Question	Expected Answers	Marks	Additional guidance
1(a) (i)	Initial KE of car = $0.5 \times 970 \times 27^2$ = **3.5×10^5 J** (353565J)	B1	
(a) (	Work done = Av Force x distance moved Av Force = 3.5×10^5 J/40 = **8.8×10^3 N** (or 8750 N) (or 353565/40 = 8836.7 N) Assumption: **<u>no air resistance</u>**	C1 A1 B1	If $v^2 = u^2 + 2as$ is used. accept $a = 0-27^2/(2 \times 40) = 9.113\ ms^{-2}$ C1 $F = ma = 970 \times 9.11 = 8.84 \times 10^3$ N A1 Allow air friction or drag
(b)	correct use of $E = mc\Delta\theta$: $3.5 \times 10^5/4 = 1.2 \times 520 \times \Delta\theta$ $\Delta\theta$ = **140^OC** (if 353565 is used $\Delta\theta = 142^O$C)	C1 A1	If cand. forgets to divide by 4 allow any value between 560 and 570 for 1 mark.
(b) (	<u>Air resistance</u> will be acting (slowing down the car) (hence) <u>reducing the KE of the car</u> (WTTE) The <u>discs are hotter</u> than the surroundings (hence) <u>energy/heat</u> will be lost from <u>discs/brakes</u> (WTTE)	M1 A1 B1 B1	Do not allow sound since only a tiny proportion of energy is lost in this way. Allow other valid comments as alternative ways of scoring one or both of the 'B' marks: e.g. 'hot spots' on discs; discs are different. Try to credit a well argued case based upon correct physics- e.g. wheels locking.
(b) (i	Any valid suggestion: e.g. use a material with a higher s.h.c use a disc with a higher heat capacity Use discs of greater mass put holes in the discs (to increase air flow)	 B1	Confusion between shc and heat capacity should not be penalised.
	Total	11	

Question			Answer	Marks	Guidance
2	(a)	(i)	*n* = number of moles (in sample) **AND** *N* = number of atoms / molecules (in sample)	B1	**Note: both** definitions are required **Not:** particles / Avogadro's constant
		(ii)	*n* or *N* **AND** T is constant (and R and k are constants) for a fixed mass (of gas), pV = constant / $p \propto 1/V$	M1 A1	nRT or NkT is constant is **not** sufficient
		(iii)	Shows that $Nm^{-2} \times m^{3} = Nm$	B1	**Allow:** Use of base units for **both** pV **and** work done
	(b)	(i)	Calculates $p \times (1/V)^{-1}$ at **two** points on the graph values are the same pV = constant / $p \propto 1/V$ / nRT = constant	M1 A1	Expected values for pV are 7500 (Nm) or 0.075 ($\times 10^{-5}$)for most points **Allow:** Correct calculation of gradient (M1) Calculates intercept = 0 hence graph is through the origin and pV = constant / $p \propto 1/V$ (A1)
		(ii)	Number of moles in 0.050 kg = 0.05/0.016 (= 3.125) $T = \frac{pV}{nR} = \frac{7500}{3.125 \times 8.31}$ $= 289$ (K) $T = 16$ (°C)	C1 C1 A1	**Allow:** possible ecf from (b)(i) or error in *n* but apply POT error for use of $pV = 0.075$ leading to $T = 2.9 \times 10^{-3}$ K **Note:** Mark is for correct conversion of their *T* (K) value **Note**: Allow full range of marks for other sensible alternative approaches e.g. use of a molecular mass of 0.032 kg/mol giving a temperature of 305°C
			Total	**9**	

Question			Answer	Marks	Guidance
3	(a)	(i)	vibrate (about their 'fixed' positions)	B1	**Allow:** molecules vibrate
		(ii)	greater amplitude / greater frequency (of vibration)	B1	**Not:** faster / more / bigger /more vigorous (vibrations)
		(iii)	**Either** internal energy increases **Or** potential energy (of molecules) increases and the kinetic energy remains constant temperature remains constant	B1 B1	
	(b)	(i)	$P\,t = m\,c\,\Delta\theta$ 48 x 720 = 0.98 x *c* x (54 - 18) + 0.027 x 850 x (38-18) c = 970 (J kg^{-1} K^{-1})	C1 C1 C1 A1	**Note:** mark is for correct substitution for total energy input **and** heat gained by **metal** **Note:** mark is for adding a correct substitution for heat gained by insulation into this equation **Note:** answer to 3 sf = 967 Calculation of c = 980 ignoring energy used to heat insulation scores 2 marks
		(ii)	Without the insulation there will be **more** heat lost to the surroundings / air (AW) final temperature will be **lower** **OR** a **lower** temperature rise **OR** more energy will be required to give the **same** temperature rise / final temperature **AND** hence c is **higher** than that calculated in (i)	M1 A1	**Not:** lost to wires / data logger
			Total	**10**	

Question			Answer	Marks	Guidance
4	(a)		latent heat of **fusion** 🖉**The term fusion to be included and spelled correctly to gain the B1 mark**	B1	**Allow**: Specific latent heat of fusion **Allow**: (Specific) latent energy of fusion **Must use tick or cross on Scoris to show if the mark is awarded**
	(b)	(i)	Total / sum of randomly (distributed) kinetic energy and potential energy of molecules/atoms	B2	**Allow**: 1 mark only if molecules / atoms and/or randomly are omitted
		(ii)	Potential energy of the molecules increases Kinetic energy of molecules is the same for water and steam (since the temperature is the same) / work is done in moving molecules apart	B1 B1	**Allow** : work is done to break the bonds (between molecules)
	(c)	(i)	Mass of air = volume x density = 15 x 1.2 (= 18 kg) Heat energy transferred to air in one hour Q = 12 x 60 x 60 (= 43200 J) $\Delta\theta = Q / mc$ = 12 x 60 x 60 / 18 x 990 Temperature rise in one hour = 2.4 K	C1 C1 A1	**Allow**: any subject Treat a transcription error as one AE. **Allow**: 2 K as question asks for an estimate
		(ii)	Any **two** from • Heat lost to structure of greenhouse / contents • Heat lost through glass / from the greenhouse / surroundings • Average rate of loss of heat reduces (as temperature falls)	B1 x 2	
			Total	**10**	

Question			Answer	Marks	Guidance
5	(a)	(i)	Collision in which kinetic energy is conserved	B1	**Allow**: no ke lost (wtte)
		(ii)	Any **four** from • Many molecules collide with the walls • A change in momentum occurs when molecule(s) collide with (and rebound from) the walls of container • Force is rate of change of momentum • The force exerted by the molecule(s) on wall is equal to force exerted by the wall on the molecule(s) (by Newton's third law) • pressure (on wall) = (total) force (on wall) / area (of wall)	B1 x 4	Symbols must be defined in formulae
		(iii)	Any **two** from • Molecules move faster/have greater kinetic energy (at higher temperature) • There is an increased rate of collision / more collisions occur per second / collisions occur more often • Each collision involves a greater change in momentum	B1 x 2	**Not**: greater force **Not**: harder collisions
	(b)	(	$P_1V_1/ T_1 = P_2V_2/T_2$ with T stated in Kelvin or clearly shown in subsequent working $P_2 = 105 \times 5 \text{x} 10^3 \times (273 – 30)/ (273 + 20) \times 1.2 \times 10^4$ $P_2 = 36$ (kPa)	C1 C1 A1	Temperatures must be in kelvin to score this mark. **Allow** : consistent working in pascal
		(ii)	Risk that balloon will burst (with further increase in volume)	B1	**Allow**: pop / explode
			Total	**11**	