Sheet 1 Model Answer

Cairo University Faculty of Science Chemistry Dep.		3rd Year Students First Term 2013 Time: 10 mins. Quantum (316Chem)
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1. Calculate the temperature of our sun if the λ_{max} of its spectra is 450nm.

$\lambda_{max} \cdot T = 2.898 \times 10^{6}$ nm K or $\lambda_{max} \cdot T = 2.898 \times 10^{-3}$ m K

$450 \cdot T = 2.898 \times 10^{6}$ $450 \times 10^{-9}\, T =$ " "

$T = 6440$ K $T = 6440$ K

2. Calculate the wavelength of a photon and an electron having the same energy of 3eV.

For photon

$E = \frac{hc}{\lambda}$

$3 \times 1.6 \times 10^{-19} = \frac{6.634 \times 10^{-34} \times 3 \times 10^{8}}{\lambda}$

$\lambda = 414$ nm

For electron

$E = \frac{p^2}{2m} = \frac{p^2}{2 \times 9.1 \times 10^{-31}} = 3 \times 1.6 \times 10^{-19}$

$p^2 = 8.736 \times 10^{-49}$

$p = 9.346 \times 10^{-25}$

$\lambda = \frac{h}{p} = \frac{6.62 \times 10^{-34}}{9.346 \times 10^{-25}} = 7 \times 10^{-10}$ m $= 7$ Å

3. Calculate the wavelength of the second line in the Balmer series for He^+.

$\frac{1}{\lambda} = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$R_H = 109680\ cm^{-1}$, $Z = 2$, $n_1 = 2$, $n_2 = 4$

$= 109680 \times 4 \times \left(\frac{1}{4} - \frac{1}{16}\right)$

$= 82260\ cm^{-1}$

$= 12.16 \times 10^{-6}$ m

4. Do the momentum and position operators commute?

$[\hat{P}, x] = \hat{P}x - x\hat{P}$ to get its value we need Function

$\left[-i\hbar \frac{\partial}{\partial x}, x\right] f(x) = -i\hbar \frac{\partial}{\partial x} x f(x) - x\left(-i\hbar \frac{\partial}{\partial x}\right) f(x)$

$= -i\hbar [f(x) + x f'(x)] + x i\hbar f'(x)$

$= -i\hbar f(x) - i\hbar x f'(x) + x i\hbar f'(x) = -i\hbar f(x)$