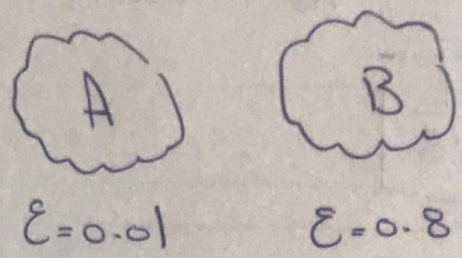
Model Answer for sheet (1)

(1)



$A_A = A_B$

$P_A = P_B$

$\lambda_B - \lambda_A = 1\ \mu m$

$T_A = 5802\ k$

λ_B ?

T_B ?

* Ans $P_A = P_B$

$(\sigma \varepsilon A T^4)_A = (\sigma \varepsilon A T^4)_B$

$\therefore (0.01)(5802)^4 = (0.8)\, T_B^4$

(1) $T_B = \sqrt[4]{\frac{(0.01)(5802)^4}{(0.8)}} = \boxed{1940\ ^\circ k}$

* From $\lambda_m T = \text{Constant}$ $\therefore \frac{\lambda_A}{\lambda_B} = \frac{T_B}{T_A}$

$\therefore \lambda_B = \frac{\lambda_A T_A}{T_B}$ $\therefore \lambda_B = \frac{5802}{1940}\lambda_A$ $\therefore \lambda_B = 3\lambda_A$

From $\lambda_B - \lambda_A = 1\ \mu m$ $\therefore \lambda_B - \frac{\lambda_B}{3} = 1\ \mu m$

$\therefore \frac{2}{3}\lambda_B = 1$ (2) $\therefore \lambda_B = \frac{3}{2}\ \mu m = \boxed{1.5 \times 10^{-6}\ m}$

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(2) $\therefore \lambda_A T_A = \lambda_B T_B$ $\therefore \lambda_A = \frac{1}{T_A}$

$r_A = 6 \times 10^{-2}\ m$

$r_B = 18 \times 10^{-2}\ m$

$\lambda_A = 500 \times 10^{-9}\ m$

$\lambda_B = 1500 \times 10^{-9}\ m$

$\frac{P_A}{P_B} = ?$

$\therefore \frac{P_A}{P_B} = \frac{\sigma \varepsilon A_A T_A^4}{\sigma \varepsilon A_B T_B^4} = \frac{\pi r_A^2 T_A^4}{\pi r_B^2 T_B^4} = \frac{r_A^2 \left(\frac{1}{\lambda_A}\right)^4}{r_B^2 \left(\frac{1}{\lambda_B}\right)^4}$

$= \frac{(6 \times 10^{-2})^2 \left(\frac{1}{500 \times 10^{-9}}\right)^4}{(18 \times 10^{-2})^2 \left(\frac{1}{1500 \times 10^{-9}}\right)^4} = \boxed{\frac{9}{1}}$

3 ∴ From $P = \sigma \varepsilon A T^4$

$$\therefore \frac{A_1}{A_2} = \frac{T_1^4}{T_2^4} \quad \therefore \frac{A_1}{A_2} = \frac{(300)^4}{(600)^4}$$

$$= \boxed{\frac{1}{16}}$$

$T_1 = 27 + 273 = 300\,°K$

$T_2 = 327 + 273 = 600\,°K$

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4 $\lambda_m T = 2.9 \times 10^{-3}$

$\lambda_m \times 310 = 2.9 \times 10^{-3}$

$$\therefore \lambda_m = \frac{2.9 \times 10^{-3}}{310} = \boxed{9.35 \times 10^{-6}\ m}$$

$T = 37 + 273 = 310\,°K$

$\lambda = ?$

$b = 2.9 \times 10^{-3}\ mK$

5

A	B	C
$r = 2m$	$r = 4m$	$r = 6m$
$\lambda_m = 300 \times 10^{-9}\ m$	$\lambda_m = 400 \times 10^{-9}\ m$	$\lambda_m = 500 \times 10^{-9}\ m$
$A_A = \pi r_A^2$	$A_B = \pi r_B^2$	$A_C = \pi r_C^2$

∴ $Q \xrightarrow{\sigma} P$

∴ $Q_A : Q_B : Q_C$

$\sigma \varepsilon A_A T_A^4 : \sigma \varepsilon A_B T_B^4 : \sigma \varepsilon A_C T_C^4$

$\pi r_A^2 T_A^4 : \pi r_B^2 T_B^4 : \pi r_C^2 T_C^4$ which $T = \frac{1}{\lambda}$

$(2)^2 \left(\frac{1}{300 \times 10^{-9}}\right) : (4)^2 \left(\frac{1}{400 \times 10^{-9}}\right)^4 : (6)^2 \left(\frac{1}{500 \times 10^{-9}}\right)^4$

$\boxed{4.93 \times 10^{26} : 6.25 \times 10^{26} : 2.77 \times 10^{26}}$

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6 $P_{net} = \sigma \varepsilon A (T_{env}^4 - T^4)$

$= (5.6 \times 10^{-8})(0.1)(0.2 \times 0.2)\left[(600)^4 - (400)^4\right]$

$= \boxed{23.296\ w}$

$A = 0.2 \times 0.2\ m^2$

$T = 400\,°K$

$T_{env} = 600\,°K$

$\varepsilon = 0.1,\ \sigma = 5.6 \times 10^{-8}$

$P_{net} = ?$

Sheet (2)

1 $\lambda = \frac{h}{mv} \therefore v = \frac{h}{m\lambda}$

$= \frac{6.625\times10^{-34}}{(9.11\times10^{-31})(1)} = 7.27\times10^{-4}\ m/s$

$\lambda = 1\ m$
$m_e = 9.11\times10^{-31}$
$h = 6.625\times10^{-34}$
$v = ?$

2 $\therefore \lambda = \frac{h}{m_e v} = \frac{6.625\times10^{-34}}{(9.11\times10^{-31})(5\times10^{6})}$

$= 1.45\times10^{-10}\ m$

$m_e = 9.11\times10^{-31}$
$v = 5\times10^{6}\ m/s$
$h = 6.625\times10^{-34}$
$\lambda = ?$

3 $\lambda = \frac{h}{mv}$, From $\frac{1}{2}mv^2 = eV$

$\therefore v = \sqrt{\frac{2eV}{m}}$

$\therefore v = \sqrt{\frac{2\times20\times10^{3}\times1.6\times10^{-19}}{9.11\times10^{-31}}} = 83.8\times10^{6}\ m/s$

Potential diff

$m_e = 9.11\times10^{-31}\ kg$
$V = 20\ keV = 20\times10^{3}\times1.6\times10^{-19}\ V$
$h = 6.625\times10^{-34}$

$\therefore \lambda = \frac{h}{mv} = \frac{6.625\times10^{-34}}{(9.11\times10^{-31})(83.8\times10^{6})} = 8.68\times10^{-12}\ m$

4

1 $\frac{1}{2}mv^2 = eV$

$\therefore K.E = \frac{1}{2}mv^2$

$\therefore 2\times10^{6}\times1.6\times10^{-19} = \frac{1}{2}\times1.67\times10^{-27}\times v^2$

$\therefore v = \sqrt{\frac{2\times10^{6}\times1.6\times10^{-19}}{\frac{1}{2}\times1.67\times10^{-27}}} = 19.57\times10^{6}\ m/s$

$\lambda = \frac{h}{mv} = \frac{6.625\times10^{-34}}{(1.67\times10^{-27})(19.57\times10^{6})} = 2.03\times10^{-14}\ m$

2 $K.E = \frac{1}{2}mv^2$

$\therefore v = \sqrt{\frac{10\times10^{6}\times1.6\times10^{-19}}{\frac{1}{2}\times1.67\times10^{-27}}} = 43.77\times10^{6}\ m/s$

$\therefore \lambda = \frac{h}{mv} = \frac{6.625\times10^{-34}}{(1.67\times10^{-27})(43.7\times10^{6})} = 9.08\times10^{-15}\ m$

$m_p = 1.67\times10^{-27}\ kg$
$K.E_1 = 2\ MeV = 2\times10^{6}\times1.6\times10^{-19}$
$K.E_2 = 10\ MeV = 10\times10^{6}\times1.6\times10^{-19}$
$h = 6.625\times10^{-34}$
$\lambda = ?$

5 (a) $\therefore \lambda = \frac{h}{mv} = \frac{6.625\times10^{-34}}{(10)(8)}$

$= \boxed{8.28\times10^{-36}\ m}$

(a) :- $m = 10\ kg$
$v = 8\ m/s$
$h = 6.625\times10^{-34}$

(b) $\lambda_e = \lambda_{yellow} = 590\times10^{-9}\ m$

$\therefore \lambda = \frac{h}{mv} \quad \therefore v = \frac{h}{m_e \lambda_e} = \frac{6.625\times10^{-34}}{(9.11\times10^{-31})(590\times10^{-9})}$

$= 1232.58\ m$

$\therefore E_e = \frac{1}{2}mv^2 = \frac{1}{2}(9.11\times10^{-31})(1232.58)^2$

$= \boxed{6.92\times10^{-25}\ J}$

(b) $E = ?$
$\lambda_e = \lambda_{photon} = 590nm$
$h = 6.625\times10^{-34}$
$m_e = 9.11\times10^{-31}\ kg$

(C) $E_{photon} = E_e = \frac{hc}{\lambda} = \frac{(6.625\times10^{-34})(3\times10^8)}{590\times10^{-9}}$

$= 3.36\times10^{-19}\ J$

$\therefore E_e = \frac{1}{2}mv^2 \quad \therefore v = \sqrt{\frac{2E}{m}} = \sqrt{\frac{2\times3.36\times10^{-19}}{9.11\times10^{-31}}}$

$= 859.9\times10^3\ m/s$

$\therefore \lambda = \frac{h}{mv} = \frac{6.625\times10^{-34}}{(9.11\times10^{-31})(859.9\times10^3)} = \boxed{8.45\times10^{-10}\ m}$

(C) $\lambda_e = ?$
$E_{electron} = E_{photon}$
$C = 3\times10^8\ m/s$
$\lambda_e = 590\times10^{-9}\ m$
$h = 6.625\times10^{-34}$
$m_e = 9.11\times10^{-31}$

6 $\lambda = 0.01\times10^{-9} = \frac{h}{mv} = \frac{6.625\times10^{-34}}{(1.675\times10^{-27})(v)}$

$\therefore v = \frac{6.625\times10^{-34}}{(0.01\times10^{-9})(1.675\times10^{-27})}$

$= \boxed{39.5\times10^3\ m/s}$

$\lambda = 0.01nm$
$m_n = 1.675\times10^{-27}\ kg$
$h = 6.625\times10^{-34}$
$v = ? \quad , E = ?$

7 $\therefore \lambda = \frac{h}{mv} = \frac{6.625\times10^{-34}}{(9.11\times10^{-31})(\frac{3}{100}\times(3\times10^{8}))}$

$= \boxed{8.08\times10^{-11}\ m}$

$\lambda_e = ?$
$v = \frac{3}{100}\times(3\times10^{8})$
$m_e = 9.11\times10^{-31}$
$h = 6.625\times10^{-34}$

8 $v_p = \frac{h}{m\lambda_p} = \frac{6.625\times10^{-34}}{(1.67\times10^{-27})(6\times10^{-15})}$

$= \boxed{66.16\times10^{6}\ m/s}$

$v_p = ?$
$\lambda_p = 6\times10^{-15}\ m$
$h = 6.625\times10^{-34}$
$m_p = 1.67\times10^{-27}\ kg$

9 $v = \frac{h}{m\lambda} = \frac{6.625\times10^{-34}}{(0.4)(7.5\times10^{-15})} = \boxed{2.21\times10^{-19}\ m/s}$

$m = 0.4\ kg$
$\lambda = 7.5\times10^{-15}\ m$
$h = 6.625\times10^{-34}$

10 $\lambda_p = \frac{h}{mv} = \frac{6.625\times10^{-34}}{(1.67\times10^{-27})(\frac{1}{100}(3\times10^{8}))}$

$= \boxed{1.32\times10^{-13}\ m}$

$\lambda_p = ?$
$v = \frac{1}{100}(3\times10^{8})$
$h = 6.625\times10^{-34}$
$m_p = 1.67\times10^{-27}$ kg