THE UNIVERSITY OF ZAMBIA

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Question ①

$E_n = -13.6 \text{ eV} \frac{Z^2}{n^2}$

$E_5 = -13.6 \text{ eV} \frac{(1)^2}{5^2}$

$E_5 = -0.544 \text{ eV}$

$E_1 = -13.6 \text{ eV} \frac{(1)^2}{(1)^2}$

$= -13.6 \text{ eV}$

energy required to remove an electron

$\Delta E = E_\infty - E_5$

$\Delta E = 0 - (-0.544 \text{ eV})$

$\Delta E = 0.544 \text{ eV}$

$\approx 8.71 \times 10^{-19} \text{ J}$

$\Delta E = E_\infty - E_1$

$= 0 - (-13.6 \text{ eV})$

$= 13.6 \text{ eV}$

$= 2.18 \times 10^{-18} \text{ J}$

$\frac{E_5}{E_1} = \frac{0.544 \text{ eV}}{13.6 \text{ eV}} = 0.04$

Question ②

$\lambda = 580 \text{ nm} = 580 \times 10^{-9} \text{ m}$

$\nu = \frac{c}{\lambda}$

$\nu = \frac{2.9979 \times 10^8 \text{ m/s}}{580 \times 10^{-9} \text{ m}}$

$\nu = 5.17 \times 10^{14} \text{ s}^{-1}$

Wave number of yellow light

$\bar{\nu} = \frac{1}{\lambda} = \frac{1}{580 \times 10^{-9} \text{ m}} = 1.72 \times 10^6 \text{ m}^{-1}$

Question 3

(i) $E_i = nh\nu$

$= (1)(3 \times 10^{15})(6.620 \times 10^{-34})$

$= 1.9848 \times 10^{-18}$ J

$\approx 2 \times 10^{-18}$ J

(ii) Energy with wavelength of $0.50\ \text{Å} = 0.50 \times 10^{-10}$ m

$E_i = nh\nu$, but $\nu = \frac{c}{\lambda}$

$= \frac{nhc}{\lambda}$

$= \frac{(1)(6.626 \times 10^{-34}\ \text{J/mol})(2.9979 \times 10^{8}\ \text{m/s})}{3.97 \times 10^{-15}\ \text{J}}$

$= 3.97 \times 10^{-15}$ J

Question (4)

(a) (i) data

$\lambda = 4 \times 10^{-7}$ m

$\phi = 2.13$ eV

$E_1 = \frac{nhc}{\lambda}$

$= \frac{(1)(6.626 \times 10^{-34})(2.9979 \times 10^{8})}{4 \times 10^{-7}}$

$= 4.97 \times 10^{-19}$ J

$= 3.1$ eV

(ii) $\phi = 2.13\ \text{eV} \times 1.602 \times 10^{-19}\ \text{J}/1\text{eV}$

$= 3.412 \times 10^{-19}$ J

$K.E = E_1 - \phi$

$K.E = 4.966 \times 10^{-19}\ \text{J} - 3.412 \times 10^{-19}\ \text{J}$

$K.E = 1.55 \times 10^{-19}$ J

$K.E = 1.6 \times 10^{-19}$ J

$KE = 0.998$ eV

≈ 1 eV

Question 4 (a)

(a) (iii) $K.E = \frac{1}{2} m v^2$

$mv^2 = 2E$

$v = \sqrt{\frac{2E}{m}}$

$V = \sqrt{\frac{2(1.6 \times 10^{-19})}{9.11 \times 10^{-31}}}$

$V = 5.9 \times 10^5 \text{ m/s}$

(b) $\lambda = 242 \text{ nm} \longrightarrow 242 \times 10^{-9} \text{ m}$

$E_1 = \frac{nhc}{\lambda}$

$E_1 = \frac{(1)(6.626 \times 10^{-34})(2.9979 \times 10^8)}{242 \times 10^{-9} \text{ m}}$

$E_1 = 8.21 \times 10^{-19} \text{ J}$

$E_1 = 8.21 \times 10^{-19} \text{ J} \times \frac{6.02 \times 10^{-9} \text{ m/s}}{1 \text{ mole}}$

$E_1 = 494303.8 \text{ m J/mol}$

$E_1 = 494 \text{ KJ/mol}$

(c) $E_n = -2.18 \times 10^{-8} \text{ s } 1/n^2 \text{ J}$

$E_2 = \cdot 2.18 \times 10^{-18} \cdot \frac{1}{2^2} \text{ J}$

$E_2 = \cdot 2.18 \times 10^{-18} \frac{1}{4} \text{ J}$

$E_2 = -5.45 \times 10^{-19} \text{ J}$

$\Delta E_2 = \frac{-2.18 \times 10^{-18} \text{ J}}{\infty} - (-5.45 \times 10^{-19} \text{ J})$

$\Delta E_2 = 5.45 \times 10^{-19} \text{ J}$

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

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

$\lambda = \frac{(1)(6.626 \times 10^{-34})(2.9979 \times 10^8)}{5.45 \times 10^{-19} \text{ J}}$

$\lambda = 3.64 \times 10^{-7} \text{ m}$

$\lambda = 364 \text{ m}$

Question 4

(d) In Rutherford experiment, Heavy atoms have a heavy nucleus carrying large ammount of positively charge, Hence some alpha particles are easily deflected back into on hitting the nucleus and some deflected through small angles. If the thin foil of aluminium is used, their nuclei will be light and will have small positive charge on the nucleus. Hence number of particles deflected back and those deflected through some angles will be negligible.

The other reason is that aluminium is not as good as gold in terms of malleability. gold foil can be stretched untill it is only a few atoms thick in place, which is not possible for alluminium.

(e) (i) Subshell associated with $n = 4$

Answer = It has four Subshells, S,P,d,F

(ii) In $n = 4$

total number of orbitals $= n^2 = 4^2 = 16$, each orbital will be occupied by 2 electrons, with spin $-\frac{1}{2}$ will be equall to 16, with spin of $+\frac{1}{2}$ will also be 16

(iii) $n = 3$, value of l and M

$n = 3$	$l = n - 1$	$m = 2l + 1$
$n = 3$	$= 1 - 1 = 0$	$= 2(0) + 1 = 1 = 0$
	$= 2 - 1 = 1$	$= 2(1) + 1 = 3 = -1, 0, +1$
	$= 3 - 1 = 2$	$= 2(2) + 1 = 5 = -2, -1, 0, 1, 2$

Hence $n = 3$, $l = 0, 1, 2$, $m \{(0), (\pm 1, 0), (\pm 2, \pm 1, 0)\}$

(iv) It has zero energy when an electron is infinite distance from the nucleus of an atom, when an electron leaves an atom ($n = \infty$), this means it no longer feels effective nuclear charge and bound loose from an atom.