* Show your work.
* Show the UNITS and what cancels.

3/3

CHEM - EMR & the Atom (Eng) - 1 -

1. Calculate the energy of the photon emitted when an electron in a H atom falls from the fifth level to the ground state.

Givens
$n_i = 5$
$n_f = 1$ (Ground state)
$R_H = 2.18 \times 10^{-18}$ J

Sign = ⊖, because it is releasing energy

① ∴ $E_{gap} = E_{photon}$

② $E_{photon} = R_H \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right)$

$E_{photon} = 2.18 \times 10^{-18}\text{ J} \left(\frac{1}{(5)^2} - \frac{1}{(1)^2} \right)$ (3 S.F.)

$E_{photon} = 2.18 \times 10^{-18}\text{ J} \left(\frac{1}{25} - 1 \right)$

$E_{photon} = -2.0928 \times 10^{-18}$ J (3 S.F.)

$E_{photon} = [-2.09 \times 10^{-18}\text{ J}]$

2. Photons of 182 kJ/mol are emitted when e⊖'s in H fall to the second energy level. Determine their original level.

Givens
IE = 182 kJ/mol
$n_f = 2$
$n_i = ?$
$R_H = 2.18 \times 10^{-18}$ J

Important:
sign = ⊖, because e⊖'s are falling, ∴ releasing energy

mol = 6.02×10^{23}

① Convert kJ/mol → J (IE → E_{photon})

$E_{photon} = \frac{182 \text{ kJ}}{1 \text{ mol}} \times \frac{1000 \text{ J}}{1 \text{ kJ}} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}}$

$E_{photon} = 3.02325 \times 10^{-19}$ J (3 S.F.)

② Find n_i

∴ $E_{gap} = E_{photon}$

$E_{photon} = R_H \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right)$

$-3.02325 \times 10^{-19}\text{ J} = 2.18 \times 10^{-18}\text{ J} \left(\frac{1}{n_i^2} - \frac{1}{(2)^2} \right)$

$\frac{-3.02325 \times 10^{-19} \text{ J}}{2.18 \times 10^{-18} \text{ J}} = \frac{1}{n_i^2} - \frac{1}{4}$

$-0.138681 + \frac{1}{4} = \frac{1}{n_i^2}$

$0.111318\, n_i^2 = 1$

$n_i = \sqrt{\frac{1}{0.111318}}$

(Note energy levels must be to the closest whole number)

$n_i = 2.997$

$n_i = [3]$

Nam[e]

ID

Chem Ass'n EMR & atom (ENK) - 2 -

3. Carbon has an ionization energy of 1086 kJ/mol. What wavelength of E.M.R. is just sufficient to ionize it?

① Convert kJ/mol → J (IE → E_{photon})

$$E_{photon} = \frac{1086 \text{ kJ}}{1 \text{ mol}} \times \frac{1000 \text{ J}}{1 \text{ kJ}} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}}$$

4 s.f. / 3 s.f.

$$E_{photon} = 1.80398 \times 10^{-18} \text{ J}$$

3 s.f.

②

$$E_{photon} = \frac{h \cdot c}{\lambda}$$

$$\lambda = \frac{h \cdot c}{E_{photon}}$$

$$\lambda = \frac{(6.626 \times 10^{-34} \text{ J} \cdot \text{s})(3.00 \times 10^{8} \text{ m/s})}{(1.80398 \times 10^{-18} \text{ J})}$$

3 s.f. / 3 s.f. / 3 s.f.

(3 s.f.)

$\lambda = [1.10 \times 10^{-7} \text{ m}]$

$\lambda = [110. \text{ nm}]$

4. You shine EMR with wavelength 189 nm onto the surface of tin (Sn) metal. The emitted electrons have 3.43×10^{-19} J of kinetic energy. Determine the work function of tin.

① Convert nm → m

$$\lambda = 189 \text{ nm} \times \frac{10^{-9} \text{ m}}{1 \text{ nm}}$$

$$\lambda = 189 \times 10^{-9} \text{ m}$$

② Find E_{photon}

$$E_{photon} = \frac{h \cdot c}{\lambda}$$

$$E_{photon} = \frac{(6.626 \times 10^{-34} \text{ J} \cdot \text{s})(3.00 \times 10^{8} \text{ m/s})}{189 \times 10^{-9} \text{ m}}$$

3 s.f. / 3 s.f. / 3 s.f.

$$E_{photon} = 1.05174 \times 10^{-18} \text{ J}$$

③

$$E_{photon} = W + KE$$

$$W = E_{photon} - KE$$

$$W = \left(\begin{array}{r} 10.5174 \times 10^{-19} \text{ J} \\ - 3.43 \times 10^{-19} \text{ J} \end{array} \right)$$

3 s.f., 2 decimal place

3 s.f., 2 decimal place

7.0874

$W = [7.1 \times 10^{-19} \text{ J}]$ 2 s.f.