Question Number	Answer		Mark
1(a)(i)	Pressure and volume read from graph A	**(1)**	
	Conversion of temperature to kelvin	**(1)**	
	Use of $pV = \mathrm{N}kT$	**(1)**	
	$N = (2.8 \pm 0.2) \times 10^{30}$	**(1)**	
	Example of calculation $N = \frac{pV}{kT} = \frac{2.5\times10^{5}\,Pa \times 0.45\times10^{5}\,m^{3}}{1.38\times10^{-23}\,JK^{-1}\times(273+25)K} = 2.76\times10^{30}$		**4**
1(a)(ii)	Values read from A and B for constant pressure or constant volume **Or** p and V read from graph B and N used from (a)(i)	**(1)**	
	T = 540 K [±50K] [accept answers in °C within this range]	**(1)**	
	Example of calculation $\frac{p_1}{p_2} = \frac{T_1}{T_2}$ $T_B = T_A \times \frac{p_B}{p_A} = (273+25)\mathrm{K} \times \frac{2.8\times10^{5}\,\mathrm{Pa}}{1.55\times10^{5}\,\mathrm{Pa}} = 538\mathrm{K}$		**2**
***1(b)**	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)** (Average) kinetic energy of molecules/atoms is less **Or** molecules/atoms slower	**(1)**	
	Collision rate with walls of container is smaller	**(1)**	
	There is less momentum/impulse (exchanged) per collision **Or** the rate of change of momentum is less	**(1)**	
	Therefore a smaller force on the container walls (MP4 is dependent upon MP2 or MP3)	**(1)**	**4**
	Total for Question		**10**

Question Number	Answer	Mark
2	Use of $pV = NkT$ **(1)** Temperature conversion **(1)** $\Delta N = 5.1 \times 10^{23}$ **(1)** [allow use of $pV = nRT$ and use of $N = n \times N_A$ for mp1] <u>Example of calculation:</u> $\Delta N = \frac{V\Delta p}{kT} = \frac{0.052\,\text{m}^3 \times \left(2.0\times10^5 - 1.6\times10^5\right)\text{Pa}}{1.38\times10^{-23}\,\text{J K}^{-1}\left(273+22\right)\text{K}} = 5.11\times10^{23}$	**3**
	Total for Question	**3**

Question Number	Answer		Mark
3(a)	Use of $pV = NkT$ Pressure difference **Or** temperature conversion $\Delta N = 5.0 \times 10^{21}$ Example of calculation: $\Delta N = \frac{\Delta p.V}{kT} = \frac{(6.5\times10^5 - 5.8\times10^5)\text{Pa} \times 2.9\times10^{-4}\,\text{m}^3}{1.38\times10^{-23}\,\text{JK}^{-1} \times (273+20)\text{K}} = 5.0\times10^{21}$	**(1)** **(1)** **(1)**	**3**
3(b	Use of $pV = NkT$ T_2 = 307 (K) stated or implied **Or** 293(K) subtracted ΔT = 14 K Example of calculation: $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ $T_2 = \frac{6.8\times10^5\,\text{Pa}}{6.5\times10^5\,\text{Pa}} \times 293\text{K} = 307\text{K}$ ΔT = (307 – 293) K = 14 K	**(1)** **(1)** **(1)**	**3**
3(c)	**M x 3** (Average) kinetic energy of molecules/atoms is greater **Or** molecules/atoms move faster Collision rate with walls of container is greater There is more momentum (exchanged) per collision **Or** the rate of change of momentum is greater Therefore a greater force on the container walls (dependent upon mp2 or mp3)	**(1)** **(1)** **(1)** **(1)**	**3**
	Total for question		**9**

Question Number	Answer	Mark
4a)	Temperature (of gas) [treat references to oil/room as neutral] (1) Mass of air/gas **Or** number of atoms/molecules/moles of air/gas [accept amount of air/gas, number of particles of air/gas] (1)	**2**
4(b)	Assumption: idea that volume occupied by trapped air ∝ length of air in tube [e.g. volume = cross-sectional area × length] (1) pL = a constant [accept pV = a constant] **Or** if p doubles, L halves (1) At least 2 pairs of p, L values correctly read from graph (1) Readings show that pL = 4500 (kPa cm) [± 100 kPa cm] **Or** Readings show that p doubles when L is halved (1) [Accept references to V instead of L] <u>Example of calculation</u> p = 400 kPa, L = 11.0 cm pL=400 × 11.0 = 4400 p = 200 kPa, L = 23.0 cm pL=200 × 23.0 = 4600	**4**
4(c)	Use of $pV=NkT$ [Allow use of pV=nRT **and** $N=n.N_A$] (1) Conversion of temperature to kelvin (1) $N = 8.4 \times 10^{20}$ [Accept answers in range 8.1×10^{20} to 8.4×10^{20}] (1) [Answer in range but with an incorrect temperature conversion score max 2] <u>Example of calculation</u> $N = \frac{450\times10^{3}\,\text{Pa}\times0.10\,\text{m}\times7.5\times10^{-5}\,\text{m}^2}{1.38\times10^{-23}\,\text{JK}^{-1}\times(273+20)\text{K}} = 8.35\times10^{20}$	**3**
4(d)(i)	No change (1)	**1**
4(d)(ii)	Similar curve (1) Shifted higher **Or** shifted to the right (1) [an annotated diagram can score full marks]	**2**
	Total for question	**12**