PRESSURE-SET-1-QP-MS

1 **(a)** A 30 dm^3 steel cylinder contained air at atmospheric pressure.

Another 100 dm^3 of air, which had also been at atmospheric pressure, was pumped into the cylinder. Atmospheric pressure is 100 000 N/m^2.

(i) State the total volume of air at atmospheric pressure before compression.

.... [1]

(ii) Calculate the final pressure of the air inside the cylinder.

Show your working and state any formula that you use.

.... [2]

(iii) When the pressure in the cylinder was actually measured it was found to be 450 000 N/m^2.

Suggest why this value is different from the value you calculated in **(ii)**.

....

....

....

.... [2]

(b) Fig. 2.1 shows a heat sensor. The plate activates the alarm when the sensor gets too hot.

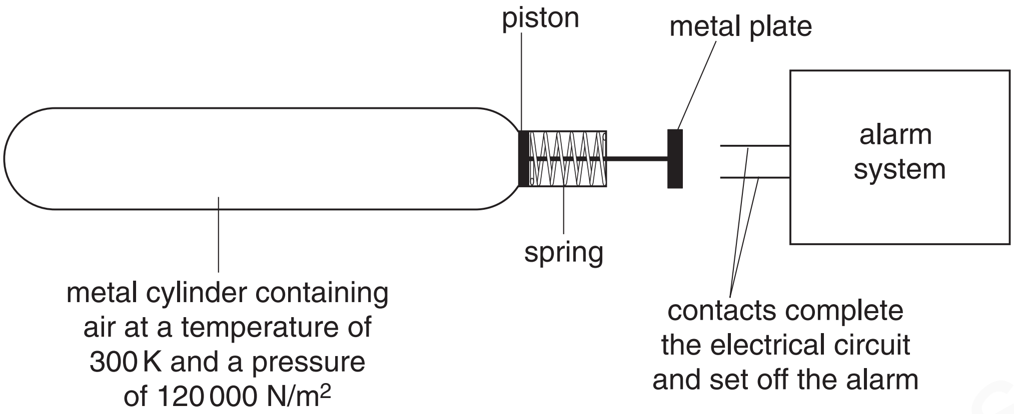

Fig. 2.1

(i) Suggest how this sensor works.

....

....

....

.... [3]

(ii) The pressure in the metal tube is 120 000 N/m^2 at 300 K.

A pressure of 180 000 N/m^2 is required to activate the alarm.

Calculate the minimum temperature, in K, at which the alarm is activated.

Show your working and state any formula that you use.

.... [2]

MARKING SCHEME

(a) (i)		130 dm^3;	1
	(ii)	$P_1V_1 = P_2V_2$ *or* 100 000 x 130 = P_2 x 30; 433 333 Pa/Nm^{-2};	2
	(iii)	ref. to possible temperature change; gas became hotter when pushed into the cylinder; higher temperature (in the same volume) increases pressure;	max 2
(b)	(i)	(gas) pressure increases when temperature increases; (this) pushes the piston/metal plate out; (which) closes the connection (and starts the alarm);	3
	(ii)	$P_1/T_1 = P_2/T_2$ *or* 120 000/300 = 180 000/T_2; 450 K.	2

Total 10 marks

2 The bodywork of a car is usually made from steel.

(a) If part of the bodywork goes very rusty it is usually removed and replaced with plastic filler, before being painted.

A car mechanic can use a magnet to find out if parts of the bodywork of a car have been filled with plastic filler.

He tests three areas of a car by placing a magnet near the surface as shown in Fig. 5.1.

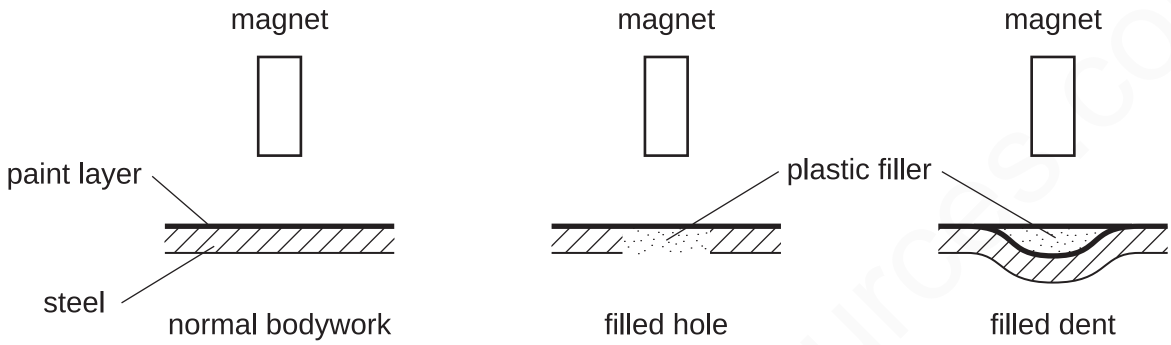

Fig. 5.1

(i) Complete the table.

area	effect on a magnet
normal bodywork	
filled hole	
filled dent	weakly attracted

[1]

(ii) What assumption have you made about the properties of plastic filler?

.... [1]

(iii) Would this method work if the bodywork was made of aluminium?

Explain your answer.

.... [1]

(iv) Suggest why the bodywork of some cars is made from aluminium rather than steel.

.... [1]

(b) After a car has been driven, the tyres are hot. The air in each tyre has a temperature of 45 °C and the pressure of the air in the tyres is 2.5 N / m^2.

After a while the temperature of the air in the tyres falls to 25 °C.

(i) What is the temperature of the air in the tyres in kelvins when the tyres are at 25 °C?

.... K [1]

(ii) Calculate the pressure of the air in the tyres at 25 °C, assuming that the volume of the tyre does not change.

State the formula that you use and show your working.

formula

working

[3]

(iii) Explain in terms of particles why the pressure of the air in the tyres increases when the temperature increases.

....

....

.... [2]

(c) **(i)** The car has a mass of 1000 kg. It is travelling at 12 m / s when it collides with a wall.

Calculate the kinetic energy of the car before the collision.

State the formula that you use and show your working.

formula

working

.... [2]

(ii) Explain why wearing seat belts can help to lessen the injuries produced in a head-on crash.

....

....

.... [2]

MARKING SCHEME

(a) **(i)** (normal bodywork) strongly attracted ;
(filled hole) not attracted ; [1]

(ii) (plastic filler) is not magnetic ; [1]

(iii) no – aluminium is not magnetic ; [1]

(iv) aluminium does not corrode/corrodes less than steel ; [1]

(b) **(i)** 298 K ; [1]

(ii) P1/T1 = P2/T2 ;
2.5/318 = P2/298 ;
P2 = 2.3 N/m^2 ; [3]

(iii) kinetic energy of particles increases/move faster ;
more frequent collisions with tyre walls ; [max 2]

(c) **(i)** kinetic energy = ½ mv^2 ;
= ½ ×1000 × 12 × 12 = 72 000 J ; [2]

(ii) seat belt, reduces/removes, kinetic energy from passenger ;
stops collision with windscreen ; [2]

[Total: 14]

3 **(a)** An elephant of mass 4000 kg moves at 0.4 m/s.

Calculate the kinetic energy of the elephant.

State the formula that you use and show your working.

formula

working

kinetic energy = ... J [2]

(b) The elephant lifts a log of weight 3000 N through a vertical distance of 2 metres.

Calculate the work done by the elephant.

State the formula that you use and show your working.

formula

working

work done = ... J [2]

(c) The elephant weighs 40 000 N and stands with all four feet in contact with the ground. Each foot of the elephant has an area of 400 cm^2.

(i) Calculate the pressure, in N/cm^2, exerted by the elephant on the ground.

State the formula that you use and show your working.

formula

working

pressure = ... N/cm^2 [2]

(ii) Write down the pressure which you calculated in **(c)(i)** in Pa.

pressure = ... Pa [1]

MARKING SCHEME

(a) (KE =) ½ mv^2 ;
= ½ × 4000 × 0.4 × 0.4 = 320 (J) ; [2]

(b) (work done =) force × distance ;
= 3000 × 2 = 6000 (J) ; [2]

(c) **(i)** (pressure =) $\frac{\text{force}}{\text{area}}$;

$\frac{40\,000}{1600}$ = 25 (N/cm^2) ; [2]

(ii) 250 000 (Pa) ; [1]

4 The cyclist has a puncture which he repairs. He pumps up the flat tyre.

Each pump stroke takes 90 cm^3 of air at a pressure of 1×10^5 Pa and pushes it into the tyre.

When fully inflated, the tyre contains 1600 cm^3 of air at room temperature and at a pressure of 2×10^5 Pa. Assume that the temperature of the air does not change.

(i) Show that the volume of air from the pump required to inflate the tyre fully is 3200 cm^3.

State the formula that you use and show your working.

formula

working

[2]

(ii) Calculate the number of pump strokes needed to pump in 3200 cm^3 of air.

Show your working.

number of pump strokes = ... [1]

MARKING SCHEME

(i) $P_1V_1 = P_2V_2$;

$V_1 = \dfrac{P_2V_2}{P_1} = 2 \times 10^5 \times \dfrac{1600}{1} \times 10^5$ (= 3200 cm^3) ; [2]

(ii) number of strokes = $\dfrac{3200}{90}$ = 35.55 so 36 ; [1]

[Total: 6]

5 **(a)** Fig. 3.4. shows a penguin walking on a beach.

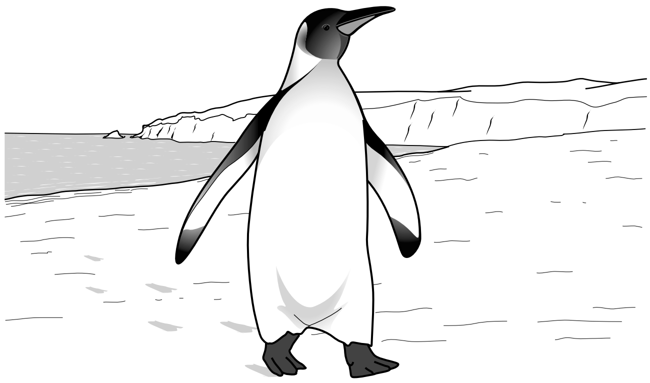

Fig. 3.4

The penguin has a weight of 20 N and each foot has an area of 12 cm^2.

(i) Calculate the pressure exerted by the penguin on the beach, when it is standing on both feet.

State the formula that you use and show your working.

formula

working

pressure = ... N/cm^2 [3]

(ii) Pressure is sometimes measured in Pascals (Pa). 1 Pa = 1 N/m^2.

Write down the pressure that you calculated in **(d)(i)** in Pa.

pressure = ... Pa [1]

(b) A scuba diver is swimming in the sea near the beach. Fig. 3.5 shows a scuba diver.

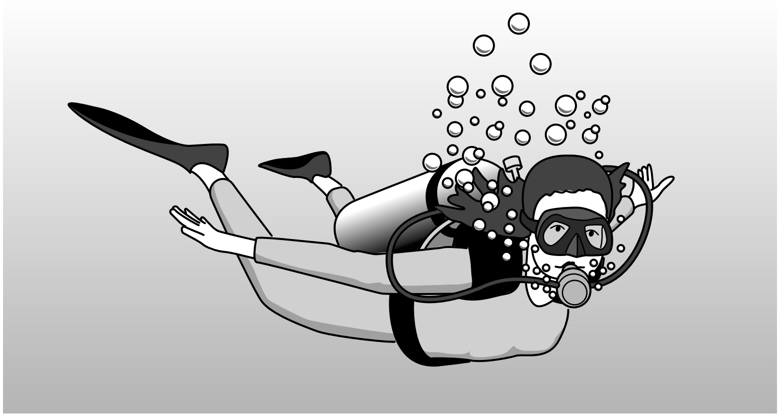

Fig. 3.5

The scuba diver can breathe underwater because she carries a cylinder of air on her back. Air is a mixture of gases.

(i) The molecules of gas in the cylinder move randomly.

Describe how the gas molecules exert a pressure on the wall of the cylinder.

....

....

....

.... [2]

(ii) The cylinder contains air at a pressure of 20 000 kPa.

The volume of the compressed air in the cylinder is $0.015\,m^3$.

The air is allowed to expand into a larger cylinder of volume $0.065\,m^3$.

The temperature of the air does not change.

Calculate the new pressure of the air.

State the formula that you use and show your working.

formula

working

pressure = ... kPa [2]

MARKING SCHEME

(a) **(i)** (pressure =) $\frac{\text{force}}{\text{area}}$;

evidence of multiplication by 2 / use of area of 24 cm^2 ;

$= \frac{20}{24} = 0.83$ (N / cm^2) ; [3]

(ii) 8300 (Pa) ; [1]

(b) **(i)** collide with walls of container ;

force of collisions exerts a pressure ; [2]

(ii) $P_1V_1 = P_2V_2$ etc. ;

$P_2 = 20\,000 \times \frac{0.015}{0.065} = 4615$ (kPa) ; [2]

6 A mountaineer is climbing a high mountain.

(a) The boiling point of water is lower at the top of the mountain than at the bottom.

Define the term *boiling point.*

....

....[1]

(b) As he climbs higher, the mountaineer is exposed to more ultraviolet radiation.
Ultraviolet radiation is part of the electromagnetic spectrum.

(i) Place ultraviolet in the correct position in the incomplete electromagnetic spectrum below.

	X-rays		visible light		microwaves	

[1]

(ii) State the speed, in km/s, at which all electromagnetic waves travel.

.... km/s [1]

(iii) Ultraviolet radiation is ionising radiation.

Name **one** other type of ionising radiation.

....[1]

(c) The mountaineer takes a bottle containing water to the top of the mountain. At the top of the mountain, he removes the cap from the bottle, drinks the water and replaces the cap securely.

Fig. 9.1A shows the empty bottle.

When he safely reaches the bottom of the mountain, he notices that the bottle has collapsed. This is shown in Fig. 9.1B.

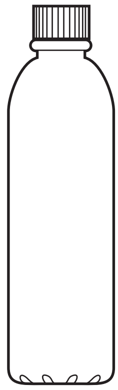

Fig. 9.1A

Fig. 9.1B

At the top of the mountain the volume of air in the bottle is 330 cm^3. The atmospheric pressure is 5×10^4 Pa.

Atmospheric pressure at the bottom of the mountain is 1×10^5 Pa.

Calculate the volume of the air inside the collapsed bottle at the bottom of the mountain.

Assume that there is no change in temperature.

State the formula you use and show your working.

formula

working

volume = ... cm^3 [2]

(d) The mountaineer lights a small fire by using a lens to focus the Sun's rays. This is shown in Fig. 9.2.

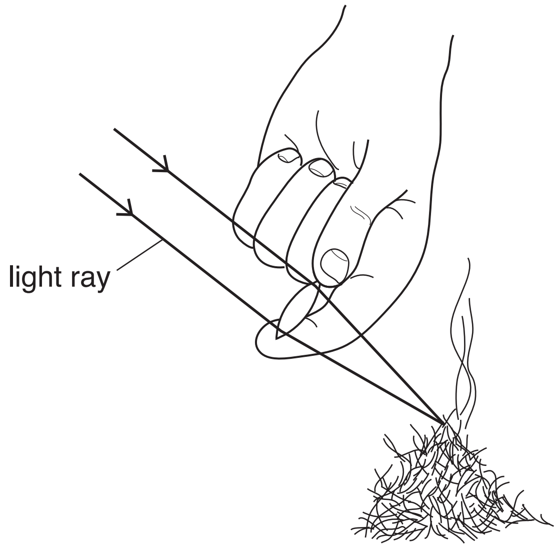

Fig. 9.2

(i) Use a labelling line to show the principal focus of the lens. Label the line **P**. [1]

(ii) Use a double headed arrow (◄►) to indicate the focal length of the lens. Label it with the letter **F**. [1]

MARKING SCHEME

(a)	temperature at which all of a liquid boils and turns into a gas / vapour ;	1
(b)(i)	between X rays and visible light ;	1
(b)(ii)	300 000 / 3×10^5 km / s ;	1
(b)(iii)	α / β / γ / X-rays ;	1
(c)	$P_1V_1 = P_2V_2$ or working ; $V_2 = 5 \times 10^4 \times 330 / 10^5 = 165\ cm^3$;	2
(d)(i)	principal focus correctly identified ;	1
(d)(ii)	focal length correctly shown ;	1
	Total:	**8**

7 Fig. 8.1 shows a car lift being used to lift a car, which weighs 10 000 N.

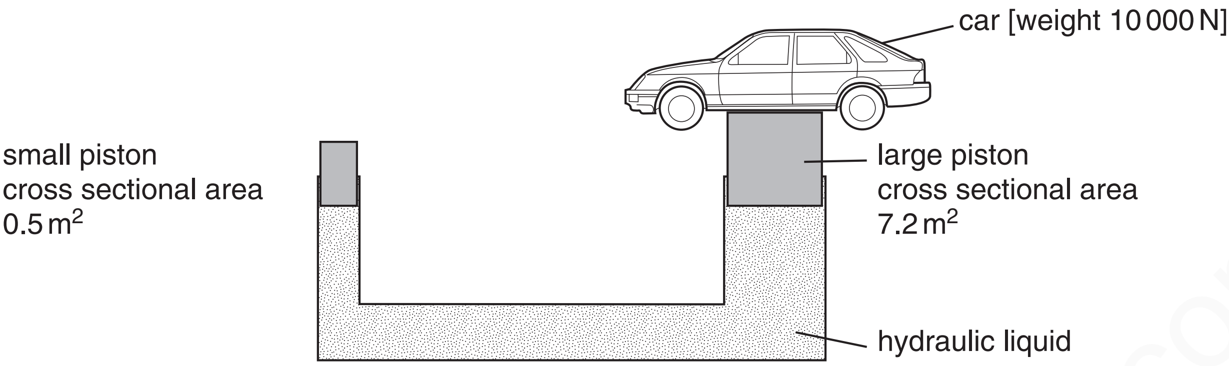

Fig. 8.1

(a) **(i)** Calculate the pressure that is exerted on the large piston.

Show your working and state any formula that you use.

....[3]

(ii) State the pressure that the small piston exerts on the fluid.

Explain your answer.

....

....[2]

(b) The car lift is an example of a hydraulic lift, which is a *force multiplier*.

With reference to Fig. 8.1, explain the meaning of this term.

....

....

....[2]

(c) A hydraulic lift uses a liquid to transmit pressure.

(i) Explain in terms of particles why liquids can be used to transmit pressure in this way.

....

....

....[2]

(ii) Explain why it is important that hydraulic liquids should contain no gas bubbles.

....

....[2]

(d) (i) Describe what happens to the pressure of a fixed volume of gas when the temperature is raised.

....

....[2]

(ii) At what temperature would a gas have zero pressure? Explain your answer.

....

....[2]

MARKING SCHEME

a(i)	pressure = force ÷ area ; 10 000 ÷ 7.2 ; = 1389, N m^{-2} / Pa ;	3
(ii)	the same as answer to (i) ; pressure is the same everywhere in the liquid ;	2
(b)	output force is greater than input force ; same pressure on a larger area ;	2
(c)(i)	particles are touching ; cannot be compresed ;	2
(ii)	gases can be compressed ; would not transmit forces ;	2
(d)(i)	pressure increases ; directly proportional / particles hit walls of container, more often / harder ;	2
(ii)	-273 °C / 0K ; temperature at which all particles have zero motion ;	2

1 **(a)** A polar bear of mass 400 kg is swimming in the sea.

Fig. 4.1 shows the speed-time graph for the polar bear over a time interval of 300 s.

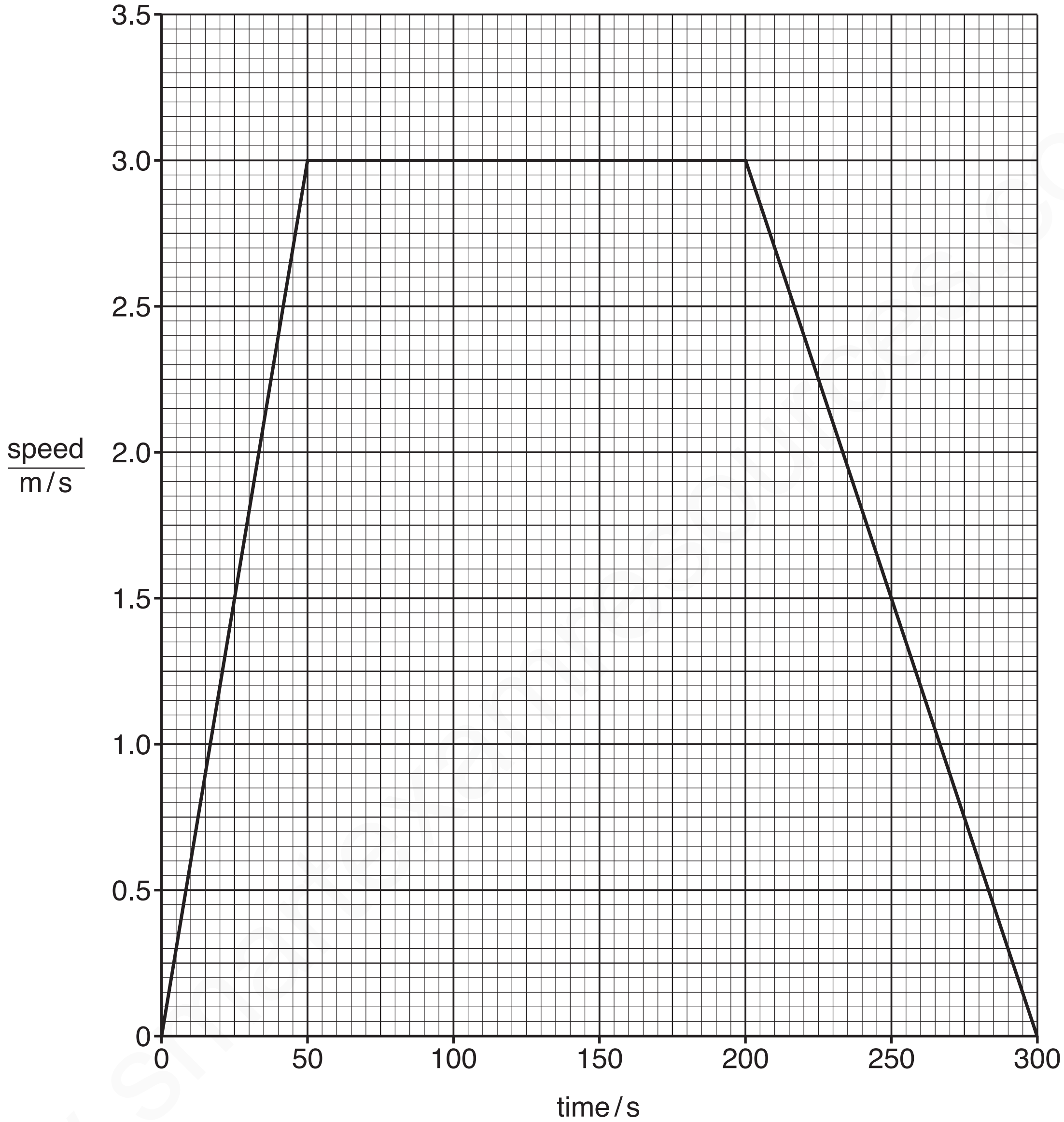

Fig. 4.1

(i) Calculate the distance travelled by the polar bear over the 300 s.

Show your working.

distance = ... m [2]