**1** An archaeologist is investigating a shipwreck and discovers a wooden box on the seabed.

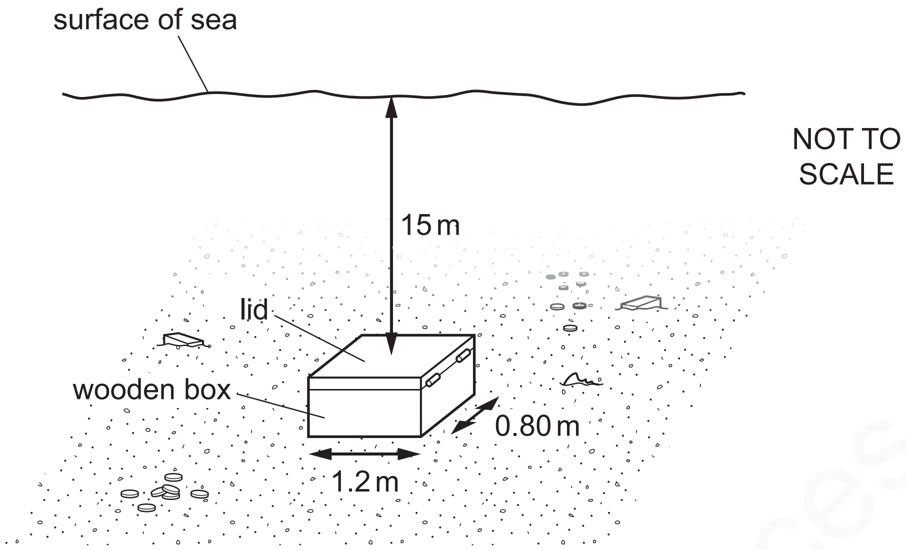


**Fig. 4.1**

The dimensions of the lid of the box are 1.2 m by 0.80 m and the pressure of the atmosphere is $1.0 \times 10^5$ Pa. The lid is 15 m below the surface of the sea.

**(a)** The density of sea-water is 1020 kg / $m^3$.

Calculate

**(i)** the pressure on the lid of the box due to the sea-water,

pressure = ............................................................ [2]

**(ii)** the total pressure on the lid,

pressure = ............................................................ [1]

**(iii)** the downward force that the total pressure produces on the lid.

force = ................................................................. [2]

**(b)** The force needed to open the lid is **not** equal to the value calculated in **(a)(iii)**.

Suggest **two** reasons for this.

1. ...........................................................................................................................

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2. ...........................................................................................................................

........................................................................................................................... [2]

[Total: 7]

**MARKING SCHEME:**

| | | |
|---|---|---|
| (a)(i) | P = hρg in any form or hρg | **C1** |
| | (15 × 1020 × 10 =) 150 000 Pa / 150 kPa | **A1** |
| (a)(ii) | 250 000 Pa / 250 kPa | **B1** |
| (a)(iii) | use of P = F / A in any form or PA | **C1** |
| | (253 000 × 1.2 × 0.8 =) 240 000 N | **A1** |
| (b) | weight of lid } any<br>(there is a) pressure inside box }<br>OR upthrust on lid } two<br>moment of force changes } from<br>friction (of hinge) } five<br>drag of water } | **B2** |
| | | **Total: 7** |

**2** All the sides of a plastic cube are 8.0 cm long. Fig. 3.1 shows the cube.

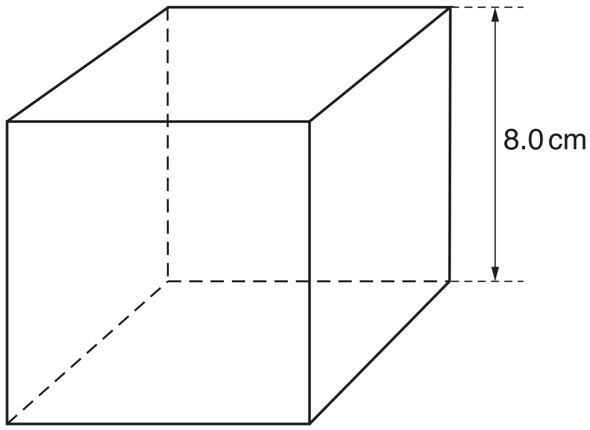


**Fig. 3.1** (not to scale)

The mass of the cube is 0.44 kg.

**(a)** Explain what is meant by *mass*.

............................................................................................................................................[1]

**(b) (i)** Calculate the density of the plastic from which the cube is made.

density = ..........................................................[2]

**(ii)** The density of one type of oil is 850 kg/$m^3$.

State and explain whether the cube floats or sinks when placed in a container of this oil.

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............................................................................................................................................[1]

**(c)** On the Moon, the weight of the cube is 0.70 N.

**(i)** Calculate the gravitational field strength on the Moon.

gravitational field strength = ..........................................................[2]

**(ii)** In a laboratory on the Moon, the plastic cube is held stationary, using a clamp, in a beaker of the oil of density 850 kg / $m^3$.

The arrangement is shown in Fig. 3.2.

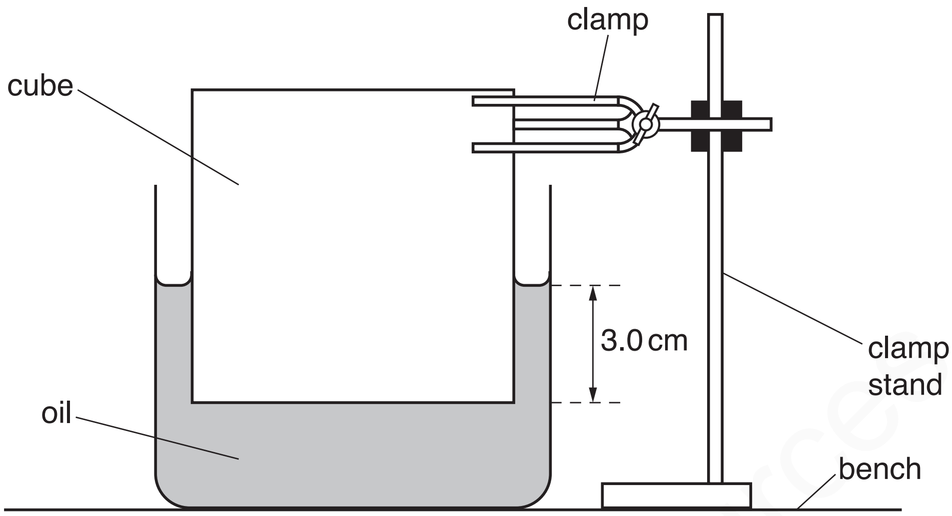


**Fig. 3.2**

The lower face of the cube is 3.0 cm below the surface of the oil.

Use your answer to **(c)(i)** to calculate the pressure due to the oil on the lower face of the cube.

pressure = ........................................................... [2]

[Total: 8]

**MARKING SCHEME:**

| | | |
|---|---|---|
| (a) | (Measure of) quantity / amount of matter OR (property) that resists change in motion / speed / momentum OR measure of a body's inertia | **B1** |
| (b)(i) | $d = m / V$ OR in words OR $0.44 / 0.080^3$ OR $0.44 / 5.12 \times 10^{-4}$ OR $440 / 8^3$ OR 440 / 512 OR $0.44 / 8^3$ OR 0.44 / 512 | **C1** |
| | 0.86 g / $cm^3$ OR 860 kg / $m^3$ OR $8.6 \times 10^{-4}$ kg / $cm^3$ | **A1** |
| (b)(ii) | Sinks OR does not float AND (cube) denser (than oil) | **B1** |
| (c)(i) | $W = mg$ OR ($g$ =) $W / m$ OR 0.70 / 0.44 | **C1** |
| | 1.6 N / kg | **A1** |
| (c)(ii) | ($P$ =) $hdg$ OR $0.030 \times 850 \times 1.6$ | **C1** |
| | 41 Pa | **A1** |

**3** Fig. 4.1 shows a balloon filled with helium that is used to lift measuring instruments to a great height above the Earth's surface.

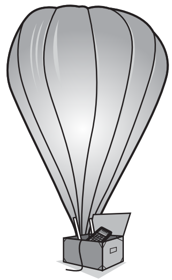

**Fig. 4.1**

**(a)** Explain, in terms of momentum, how the atoms of helium produce a force on the wall of the balloon.

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**(b)** At ground level, the pressure of the helium in the balloon is $1.0 \times 10^5$ Pa. The volume occupied by the helium is $9.6\,m^3$.

The balloon is released and it rises quickly through the atmosphere. The volume occupied by the helium increases, but the temperature of the helium may be assumed to stay constant.

**(i)** Explain, in terms of the helium atoms in the balloon, why the pressure in the balloon is smaller than at ground level.

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**(ii)** Calculate the pressure of the helium when it occupies a volume of $12\,m^3$.

pressure = ...........................................................[2]

[Total: 7]

 

MARKING SCHEME:

| | | |
|---|---|---|
| (a) | Atoms collide with wall (and rebound) OR atoms rebound from wall | **B1** |
| | (Atoms) undergo change of momentum | **C1** |
| | Force on wall = (total) rate of change of momentum (of atoms)<br>OR = change of momentum (of atoms) per second<br>OR = change of momentum (of atoms) / time | **A1** |
| (b)(i) | Fewer atoms per unit volume OR density of gas less | **B1** |
| | Rate of collision (with walls of balloon) decreases OR Fewer collisions per unit area | **B1** |
| (b)(ii) | $PV$ = constant OR $P_1V_2 = P_2V_2$ OR ($P_2$ =) $P_1V_1 / V_2$ OR $1.0 \times 10^5 \times 9.6 / 12$ | **C1** |
| | $8.0 \times 10^4$ Pa | **A1** |

**4** Fig. 5.1 shows some gas trapped in a metal cylinder by a piston.

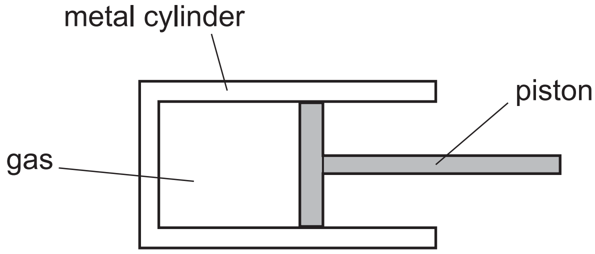


**Fig. 5.1**

**(a)** The position of the piston is fixed. The cylinder is moved from a cold room to a warm room.

Explain, in terms of molecules, what happens to the pressure of the gas in the cylinder.

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**(b)** The piston is now released. It moves to the right and finally stops.

Explain these observations in terms of the pressure and the volume of the gas in the cylinder.

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[Total: 6]

MARKING SCHEME:

| | | |
|---|---|---|
| (a) | Pressure increases | **B1** |
| | Molecules (of gas) move faster/their kinetic energy increases/their momentum increases | **B1** |
| | (Molecules) collide with walls/piston more often/more frequently<br>OR greater (rate of) change of momentum | **B1** |
| | (Molecules) exert greater/more force (on wall)/hit (walls) harder | **B1** |
| (b) | Pressure (of gas) falls **and** volume (of gas) increases | **B1** |
| | Initially there is a larger pressure inside than outside/atmospheric pressure<br>OR (Piston stops when) pressure (of gas) = external/outside/atmospheric pressure | **B1** |
| | **Total:** | **6** |

**5** Fig. 2.1 shows a measuring cylinder that contains a coloured liquid.

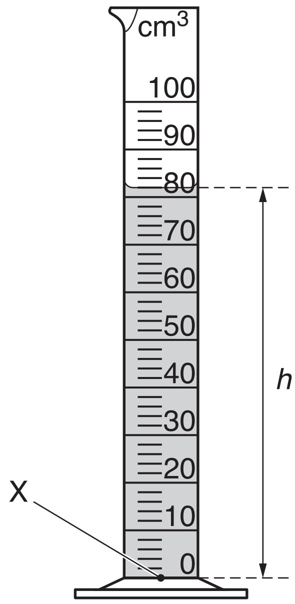


**Fig. 2.1**

The measuring cylinder contains 82 $cm^3$ of the liquid. The density of the liquid is 950 $kg/m^3$.

**(a)** Calculate the mass of the liquid.

mass = ........................................................... [3]

**(b)** The height *h* of the liquid in the measuring cylinder is 0.094 m.

**(i)** Calculate the pressure due to the liquid at point X in Fig. 2.1.

pressure = ........................................................... [2]

**(ii)** The true pressure at point X is different from the value calculated in **(b)(i)**.
Explain why.

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..........................................................................................................................................[1]

**(c)** A small object is made of steel. It is placed level with the top surface of the liquid in the measuring cylinder and then released. The object sinks in this liquid.

**(i)** Explain why the object sinks in this liquid.

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**(ii)** Describe how the volume of the object can now be determined.

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..........................................................................................................................................[1]

[Total: 8]

MARKING SCHEME:

| | | |
|---|---|---|
| (a) | ($m$ = )$\rho V$ **or** 950 × 8.2 × $10^{-5}$ **or** 0.95 × 82 | **C1** |
| | 7.8 / 7.79 × $10^{N}$ (where N is a integer) | **C1** |
| | 0.078 / 0.0779 kg **or** 78 / 77.9 g | **A1** |
| (b)(i) | ($p$ = )$h\rho g$ **or** 0.094 × 950 × 10 | **C1** |
| | 890 / 893 Pa | **A1** |
| (b)(ii) | atmospheric pressure (is acting) | **B1** |
| (c)(i) | steel is denser (than liquid) **or** denser than 950 kg / $m^3$ | **B1** |
| (c)(ii) | take new reading **and** subtract 82 ($cm^3$) / original reading | **B1** |

**6** On a particular day, the atmospheric pressure is $1.0 \times 10^5$ Pa. A bubble of gas forms at a point 5.0 m below the surface of a lake. The density of water is $1000\,kg/m^3$.

**(a)** Determine

**(i)** the total pressure at a depth of 5.0 m in the water,

pressure = ............................................................[3]

**(ii)** the pressure of the gas in the bubble.

pressure = ............................................................[1]

**(b)** As the bubble rises to the surface, the mass of gas in the bubble stays constant. The temperature of the water in the lake is the same throughout.

Explain why the bubble rises to the surface and why its volume increases as it rises.

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...................................................................................................................................[3]

[Total: 7]

MARKING SCHEME:

| | | |
|---|---|---|
| (a)(i) | ($p$ =) $h \times \rho \times g$ or $5.0 \times 1000 \times 10$ | **C1** |
| | 50 000 (Pa) | **C1** |
| | (total pressure = 50 000 + $1.0 \times 10^5$ =) $1.5 \times 10^5$ Pa | **A1** |
| (a)(ii) | $1.5 \times 10^5$ Pa | **B1** |
| (b) | (rises because) density of gas is less than density of **OR** resultant upward force on bubble | **B1** |
| | (as bubble rises) pressure (of gas in bubble) decreases | **B1** |
| | (volume of bubble increases because) $p \times V$ = constant **OR** $V \propto 1 \div p$ | **B1** |

**7** **(a)** A microscope that produces a very high magnification is used to observe the Brownian motion of smoke particles in air.

Fig. 5.1(a) shows the apparatus used with the microscope. Fig. 5.1(b) represents the view through the microscope and shows one of the smoke particles being observed.

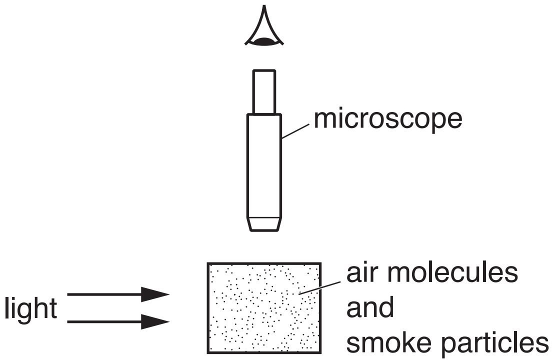


**Fig. 5.1(a)**

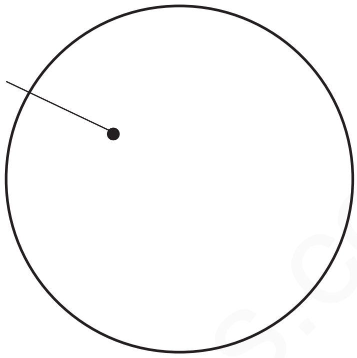


**Fig. 5.1(b)**

**(i)** On Fig. 5.1(b), draw a possible path for the smoke particle. [2]

**(ii)** Describe how air molecules cause the smoke particle to follow the observed path.

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**(b)** Fig. 5.2 shows a volume of gas in a cylinder.

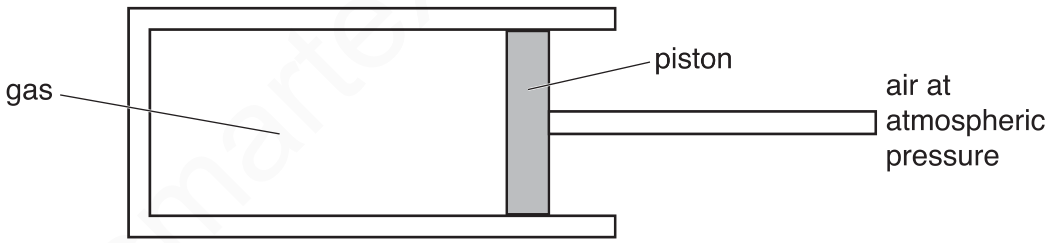


**Fig. 5.2**

The piston in the cylinder is free to move. The piston moves to the left when the temperature of the gas is decreased.

Explain, in terms of the molecules of the gas, why this happens.

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.....................................................................................................................................[4]

MARKING SCHEME:

| | | |
|---|---|---|
| (a)(i) | path shows three or more straight line sections | **B1** |
| | with sudden changes of direction **and** at least two different lengths | **B1** |
| (a)(ii) | air molecules travelling in random (directions) | **B1** |
| | collide with the smoke particle | **B1** |
| (b) | (average) speed of the molecules decreases | **B1** |
| | molecules collide less often (on the piston and the walls of the cylinder) | **B1** |
| | smaller momentum change molecules (on collision) | **B1** |
| | piston now has a greater force on its right-hand side **OR** pressure less than atmospheric | **B1** |