Question Number	Answer		Mark
1(a)(i)	10.8 + or – 0.2 (cm)	Any value between 10.6(cm) and 11.0 (cm) Accept 11 cm	**(1)**

Question Number	Answer	Acceptable answers	Mark
1 (a)(ii)	B 2.1×10^{-2} cm^3		**(1)**

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

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

Total for Question 2= 8 marks

Question Number	Answer	Acceptable answers	Mark
2(a)	B do not move at absolute zero		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(b)(i)	An explanation linking: • particles move / collide (1) with • the walls of the syringe (1) 2nd mark dependent on first	hit/strikes/bounces ignore vibrate with the syringe 'hits the syringe' = 2 marks ignore 'push against the syringe'	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(b)(ii)	323K (1) 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		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(b)(iii)	A description including: • V increases as T increases (or reverse) / there is a positive correlation (1) • proportional / goes up in equal steps / constant increase (1)	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	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(c)	• Substitution $\frac{6.5 \times 450}{298}$ (1) • evaluation 9.8 (ml) (1)	Any answer between 9.8(ml) and 9.9(ml) (ignore dp / rounding off) Accept answer with no working for full marks	**(2)**

(Total for Question 2 = 8 marks)

Question Number	Answer	Acceptable answers	Mark
3 (a)(i)	C stationary		**(1)**

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

Question Number	Answer	Acceptable answers	Mark
3 (b)	Explanation in terms of particles linking the following:- • particles collide with / hit /strike / bombard (1) • the wall / sides of the balloon (1) • (causing a) force / (rate of) change in momentum (1)	 Accept "molecules/atoms" for particles Must mention particles etc to gain this mark Ignore "push"	**(3)**

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

Question Number	Answer	Acceptable answers	Mark
3 (c)(ii)	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^3)	Accept either Pa or kPa for substitution substitution and transposition in any order ignore power of ten error until evaluation 680 (m^3), 682.4 (m^3), 682.35 (m^3) full marks for the correct numerical answer without working	**(3)**

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

(Total marks for question 4 = 10 marks)

Question Number	Answer	Acceptable answers	Mark
4(a)	☒ **C** (graph C)		**(1)**

Question Number	Answer	Acceptable answers	Mark
4(b)(i)	A description including: • collisions (1) • with (walls of) cylinder (1)	hit / bounce off exert force	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b)(ii)	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) $V_2P_2 =$ **100** $\times 3200 = 320000$ (1 mark) award full marks for 3150 (litres) without working	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b)(iii)	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	**(3)**

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: • thermal/heat energy (1) • dissipated in/transferred to air/surroundings (1)	allow heat 'lost' to surroundings	(2)

Question number	Answer	Additional guidance	Mark
5(b)	An explanation that combines identification – improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark): • place the beaker on an insulator (1) • so this (material) will reduce rate of energy transfer (1) or • wrap the beaker in an insulator (1) • so this (material) will reduce the rate of energy transfer (1) or • reduce the surface areas of the water (1) • to give less evaporation (1)	allow named insulator, e.g. cork mat put a lid on the beaker/make the beaker taller and narrower	**(2)**

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