Name of the Student:_____

Max. Marks : 20 Marks **Time : 20 Minutes**

Mark Schemes

Q1.

Question Number	Acceptable answers		Additional guidance	Mark
	• Use of $pV = NkT$	(1)	Example of calculation $p_1 V_1 = NkT_1$	
	• Conversion of T in K	(1)	$p_1 V_1 / T_1 = NkT_1 = p_2 V_2 / T_2$ V_1 / 293 K = 2800 m^3 / 393 K	
	• Use of $\rho = m/V$ to determine mass of air in the balloon	(1)	Volume of gas before heating, V_1 = 2087 m^3 mass of air in balloon	
	• Calculation of total mass = mass of air at 120 °C + passengers + balloon	(1)	= 1.2 kg m^{-3} × 2087 m^3 = 2505 kg Total mass with 5 passengers = (2505 + 340 + 380) kg = 3225 kg	
	• Use of $W = mg$	(1)	W = 3225 kg × 9.81 N kg^{-1} = 31 637 N 31 600 N < 33 000 N	
	• W = 31 600 N, which is less than 33 000 N, so the balloon can take off			6

Q2.

Question Number	Acceptable answers		Additional guidance	Mark
	• Energy lost by block = energy gained by water and/ or glass	(1)	Example of calculation: $0.22\ \text{kg} \times c \times (100 - 23)\text{K}$ $= 0.05\ \text{kg} \times 840\ \text{J kg}^{-1}\ \text{K}^{-1} \times 4\ \text{K} +$ $0.3\ \text{kg} \times 4200\ \text{J kg}^{-1}\ \text{K}^{-1} \times 4\ \text{K}$ $16.94\ c = 168 + 5040 = 5208\ \text{J}$ $c = 307\ \text{J kg}^{-1}\ \text{K}^{-1}$ MP1 may be awarded for approach comparing energy gained by water and/or glass with maximum energy lost by block without equating them	5
	• Use of $\Delta E = mc\Delta\theta \ldots$	(1)		
	• …using temperature change of block	(1)		
	• $c = 310\ (\text{J kg}^{-1}\ \text{K}^{-1})$ **Or** Required temperature change for tin = 103 K **Or** required starting temperature for tin = 126 °C	(1)		
	• Block is copper with justification e.g. some energy transferred to surroundings (so causes an underestimate in c) **or** block not fully at 100°C (so causes an underestimate in c) **or** tin cannot produce the required temperature change	(1)		

Q3.

Question Number	Acceptable answers		Additional guidance	Mark
	• Use of $W = mg$	(1)	Example of calculation $T = 0.010\ \text{kg} \times 9.81\ \text{N kg}^{-1} = 0.0981$ N $v = \sqrt{(0.0981\ \text{N} / 9.1 \times 10^{-4}\ \text{kg m}^{-1})} =$ $10.4\ \text{m s}^{-1}$ $\lambda = 0.69\ \text{m} / 2 = 0.345\ \text{m}$ $f = 10.4\ \text{m s}^{-1} / 0.345\ \text{m}$ $= 30\ \text{Hz}$	5
	• Use of $v = \sqrt{(T/\mu)}$	(1)		
	• Determination of wavelength	(1)		
	• Use of $v = f\lambda$	(1)		
	• $f = 30$ Hz	(1)		

Q4.

Question Number	Acceptable Answer		Additional guidance	Mark
(i)	• Working leading to $W = 245$ (N)	(1)	Example of calculation $W = 25.0\ \text{kg} \times 9.81\ \text{m s}^{-2} = 245\ \text{N}$	1
(ii)	• Use of moment of force = Fx	(1)	Example of calculation $245\ \text{N} \times 2.5\ \text{m} = F \times 3.6\ \text{m}$	
	• Use of the principle of moments	(1)	$F = 170\ \text{N}$	
	• Support force = 170 N (ecf from (a)(i))	(1)	Show that value gives 174 N	3