Properties of Matters

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

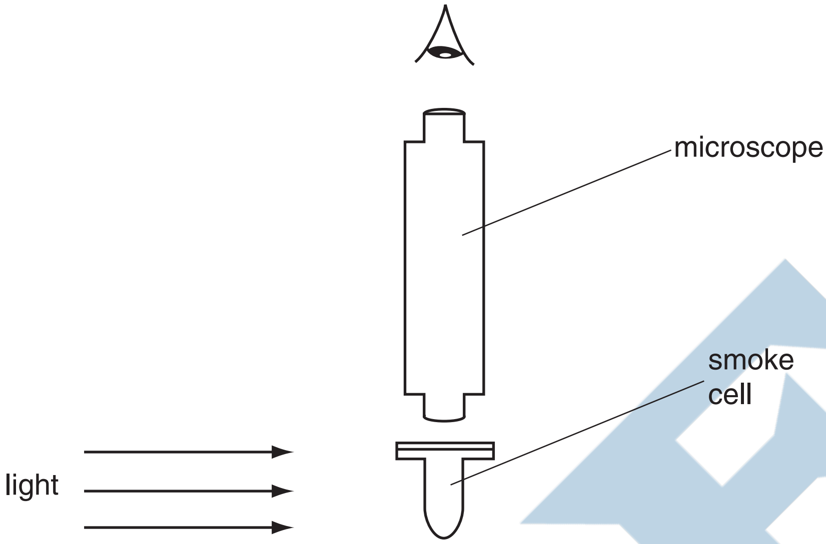

Fig. 2.1

(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]

2 **(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.

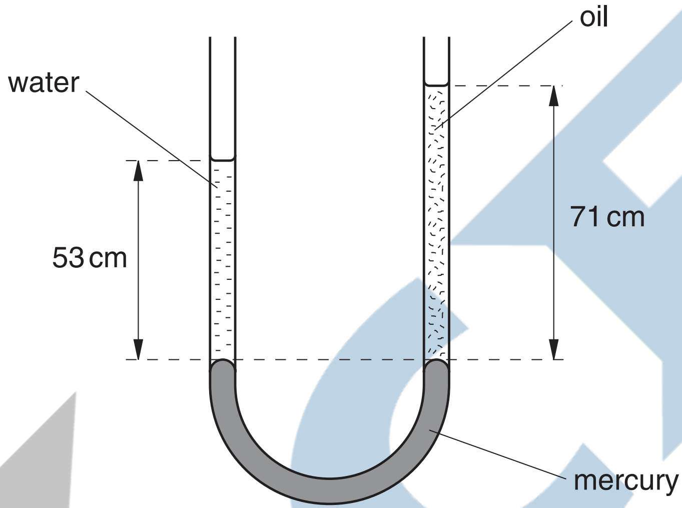

Fig. 4.1

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 $1.0 \times 10^3\,\text{kg m}^{-3}$, 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]

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

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]

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3 A sphere has volume *V* and is made of metal of density ρ.

(a) Write down an expression for the mass *m* of the sphere in terms of *V* and ρ.

....[1]

(b) The sphere is immersed in a liquid. Explain the apparent loss in the weight of the sphere.

....

....

....

....[3]

(c) The sphere in **(b)** has mass 2.0×10^{-3} kg. When the sphere is released, it eventually falls in the liquid with a constant speed of $6.0\,\text{cm s}^{-1}$.

(i) For this sphere travelling at constant speed, calculate

1. its kinetic energy,

kinetic energy = ... J

2. its rate of loss of gravitational potential energy.

rate = ... J s^{-1} [5]

(ii) Suggest why it is possible for the sphere to have constant kinetic energy whilst losing potential energy at a steady rate.

....

....

....[2]

Compilation

For Examiner's Use

4 **(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]

For Examiner's Use

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

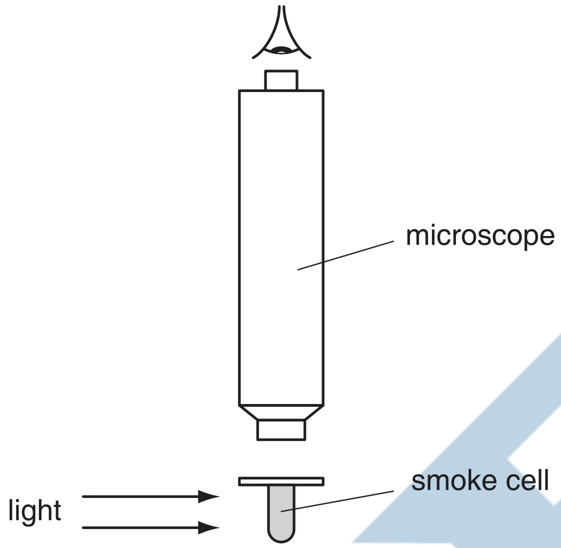

Fig. 5.1

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]

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For Examiner's Use

6 **(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]

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(ii) Estimate

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

volume = ... cm^3 [1]

2. the separation of the atoms in the cube.

separation = ... cm [1]

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For Examiner's Use

4 **(a)** State the evidence for the assumption that

(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]

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For Examiner's Use

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]

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

....

....

.... [1]

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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]

GCE Compilation