AP Chem - Unit 5 - Atomic Structure - NMS I

① **Given:**

$\lambda = 650\,nm$

$\nu = ?$

$c = 3.00 \times 10^8\,m/s$

Soln: $c = \lambda\nu$

$$\nu = \frac{c}{\lambda} = \frac{3.00\times10^8\,m/s}{(650\,nm)\left(\frac{1\,m}{1\times10^9\,nm}\right)}$$

$$\boxed{\nu = 4.62\times10^{14}\,Hz}$$

② **Given:**

$\lambda = 450\,nm$

$h = 6.6260755\times10^{-34}\,J\cdot s$

$E = ?$

Soln: $\overset{?}{E} = h\overset{?}{\nu}$

$c = \lambda\overset{?}{\nu}$

$$\nu = \frac{c}{\lambda} = \frac{3.00\times10^8\,m/s}{(450\,nm)\left(\frac{1\,m}{1\times10^9\,nm}\right)}$$

$\nu = 6.67\times10^{14}\,Hz$

$E = (6.6260755\times10^{-34}\,J\cdot s)(6.67\times10^{14}\,1/s)$

$$\boxed{E = 4.42\times10^{-19}\,J}$$

③ **Given:**

Electron

$m_E = 9.11\times10^{-31}\,kg$

$V_e = 1.0\times10^7\,m/s$

$\lambda_e = ?$

Ball

$m_B = 0.10\,kg$

$V_B = 35\,m/s$

$\lambda_B = ?$

Soln:

$$\lambda_e = \frac{h}{m_e V_e} = \frac{6.6260755\times10^{-34}\,J\cdot s}{(9.11\times10^{-31}\,kg)(1.0\times10^7\,m/s)}$$

$$\boxed{\lambda_e = 7.27\times10^{-11}\,m}$$

$$\lambda_B = \frac{h}{m_B V_B} = \frac{6.6260755\times10^{-34}\,J\cdot s}{(0.10\,kg)(35\,m/s)}$$

$$\boxed{\lambda_B = 1.89\times10^{-34}\,m}$$

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(4) Given:

Hydrogen

n=1 E=?

n=2

λ=? @ n=1

Z=1, since Hydrogen has 1 proton

Soln: $E_1 = -2.178 \times 10^{-18} J \left(\frac{Z^2}{n^2}\right)$

$= -2.178 \times 10^{-18} J \left(\frac{1^2}{1^2}\right)$

$E_1 = -2.178 \times 10^{-18} J$

$E_6 = -2.178 \times 10^{-18} J \left(\frac{1^2}{6^2}\right)$

$E_6 = -6.05 \times 10^{-20} J$

$\Delta E = E_1 - E_6 = (-2.178 \times 10^{-18} J) - (-6.05 \times 10^{-20} J)$

$\boxed{\Delta E = -2.12 \times 10^{-18} J}$

note: - Change means Atom lost/emitted Energy

$\lambda_1 = \frac{hc}{\Delta E} = \frac{(6.6260755 \times 10^{-34} J \cdot s)(3.00 \times 10^{8} m/s)}{-2.12 \times 10^{-18} J}$

$\lambda_1 = -9.38 \times 10^{-8} m$

note: But we are measuring λ of Emitted wave so $|\Delta E|$ can't have $-\lambda$

$\boxed{\lambda_1 = 9.38 \times 10^{-8} m}$

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(5) Given:

Hydrogen Removing e

from n=1 to n=∞

Z=1, 1 proton

soln:

$$E = -2.178\times10^{-18} J \left[\frac{Z^2}{n^2}\right]$$

$$= -2.178\times10^{-18} J \left[\frac{1^2}{\infty} - \frac{1^2}{1^2}\right]$$

$$= -2.178\times10^{-18} J [-1]$$

$$\boxed{E = 2.178\times10^{-18} J}$$

(6) n=5

l=0 5s l=3 5f

l=1 5p l=4 5g

l=2 5d

(8) P 1st IE = 1060 KJ/mol S 1st IE = 1005 KJ/mol why?

Ionization energy is the energy Required to remove 1 electron

P $1s^2 2s^2 2p^3$ (↑ ↑ ↑) IE = 1060 KJ/mol S $1s^2 2s^2 2p^4$ (↑↓ ↑ ↑) IE = 1005 KJ/mol

1st ionization energy ↑ as we go across a period, so we would Expect S to Be greater the P.

But S has a paired electron in $2p^4$ vs P which are are all single in $2p^3$. S has a higher e^-/e^- Repulsion & the IE is lower for S

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9. A) $1s^2 2s^2 2p^6$ Ne
B) $1s^2 2s^2 2p^6 3s^1$ Na
C) $1s^2 2s^2 2p^6 3s^2$ Mg

Ne (a) has the largest 1st IE due to All the orbitals Being filled, & Also Ne has the smallest Radius, causing the Proton's to have the strongest Pull on e's. This is also called Z_{eff}

Mg (c) will have lowest 2nd IE. After 1st e is Removed the now Anion, will Be $3s^1$, a single e is still a valence electron. IN Na after you Remove the $3s^1$, the Z_{eff} will increase, And you are trying to Remove core elections which will have a higher IE due to proton + electron Attraction Being higher (Z_{eff})

10. Predict the trend in Radius for the following ions: Be^{+2}, Mg^{+2}, Ca^{+2}, Sr^{+2}

All of these ions form By Removing 2e's from Group 2 Atoms Going down in Group Size (increasing Atomic #'s) Size increases to Adding more levels

$$Be^{+2} < Mg^{+2} < Ca^{+2} < Sr^{+2}$$