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Answers Key:

Case Study Questions

1. 1. (b) Atom is mostly empty space

Explanation:

Most alpha particles passed through → **atoms are mostly empty space**.

2. (c) The dense nucleus

Explanation:

Strong deflection occurred when alpha particles came close to the **positively charged nucleus**

3. (b) Unstable orbits for electrons

Explanation:

Electrons revolving around the nucleus should lose energy and spiral in — **Rutherford's model couldn't explain atom's stability**.

5 Marks

2. (i) Energy of a photon

E = $\frac{hc}{\lambda} = \frac{6.626\times10^{-34}Js\times3.0\times10ms^{-1}}{4\times10^{-7}m}$

$E = 4.969 \times 10^{-19}J\ [\because 1.602 \times 10^{-19}J = 1eV]$

$= \frac{4.969\times10^{-19}}{1.602\times10^{-19}} = 3.10\ eV$

(ii) Kinetic energy of an ejected electron,

KE = hv - hv_0

hv = 3.10 eV (Energy of striking photon)

$hv_0 = W_0$ = 2.13 eV (Work function of the metal)

KE = $\frac{1}{2}mv^2$ = 3,10 - 2.13 = 0.97 eV

(iii) $KE = \frac{1}{2}mv^2 = 0.97\ eV$

$\frac{1}{2}mv^2 = 0.97 \times 1.602 \times 10^{-19}$

$[\because\ 1\ eV = 1.602 \times 10^{-19}J]c$

$\frac{1}{2} \times 9.11 \times 10^{-31}kg \times v^2 = 0.97 \times 1.602 \times 10^{-19}J$

$[\because Mass\ of\ 1e^- = 9.11 \times 10^{-31}kg]$

$v^2 = \frac{0.97\times1.602\times10^{-19}\times2J}{9.11\times10^{-31}kg} = 0.341 \times 10^{12}$

$v = 0.584 \times 10^6 = 5.84 \times 10^5 ms^{-1}$

3 Marks

3. Energy of electron in unielectron atomic system,

$E_n = \frac{-2\pi^2mZ^2e^4}{n^2h^2}$

For H-atom, ionisation energy (I.E) = $E_\infty - E_1$

I.E = $0 - \left(-\frac{2\pi^2me^4(1)^2}{1^2h^2}\right)$

(where, Z = 1 and n = 1 for H - atom)

Given, I.E for the H - atom in the ground state

$2.18 \times 10^{-18}J\ atom^{-1}$

For He^+, I.E = $E_\infty - E_1$ =0 $- \left(-\frac{2\pi^2me^4(1)^2}{1^2h^2}\right)$

$= 4 \times \frac{2\pi^2me^4}{h^2}$

$= 4 \times 2.18 \times 10^{-18}J\ atom^{-1}$

$= 8.72 \times 10^{-18}J\ atom^{-1}$

∴ The energy required for the process

$He^+(g) \longrightarrow He^{2+}(g) + e^-\ is\ 8.72 \times 10^{-18}J\ atom^{-1}$.

4. **Aufbau's principle:**

Electrons are filled in the orbitals in increasing order of energies in grand state.

2 Marks

5. (a) If n = 4 then l = 0, 1, 2, 3. Therfore, subshell in n = 4 are 4 i.e 4s, 4p,4d and 4f.

(b) Number of orbitals in 4th shell = $n^2, 4^2 = 16$

The maximum number of electrons present in any orbital is two and each orbital has one electron with $m_s = -1/2$ Hence, there are 16 electrons with $m_s = -1/2$

6. s-orbital.

Multiple Choice Question

7. (c) greater than the number of protons
8. (b) 4.57 x 10^{14} S^{-1}
9. (d) The two electrons present in the 2s orbital have spin quantum numbers ms but of opposite sign
10. (b) Ni^{2+}
11. (c) The energy of 2s orbital is less than the energy of 2p-orbitals in case of hydrogen like atoms.
12. (b) n = 2
    l = 1

$m_l = +1$

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QUESTION BANK 365