

Question Number	Answer	Acceptable answers	Mark
<b>1(a)(i)</b>	10.8 + or - 0.2 (cm)	Any value between 10.6(cm) and 11.0 (cm) Accept 11 cm	<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>1 (a)(ii)</b>	B $2.1 \times 10^{-2} \text{ cm}^3$		<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>1(a)(iii)</b>	<p>Temperature conversion to K 50°C to 323K <b>OR</b> 100°C to 373K (1)</p> <p>Substitution <math>V_1 = \frac{2.31 \times 10^{-2} \times 373}{323}</math> (1)</p> <p>Evaluation <math>2.67 \times 10^{-2} \text{ (cm}^3\text{)}</math> (1)</p>	<p>If equation is transformed to give <math>V_2</math>, allow correct substitution mark.</p> <p><math>0.0267 \text{ (cm}^3\text{)}, 2.7 \times 10^{-2} \text{ (cm}^3\text{)}, 0.027 \text{ (cm}^3\text{)}, 2.67 \times 10^{-8} \text{ m}^3, 2.7 \times 10^{-8} \text{ m}^3</math> Allow power of ten error for 2 marks e.g. 267</p> <p>Allow <math>2.6 \times 10^{-2}</math> for 3 marks</p> <p>Full marks for correct answer with no working</p> <p>If temperature is not converted to Kelvin, maximum two marks e.g.</p> <p><math>V_1 = \frac{2.31 \times 10^{-2} \times 100}{50}</math> <math>4.62 \times 10^{-2} \text{ (cm}^3\text{)}</math></p> <p>Allow power of ten error for 1 mark e.g. 4.62</p> <p>2 marks for <math>4.62 \times 10^{-2} \text{ (cm}^3\text{)}</math> with no working</p>	<b>(3)</b>

Question Number	Answer	Acceptable answers	Mark
<b>1(b)</b>	<p>A description including:</p> <p>(Average) KE/it increases as the temperature increases (1)</p> <p>Idea of proportionality / KE doubles when the temperature doubles (1)</p> <p>(when) temperature in Kelvin /K (1)</p>	<p>Allow energy for kinetic energy</p> <p>Or reverse argument</p> <p>(Average) KE/it is (directly) proportional to the Kelvin temperature gets all three marks</p> <p>(Average) KE/it is (directly) proportional to the temperature gets first two marks</p> <p>Allow absolute scale</p>	<b>(3)</b>

Total for Question 2= 8 marks

Question Number	Answer	Acceptable answers	Mark
<b>2(a)</b>	B do not move at absolute zero		<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>2(b)(i)</b>	An explanation linking: <ul style="list-style-type: none"> <li>particles move / collide (1) with</li> <li>the walls of the syringe (1)</li> </ul> 2 <sup>nd</sup> mark dependent on first	hit/strikes/bounces ignore vibrate  with the syringe 'hits the syringe' = 2 marks ignore 'push against the syringe'	<b>(2)</b>

Question Number	Answer	Acceptable answers	Mark																		
<b>2(b)(ii)</b>	323K (1) <table border="1" data-bbox="397 878 852 1011"> <thead> <tr> <th>Volume/ml</th> <th>Temperature/°C</th> <th>Temperature/K</th> </tr> </thead> <tbody> <tr> <td>6</td> <td>0</td> <td>273</td> </tr> <tr> <td>6.5</td> <td>25</td> <td>298</td> </tr> <tr> <td>7.1</td> <td>50</td> <td>323</td> </tr> <tr> <td>7.6</td> <td>75</td> <td>348</td> </tr> <tr> <td>8.2</td> <td>100</td> <td>373</td> </tr> </tbody> </table>	Volume/ml	Temperature/°C	Temperature/K	6	0	273	6.5	25	298	7.1	50	323	7.6	75	348	8.2	100	373		<b>(1)</b>
Volume/ml	Temperature/°C	Temperature/K																			
6	0	273																			
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7.1	50	323																			
7.6	75	348																			
8.2	100	373																			

Question Number	Answer	Acceptable answers	Mark
<b>2(b)(iii)</b>	A description including: <ul style="list-style-type: none"> <li>V increases as T increases (or reverse) / there is a positive correlation (1)</li> <li>proportional / goes up in equal steps / constant increase (1)</li> </ul>	hotter leads to greater volume / cooler leads to smaller volume do not allow 'as heat rises'  accept a doubling argument for the second mark.(Ignore readings taken from graph if not supporting doubling.)  volume is (directly) proportional to temperature for 2 marks	<b>(2)</b>

Question Number	Answer	Acceptable answers	Mark
<b>2(c)</b>	<ul style="list-style-type: none"> <li>• Substitution  <math display="block">\frac{6.5 \times 450}{298}</math> (1)</li> <li>• evaluation  9.8 (ml)  (1)</li> </ul>	Any answer between 9.8(ml) and 9.9(ml) (ignore dp / rounding off) Accept answer with no working for full marks	<b>(2)</b>

**(Total for Question 2 = 8 marks)**

Question Number	Answer	Acceptable answers	Mark
<b>3 (a)(i)</b>	C stationary		<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>3(a)(ii)</b>	(Average KE/it is ) halved	divided by 2,multiplied by 0.5	<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>3 (b)</b>	<p>Explanation in terms of particles linking the following:-</p> <ul style="list-style-type: none"> <li>• particles collide with / hit /strike / bombard (1)</li> <li>• the wall / sides of the balloon (1)</li> <li>• (causing a) force / (rate of) change in momentum (1)</li> </ul>	<p>Accept "molecules/atoms" for particles</p> <p>Must mention particles etc to gain this mark</p> <p>Ignore "push"</p>	<b>(3)</b>

Question Number	Answer	Acceptable answers	Mark
<b>3 (c)(i)</b>	-46 + 273 (1)	273-46 / any use of 273	<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>3 (c)(ii)</b>	substitution: (1) $\frac{101 \times 9.1}{273} = \frac{1.12 \times V_2}{227}$ Transposition (1) $V_2 = \frac{101 \times 9.1 \times 227}{273 \times 1.12}$ evaluation: (1) 682 (m <sup>3</sup> )	Accept either Pa or kPa for substitution  substitution and transposition in any order  ignore power of ten error until evaluation  680 (m <sup>3</sup> ), 682.4 (m <sup>3</sup> ), 682.35 (m <sup>3</sup> )  full marks for the correct numerical answer without working	<b>(3)</b>

Question Number	Answer	Acceptable answers	Mark
<b>3 (c)(iii)</b>	bursts/explodes or words to that effect		<b>(1)</b>

**(Total marks for question 4 = 10 marks)**

Question Number	Answer	Acceptable answers	Mark
<b>4(a)</b>	<input checked="" type="checkbox"/> <b>C</b> (graph C)		<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>4(b)(i)</b>	A description including: <ul style="list-style-type: none"> <li>• collisions (1)</li> <li>• with (walls of) cylinder (1)</li> </ul>	hit / bounce off exert force	<b>(2)</b>

Question Number	Answer	Acceptable answers	Mark
<b>4(b)(ii)</b>	substitution (1) either $100 \times V = 15.0 \times 21\ 000$ or $V = \frac{15.0 \times 21\ 000}{100}$  evaluation (1) 3 150(litres)	$V_1P_1 = 15 \times 21000 = 315000$ (1 mark)  $V_2P_2 = \mathbf{100} \times 3200 = 320000$ (1 mark)  award full marks for 3150 (litres) without working	<b>(2)</b>

Question Number	Answer	Acceptable answers	Mark
<b>4(b)(iii)</b>	substitution (1) $\frac{21\ 000 (\times V)}{305} = \frac{P (\times V)}{278}$  volume same (1)  evaluation (1) 19 100 (kPa)	give full marks for correct answer, no working  transposition  accept 19141 (kPa) or 19000 and numbers rounding down to 191 00	<b>(3)</b>

Question number	Answer	Mark
5(a)(i)	A	(1)

Question number	Answer	Additional guidance	Mark
5(a)(ii)	An answer that provides a description by making reference to: <ul style="list-style-type: none"> <li>• thermal/heat energy (1)</li> <li>• dissipated in/transferred to air/surroundings (1)</li> </ul>	allow heat 'lost' to surroundings	(2)



Question number	Answer	Additional guidance	Mark
5(b)	<p>An explanation that combines identification – improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark):</p> <ul style="list-style-type: none"> <li>place the beaker on an insulator (1)</li> <li>so this (material) will reduce rate of energy transfer (1)</li> </ul> <p>or</p> <ul style="list-style-type: none"> <li>wrap the beaker in an insulator (1)</li> <li>so this (material) will reduce the rate of energy transfer (1)</li> </ul> <p>or</p> <ul style="list-style-type: none"> <li>reduce the surface areas of the water (1)</li> <li>to give less evaporation (1)</li> </ul>	<p>allow named insulator, e.g. cork mat</p> <p>put a lid on the beaker/make the beaker taller and narrower</p>	(2)

Question number	Answer	Additional guidance	Mark
5(c)	<p>rearrangement (1)</p> $l = \frac{\Delta Q}{\Delta m}$ <p>substitution (1)</p> $l = \frac{270000}{0.12}$ <p>answer (1)</p> <p>2 250 000 (J/kg °C)</p>	<p>award full marks for correct numerical answer without working</p> <p>2250 (J/kg °C) gains 2 marks as power of 10 error</p>	(3)