CLASSIFIED

International Examinations Papers

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Matter and materials: 7

TOPIC- Density, pressure, compressive and tensile forces, **HOOKE'S LAW,** modulus of elasticity (Young), Experiment, elastic potential energy

(a) Define *pressure*.

....

.... [1]

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

....

....

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....

.... [4]

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

....

....

.... [2]

Answer **all** the questions in the spaces provided.

For Examiner's Use

1 **(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.

....

....

....

.... [3]

For Examiner's Use

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.

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....

....

....

.... [3]

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

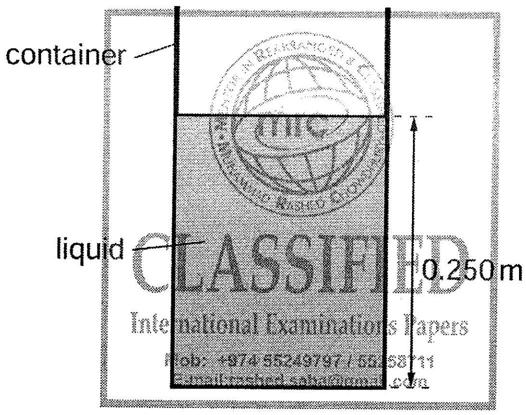


Fig. 3.1

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.

For Examiner's Use

pressure = ... Pa [1]

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

....

.... [1]

4 **(a)** Compare the molecular motion of a liquid with

(i) a solid,

....

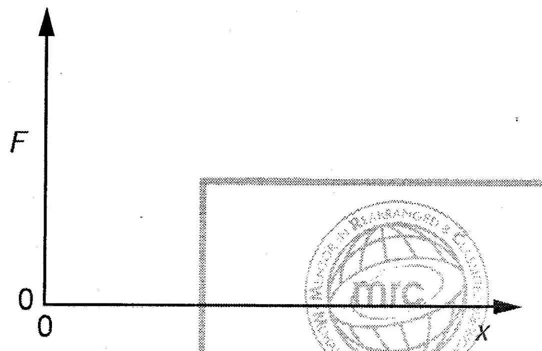
....[2]

(ii) a gas.

....

....[1]

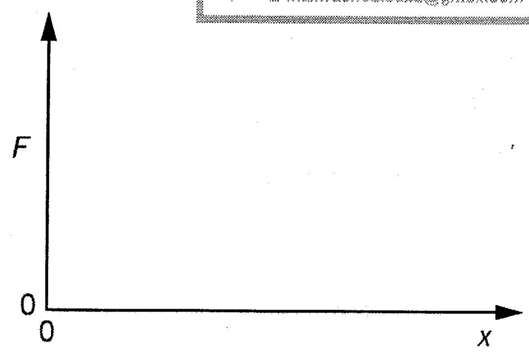
(b) (i) A ductile material in the form of a wire is stretched up to its breaking point. On Fig. 4.1, sketch the variation with extension *x* of the stretching force *F*.



ductile material

Fig. 4.1 [1]

(ii) On Fig. 4.2, sketch the variation with extension *x* of the stretching force *F* for a brittle material up to its breaking point.



brittle material

Fig. 4.2 [1]

(c) Describe a similarity and a difference between ductile and brittle materials.

similarity: ....

....

difference: ....

....
[2]

Fig. 4.1 shows a metal cylinder of height 4.5 cm and base area 24 cm^2.

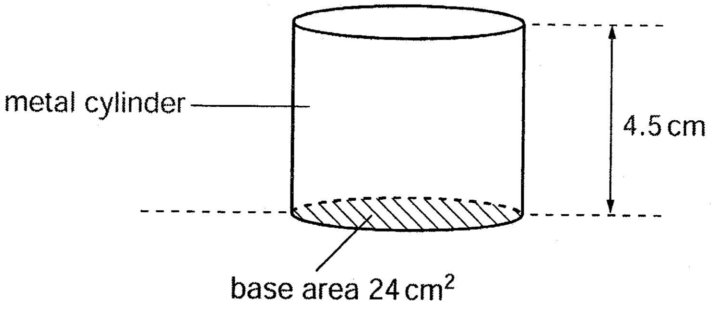


Fig. 4.1

The density of the metal is 7900 $kg\,m^{-3}$.

(a) Show that the mass of the cylinder is 0.85 kg.

[2]

(b) The cylinder is placed on a plank, as shown in Fig. 4.2.

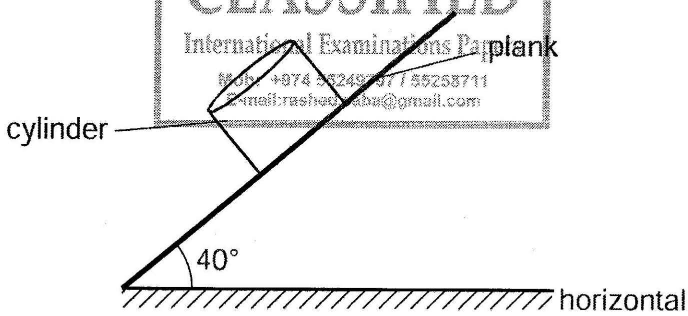


Fig. 4.2

The plank is at an angle of 40° to the horizontal.

Calculate the pressure on the plank due to the cylinder.

pressure = ... Pa [3]

(c) The cylinder then slides down the plank with a constant acceleration of $3.8\,\text{m}\,\text{s}^{-2}$.
A constant frictional force f acts on the cylinder.

Calculate the frictional force f.

f = ... N [3]

A steel wire of cross-sectional area 15 mm^2 has an ultimate tensile stress of 4.5×10^8 N m^{-2}.

(a) Calculate the maximum tension that can be applied to the wire.

tension = ... N [2]

(b) The steel of the wire has density 7800 kg m^{-3}. The wire is hung vertically.

Calculate the maximum length of the steel wire that could be hung vertically before the wire breaks under its own weight.

length = ... m [3]

Please turn over for Question 8.

For Examiner's Use

(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]

For Examiner's Use

(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.

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.... [3]

For Examiner's Use

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

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....

....

.... [2]

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

....

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.... [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]

For Examiner's Use

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

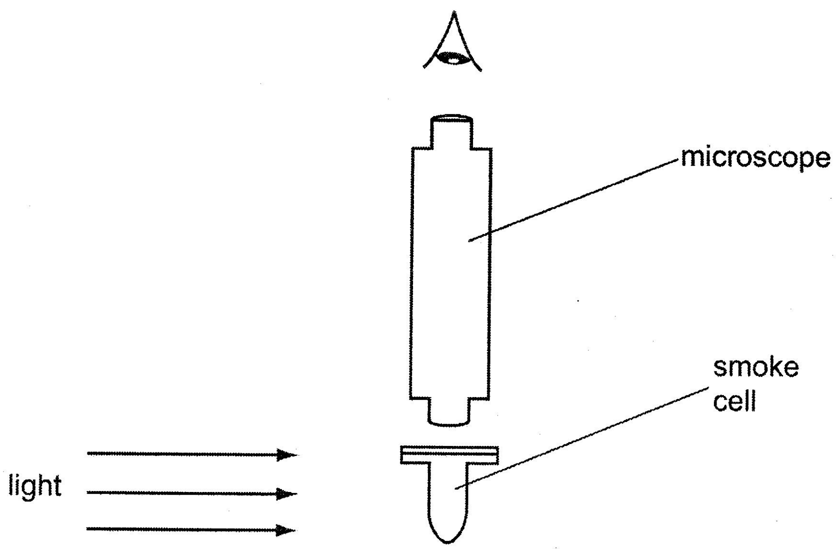

Fig. 2.1

(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]

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

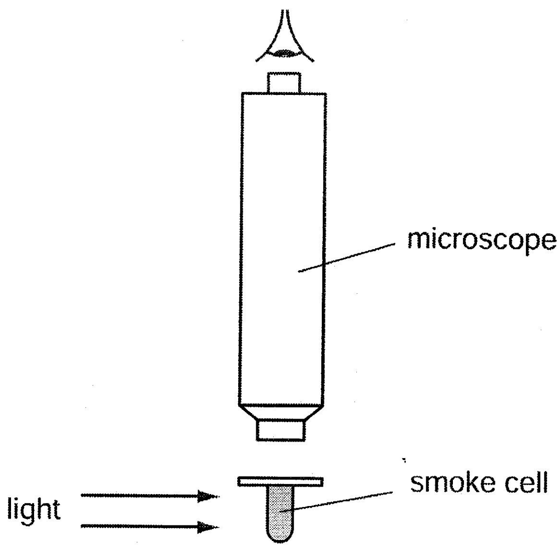

Fig. 5.1

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.

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.... [2]

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

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.... [2]

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

....

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.... [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

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.... [3]

(ii) some water as it evaporates at constant temperature

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.... [3]

Distinguish between *evaporation* and *boiling*.

evaporation: ....

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boiling: ....

....

....

[4]

For Examiner's Use

(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]

For Examiner's Use

(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]