1 **(a)** Fig. 3.1 shows an oil can containing only air at atmospheric pressure.

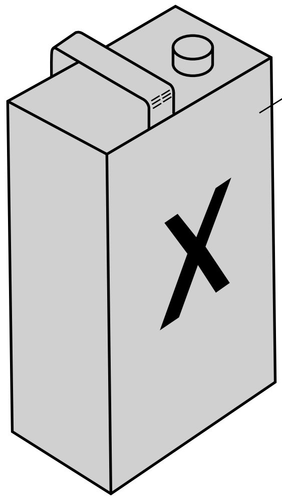

Fig. 3.1

Atmospheric pressure is 1.0×10^5 Pa.

The pressure of the air in the can is reduced by means of a pump. The can collapses when the pressure of the air in the can falls to 6000 Pa.

(i) Explain why the can collapses.

....

....[1]

(ii) The surface area of face X of the can is $0.12\,m^2$.

Calculate the resultant force on face X when the can collapses.

force = ...[3]

(b) Mercury is poured into a U-shaped glass tube. Water is then poured into one of the limbs of the tube. Oil is poured into the other limb until the surfaces of the mercury are at the same level in both limbs.

Fig. 3.2 shows the result.

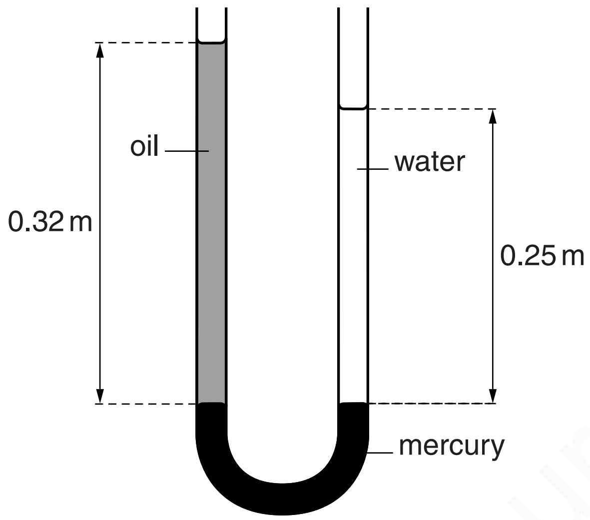

Fig. 3.2

(i) State a condition that must be true in order for the mercury surfaces to be at the same level in both limbs of the tube.

....[1]

(ii) The height of the water column is 0.25 m. The height of the oil column is 0.32 m. The density of water is 1000 kg / m^3.

Calculate

1. the pressure exerted by the water on the surface of the mercury,

pressure = ...[2]

2. the density of the oil.

density = ...[2]

[Total: 9]

MARKING SCHEME:

(a)	**(i)**	force / pressure greater on outside surface owtte	B1
	(ii)	$p = F / A$ in any form **OR** $(F =)\ pA$	C1
		$= (1.0 \times 10^5 - 6000) \times 0.12$	C1
		11280 N to at least 2 sig. figs.	A1
(b)	**(i)**	pressure of oil = pressure of water	B1
	(ii)	**1.** $(p=)\ h\rho g$	C1
		$(= 0.25 \times 1000 \times 10 =)$ 2500 Pa	A1
		2. $h\rho g = 2500$	C1
		$(\rho = 2500 / (0.32 \times 10) =)$ 781 kg / m^3 to at least 2 sig. figs.	A1

[Total: 9]

2 A small cylinder of compressed helium gas is used to inflate balloons for a celebration.

(a) **(i)** In the box below, sketch a diagram to represent the arrangement of helium molecules in a balloon.

[2]

(ii) State and explain how the size of the attractive forces acting between the molecules of a gas compares with the size of the attractive forces between the molecules of a solid.

....

....

....[2]

(b) The helium in the cylinder has a volume of $6.0 \times 10^{-3}\,m^3$ ($0.0060\,m^3$) and is at a pressure of 2.75×10^6 Pa.

(i) The pressure of helium in each balloon is 1.1×10^5 Pa. The volume of helium in an inflated balloon is 3.0×10^{-3} ($0.0030\,m^3$). The temperature of the helium does not change.

Calculate the number of balloons that were inflated.

number of balloons = ...[3]

(ii) Later, the temperature increases and some of the balloons burst.

Suggest and explain why this happens.

....

....

....[2]

[Total: 9]

MARKING SCHEME:

(a)	**(i)**	diagram showing:	
		molecules widely spaced	B1
		molecules randomly positioned	B1
	(ii)	(attractive) forces (much) smaller between gas molecules	B1
		gas molecules (much) farther apart	B1
(b)	**(i)**	pV = constant **OR** $p_1V_1 = p_2V_2$ **OR** $(V_2 =)\ p_1V_1/p_2$	
		OR $(V_2 =)\ 2.75 \times 10^6 \times 6 \times 10^{-3}/1.1 \times 10^5$	C1
		$= 0.15\,m^3$	C1
		(no. of balloons = $(0.15 - 6 \times 10^{-3})/3 \times 10^{-3}$ =) 48	A1
	(ii)	pressure of air in balloon increases	B1
		molecules move faster **OR** hit balloon surface harder / more often **OR** larger force rips / breaks rubber **OR** balloon expands	B1

[Total: 9]

3 Fig. 2.1 shows a uniform, rectangular slab of concrete ABCD standing upright on the ground. The slab has height 0.60 m, width 0.30 m and mass 18 kg. A force of 40 N acts horizontally to the left at B.

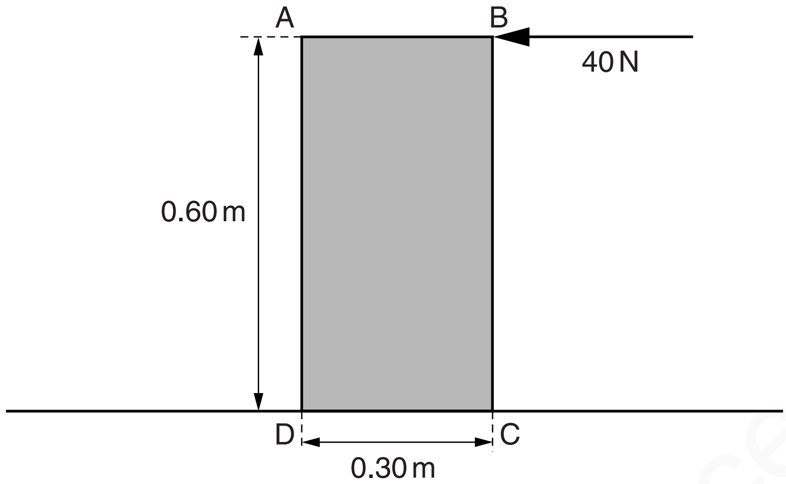

Fig. 2.1

(a) **(i)** Calculate the weight *W* of the concrete slab.

W = ... [1]

(ii) The thickness of the slab is 0.040 m.

Calculate the pressure exerted by the slab on the ground.

pressure = ... [2]

(b) **(i)** On Fig. 2.1, draw and label an arrow to show the weight W of the slab acting at its centre of mass. [1]

(ii) Calculate

1. the moment of the 40 N force about point D,

moment = ...

2. the moment of W about point D.

moment = ...
[3]

(iii) The ground is rough so that the slab does not slide.

State and explain what happens to the slab as the horizontal force at B is gradually increased.

....

....

....[2]

[Total: 9]

MARKING SCHEME:

(a)	**(i)**	180 N		B1
	(ii)	(*P* =) *F* ÷ *A* **OR** 180÷(0.30 × 0.04)		C1
		15 000 Pa		A1
(b)	**(i)**	arrow (labelled *W*) from / to correct centre of mass		B1
	(ii)	**1.** force × (perpendicular) distance **OR** 40 × 0.60 **OR** 180 × 0.15 in **2.**		C1
		24 N m		A1
		2. 27 N m	e.c.f. from **(a)(i)**	A1
	(iii)	slab topples / rotates (about point D) **OR** corner C lifts from ground **OR** falls over		B1
		<u>moment</u> of force at B becomes bigger than <u>moment</u> of weight / W **OR** anticlockwise <u>moment</u> becomes bigger than clockwise <u>moment</u> **OR** weight/centre of mass outside base		B1

[Total: 9]

4 **(a)** Fig. 4.1 shows a syringe containing 100 cm^3 of air at atmospheric pressure. Atmospheric pressure is 1.0×10^5 Pa.

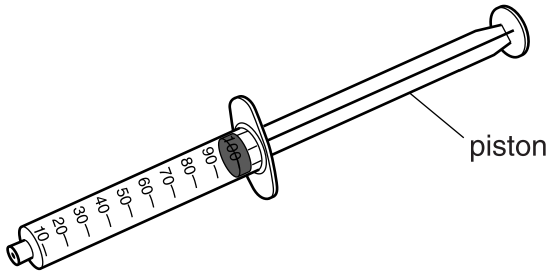

Fig. 4.1

The open end of the syringe is sealed and the piston is pushed inwards until the air occupies a volume of 40 cm^3. The temperature of the air remains constant.

Calculate the new pressure of the air in the syringe.

air pressure = ... [2]

(b) A syringe is used to transfer smokey air from above a flame to a small glass container.

Extremely small solid smoke particles are suspended in the air in the container.

The container is brightly illuminated from the side and viewed through a microscope.

(i) The movement of the suspended smoke particles is called Brownian motion. Describe this Brownian motion.

....

....

....[2]

(ii) Explain what causes the motion of the smoke particles.

....

....

....[2]

(c) In the space below, sketch a diagram to represent the molecular structure of a solid. Show the molecules as small circles of equal sizes.

[2]

[Total: 8]

MARKING SCHEME:

(a) pV = constant **OR** $p_1V_1 = p_2V_2$ **OR** p_1V_1 / V_2 or $1.0 \times 10^5 \times 100 \div 40$ C1
2.5×10^5 Pa A1

(b) **(i)** (the particles move) randomly B1

(the particles move) slowly **OR** through small distances **OR** disappear **OR** zigzag **OR** directions change **OR** erratic **OR** straight lines between collisions B1

(ii) air molecules / particles collide with smoke particles (at high speed) B1
fast(er) air molecules **OR** move randomly **OR** many collisions B1

(c) diagram showing:
molecules touching each other B1
molecules positioned in an ordered structure B1

[Total: 8]

5 A large stone block is to be part of a harbour wall. The block is supported beneath the surface of the sea by a cable from a crane. Fig. 2.1 shows the block with its top face a distance h beneath the surface of the sea.

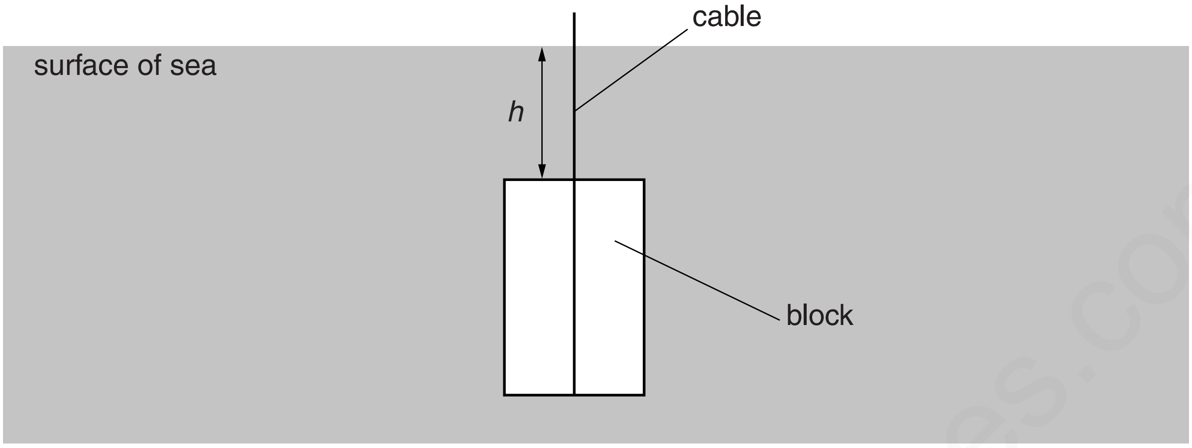

Fig. 2.1

The force acting downwards on the top face of the block, due to the atmosphere and the depth h of water, is 3.5×10^4 N.

(a) The top face of the block has an area of $0.25\,m^2$.

(i) Calculate the pressure on the top face of the block.

pressure = ... [2]

(ii) The atmospheric pressure is 1.0×10^5 Pa.

Calculate the pressure on the top face of the block due to the depth h of water.

pressure = ... [1]

(iii) The density of sea water is $1020\,kg/m^3$.

Calculate the depth h.

h = ... [2]

(b) Suggest two reasons why the tension force in the cable is not 3.5×10^4 N.

1. ....

2. ....
[2]

(c) The block is lowered so that it rests on the sea-bed.

State what happens to the tension force in the cable.

.... [1]

[Total: 8]

(a)	**(i)**	$(P =)\ F \div A$ OR $3.5 \times 10^4 \div 0.25$	C1
		$= 1.4 \times 10^5$ Pa ecf **(i)**	A1
	(ii)	$(1.4 \times 10^5 - 1.0 \times 10^5 =)\ 4(.0) \times 10^4$ Pa ecf **(ii)**	B1
	(iii)	$P = h\rho g$ in any form OR $(h =)\ P \div \rho g$ OR $4.0 \times 10^4 \div (1020 \times 10)$	C1
		= 3.9 m OR 4 m	A1

(b) any 2 from: — max. B2

- weight of block
- upward force of water (on block) / upthrust (of water on block)
- weight of cable

(c) (tension force) becomes smaller or zero — B1

[Total: 8]