PRESSURE-PAPER-4-SET-3-QP-MS

1 Fig. 4.1 is a design for remotely operating an electrical switch using air pressure.

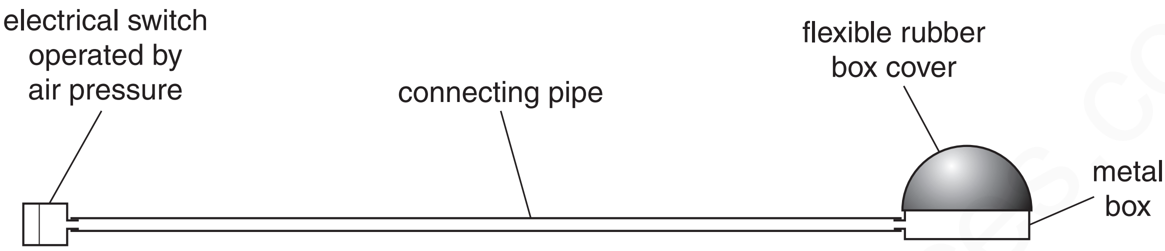

Fig. 4.1

The metal box and the pipe contain air at normal atmospheric pressure and the switch is off. When the pressure in the metal box and pipe is raised to 1.5 times atmospheric pressure by pressing down on the flexible rubber box cover, the switch comes on.

(a) Explain in terms of pressure and volume how the switch is made to come on.

....

....

....

.... [2]

(b) Normal atmospheric pressure is 1.0×10^5 Pa. At this pressure, the volume of the box and pipe is $60\,cm^3$.

Calculate the **reduction** in volume that must occur for the switch to be on.

reduction in volume = ... [3]

(c) Explain, in terms of air particles, why the switch may operate, without the rubber cover being squashed, when there is a large rise in temperature.

....

....

....

.... [2]

[Total: 7]

MARKING SCHEME:

(a)	(pushing rubber cover) volume reduced	M1
	(when volume reduce), pressure goes up	A1
(b)	$1 \times (10^5) \times 60 = 1.5 \times (10^5) \times V$	C1
	40 (cm^3)	C1
	reduction in volume = 20 cm^3 or 1/3	A1
(c)	(ave) speed of mols/particles/atoms greater at high temp NOT energy/KE	B1
	stronger/more collisions with walls OR greater pressure	B1

[7]

2 **(a)** A man squeezes a pin between his thumb and finger, as shown in Fig. 6.1.

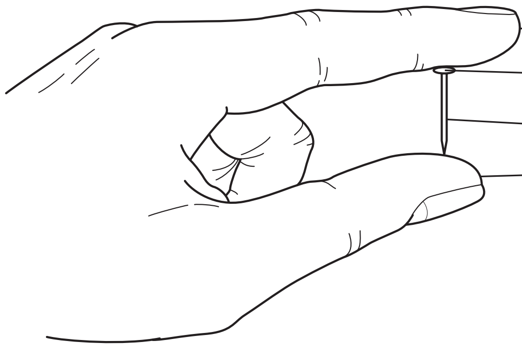

Fig. 6.1

The finger exerts a force of 84 N on the pinhead.

The pinhead has an area of $6.0 \times 10^{-5}\,m^2$.

(i) Calculate the pressure exerted by the finger on the pinhead.

pressure = ... [2]

(ii) State the value of the force exerted by the pin on the thumb.

.... [1]

(iii) Explain why the pin causes more pain in the man's thumb than in his finger.

....

.... [2]

(b) The density of the water in a swimming pool is 1000 kg / m^3. The pool is 3 m deep.

(i) Calculate the pressure of the water at the bottom of the pool.

pressure = ... [2]

(ii) Another pool has the same depth of water, but has twice the area.

State the pressure of the water at the bottom of this pool.

pressure = ... [1]

[Total: 8]

MARKING SCHEME:

(a) (i)	$P = F/A$ in any form, letters, words or numbers	C1	
	1.4×10^6 Pa accept N/m^2	A1	
(ii)	84 N OR 84.0 N	B	
(iii)	<u>same force</u> over (much) smaller area	B1	
	(much) bigger pressure	B1	
(b) (i)	$P = hdg$ in any form, letters, words or numbers	C1	
	3×10^4 Pa OR 30 000 Pa OR 30 kPa accept N/m^2	A1	
(ii)	his **(i)**	B1	[8]

3 During a period of hot weather, the atmospheric pressure on the pond in Fig. 3.1 remains constant. Water evaporates from the pond, so that the depth h decreases.

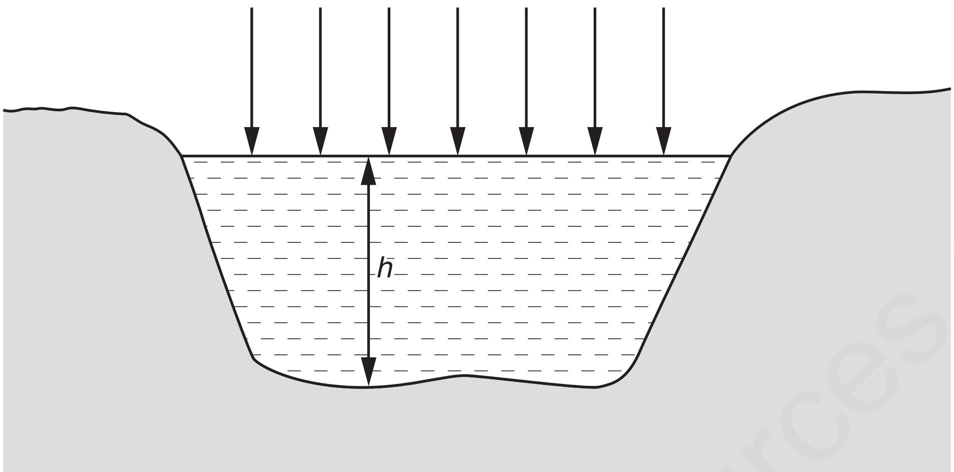

Fig. 3.1

(a) Study the diagram and state, giving your reason, what happens during this hot period to

(i) the force of the air on the surface of the pond,

....

....[1]

(ii) the pressure at the bottom of the pond.

....

....[1]

(b) On a certain day, the pond is 12 m deep.

(i) Water has a density of 1000 kg / m^3.

Calculate the pressure at the bottom of the pond due to the water.

pressure due to the water = ...[2]

(ii) Atmospheric pressure on that day is 1.0×10^5 Pa.

Calculate the total pressure at the bottom of the pond.

total pressure = ...[1]

(iii) A bubble of gas is released from the mud at the bottom of the pond. Its initial volume is $0.5\,cm^3$.

Ignoring any temperature differences in the water, calculate the volume of the bubble as it reaches the surface.

volume = ...[2]

(iv) In fact, the temperature of the water is greater at the top than at the bottom of the pond.

Comment on the bubble volume you have calculated in **(b)(iii)**.

....

....

....[1]

[Total: 8]

MARKING SCHEME:

(a) (i)	smaller because <u>area</u> smaller	B1	
(ii)	smaller because depth/height smaller ignore less water	B1	
(b) (i)	$h\rho g$ OR 12 × 1000 × 10	C1	
	1.2 × 10^5 Pa OR 1.1772 × 10^5 Pa OR 1.176 × 10^5 Pa accept N/m^2	A1	
(ii)	candidate's **(i)** + 1.0 × 10^5 Pa correctly evaluated with unit (correct value 2.2 × 10^5)	B1	
(iii)	$p_1V_1 = p_2V_2$ in any form	C1	
	1.1 cm^3 OR 0.5 × candidate's **(ii)**/10^5 correctly evaluated	A1	
(iv)	value in **(iii)** too small OR volume larger o.w.t.t.e.	B1	[8]

4 Fig. 4.1 represents part of the hydraulic braking system of a car.

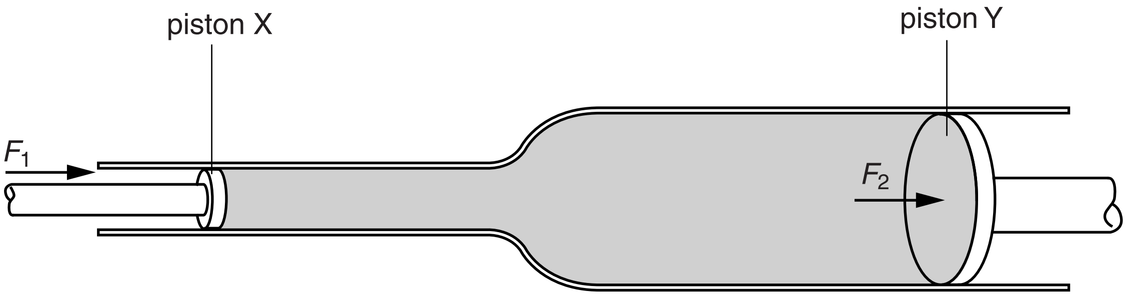

Fig. 4.1

The force F_1 of the driver's foot on the brake pedal moves piston X. The space between pistons X and Y is filled with oil which cannot be compressed. The force F_2 exerted by the oil moves piston Y. This force is applied to the brake mechanism in the wheels of the car.

The area of cross-section of piston X is $4.8\,\text{cm}^2$.

(a) The force F_1 is 90 N. Calculate the pressure exerted on the oil by piston X.

pressure = ... [2]

(b) The pressure on piston Y is the same as the pressure applied by piston X. Explain why the force F_2 is greater than the force F_1.

....

.... [1]

(c) Piston Y moves a smaller distance than piston X. Explain why.

....

....

.... [2]

(d) Suggest why the braking system does not work properly if the oil contains bubbles of air.

....

....

.... [2]

[Total: 7]

MARKING SCHEME:

(a)	(p =) F/A OR in words OR 90/4.8 OR 90 / 0.00048	C1
	= 18.75 N/cm^2 OR 1.875 × 10^5 Pa OR 187500 Pa OR 187.5 kPa OR 0.1875 MPa at least 2 s.f.	A1
(b)	Area of Y bigger (than area of X so force greater)	B1
(c)	Volume of oil moved at Y = volume of oil moved at X	B1
	Area of Y × distance moved by Y = Area of X × distance moved by X (so distance move by Y smaller)	B1
	OR	
	Work done by piston X = work done on piston Y	(B1)
	Work = force × distance and F_2 is greater than F_1 so distance moved by Y smaller (than distance moved by X)	(B1)
(d)	Air bubbles compress when pressure applied	M1
	More movement of piston X required for same movement of piston Y OR Y moves less (for same movement of X) OR Driver must push the brake pedal further / do more work OR Pressure reduced / force on Y reduced OR System is less efficient	A1

[Total: 7]

5 **(a)** **(i)** Define *pressure*.

.... [1]

(ii) A closed box contains a gas.

Explain, in terms of molecules, how the gas exerts a pressure on the walls of the box.

....

....

....

....

.... [3]

(b) Fig. 6.1 shows a flask connected to a pump and also to a manometer containing mercury.

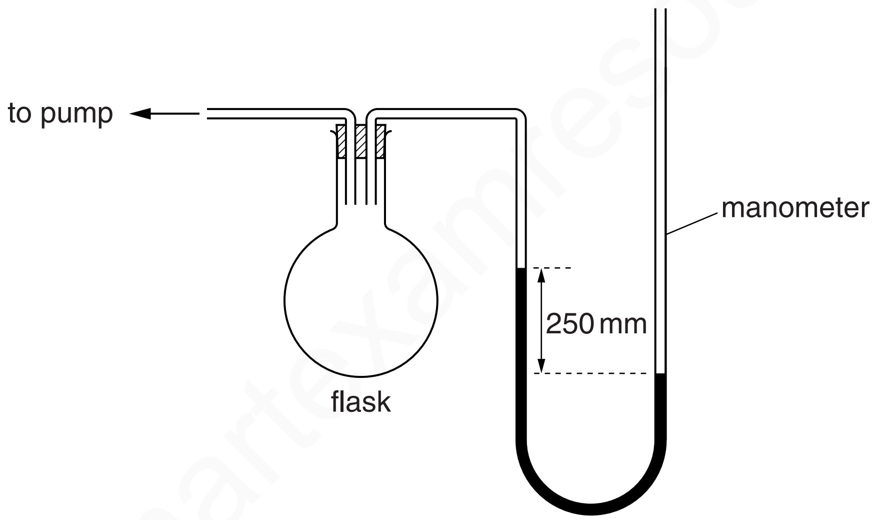

Fig. 6.1

The right-hand tube of the manometer is open to the atmosphere.

The pump has been operated so that the mercury levels differ, as shown, by 250 mm. The density of mercury is 13 600 kg / m^3.

(i) Calculate the pressure, in Pa, due to the 250 mm column of mercury.

pressure = ... [2]

(ii) The pressure of the atmosphere is 1.02×10^5 Pa.

Calculate the pressure of the air in the flask.

pressure = ... [1]

[Total: 7]

MARKING SCHEME:

(a)	**(i)**	(pressure =) force/area OR force per unit area OR (*P* =) *F*/*A* with symbols explained	B1
	(ii)	molecules collide with/hit walls/surface (of box)	B1
		molecule(s) exert force on wall	B1
		pressure is total force / force of all molecules divided by (total) area of wall	B1
(b)	**(i)**	(*P* =) $h\rho g$ OR in words OR $0.25 \times 13\,600 \times 10$	C1
		34 000 Pa OR N/m^2	A1
		allow 1 mark for $h = 250$ used and 3.4×10^7 Pa obtained	
	(ii)	($P = 1.02 \times 10^5 - 34\,000$)	
		68 000 Pa or N/m^2	B1
		e.c.f. from **(b)(i)** only if **(b)(i)** is less than 1.02×10^5	

[Total 7]

6 A large crane has a mass of 8500 kg. Fig. 4.1 shows the crane on a muddy building-site.

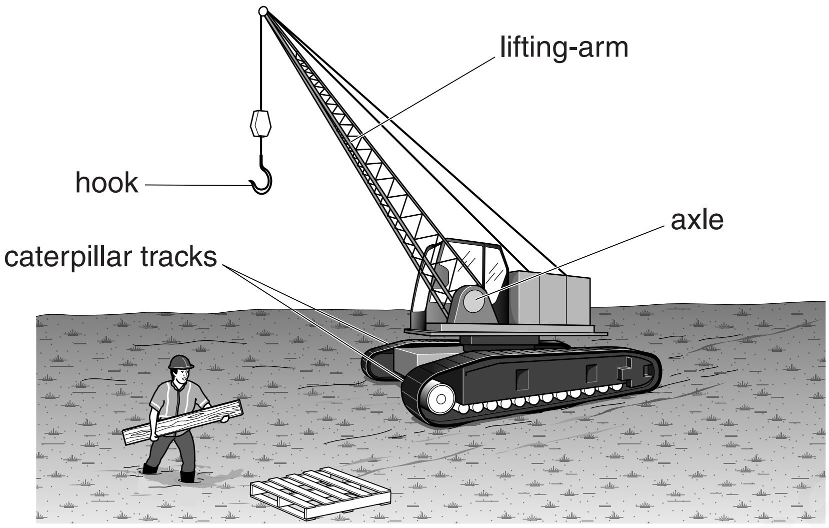

Fig. 4.1

(a) Calculate the weight of the crane.

weight = ... [1]

(b) The crane rests on two caterpillar tracks each of which has a contact area with the ground of 3.4 m^2.

(i) Calculate the pressure that the crane exerts on the ground.

pressure = ... [2]

(ii) As the crane driver walks towards the crane, he starts to sink into the mud. He lays a wide plank of wood on the mud and he walks along the plank.

Explain why he does not sink into the mud when he walks along the plank.

....

....

.... [2]

(c) When the crane lifts a heavy load with its hook, the load exerts a moment on the lifting-arm about the axle.

(i) Explain what is meant by *moment* of a force.

....

.... [1]

(ii) Despite the moment exerted on the lifting-arm, the crane remains in equilibrium.

State the two conditions required for any object to be in equilibrium.

1. ....

2. ....

[2]

[Total: 8]

MARKING SCHEME:

(a) 85 000 N (accept 83 300 N))

(b) (i)	(*P* =)*F*/*A* OR 85 000/3.4 OR 85 000/3.4 × 2 OR 85 000/6.8 (e.c.f. from **(a)(i)**)	C1	
	1.2/1.25/1.3 × 10^4 Pa (e.c.f. from **(a)(i)**)	A1	
(ii)	larger area	M1	
	smaller pressure	A1	
(c) (i)	(measure of) turning effect OR $F \times x$	B1	
(ii)	no resultant/net force	B1	
	no resultant/net turning effect/moment	B1	[8]

7 **(a)** A water tank has a rectangular base of dimensions 1.5 m by 1.2 m and contains 1440 kg of water.

Calculate

(i) the weight of the water,

weight = ... [1]

(ii) the pressure exerted by the water on the base of the tank.

pressure = ... [2]

(b) Fig. 5.1 shows two water tanks **P** and **Q** of different shape. Both tanks are circular when viewed from above. The tanks each contain the same volume of water. The depth of water in both tanks is 1.4 m.

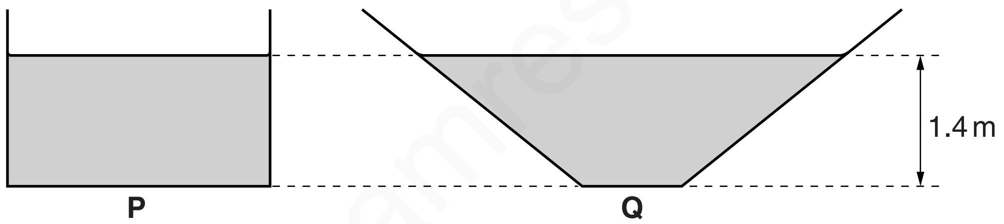

Fig. 5.1

(i) The density of water is 1000 kg / m^3. The pressures exerted by the water on the base of the two tanks are equal.

Calculate this pressure.

pressure = ... [2]

(ii) Equal small volumes of water are removed from each tank.

State which tank, **P** or **Q**, now has the greater water pressure on its base. Explain your answer.

....

....

.... [2]

[Total: 7]

MARKING SCHEME:

(a) **(i)**	($W = mg$ =1440 × 10 =) 14 400 N	B1
(ii)	(P =) F/A OR 14 400 / (1.5 × 1.2)	C1
	8000 Pa OR N / m^2	A1
(b) **(i)**	(P =) $h\rho g$ OR 1.4 × 1000 × 10	C1
	14 000 Pa OR N / m^2	A1
(b) **(ii)**	pressure on base of **P** smaller / **Q** greater	M1
	(with same volume removed) smaller decrease in depth in Q OR height in **Q** is greater	A1

[Total: 7]