Density & Pressure

Question paper

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Forces, Density & Pressure
Sub Topic	Density & Pressure
Paper Type	Theory
Booklet	Question paper

Time Allowed: **71 minutes**

Score: **/59**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** Define *pressure*.

.....

..... [1]

(b) Explain, in terms of the air molecules, why the pressure at the top of a mountain is less than at sea level.

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.....

.....

..... [3]

(c) Fig. 3.1 shows a liquid in a cylindrical container.

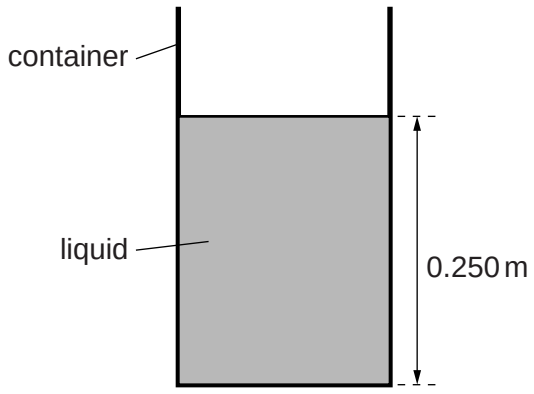

Fig. 3.1

The cross-sectional area of the container is 0.450 m^2. The height of the column of liquid is 0.250 m and the density of the liquid is 13 600 kg m^{-3}.

(i) Calculate the weight of the column of liquid.

weight = ... N [3]

(ii) Calculate the pressure on the base of the container caused by the weight of the liquid.

pressure = ... Pa [1]

(iii) Explain why the pressure exerted on the base of the container is different from the value calculated in **(ii)**.

.....

..... [1]

2 **(a)** Show that the pressure P due to a liquid of density ρ is proportional to the depth h below the surface of the liquid.

[4]

(b) The pressure of the air at the top of a mountain is less than that at the foot of the mountain. Explain why the difference in air pressure is not proportional to the difference in height as suggested by the relationship in **(a)**.

.....

.....

.....

.....[2]

3 **(a)** Define *density*.

.....

..... [1]

(b) Explain how the difference in the densities of solids, liquids and gases may be related to the spacing of their molecules.

.....

.....

.....

..... [2]

(c) A paving slab has a mass of 68 kg and dimensions 50 mm × 600 mm × 900 mm.

(i) Calculate the density, in $kg\,m^{-3}$, of the material from which the paving slab is made.

density = ... $kg\,m^{-3}$ [2]

(ii) Calculate the maximum pressure a slab could exert on the ground when resting on one of its surfaces.

pressure = ... Pa [3]

4 **(a)** Define *density*.

.....[1]

(b) Liquid of density ρ fills a container to a depth h, as illustrated in Fig. 3.1.

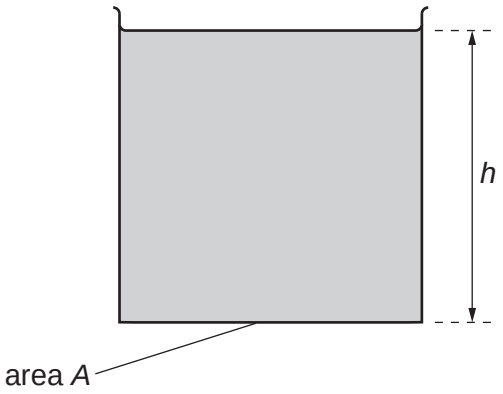

Fig. 3.1

The container has vertical sides and a base of area A.

(i) State, in terms of A, h and ρ, the mass of liquid in the container.

.....[1]

(ii) Hence derive an expression for the pressure p exerted by the liquid on the base of the container. Explain your working.

[2]

(c) The density of liquid water is $1.0\,\text{g}\,\text{cm}^{-3}$. The density of water vapour at atmospheric pressure is approximately $\frac{1}{1600}\,\text{g}\,\text{cm}^{-3}$.

Determine the ratio

(i) $\frac{\text{volume of water vapour}}{\text{volume of equal mass of liquid water}}$,

ratio = ...[1]

(ii) $\frac{\text{mean separation of molecules in water vapour}}{\text{mean separation of molecules in liquid water}}$.

ratio = ...[2]

(d) State the evidence for

(i) the molecules in solids and liquids having approximately the same separation,

.....

.....[1]

(ii) strong rigid forces between molecules in solids.

strong: .....

rigid: .....[2]

5 **(a)** Define *density*.

.....

.....

..... [1]

(b) A U-tube contains some mercury. Water is poured into one arm of the U-tube and oil is poured into the other arm, as shown in Fig. 4.1.

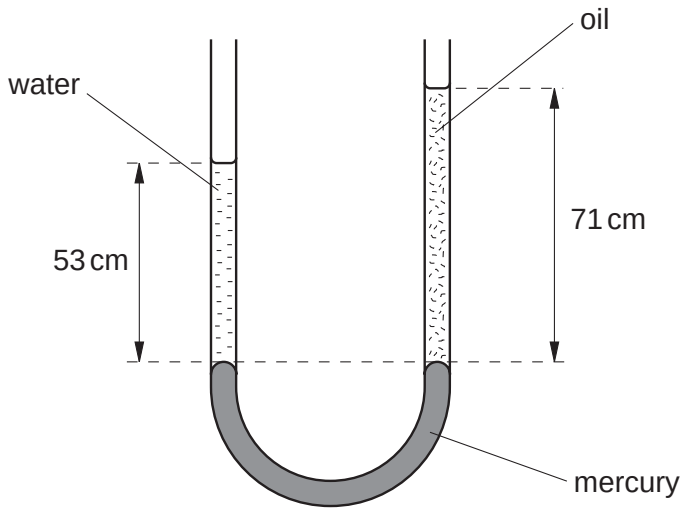

Fig. 4.1

The amounts of oil and water are adjusted until the surface of the mercury in the two arms is at the same horizontal level.

(i) State how it is known that the pressure at the base of the column of water is the same as the pressure at the base of the column of oil.

.....

..... [1]

(ii) The column of water, density $1.0 \times 10^3\,\text{kg}\,\text{m}^{-3}$, is 53 cm high. The column of oil is 71 cm high.

Calculate the density of the oil. Explain your working.

6 **(a)** **(i)** Define *pressure*.

.....

..... [1]

(ii) State the units of pressure in base units.

..... [1]

(b) The pressure p at a depth h in an incompressible fluid of density ρ is given by

$$p = \rho g h,$$

where g is the acceleration of free fall.
Use base units to check the homogeneity of this equation.

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.....

..... [3]

7 **(a)** Define *pressure*.

..... [1]

(b) A cylinder is placed on a horizontal surface, as shown in Fig. 2.1.

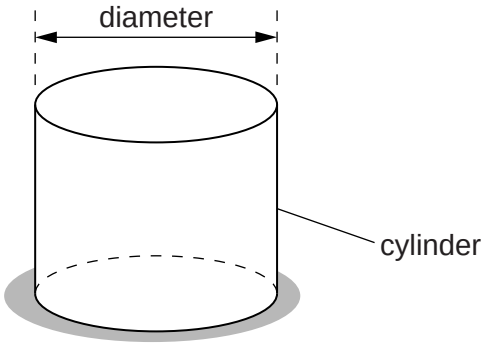

Fig. 2.1

The following measurements were made on the cylinder:

mass = 5.09 ± 0.01 kg
diameter = 9.4 ± 0.1 cm.

(i) Calculate the pressure produced by the cylinder on the surface.

pressure = ... Pa [3]

(ii) Calculate the actual uncertainty in the pressure.

actual uncertainty = ... Pa [3]

(iii) State the pressure, with its actual uncertainty.

pressure = ... ± ..... Pa [1]

8 One isotope of iron may be represented by the symbol

$$^{56}_{26}\text{Fe}.$$

(a) State, for one nucleus of this isotope,

(i) the number of protons,

number = ...

(ii) the number of neutrons.

number = ...
[2]

(b) The nucleus of this isotope of iron may be assumed to be a sphere of radius 5.7×10^{-15} m.

Calculate, for one such nucleus,

(i) the mass,

mass = ... kg

(ii) the density.

density = ... kg m^{-3}
[4]

(c) An iron ball is found to have a density of 7900 kg m^{-3}. By reference to your answer in **(b)(ii)**, suggest what can be inferred about the structure of an atom of iron.

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.....

..... [2]