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 $3.7\,\text{m}\,\text{s}^{-2}$.

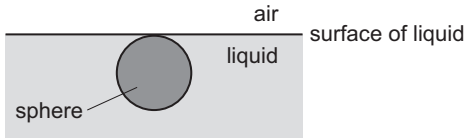
Assume that the liquid's density and the object's volume have the same values on Earth and Mars.

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.

.....

..... [1]

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

.....

.....

.....

..... [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

[3]

(ii) Determine the SI base units of η.

base units ..... [2]

(c) The oil in **(b)** has a density of $920\,\text{kg}\,\text{m}^{-3}$ 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.

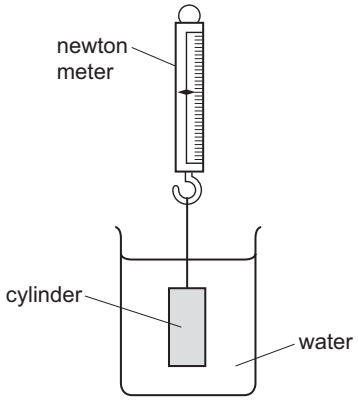
v = ... $\text{m}\,\text{s}^{-1}$ [3]

[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.

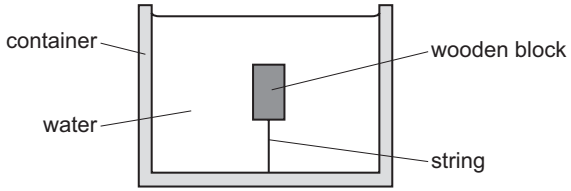
The submarine sinks to a depth of 260 m below the surface.

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 ρgV **B** $mg + \rho gV$ **C** mg **D** $\rho gV - mg$

13 What is the definition of density?

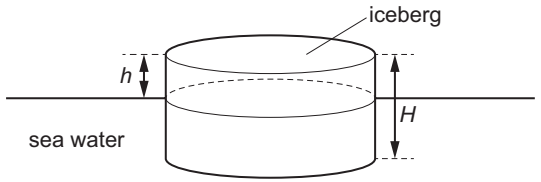
A mass of one cubic metre

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.

.....

..... [1]

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

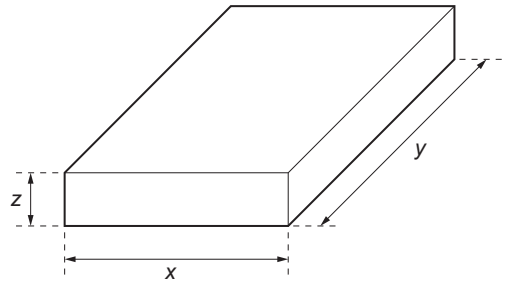


Fig. 1.1 (not to scale)

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 ± 0.001) kg
x	(5.41 ± 0.01) cm
y	(11.09 ± 0.01) cm
z	(1.62 ± 0.01) 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.

.....

.....

..... [1]

[Total: 7]