

- 16** The formula for the upthrust on a block of wood partially submerged in water is shown.

$$F = \rho g V$$

What do the symbols ρ and V represent?

	ρ	V
A	density of water	volume of whole block
B	density of water	volume of block below surface of water
C	density of wood	volume of whole block
D	density of wood	volume of block below surface of water

- 15** The mass and volume of an object are varied.

Which two changes, when made together, **must** increase the density of the object?

	mass	volume
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

- 16** On Earth, a solid object that is fully submerged in a liquid experiences an upthrust U_E .

On Mars, the same object, fully submerged in the same liquid, experiences an upthrust U_M .

The acceleration of free fall on Mars is 3.7 m s^{-2} .

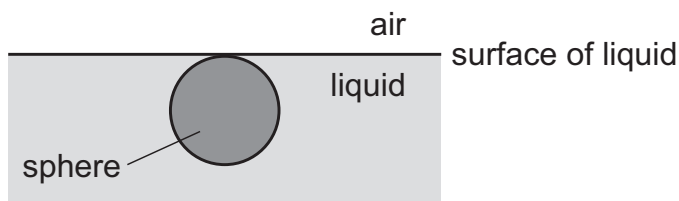
Assume that the liquid's density and the object's volume have the same values on Earth and Mars.

What is the ratio $\frac{U_M}{U_E}$?

- A** 0.38 **B** 1.0 **C** 2.7 **D** 3.6

- 12** The diagram shows a stationary sphere that is just fully submerged in a liquid. The radius of the sphere is r and the density of the liquid is ρ . The acceleration of free fall is g .

The air exerts pressure P_A on the surface of the liquid.



What is the pressure at the lowest point of the sphere?

- A** $P_A + \frac{4}{3}\pi r^3 \rho g$
- B** $P_A - \frac{4}{3}\pi r^3 \rho g$
- C** $2r\rho g + P_A$
- D** $2r\rho g - P_A$

2 (a) (i) Define pressure.

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(ii) Explain how hydrostatic pressure results in an upthrust force acting on a solid object immersed in a liquid.

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..... [2]

(b) A small steel ball of radius r and mass m falls vertically at terminal speed v through oil.

The viscous drag force D that acts on the ball is given by

$$D = 6\pi\eta r v$$

where η is a property of the oil called its viscosity.

(i) On Fig. 2.1, draw labelled arrows from the ball to show the directions of the **three** forces that act on the ball as it falls.



Fig. 2.1

(ii) Determine the SI base units of η .

base units [2]

(c) The oil in (b) has a density of 920 kg m^{-3} and a viscosity of 4.7 in SI units.

The steel ball has a mass of $2.4 \times 10^{-3} \text{ kg}$ and a radius of $4.2 \times 10^{-3} \text{ m}$.

(i) Show that the upthrust force acting on the ball is $2.8 \times 10^{-3} \text{ N}$.

[1]

(ii) Determine the terminal speed v of the ball.

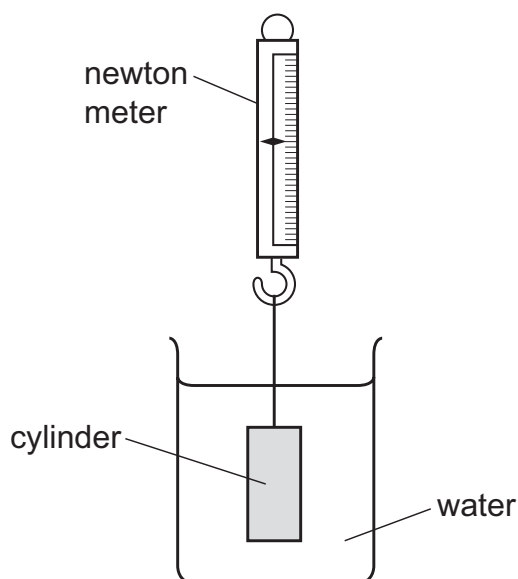
$v =$ m s^{-1} [3]

[Total: 12]

- 14** A uniform cylinder of weight 25.0 N is suspended from a newton meter.

The cylinder is fully submerged in water, as shown.

The reading on the newton meter is 10.0 N.



The water is replaced by a liquid with a density 10% greater than the density of water. The cylinder remains fully submerged.

What is the new reading on the newton meter?

- A** 8.5 N **B** 9.0 N **C** 11.0 N **D** 11.5 N

- 16** A submarine is at a depth of 130 m below the surface of the sea.

The pressure on the submarine due to the sea water is p .

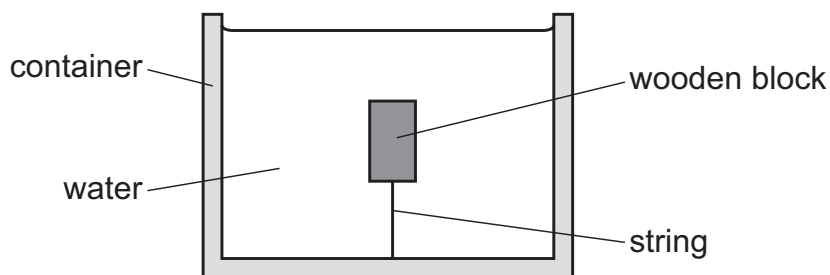
The submarine sinks to a depth of 260 m below the surface.

Assume that the density of sea water is constant.

What is the **difference** between the pressures on the submarine due to the sea water at the two depths?

- A** 0 **B** $0.5p$ **C** p **D** $2p$

- 14** A wooden block is held stationary in a container of water using a string that is attached to both the wooden block and the bottom of the container.



The wooden block has mass m and volume V . The water has density ρ . The acceleration of free fall is g .

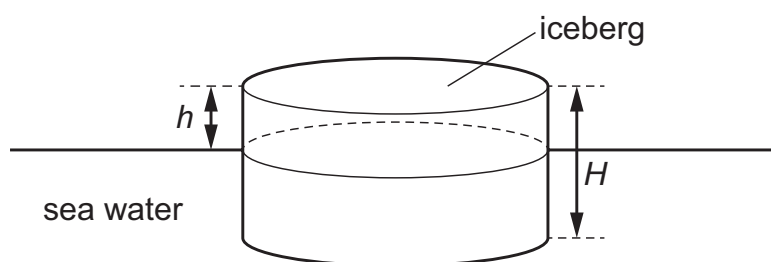
What is the magnitude of the force acting on the block due to the tension in the string?

- A** $\rho g V$ **B** $mg + \rho g V$ **C** mg **D** $\rho g V - mg$

- 13** What is the definition of density?

- A** mass of one cubic metre
B mass of a unit volume
C mass per cubic metre
D mass per unit volume

- 13** A cylindrical iceberg of height H floats in sea water. The top of the iceberg is at height h above the surface of the water.



The density of ice is ρ_i and the density of sea water is ρ_w .

What is the height h of the iceberg above the sea water?

- A** $\left(1 - \frac{\rho_i}{\rho_w}\right)H$ **B** $\left(\frac{\rho_i}{\rho_w} - 1\right)H$ **C** $\frac{\rho_w}{\rho_i}H$ **D** $\frac{\rho_i}{\rho_w}H$

10 An object is fully submerged in a liquid.

A student determines the ratio $\frac{\text{upthrust acting on the object}}{\text{weight of the object}}$.

Which single change would double the value of this ratio?

- A Use a different liquid that has twice the density and the same volume as the original liquid.
- B Use a different object that has half the volume and the same density as the original object.
- C Use a different object that has twice the density and the same volume as the original object.
- D Use a different object that has twice the volume and the same density as the original object.

1 (a) Define density.

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..... [1]

(b) Fig. 1.1 shows a cuboidal glass block.

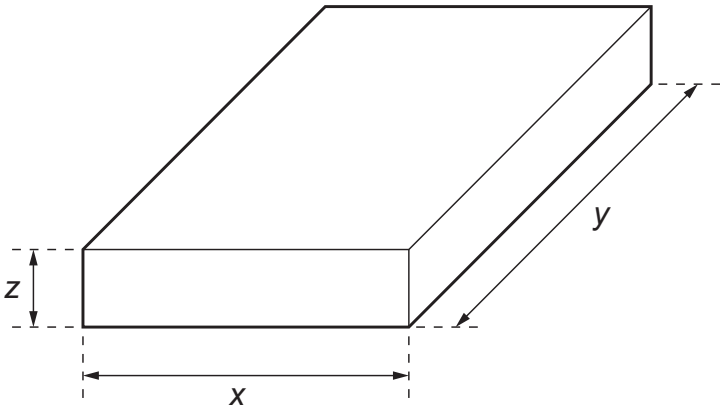


Fig. 1.1 (not to scale)

A student measures the mass m of the block and the side lengths x , y and z . The measurements are shown in Table 1.1.

Table 1.1

quantity	measurement
m	$(0.243 \pm 0.001)\text{kg}$
x	$(5.41 \pm 0.01)\text{cm}$
y	$(11.09 \pm 0.01)\text{cm}$
z	$(1.62 \pm 0.01)\text{cm}$

(i) Determine the density of the glass.

density = kg m⁻³ [2]

(ii) Calculate the percentage uncertainty in the density.

percentage uncertainty =% [3]

(c) The true value of the density of the glass is different from the answer in (b)(i) because of a systematic error in the measurements.

Suggest **one** possible cause of this systematic error.

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[Total: 7]