now has a lower constant speed.
Your answer should refer to all the horizontal forces on the boat.

(3)

.....

.....

.....

.....

.....

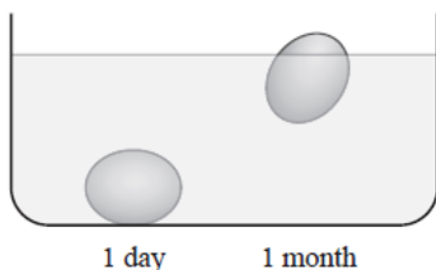
.....

.....

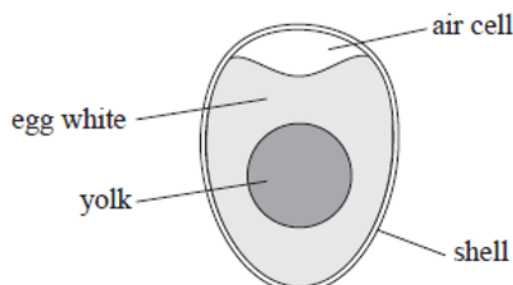
www.RocketRevise.com
(Total for question = 11 marks)

Q5.

* The approximate age of an egg can be determined by placing it in a bowl of water. Two eggs of different ages are placed in water and come to rest as shown.



The internal structure of an egg is shown below.



RocketRevise

A student searched on the internet to find the reason why old eggs float.

He found the following statements on different websites.

Statement 1

Old eggs float because as the egg ages it starts to decompose. As it decomposes gases are produced that escape through the eggshell.

Statement 2

As the egg ages, air enters the egg through the eggshell and increases the size of the air cell. The larger air cell acts as a flotation device and hence old eggs float.

Assess which of these two statements is correct.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

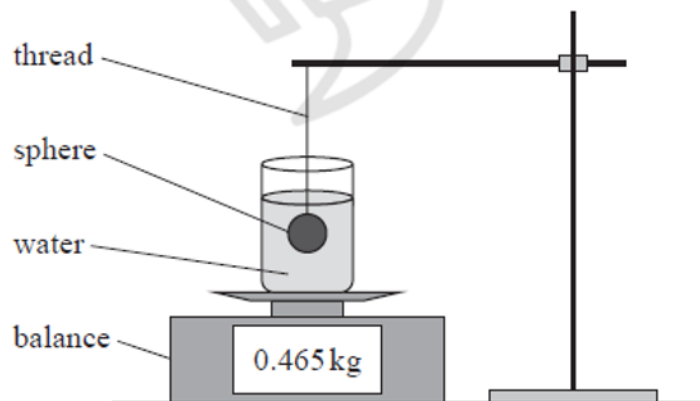
www.RocketRevise.com



(Total for question = 6 marks)

Q6.

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

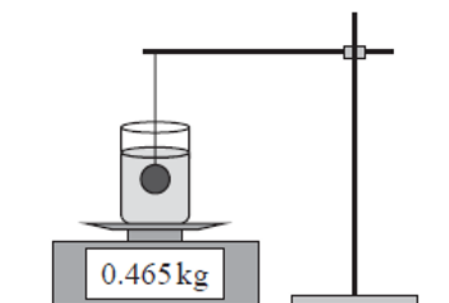
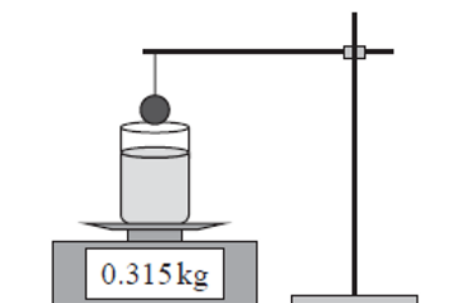


(a) Draw a free-body force diagram for the sphere when it is suspended in water as shown.

(3)



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



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

(3)

RocketRevise

(ii) Determine the mass of the sphere.

density of water = 1000 kg m^{-3}
density of sphere = 2000 kg m^{-3}

(4)

www.RocketRevise.com

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.

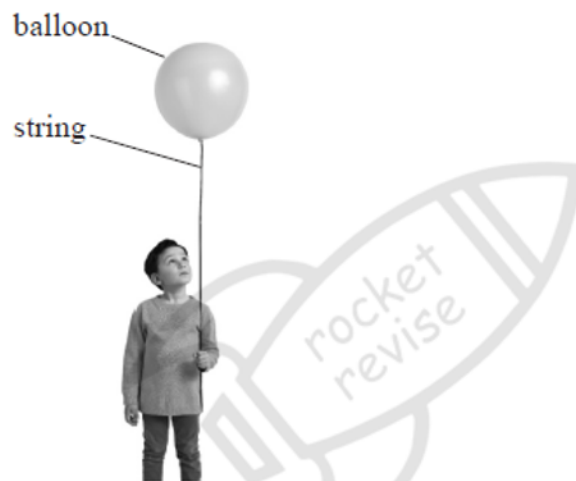
(2)



(Total for question = 12 marks)

Q7.

A child is holding a balloon by a string, as shown. The balloon contains helium gas. Helium gas is less dense than air.



(Source: © pinstock/Getty Images)

(a) The child releases the balloon by letting go of the string.

Calculate the resultant force on the balloon immediately after it is released.

mass of balloon and string = $9.20 \times 10^{-3} \text{ kg}$

volume of balloon and string = $5.00 \times 10^{-2} \text{ m}^3$

density of air = 1.20 kg m^{-3}

www.RocketRevise.com (4)



Resultant force =

*(b) Immediately after the balloon is released, it begins to move upwards.

The density of the air remains constant and there is no wind.

Explain how the forces acting on the balloon affect its motion as it moves upwards from the moment it is released.

(6)

RocketRevise

(Total for question = 10 marks)

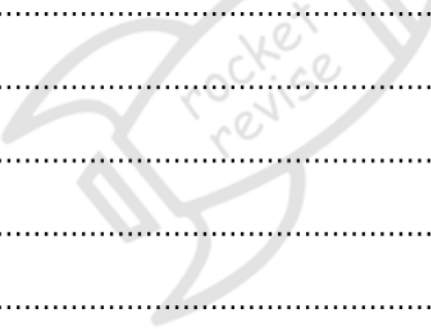
www.RocketRevise.com

Q8.

A Galilean thermometer consists of a closed glass cylinder containing a liquid. In the liquid there are several identical sealed glass bulbs, as shown. Attached to each bulb is a metal disc labelled with a temperature. Each disc has a different mass.



Explain why a particular bulb will float until the temperature of the liquid exceeds a certain value.



www.RocketRevise.com

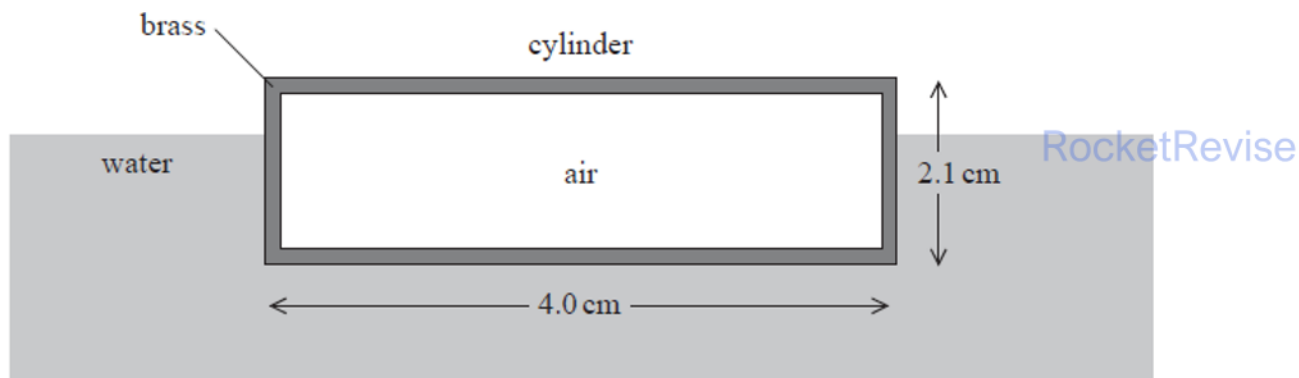
www.RocketRevise.com



Q9.

A hollow brass cylinder with closed ends is floating on the surface of water.

The cylinder has a length of 4.0 cm and an external diameter of 2.1 cm as shown.



63% of the volume of the cylinder is submerged. The cylinder contains negligible weight of air.

(a) Explain why the brass cylinder floats.

(2)

.....

.....

.....

.....

(b) The density of water is $1.0 \times 10^3 \text{ kg m}^{-3}$

(i) Show that the mass of the cylinder is about $9 \times 10^{-3} \text{ kg}$.

(4)

.....

.....

.....

.....

.....

.....

.....



(ii) Deduce whether an identical hollow cylinder made of gold would also float.

Assume that the volume of gold is the same as the volume of brass.

density of gold = $19.3 \times 10^3 \text{ kg m}^{-3}$

density of brass = $8.7 \times 10^3 \text{ kg m}^{-3}$

(4)

RocketRevise

(Total for question = 10 marks)

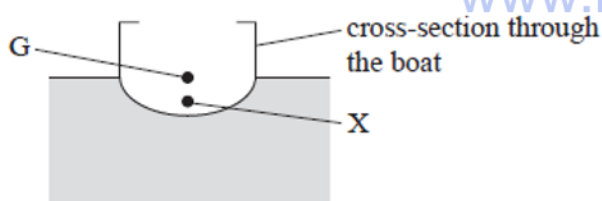
Q10.

For a boat to maintain a constant upright position in the water, the weight W and upthrust U should have the same line of action.

W acts through G, the centre of gravity of the boat.

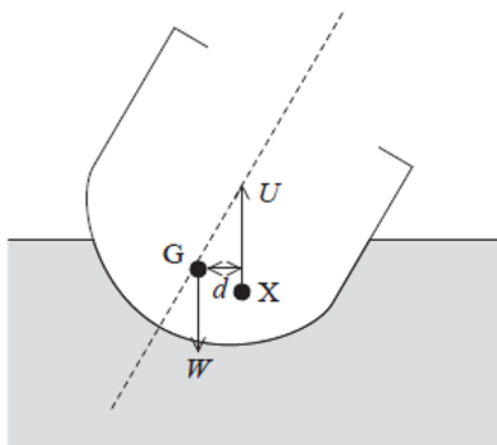
U acts through X, the centre of gravity of the volume of water displaced by the boat.

G and X are shown on the diagram.



(a) A sudden gust of wind applies a force to the side of the boat, causing it to tilt.

The lines of action of W and U move apart a distance d , as shown below.



(i) Explain the effect of the moment Ud .

RocketRevise (2)

.....

.....

.....

.....

(ii) Explain what would happen to the boat in windy weather if the centre of gravity G were higher.

(3)

.....

.....

.....

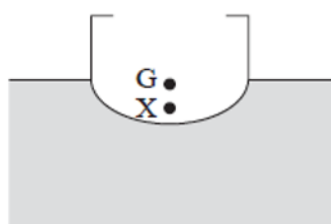
.....

.....

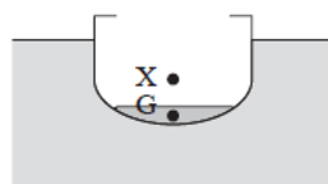
.....

(b) Some boats use a ballast tank, which is a refillable tank of water in the base of the boat, to improve stability.

www.RocketRevise.com



Ballast tank empty



Ballast tank full

(i) Explain why the position of X for the ship when it has a full ballast tank is lower than when the ship has an empty ballast tank.

RocketHub

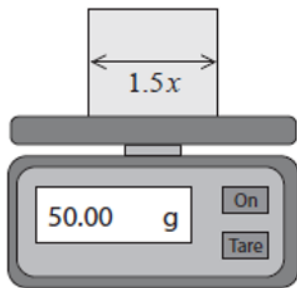
(2)

 Rocket
revise

www.RocketRevise.com

A diagram of a digital scale. The scale's display shows "50.00 g". Above the scale pan, a rectangular block is shown with a double-headed arrow indicating its width, labeled with the variable x . The scale has two buttons on the right: "On" and "Tare".

www.RocketRevise.com



Which of the following is the density ρ_L of the larger cube in terms of the density ρ_S of the smaller cube?

- ☐ **A** $\rho_L = 3.4 \rho_S$
- ☐ **B** $\rho_L = 1.5 \rho_S$
- ☐ **C** $\rho_L = 0.67 \rho_S$
- ☐ **D** $\rho_L = 0.30 \rho_S$

RocketRevise

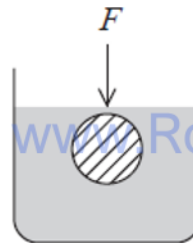
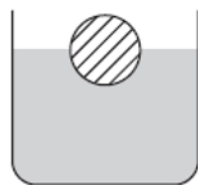
(Total for question = 1 mark)

Q12.

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 ☐.

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 ?

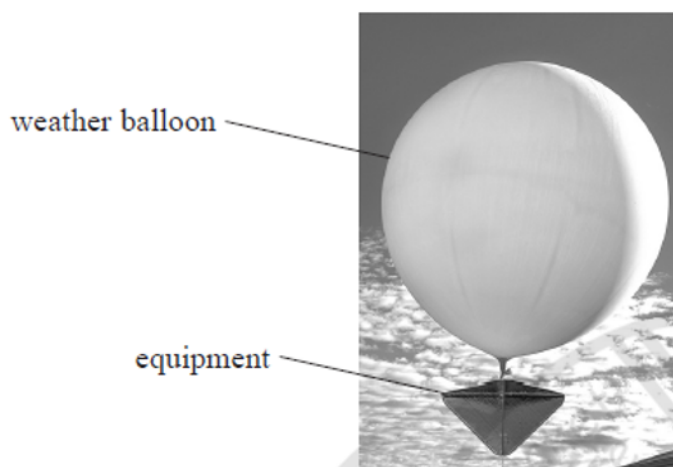
- ☐ **A** $2 \times 2.5 \text{ N}$
- ☐ **B** $1 \times 2.5 \text{ N}$
- ☐ **C** $\frac{1}{2} \times 2.5 \text{ N}$
- ☐ **D** $\frac{1}{4} \times 2.5 \text{ N}$



(Total for question = 1 mark)

Q13.

Scientists use weather balloons to carry equipment into the upper atmosphere to monitor weather conditions. The photograph shows a weather balloon.



RocketRevise

(Source: © Edward Haylan/Shutterstock)

Upthrust acts on the balloon. The balloon is released and accelerates upwards.

(a) State what is meant by upthrust.

(1)

.....

.....

(b) (i) When the balloon is released, the initial upward acceleration is 4.80 m s^{-2} .

volume of balloon and equipment = 1.63 m^3

density of air at ground level = 1.23 kg m^{-3}

www.RocketRevise.com

(3)

.....

.....

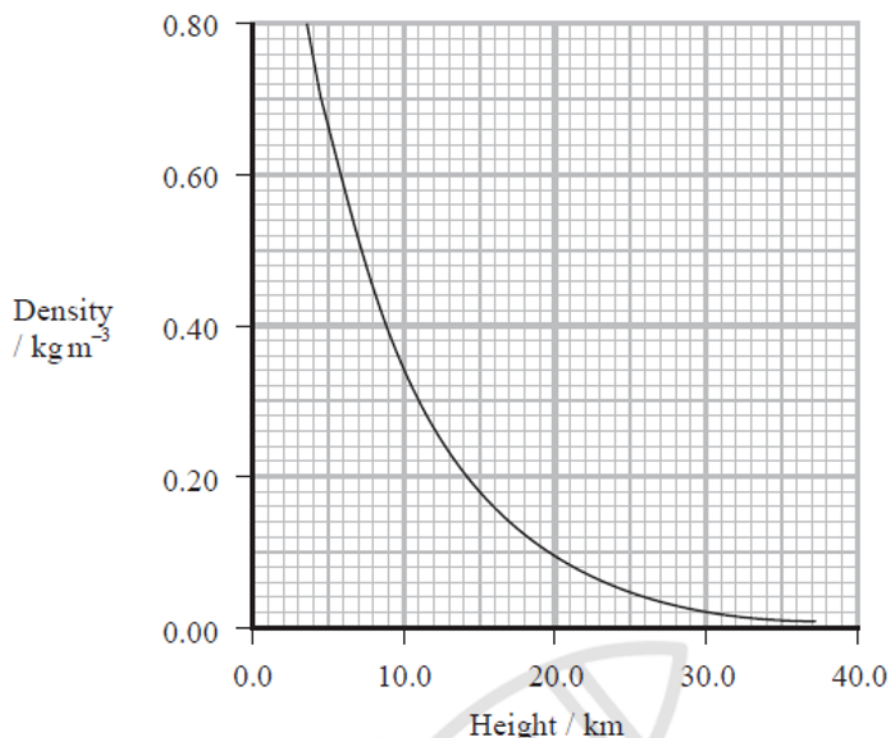
.....

.....

.....



(ii) The graph shows how the density of air decreases with height above the ground.



RocketRevise

The scientists want to make measurements at a height of 25 km where the balloon would stop rising.

The balloon will expand as it rises and will burst if its volume exceeds 50 m³.

Deduce whether the weather balloon could support the equipment at a height of 25 km, without bursting.

(4)

www.RocketRevise.com

*(c) A weather balloon made of a strong material will rise and eventually stop expanding. It will continue to rise until it reaches a maximum height.

Explain how and why the velocity of the weather balloon changes from release until it reaches its



maximum height.

Ignore the effects of viscous drag force.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

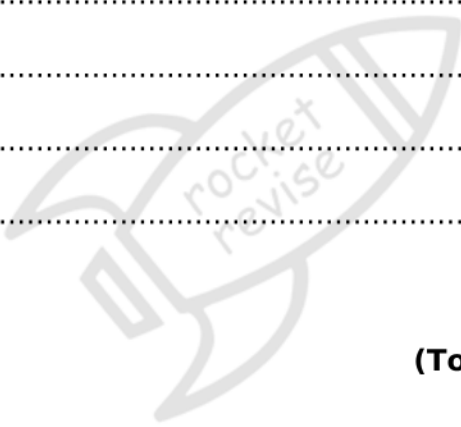
.....

.....

.....

.....

RocketRevise



(Total for question = 14 marks)