1 A vertical cylinder has a smooth well-fitting piston in it. Weights can be added to or removed from a tray on the top of the piston.

(a) Weights are added to the tray, as shown in Fig. 6.1.

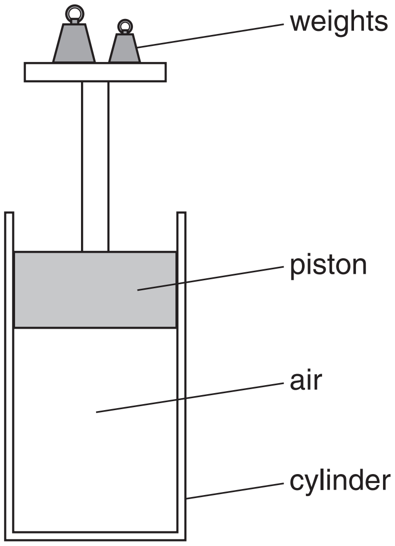


Fig. 6.1

(i) State what happens to the pressure of the air in the cylinder as a result of adding these weights.

.... [1]

(ii) The initial pressure of the trapped air is 1.05×10^5 Pa. When the weights are added, the volume of the air decreases from 860 cm^3 to 645 cm^3.

The temperature of the air does not change.

Calculate the final pressure of the trapped air.

pressure = ... [3]

(iii) The area of the piston is 5.0×10^{-3} m^2.

Calculate the weight that is added to the piston.

weight added = ... [4]

(b) The weights are kept as shown in Fig. 6.1. The temperature of the air in the cylinder is increased.

(i) State what happens to the volume of the air in the cylinder as a result of this temperature rise.

.... [1]

(ii) State how, if at all, the pressure of the air changes as the temperature changes.

.... [1]

(iii) State what must be done to prevent the volume change in **(b)(i)**.

.... [1]

(iv) The volume change in **(b)(i)** is prevented. State what happens to the pressure of the air in the cylinder.

.... [1]

[Total: 12]

MARKING SCHEME:

(a) (i)	increases	B1
(ii)	pV = const in any form	C1
	$1.05\ (\times 10^5) \times 860\ (\times 10^{-6}) = p \times 645\ (\times 10^{-6})$	C1
	1.4×10^5 Pa	A1
(iii)	F = pA in any form accept weight for F	C1
	EITHER increase in pressure = 0.35×10^5 (Pa)	C1
	$0.35 \times 10^5 \times 5.0 \times 10^{-3}$	C1
	175 N (minimum 2 s.f.) c.a.o.	A1
	OR $1.05 \times 10^5 \times 5.0 \times 10^{-3}$ or 525 N or $1.4 \times 10^5 \times 5.0 \times 10^{-3}$ or 700 N	(C1)
	700 – 525 N e.c.f. from **(a) (ii)**	(C1)
	175 N (minimum 2 s.f.) c.a.o.	(A1)
(b) (i)	increases	B1
(ii)	no change	B1
(iii)	extra weight (on tray/piston)	B1
(iv)	increases	B1

[12]

2 Fig. 3.1 shows a hydraulic lift in a car repair workshop.

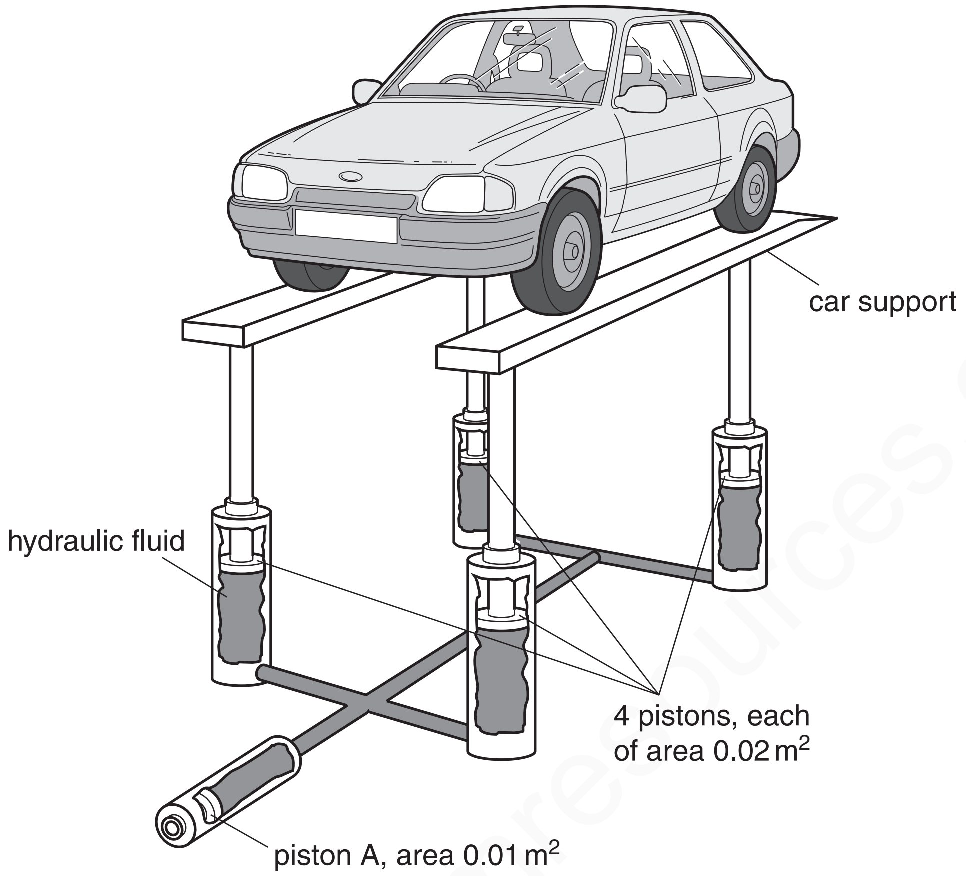


Fig. 3.1

The hydraulic fluid transmits the pressure, caused by piston A, equally to each of the four pistons holding up the car supports. The pressure throughout the fluid is the same.

A force of 1000 N on piston A is just enough to raise the car.

(a) Using values from Fig. 3.1, find

(i) the pressure caused by piston A on the fluid,

pressure = ... [2]

(ii) the total upward force caused by the fluid.

force = ... [3]

(b) The weight of each of the two car supports is 1000 N.

Calculate the mass of the car.

mass = ... [2]

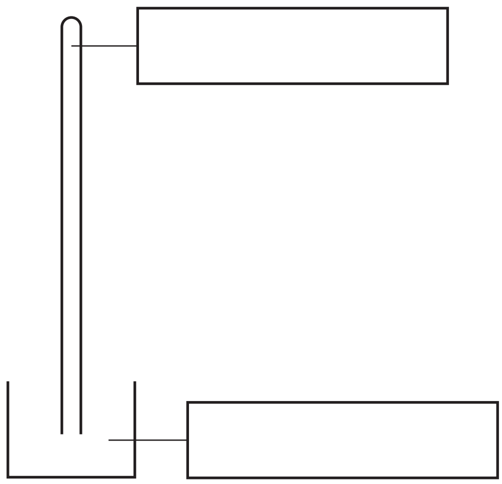
[Total: 7]

MARKING SCHEME:

(a) **(i)**	(P =) F/A in any form OR 1000/0.01	C1
	100 000 Pa accept N/m^2	A1
(ii)	multiplication of either force or area by 4	C1
	0.08 × his **(i)** OR 0.02 × his **(i)**	C1
	8000 N e.c.f. from **(i)**	A1
	(2000 N gets C0, C1, A1)	
(b)	his **(ii)** – 2000 correctly evaluated	C1
	600 kg e.c.f.	A1

[Total: 7]

3 **(a)** Complete Fig. 4.1 to show a simple mercury barometer. Insert the correct labels in the boxes. Label with the letter *h* the measurement required to calculate the pressure of the atmosphere.



[3]

Fig. 4.1

(b) The value of *h* taken using this barometer is 0.73 m. The density of mercury is 13 600 kg/m^3. Calculate the value of the atmospheric pressure suggested by this measurement. Use $g = 10\,\text{m/s}^2$.

atmospheric pressure = ...[2]

(c) Standard atmospheric pressure is 0.76 m of mercury. Suggest a reason why the value of *h* in **(b)** is lower than this.

....

....[1]

[Total: 6]

MARKING SCHEME:

4	**(a)**	surfaces shown at realistic levels in dish and tube AND vertical height *h* between levels clearly shown	B1	
		top label: vacuum / mercury vapour	B1	
		bottom label: mercury	B1	
	(b)	(P =) hdg OR $0.73 \times 13600 \times 10$	C1	
		99280 Pa at least 2 s.f.	B1	
	(c)	one from: abnormal weather / atmospheric conditions o.w.t.t.e. air in space above mercury in tube barometer is in a high altitude location o.w.t.t.e. space above mercury is not a vacuum ignore atmospheric pressure varies ignore temperature	B1	[6]

A soldier wears boots, each having an area of $0.016\,m^2$ in contact with the ground.

4 The soldier weighs 720 N.

(a) **(i)** Write down the equation that is used to find the pressure exerted by the soldier on the ground.

(ii) Calculate the pressure exerted by the soldier when he is standing to attention, with both boots on the ground.

pressure = ...

[2]

(b) The soldier is crossing a sandy desert.

Explain, stating the relevant Physics, why this soldier is at an advantage over another soldier who has the same weight but smaller feet.

....

....

....

....[2]

(c) The soldier's unit is sent to a cold country, and on one occasion he has to cross a frozen lake.

Suggest one way that the soldier can reduce the risk of the ice breaking under his weight.

....

....

....[1]

[Total: 5]

MARKING SCHEME:

(a)	**(i)** (*P* =) *F/A* words or symbols	B1	
	(ii) 22 500 Pa	B1	
(b)	less pressure	B1	
	less sinking	B1	
(c)	any suggestion which involves increasing the area in contact with the ice e.g. snow shoes / skis	B1	[5]

5 **(a)** Explain

(i) how gas molecules exert a force on a solid surface,

....

....

.... [1]

(ii) the increase in pressure of a gas when its volume is decreased at constant temperature.

....

....

....

.... [3]

(b) A cylinder of volume $5.0 \times 10^3 \, cm^3$ contains air at a pressure of 8.0×10^5 Pa.

A leak develops so that air gradually escapes from the cylinder until the air in the cylinder is at atmospheric pressure. The pressure of the atmosphere is 1.0×10^5 Pa.

Calculate the volume of the escaped air, now at atmospheric pressure. Assume that the temperature stays constant.

volume = ...cm^3 [4]

[Total: 8]

MARKING SCHEME

(a) (i) (Force exerted when) molecules hit wall / surface / solid (and rebound)	B1	
Allow (force) due to momentum change in collision		
(ii) Molecules/atoms/particles collide with / push against walls	B1	
more (often)	B1	
(so) bigger force / push	B1	
NOT collide faster		
(b) $P_1V_1 = P_2V_2$ OR PV = constant	C1	
$8.0 \times 10^5 \times 5000 = 1 \times 10^5 \times V_2$	C1	
$V_2 = 40\ 000\ cm^3$	C1	
Volume escaped = 40 000 – 5000 = 35 000 cm^3	A1	**[8]**

6 A diver is at a depth of 25 m beneath the surface of a lake. He carries a cylinder of high-pressure air on his back.

(a) **(i)** Explain how the air molecules exert a pressure on the inside surface of the cylinder.

....

....

....

.... [3]

(ii) The diver gradually uses up the air in the cylinder. Explain why the pressure falls.

....

....

.... [1]

(b) The density of the water in the lake is 1000 kg/m^3 and the atmospheric pressure at the surface is 1.0×10^5 Pa.

Calculate the total pressure 25 m beneath the surface of the lake.

total pressure = ... [3]

[Total: 7]

MARKING SCHEME:

(a) **(i)** atoms/molecules/particles move **or** collide (ignore with each other)	B1	
atoms/molecules/particles collide with (inside) surface/wall	M1	
force (exerted) on wall etc. **or** force/unit area **or** force spread-out	A1	
(ii) fewer atoms/molecules/particles **and** fewer collisions (with wall)	B1	
(b) (P =) hρg **or** $25 \times 1.0 \times 10^3 \times 10$	C1	
$h\rho g + p_{atm}$ **or** $25 \times 1.0 \times 10^3 \times 10 + 10^5$ **or** 2.5×10^5	C1	
3.5×10^5 Pa *Unit penalty applies	A1	**[7]**

*Apply unit penalty once only

7 Complete the following statements by writing appropriate words in the spaces.

The pressure of a gas in a sealed container is caused by the collisions of

.... with the container wall.

An increase in the temperature of the gas increases the pressure because the

.... of the .... increases.

The force on the wall due to the gas is the pressure multiplied by the ....

of the wall. [2]

(b) A mountaineer takes a plastic bottle containing some water to the top of a mountain. He removes the cap from the bottle, drinks all the water and then replaces the cap, as shown in Fig. 6.1.

On returning to the base of the mountain, he finds that the bottle has collapsed to a much smaller volume, as shown in Fig. 6.2.

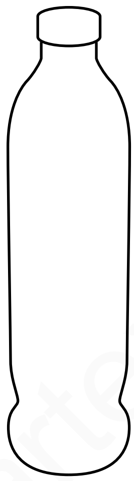


Fig. 6.1

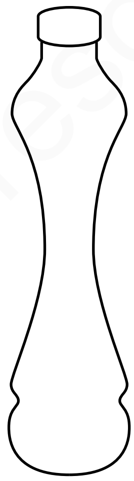


Fig. 6.2

(i) Explain why the bottle collapsed.

....

....

....

.... [2]

(ii) At the top of the mountain the atmospheric pressure was 4.8×10^4 Pa and the volume of the bottle was $250\,cm^3$.

Calculate the volume of the bottle at the base of the mountain where the pressure of the air inside the bottle is 9.2×10^4 Pa. Assume no change of temperature.

volume = ... [3]

[Total: 7]

MARKING SCHEME:

(a) molecules OR atoms OR particles
speed OR velocity OR kinetic energy
molecules OR atoms OR particles
(Surface) area — B2
any four correct gains 2 marks, two or three correct gains 1 mark

(b) **(i)** (when cap is screwed on) at top of mountain:
pressure of air in bottle = the low pressure of the air outside
OR is less than pressure at bottom of mountain
OR is low — B1

(at bottom of mountain) bottle collapses because pressure outside (bottle) is greater than pressure inside — B1

(ii) Boyle's law applies OR PV = constant OR $P_1V_1 = P_2V_2$ — C1
$9.2 \times 10^4 \times V = 4.8 \times 10^4 \times 250$ — C1
$130\,cm^3$ — A1

[Total: 7]