

Questions

Q1.

Figure 2 shows a rubber tube that can be used inside a bicycle tyre.

The tube is inflated with a bicycle pump.



Figure 2

(i) The air inside the tube exerts an outward force on the wall of the tube.

State the angle that this outward force makes with the wall of the tube.

(1)

.....
.....

(ii) It takes 4.8 litres of air from the atmosphere to inflate the empty tube to a pressure of 400 000 Pa.

Atmospheric pressure is 100 000 Pa.

Calculate the volume of air inside the tube.

Assume the temperature of the air inside the tube is the same as the temperature of the air outside the tube.

Use an equation selected from the list of equations at the end of this paper.

(3)

volume = litres

(iii) When a bicycle pump is used to inflate the tube, the air in the bicycle pump gets warm.

You should ignore any effects of friction in the pump.

Explain why the air in the bicycle pump gets warm.

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.....
.....
(Total for question = 6 marks)

Q2.

Figure 1 shows air inside a cylinder with a movable piston.

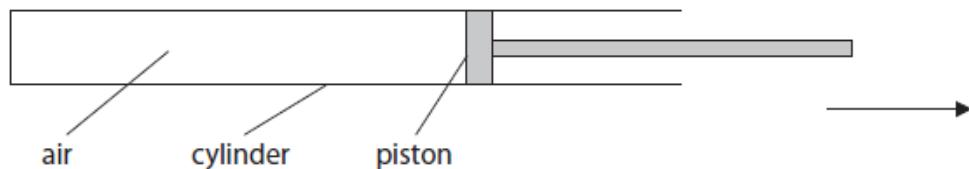


Figure 1

The piston is pulled a little way in the direction of the arrow, but stays inside the cylinder.

Which of these increases?

- A** The mass of the air inside the cylinder.
- B** The rate at which air particles collide with the walls of the cylinder.
- C** The volume of the air inside the cylinder.
- D** The pressure of the air inside the cylinder.

.....
.....
.....
(Total for question = 1 mark)

Q3.

Figure 1 shows some gas in a container.

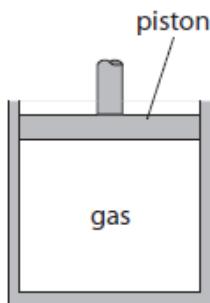


Figure 1

The pressure of gas in Figure 1 is 103 kPa, and the volume of gas is 0.010 m³.

Calculate the pressure of the gas in Figure 2 if the volume is now 0.0070 m³.

Use an equation selected from the list of equations at the end of this paper.

(3)

pressure = kPa

(Total for question = 3 marks)

Q4.

Figure 24 shows a submarine underwater.

air

water

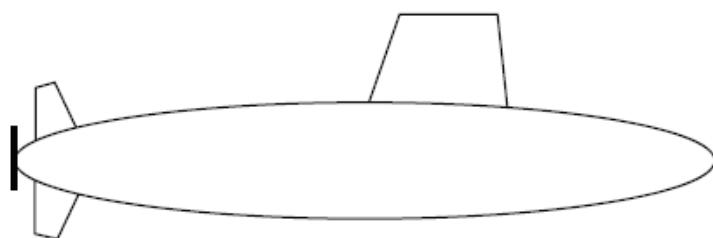


Figure 24

A bubble of gas escapes from the submarine.

The volume of the bubble is 23.0 cm³.

The pressure of the gas inside the bubble is 297 kPa.

The bubble rises to the surface without changing temperature.

Calculate the volume of the bubble when it reaches the surface.

Atmospheric pressure = 101 kPa

Use an equation from the formula sheet.

(3)

$$\text{volume} = \dots \text{cm}^3$$

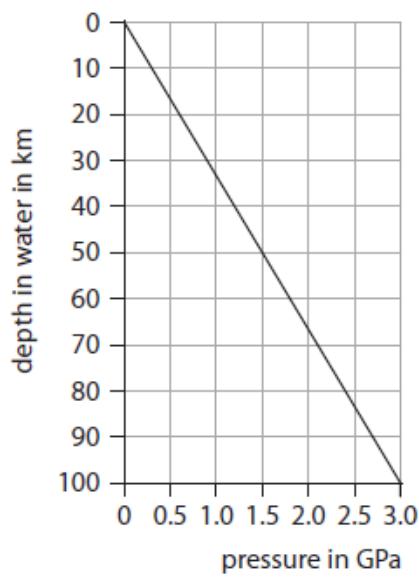
(Total for question = 3 marks)

Q5.

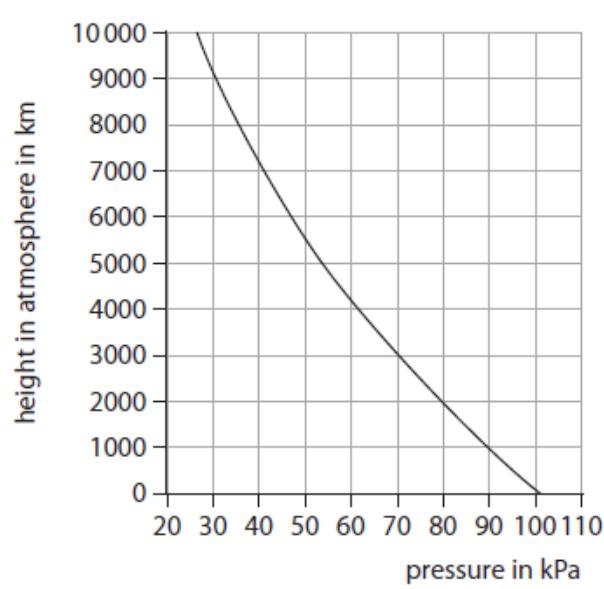
Figure 17 shows information about the pressures in the ocean and in the atmosphere of a distant planet.

Graph A shows the variation of pressure as the depth in the ocean increases.

Graph B shows the variation of pressure as the height in the atmosphere increases.



Graph A



Graph B

Figure 17

- (i) Use information from Graph A to obtain a value for the density of the ocean water.

Use an equation selected from the list of equations at the end of this paper.

(4)

density = kg/m³

* (ii) Explain the similarities and differences in the pressure variations shown in graphs A and B.

Your answer should refer to both the particle model (kinetic theory) and to density.

(6)

(Total for question = 10 marks)

Q6.

Figure 1 shows some gas in a container.

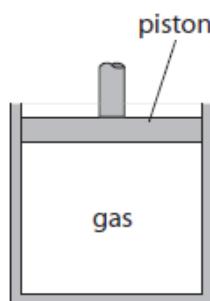


Figure 1

Explain, in terms of particles, how the gas exerts a pressure on the piston.

(2)

(Total for question = 2 marks)

Q7.

Figure 1 shows some gas in a container.

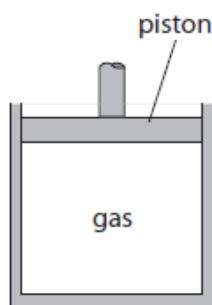


Figure 1

The piston is forced down to a new position, compressing the gas, as in Figure 2.

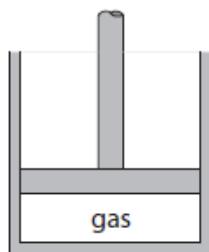


Figure 2

The temperature of the gas remains constant.

Explain, in terms of particles, why the pressure of the gas increases.

(2)

.....
.....
.....
(Total for question = 2 marks)

Q8.

Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Figure 21 shows a sealed aerosol can.



Figure 21

The sealed can is taken from a cold room into a warm room.

If the volume of the can remains the same, which of these does **not** change?

- A** the pressure inside the can
- B** the mean speed of the particles inside the can
- C** the mean distance between the particles inside the can
- D** the mean size of the momentum of the particles inside the can

(1)

.....
.....
.....
(Total for question = 1 mark)

Mark Scheme

Q1.

Question Number:	Answer	Additional Guidance	Mark
(i)	at right angles / 90°	perpendicular / normal to the tube wall	(1) AO 1 1

Question Number:	Answer	Additional Guidance	Mark
(ii)	<p>select and substitute into $P_1 \times V_1 = P_2 \times V_2$ (1)</p> $400\ 000 \times V_1 = 100\ 000 \times 4.8$ <p>rearrangement (1)</p> $V_1 = \frac{100\ 000 \times 4.8}{400\ 000}$ <p>evaluation (1)</p> $(V_1 =) 1.2 \text{ (litres)}$	<p>substitution and rearrangement in either order</p> <p>award full marks for the correct answer without working</p> <p>POT error 2 marks</p>	(3) AO 2 1

Question Number:	Answer	Additional Guidance	Mark
(iii)	<p>an explanation linking: work is done (in compressing the air) (1)</p> <p>increases the kinetic energy of the (air) particles / thermal energy (of the system) (1)</p>	<p>heat for thermal</p> <p>accept answer in terms of $p \Delta V$</p> $\begin{aligned} W &= F \times d \\ &= p \times (A \times d) \\ &= p \Delta V \end{aligned}$	<p>(2) AO 1 1</p>

Q2.

Question Number	Answer	Mark
	<p>C The volume of the air inside the cylinder.</p> <p>The only correct answer is C</p> <p><i>A is not correct because the mass remains unchanged B is not correct because the rate of collision decreases D is not correct because the pressure decreases</i></p>	<p>(1) AO 1 1</p>

Q3.

Question number	Answer	Additional guidance	Mark
	<p>Rearrangement (1) $P_2 = \frac{P_1 V_1}{V_2}$</p> <p>substitution (1) $P_2 = \frac{103 \times 0.010}{0.0070}$</p> <p>evaluation to 2 sf (1) $= 150 \text{ (kPa)}$</p>	<p>147 (kPa)</p> <p>$1.5 \times 10^2 \text{ kPa}$ or $1.5 \times 10^5 \text{ Pa}$</p> <p>rearrangement and substitution in either order</p> <p>award full marks for correct answer without working</p>	(3)

Q4.

Question number	Answer	Additional guidance	Mark
	<p>Rearrangement (1) $V_2 = (p_1 \times V_1) \div p_2$</p> <p>Substitution (1) $V_2 = (297 \times 10^3 \times 23.0) \div (101 \times 10^3)$</p> <p>Evaluation (1) $V_2 = 67.6 \text{ (cm}^3\text{)}$</p>	67.633	(3)

Q5.

Question number	Answer	Additional guidance	Mark
(i)	<p>rearrange $p = \rho g h$ to give $\rho = p / (g h)$ (1)</p> <p>substitution using any point from graph (1)</p> <p>e.g. depth = 50km and pressure = 1.5 GPa $\rho = p / (g h)$ $= 1.5 \times 10^9 / (10 \times 50 \times 10^3)$</p> <p>Evaluation (2) $= 3000 \text{ (kg/m}^3\text{)}$</p>	<p>rearrangement and substitution in any order</p> <p>allow any combination from the graph and ignore 'pot' error here</p> <p>'pot' error scores 2 marks maximum</p>	(4)

Question number	Indicative content	Mark
(ii)	<p>Answers will be credited according to the candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all of the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;">A02 (3 marks) A03 (3 marks)</p> <p>A03 Interpretation and evaluation from the graph</p> <p>Similarities:</p> <ul style="list-style-type: none"> • both show increasing pressure with depth • both show a range of pressures over kilometre depths / heights <p>Differences:</p> <ul style="list-style-type: none"> • ocean water shows a linear relationship (straight line) but atmosphere gives a non-linear (curved) relationship • density of ocean water not changing with depth but density of atmosphere changes as you go higher • The pressures in the ocean recorded are much bigger (GPA compared with kPa) <p>The depth of the ocean shown is up to 100km whereas the height of the atmosphere involved is only up to 10km</p> <p>A02 Link between graph shapes and underlying physics</p> <p>Similarities:</p> <ul style="list-style-type: none"> • pressure is due to (increasing) weight of fluid (liquid / gas) above • more molecules above <p>Differences:</p> <ul style="list-style-type: none"> • atmosphere becomes thinner the higher you go molecules in the ocean stay (on average) the same distance apart but in the atmosphere they get further apart (on average) as you go higher up 	(6)

Level	Mark	Descriptor
	0	<ul style="list-style-type: none"> No awardable content
Level 1	1-2	<ul style="list-style-type: none"> Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3-4	<ul style="list-style-type: none"> Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5-6	<ul style="list-style-type: none"> Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Q6.

Question number	Answer	Mark
	<p>An explanation that combines identification –knowledge and reasoning / justification</p> <ul style="list-style-type: none"> (particles / atoms / molecules) {hit / collide with} piston (1) causing a force (on the piston) (1) 	(2)

Q7.

Question number	Answer	Mark
	<p>An explanation that combines identification – knowledge and reasoning / justification</p> <ul style="list-style-type: none"> • volume decrease makes the density of particles increase / more crowded idea (1) • increasing the rate at which particles collide (with the piston) (1) 	(2)

Q8.

Question Number	Answer	Mark
	<p>The only correct answer is C the mean distance between the particles inside the can</p> <p><i>A, B and D have physical quantities which will all increase upon heating</i></p>	(1) AO3.1