Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Mark Schemes

Q1.

Question Number	Acceptable answers	Additional guidance	Mark
	• Equates right hand sides (1) • Final E_k formula ($\frac{1}{2} m \langle c^2 \rangle = 3/2\ kT$) and k is constant (1)		2

Q2.

Question Number	Acceptable answers	Additional guidance	Mark
(i)	An explanation that makes reference to: • quantisation of energy is the idea that energy is emitted/radiated in discrete packets/photons **(1)** • each photon has an energy which is related to frequency OR suitable reference to $E = hf$ **(1)**		2
(ii)	• Model A is successful at long wavelengths because the curve for model A follows the experimental curve **(1)** • But model A breaks down for short wavelengths, since it suggests that the intensity tends to infinity as the wavelength gets shorter **(1)** • Model B is successful for short wavelengths because curve B follows the experimental curve **(1)** • But model B indicates higher than expected intensities at larger wavelengths **(1)**		4

Q3.

Question Number	Answer		Mark
(a)	(B2 =) 2.9×10^{-3}/A2 **Or** (B2 =) $2.9 \times 10^{-3}/\lambda_{max}$ **Or** (B2=) $2.9 \times 10^{-3}/6.85 \times 10^{-7}$ [Ignore incorrect powers of 10]	(1)	1
(b)	Use of $L = \sigma T^4 A$ $A = 0.21(48) \times 10^{19}$ (m^2) For max 1 Use of $A = 4\pi R^2$ to give $A = 2.1(1) \times 10^{18}$ (m^2) Example of calculation: $A = \frac{0.392 \times 10^{26}\ \text{W m}^{-2}}{5.67 \times 10^{-8}\ \text{W m}^{-4}\ \text{K}^{-4} \times (4230\ \text{K})^4} = 2.148 \times 10^{18}\ \text{m}^2$	(1) (1)	2
(c)	Flux/brightness/intensity measured and distance to star determined (Luminosity calculated using) $L = 4\pi d^2 F$ **Alternative mark scheme:** Temperature and type of star identified [e.g. main sequence]	(1) (1) (1)	
	Hertzsprung-Russell diagram used to find luminosity	(1)	2
	Total for question		5

Q4.

Question Number	Acceptable answers		Additional guidance	Mark
	• Use of ½ $m \langle c^2 \rangle = 3/2\ kT$ • with T in Kelvin • $\sqrt{\langle c^2 \rangle} = 497\ \text{m s}^{-1}$	(1) (1) (1)	Example of calculation ½ $m \langle c^2 \rangle = 3/2\ kT$ ½ × 5.0×10^{-26} kg × $\langle c^2 \rangle = 3/2 \times 1.38 \times 10^{-23}\ \text{J K}^{-1} \times 298\ \text{K}$ $\langle c^2 \rangle = 247\ 000\ \text{m}^2\ \text{s}^{-2}$ $\sqrt{\langle c^2 \rangle} = 497\ \text{m s}^{-1}$	3

Q5.

Question Number	Acceptable answers	Additional guidance	Mark
(a)	• use of $W = VIt$ (1) • use of $\Delta E = mc\Delta\theta$ (1) • use of efficiency = useful power / output / total power input (1) • efficiency = 0.90 Or 90% (1)	Example of calculation: W = 247 V × 11.8 A × 172 s = 501 000 J ΔE = 1.20 kg × 4180 J kg^{-1} K^{-1} × (101 - 11) K = 451 000 J Efficiency = 451 000 / 501 000 = 0.90	**(4)**

Question Number	Acceptable answers	Additional guidance	Mark
(b)	• calculates area of sphere of radius 30 cm = 1.13 m^2 (1) • use of $I = P/A$ (1) • use of $W = Pt$ (1) • W = 2.0 J (1)	Example of calculation: Area = 4π × (0.3 m)^2 = 1.13 m^2 P = 10.5 × 10^{-3} W m^{-2} × 1.13 m^2 = 1.19 × 10^{-2} W W = 1.19 × 10^{-2} W × 172 s = 2.0 J	**(4)**

Question Number	Acceptable answers	Additional guidance	Mark
(c)	An explanation that makes reference to the following: • the quiet boil electric kettle is more efficient, but only by 3% which isn't 'much' (1) • the energy transferred by sound is very small, so it is not the reason for the difference (1)	Allow 1 mark if the student gives a comment that the uncertainties are too high to draw a valid conclusion without reference to the data in the question, the candidate's calculations may be awarded one mark	**(2)**