Pressure

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.

(2)

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(Total for question = 6 marks)

Q2.

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

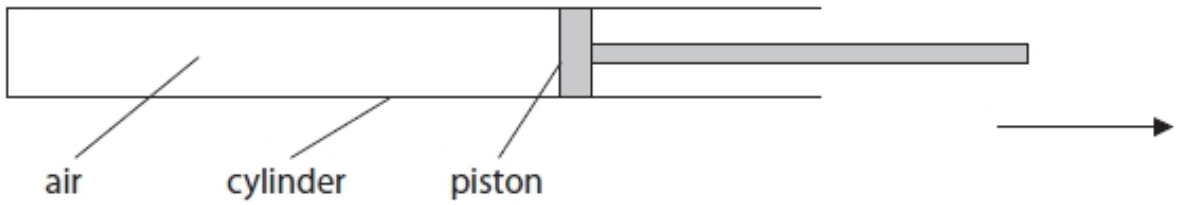

Figure 1

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

Which of these increases?

(1)

- ☒ 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.

A student investigates the pressure and volume of some trapped gas.
Figure 4 shows the apparatus used.

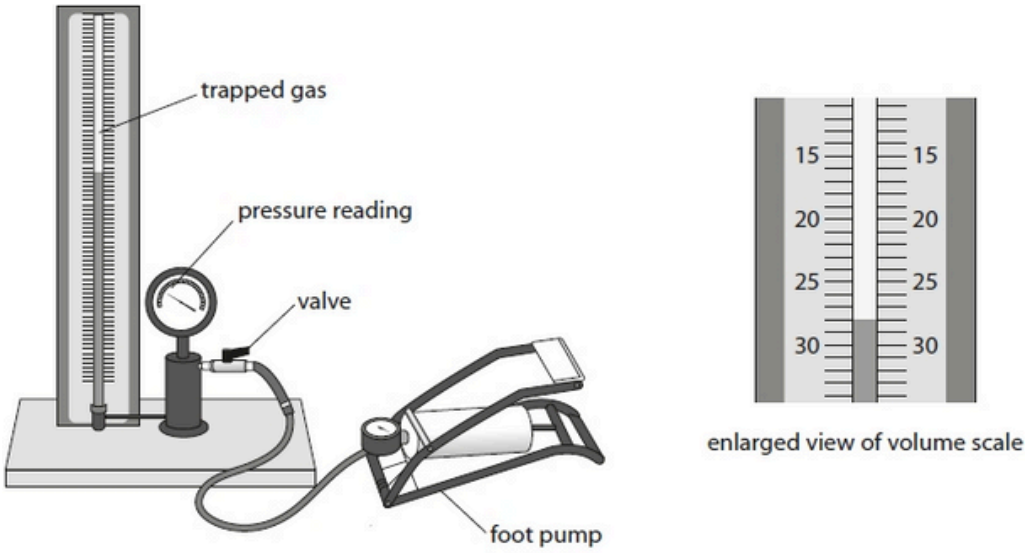

Figure 4

Figure 5 shows the student's table of results.

p	V	$p \times V$
100	28.0	2800
123	23.0	2829
140	20.0	2800
160	18.0	2880
180	16.5	2970

Figure 5

(i) Suggest what the student should add to the headings of the table in Figure 5.

(1)

.....

.....

(ii) Use Figure 5 to estimate the volume of gas for a pressure reading of '170'.

(2)

volume of gas = ...

(iii) Suggest **two** ways the student could improve the investigation.

(2)

1 .....

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2 .....

.....

(iv) Explain whether the values, in the column headed '$p \times V$' in Figure 5, fit the equation

$$p1 \times V1 = p2 \times V2$$

(3)

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(Total for question = 8 marks)

Q4.

Figure 16 shows a metal container with a movable piston.

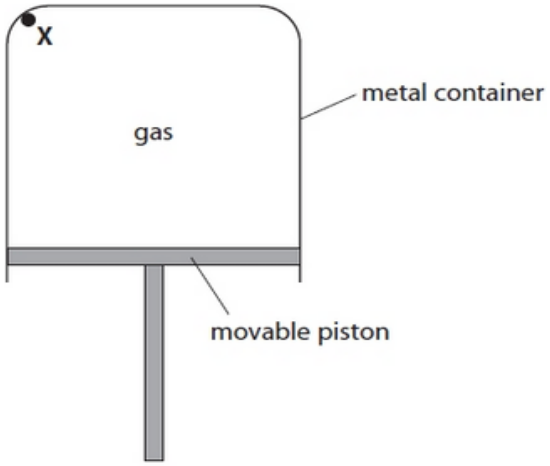

Figure 16

Point X is on the inner surface of the container.

The gas in the container is at a higher pressure than the air outside the container.

The pressure of the gas in Figure 16 ($P1$) is 120 kPa.

The volume of the gas in Figure 16 ($V1$) is 2500 cm3.

The piston is pushed up slowly so that the temperature of the gas does not change.

The new volume of the gas ($V2$) is 1600 cm3.

Calculate the new pressure of the gas, $P2$.

Use the equation

$$P_2 = \frac{P_1 \times V_1}{V_2}$$

(2)

new pressure $P2$ = ... kPa

(Total for question = 2 marks)

Q5.

Figure 8 shows a small container of carbon dioxide at high pressure.

The pressure, P1 , in the container is 8.00 MPa.

The volume, V1 , of the container is 14.5 cm3.

Figure 8

The container is pierced and all of the carbon dioxide goes into a large balloon.

The volume of gas, V2, in the large balloon is 1160 cm3.

Calculate the pressure, P2, in the large balloon.

Use the equation

$$P_1V_1 = P_2V_2$$

(3)

pressure in the large balloon = ... MPa

(Total for question = 3 marks)

Q6.

When the pressure in a container of gas increases, the particles of the gas

(1)

- ☒ A hit the sides of the container less often
- ☒ B hit the sides of the container more often
- ☒ C move with lower speeds
- ☒ D vibrate more energetically about fixed positions

(Total for question = 1 mark)

Q7.

*A container is sealed so that the mass of the gas inside cannot change. The volume of the gas is changed and the pressure is measured at different volumes. The temperature of the gas does not change. Figure 18 is a graph of the results.

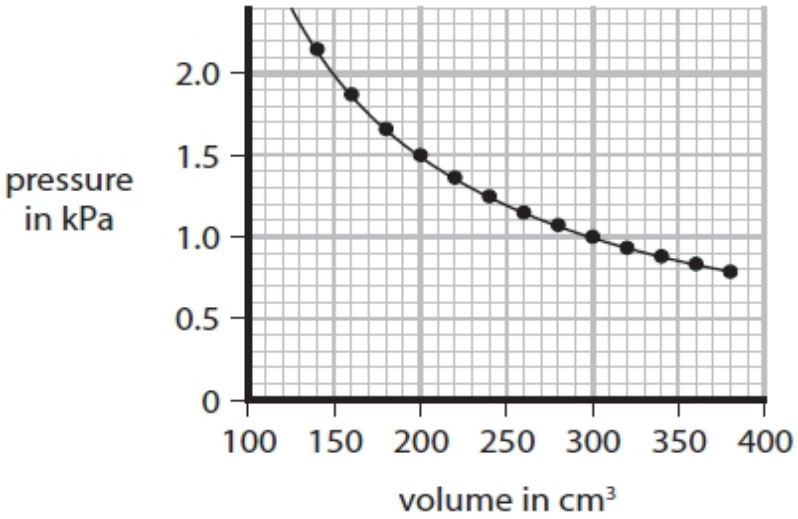

Figure 18

Explain, in terms of the movement of particles, why there is a pressure on the container and why the pressure changes as shown in Figure 18.

(6)

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(Total for question = 6 marks)

Q8.

Figure 1 shows a fixed mass of gas inside a cylinder with a movable piston.

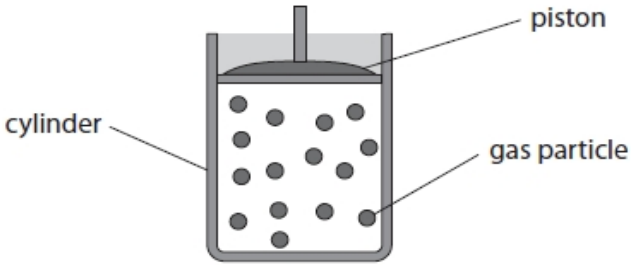

Figure 1

(i) Describe, in terms of gas particles , how the gas exerts a pressure on the cylinder.

(3)

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(ii) Figure 2 shows the same gas squashed into a smaller volume.

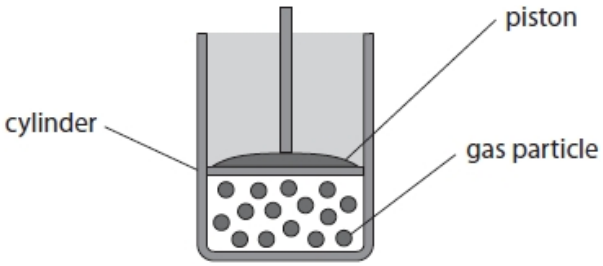

Figure 2

State what happens to the pressure the gas exerts on the cylinder when the volume of gas is reduced, as in Figure 2.

(1)

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.....

(iii) State what happens to the gas particles when the volume of the gas is reduced, as in Figure 2.

(1)

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.....

(Total for question = 5 marks)

Q9.

A student changes the volume of gas in a container and notes the pressure for different values of the volume. The results are shown in Figure 6 and plotted on the graph in Figure 7.

volume in ml	pressure in kPa
10	260
12	200
20	140
25	150
30	100
40	75
50	65

Figure 6

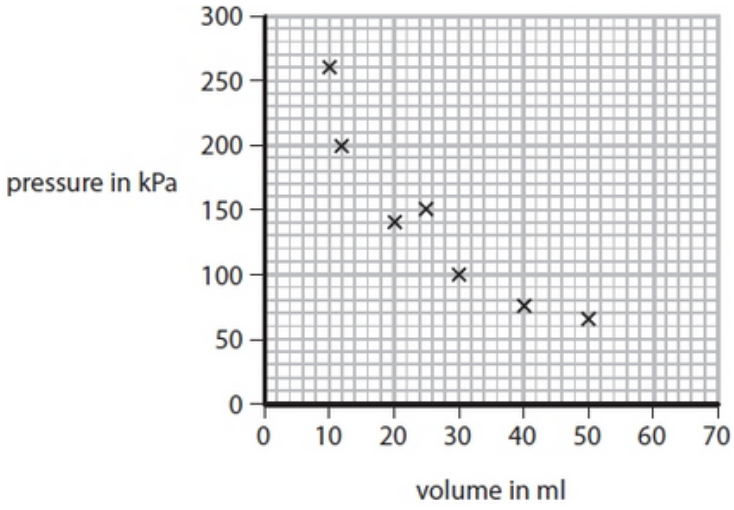

Figure 7

(i) Identify the anomalous result plotted on Figure 7 by drawing a circle on Figure 7 around the anomalous point.

(1)

(ii) Draw the curve of best fit on Figure 7.

(1)

(iii) Describe how the graph in Figure 7 would change if the student repeated the experiment with the same mass of gas, at a higher constant temperature.

(2)

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(Total for question = 4 marks)

Q10.

Figure 16 shows a metal container with a movable piston.

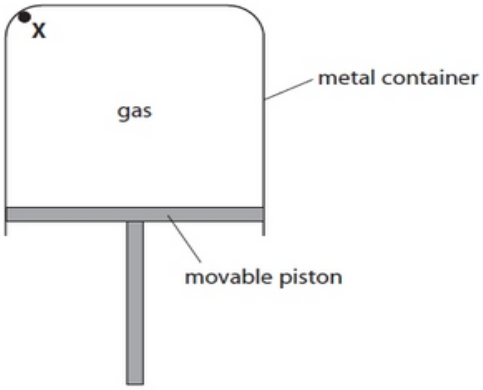


Figure 16

Point X is on the inner surface of the container.

The gas in the container is at a higher pressure than the air outside the container.

Which of these shows the direction of the force, due to the gas, on the container at point X?

(1)

☒ **A** ☒ **B** ☒ **C** ☒ **D**

(Total for question = 1 mark)

Q11.

The particles of a gas exert a pressure on the walls of a container. Which row of the table is correct when the pressure of the gas changes?

(1)

	pressure of gas	number of particles colliding with the walls of the container each second
☒ **A**	increases	stays the same
☒ **B**	increases	increases
☒ **C**	decreases	stays the same
☒ **D**	decreases	increases

(Total for question = 1 mark)

Q12.

Figure 3 shows an oxygen cylinder.

Figure 3

The volume of the gas in the cylinder is 2100 cm3.

When the gas is released into the atmosphere the volume of the gas is 8600 cm3.

The pressure of the atmosphere is 98 kPa.

Calculate the pressure of the gas when it is in the cylinder.

Use the equation

$$P_1 = \frac{P_2 \times V_2}{V_1}$$

(2)

pressure of the gas in the cylinder = ... kPa

(Total for question = 2 marks)

Mark Scheme - Pressure

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)	select and substitute into $P_1 \times V_1 = P_2 \times V_2$ (1) $400\,000 \times V_1 = 100\,000 \times 4.8$ rearrangement (1) $V_1 = \frac{100\,000 \times 4.8}{400\,000}$ evaluation (1) (V_1 =) 1.2 (litres)	substitution and rearrangement in either order award full marks for the correct answer without working POT error 2 marks	(3) AO 2 1

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

Q2.

Question Number	Answer	Mark
	C The volume of the air inside the cylinder. **The only correct answer is C** ***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*	**(1)** AO 1 1

Q3.

Question number	Answer	Additional guidance	Mark
i	(headings to the table should have) **units** or **names** (1)	accept any correct unit suggestion e.g. cm^3 / Pascals or any correct name e.g. pressure / volume	**(1)** **AO3**

Question number	Answer	Additional guidance	Mark
ii	attempts to find any 'in between number' (interpolates) (1) evaluation (1) 17.2, 17.3 or 17.25	accept any number between 16.6 and 17.9 award full marks for correct answer without working	**(2)** **AO3**

Question number	Answer	Additional guidance	Mark
iii	Suggestions, including any **two** from: take intervening pressure reading(s) (1) give (plenty of) time between readings (1) use apparatus with smaller scale divisions (1) take repeat readings and average (1) make sure temperature stays constant (1)	 e.g. steps of 0.2 cm^3 on volume scale allow repeat to check for anomaly e.g. check temperature of the room ignore any ideas of extending the investigation	**(2) AO3**

Question number	Answer	Additional guidance	Mark
iv	An explanation including any **three** from: any reference to data from the table (1) (the product) p x V remains constant (1) for most readings p x V is similar / close to 2800 (1) which points to $p_1 \times V_1 = p_2 \times V_2$ (1) OR equation doesn't fit because values are different (mp4 dependent upon mp2 / mp3) last value(s) of p x V discordant compared with the others (1)	 e.g. no, because almost all the (pV) values are different agrees / disagrees with hypothesis last value(s) values of pV don't agree	**(3) AO3**

Q4.

Question number	Answer	Additional guidance	Mark
	substitution (1) $(P_2=)\ \frac{120 \times 2500}{1600}$ evaluation (1) 190 (kPa)	 award full marks for the correct answer without working accept values that round to 190; e.g.187.5, 188, 187	**(2)**

Q5.

Question Number	Answer	Additional guidance	Mark
	substitute (1) $8.00 \times 14.5 = P_2 \times 1160$ rearrangement (1) $\frac{8.00 \times 14.5}{1160}$ ($=P_2$) evaluation 0.1 (MPa)	Allow 8.00×14.5 =116 for one mark award full marks for the correct answer without working	**(3)**

Q6.

Question number	Answer	Mark
	B hit the sides of the container more often Options A, C and D are incorrect associations	**(1)** **AO1**

Q7.

Question number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • Gas particles are in (random) motion • Particles hit sides of container / each other • This produces (net) force on (sides of) container • This causes a pressure (on the container) • As volume increases the particles have more space to move • This means that particles hit sides less frequently • Smaller (net) force on sides of container • Pressure decreases. • Change in pressure (with increase in volume) is not linear • Pressure never becomes zero	(6)

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance simple description of how pressure is caused **or** how it changes	Possible candidate responses Particles hit sides of container **or** Pressure becomes less as volume increases
Level 2	3–4	Additional guidance description of how pressure is caused and how it changes	Possible candidate responses Particles hit sides of container. This causes a (net) force on sides of container. Pressure becomes less as volume increases
Level 3	5–6	Additional guidance Description of how pressure is caused, and why it changes in the way shown	Possible candidate responses Particles hit sides of container. This causes a (net) force on sides of the container. As volume increases the particles hit the sides less frequently so the pressure becomes less.

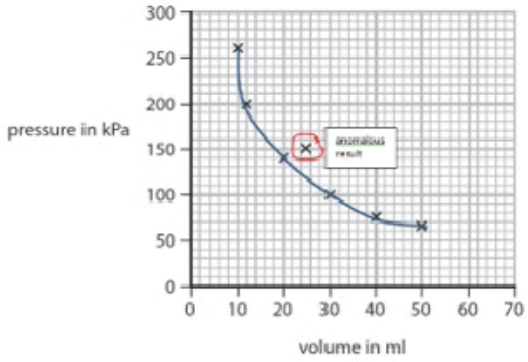
Q8.

Question Number:	Answer	Additional guidance	Mark
(i)	a description to include 3 of the following: gas particles/molecules/atoms are continually in motion (1) collide /hit/bombard (1) with the (sides/walls) of the container (1) (gas particles) exert force (on the side of the container) (1)	 allow cylinder /glass	(3) AO 1 1

Question Number:	Answer	Additional guidance	Mark
(ii)	pressure (of gas) increases (1)		(1) AO 1 1

Question Number:	Answer	Additional guidance	Mark
(iii)	more (frequent) collisions (of particles with walls) (1)	 accept particles move closer together particles move faster	(1) AO 1 1

Q9.

Question Number	Answer	Additional guidance	Mark
			**(2)**
(i)	anomalous point (1)	ringed or other indication	
(ii)	curve touches one part of the cross for each of the points, excluding the anomalous point (1)	ignore curve beyond 260 kPa and beyond 50ml	

Question Number	Answer	Additional guidance	Mark
(iii)	A description that combines the following points the line will be higher (1) have a similar shape (1)	 Allow for one mark all data will be higher allow the pressure will be higher for the same volume for 2 marks allow the volumes will be higher for the same pressure for 2 marks	**(2)**

Q10.

Question number	Answer	Additional guidance	Mark
	 ☐ C B and D are incorrect because they are not normal to the surface A is incorrect because the force should act outwards		**(1)**

Q11.

Question Number	Answer	Mark
(i)	**B** increase | increase **B** is the only correct answer. **A** is incorrect because as the pressure of the gas increases the number of particles colliding with the walls of the container does not stay the same. **C** is incorrect because as the pressure of the gas decreases the number of particles colliding with the walls of the container does not stay the same. **D** is incorrect because as the pressure of the gas decreases the number of particles colliding with the walls of the container does not increase.	**(1)**

Q12.

Question Number:	Answer	Additional guidance	Mark
	substitution (1) $(P_1) = \frac{98 \times 8600}{2100}$ evaluation (1) 400 (kPa)	 accept any answer that rounds to 400 eg. 401.33 (kPa) award full marks for the correct answer without working.	**(2)** AO 2 1