Mark Scheme

Q1.

Question Number	Answer	Mark
	B	1

Q2.

Question Number	Answer	Mark
	B	1

Q3.

Question Number	Answer	Mark
	D	1

Q4.

Question Number	Answer	Mark
	C	1

Q5.

Question Number	Answer	Mark
	C	1

Q6.

Question Number	Answer	Mark
	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> $\Delta N = \frac{V\Delta p}{kT} = \frac{0.052\,\text{m}^3 \times (2.0\times10^5 - 1.6\times10^5)\,\text{Pa}}{1.38\times10^{-23}\,\text{J K}^{-1}(273+22)\,\text{K}} = 5.11\times10^{23}$	3
	Total for Question	**3**

Q7.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	• Use of $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$ (1) • mean kinetic energy $= 6.4\times10^{-20}\,\text{J}$ (1)	<u>Example of calculation:</u> $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$ $= \frac{3}{2}\times1.38\times10^{-23}\,\text{J K}^{-1}\times3100\,\text{K} = 6.42\times10^{-20}\,\text{J}$	**2**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	• There are electron transitions between energy levels in the atoms, (1) • When electrons return to a lower level they emit energy in the form of <u>photons</u> (1)		**2**

Q8.

Question Number	Answer		Mark
(a)	Pressure (of gas) Amount of gas **Or** mass of gas **Or** number of moles / molecules / atoms	(1) (1)	2
(b)	Extending/extrapolating the line backwards The volume occupied by a gas will be zero at a particular temperature **Or** The graphs for different gases All cut the x axis at the same temp	(1) (1) (1) (1)	2

Q9.

Question Number	Answer		Mark
(a)	Use of $pV = NkT$ Pressure difference **Or** temperature conversion $\Delta N = 5.0 \times 10^{21}$ <u>Example of calculation:</u> $\Delta N = \frac{\Delta p.V}{kT} = \frac{(6.5\times10^{5} - 5.8\times10^{5})\text{Pa} \times 2.9\times10^{-4}\,\text{m}^{3}}{1.38\times10^{-23}\,\text{JK}^{-1}\times(273+20)\text{K}} = 5.0\times10^{21}$	(1) (1) (1)	3
(b)	Use of $pV = NkT$ T_2 = 307 (K) stated or implied **Or** 293(K) subtracted ΔT = 14 K <u>Example of calculation:</u> $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ $T_2 = \frac{6.8\times10^{5}\,\text{Pa}}{6.5\times10^{5}\,\text{Pa}} \times 293\text{K} = 307\text{K}$ $\Delta T = (307 - 293)\text{ K} = 14\text{ K}$	(1) (1) (1)	3
(c)	**Max 3** (Average) <u>kinetic</u> 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

Q10.

Question Number	Answer		Mark
(a)	(When the air is heated) the density (of air in) the balloon decreases So the upthrust is greater than the weight of the balloon (plus occupants)	(1) (1)	2
(b)	Use of $\rho = \frac{m}{V}$ Use of $\Delta E = mc\Delta\theta$ [$\Delta\theta$ must be a temperature difference] $\Delta E = 1.3(5) \times 10^9$ J <u>Example of calculation:</u> $m = \rho V = 1.20\,\text{kg m}^{-3} \times 7.4 \times 10^4\,\text{m}^3 = 8.88 \times 10^4\,\text{kg}$ $\Delta E = mc\Delta\theta = 8.88 \times 10^4\,\text{kg} \times 1010\,\text{J kg}^{-1}\,\text{K}^{-1}(35-20)\text{K} = 1.345 \times 10^9\,\text{J}$	(1) (1) (1)	3
(c)(i)	Use of $pV = NkT$ [temperature in either K or °C] $p = 9.24 \times 10^4$ Pa <u>Example of calculation:</u> $\frac{p_2}{p_1} = \frac{T_2}{T_1}$ $p_2 = (1.01 \times 10^5)\text{Pa} \times \frac{(273-5)\text{K}}{(273+20)\text{K}} = 9.238 \times 10^4\,\text{Pa}$	(1) (1)	2
(c)(ii)	**Max 2** Hydrogen/gas behaves as an ideal gas Mass of hydrogen/gas in balloon stays constant [Accept amount of hydrogen/gas] **Or** number of molecules/atoms/particles of hydrogen/gas in balloon stays constant Temperature of hydrogen/gas is the same as the temperature of the surroundings	(1) (1) (1)	2
(c)(iii)	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) The average/mean kinetic energy of the molecules decreases Molecules travel slower (on average) **Or** rate of collisions with walls is less So rate of change of momentum (during collisions) with walls is less	(1) (1) (1)	3
	Total for question		**12**

Q11.

Question Number	Answer		Mark
(a)	Temperature (of gas) [treat references to oil/room as neutral] 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) (1)	**2**
(b)	Assumption: idea that volume occupied by trapped air ∝ length of air in tube [e.g. volume = cross-sectional area × length] pL = a constant [accept pV = a constant] **Or** if p doubles, L halves At least 2 pairs of p, L values correctly read from graph Readings show that pL = 4500 (kPa cm) [± 100 kPa cm] **Or** Readings show that p doubles when L is halved [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	(1) (1) (1) (1)	**4**
(c)	Use of $pV=NkT$ [Allow use of pV=nRT **and** $N=n.N_A$] Conversion of temperature to kelvin $N = 8.4 \times 10^{20}$ [Accept answers in range 8.1×10^{20} to 8.4×10^{20}] [Answer in range but with an incorrect temperature conversion score max 2] <u>Example of calculation</u> $N = \frac{450 \times 10^3\,\text{Pa} \times 0.10\,\text{m} \times 7.5 \times 10^{-5}\,\text{m}^2}{1.38 \times 10^{-23}\,\text{JK}^{-1} \times (273+20)\text{K}} = 8.35 \times 10^{20}$	(1) (1) (1)	**3**
(d)(i)	No change	(1)	**1**
(d)(ii)	Similar curve Shifted higher **Or** shifted to the right [an annotated diagram can score full marks]	(1) (1)	**2**
	Total for question		**12**