Q1.

2   The Brownian motion of smoke particles in air may be observed using the apparatus shown in Fig. 2.1.

Fig. 2.1
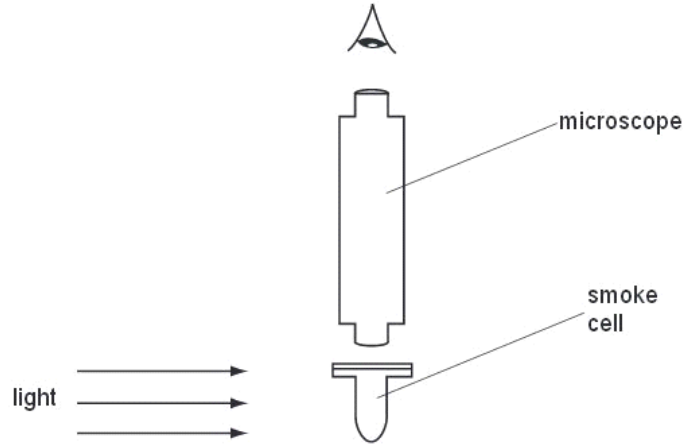
(a) Describe what is seen when viewing a smoke particle through the microscope.

....

....

....[2]

(b) Suggest and explain what difference, if any, would be observed in the movement of smoke particles when larger smoke particles than those observed in (a) are viewed through the microscope.

....

....

....[2]

Q2.

3   (a) Explain what is meant by the *internal energy* of a substance.

....

....

.... [2]

(b) State and explain, in molecular terms, whether the internal energy of the following increases, decreases or does not change.

    (i) a lump of iron as it is cooled

....

....

....

.... [3]

    (ii) some water as it evaporates at constant temperature

....

....

....

.... [3]

Q3.

4   **(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.
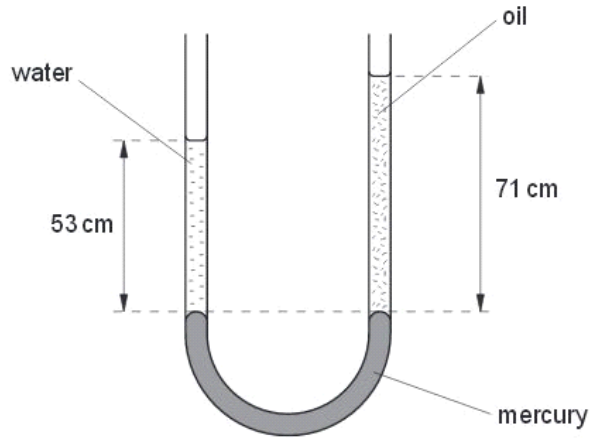

Fig. 4.1

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 $1.0 \times 10^3 \, kg \, m^{-3}$, is 53 cm high. The column of oil is 71 cm high.

Calculate the density of the oil. Explain your working.

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

Q4.

3

3 (a) Define *density*.

....[1]

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

area A

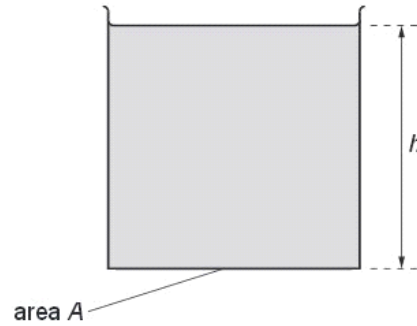**Fig. 3.1**

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

Determine the ratio

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

ratio = ...[1]

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

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

4   (a) State the evidence for the assumption that

Ex.

(i)   there are significant forces of attraction between molecules in the solid state,

....

....[1]

(ii) the forces of attraction between molecules in a gas are negligible.

....

....[1]

(b) Explain, on the basis of the kinetic model of gases, the pressure exerted by a gas.

....

....

....

....

....[4]

(c) Liquid nitrogen has a density of $810 \, kg \, m^{-3}$. The density of nitrogen gas at room temperature and pressure is approximately $1.2 \, kg \, m^{-3}$.
Suggest how these densities relate to the spacing of nitrogen molecules in the liquid and in the gaseous states.

....

....

....[2]

Q6.

6 **(a)** State two assumptions of the simple kinetic model of a gas.

1. ....

....

2. ....

....
                                                                                                                    [2]

(b) Use the kinetic model of gases and Newton's laws of motion to explain how a gas exerts a pressure on the sides of its container.

....

....

....

....

.... [3]

Q7.

7 **(a)** Explain the difference in densities in solids, liquids and gases using ideas of the spacing between molecules.

....

....

....

....

....

....

....[3]

(b) A hydrogen nucleus (proton) may be assumed to be a sphere of radius 1×10^{-15} m. Calculate the density of a hydrogen nucleus.

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

7

(c) The density of hydrogen gas in a pressurised cylinder is $4\,\text{kg}\,\text{m}^{-3}$. Suggest a reason why this density is much less than your answer in **(b)**.

....

....

....[1]

Q8.

3 **(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.

Ex

[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]

Q9.

4 **(a)** Define *pressure*.

....

.... [1]

(b) Use the kinetic model to explain the pressure exerted by a gas.

....

....

....

....

....

.... [4]

(c) Explain whether the collisions between the molecules of an ideal gas are elastic or inelastic.

....

....

.... [2]

Q10.

4 (a) Describe apparatus that demonstrates Brownian motion. Include a diagram.

....

....

....

....

....[2]

(b) Describe the observations made using the apparatus in (a).

....

....

....[2]

(c) State and explain two conclusions about the properties of molecules of a gas that follow from the observations in (b).

1. ....

....

2. ....

....
[2]

Q11.

5 (a) Distinguish between the structure of a metal and of a polymer.

metal: ....

....

....

polymer: ....

....

.... [4]

(b) Latex is a natural form of rubber. It is a polymeric material.

(i) Describe the properties of a sample of latex.

....

....

.... [2]

(ii) The process of heating latex with a small amount of sulphur creates cross-links between molecules. Natural latex has very few cross-links between its molecules.

Suggest how this process changes the properties of latex.

....

....

.... [2]

Q12.

5   Some smoke particles are viewed through a microscope, as illustrated in Fig. 5.1.
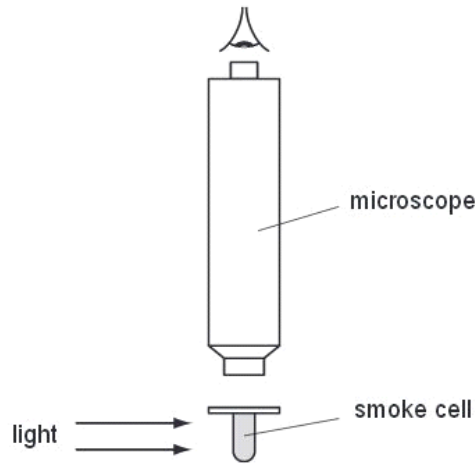
Fig. 5.1

Brownian motion is observed.

(a) Explain what is meant by *Brownian motion.*

....

....

.... [2]

(b) Suggest and explain why Brownian motion provides evidence for the movement of molecules as assumed in the kinetic theory of gases.

....

....

....

.... [2]

(c) Smoke from a poorly maintained engine contains large particles of soot.
Suggest why the Brownian motion of such large particles is undetectable.

....

....

.... [2]

Q13.

2 (a) (i) State one **similarity** between the processes of evaporation and boiling.

....

.... [1]

(ii) State two **differences** between the processes of evaporation and boiling.

1. ....

....

2. ....

....
                                                                                          [4]

(b) Titanium metal has a density of 4.5 g cm^{-3}.

A cube of titanium of mass 48 g contains 6.0 × 10^{23} atoms.

(i) Calculate the volume of the cube.

volume = ... cm^3 [1]

(ii) Estimate

    1. the volume occupied by each atom in the cube,

volume = ... cm³ [1]

    2. the separation of the atoms in the cube.

separation = ... cm [1]

Q14.

2   Briefly describe the structures of crystalline solids, polymers and amorphous materials.

crystalline solids ....

....

....

polymers ....

....

....

amorphous materials ....

....

....

[5]

Q15.

1   (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]

Q16.

3 (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.

....

....

....

....

.... [3]

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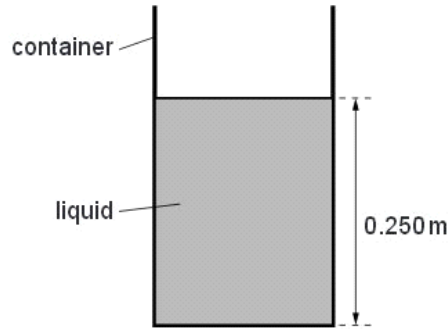
Fig. 3.1

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]

17

Q17.

3 **(a)** With reference to the arrangement of atoms, distinguish between metals, polymers and amorphous solids.

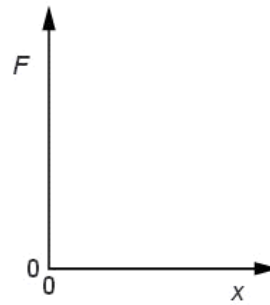metals: ....

....

polymers: ....

....

amorphous solids: ....

....

[3]

(b) On Fig. 3.1, sketch the variation with extension x of force F to distinguish between a metal and a polymer.
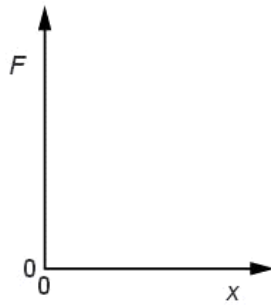
metal   polymer

Fig. 3.1

[2]
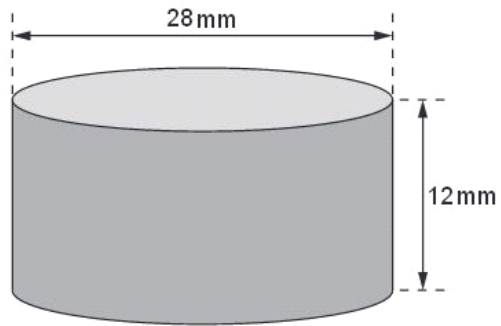
Q18.

1   A cylindrical disc is shown in Fig. 1.1.

Fig. 1.1

The disc has diameter 28 mm and thickness 12 mm.
The material of the disc has density 6.8×10^3 kg m^{-3}.

Calculate, to two significant figures, the weight of the disc.

weight = ... N [4]