Question	Expected Answers	Marks	Additional guidance
1(a)	The magnitude of the impulse on each object is the same Total energy is conserved	B1 B1	For 3 or 4 ticks mark and deduct 1 mark for each error.
(b) (i)	Correct use of ½ mv^2 Loss of KE = 0.03(144-81) = **1.9** (or 1.89) **J**	C1 A1	0.27 J scores 1st mark Do not allow 1.8
(b) (ii)	Change in momentum = (0.06x12)+(0.06x9) = 1.26 (Ns) Average force=rate of change of momentum = 1.26/0.15 = **8.4** (or 8) **N**	C1 A1	Award 1 mark for 1.2 N ignore minus signs
(b) (iii)	**8.4 N** (or - 8.4)	B1	Allow ecf from (ii)
(c) (i)	ANY 3 of the following particles move with <u>rapid, random</u> motion (WTTE) elastic collisions negligible (or zero) volume of atoms (compared with volume of container) no intermolecular forces (except during collisions)/all internal energy is KE collision time negligible (compared to time between collision).	 B1 B1 B1	Allow “ gravitational force on molecules is negligible” Do not allow a bare “large number of particles”.
(c) (ii)	molecules make <u>collisions with walls/surface</u> (WTTE) (hence) exerts a force on the wall (or each collision has a change of momentum) Pressure = force/area	B1 B1 B1	Do not allow a bare “molecules collide with each other”
	Total	13	

Question	Expected Answers	Marks	Additional guidance
2(a) (i)	Initial KE of car = $0.5 \times 970 \times 27^2$ = **3.5×10^5 J** (353565J)	B1	
(a) (ii)	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: **no air resistance**	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) (i)	correct use of $E = mc\Delta\theta$: $3.5 \times 10^5/4 = 1.2 \times 520 \times \Delta\theta$ $\Delta\theta$ = **$140^{O}C$** (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) (ii)	Air resistance will be acting (slowing down the car) (hence) reducing the KE of the car (WTTE) The discs are hotter than the surroundings (hence) energy/heat will be lost from discs/brakes (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) (iii)	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
3	(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 $P_2 = 105 \times 5x10^3 \times (273 - 30)/(273 + 20) \times 1.2 \times 10^4$ $P_2 = 36$ (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**	