CHEMISTRY CLASS XI
CHAPTER – 2 STRUCTURE OF ATOM

Q.1. Arrange the following type of radiation in increasing order of frequency.

(i) Radiations from microwave oven

(ii) Amber light from traffic signal

(iii) Radiation from FM radio

(iv) Cosmic rays from outer space and

(v) X – rays

Ans. The order frequency is radiation from FM radio < microwaves < amber colour < X – rays < cosmic rays.

Q.2. How does the intensity of the spectral line vary with wavelength?

Ans. As the wavelength decreases, intensity also decreases.

Q.3. What is the maximum number of emission lines when the excited electron of a H – atom in n = 6 drops to the ground state?

Ans. Number of lines produced when electron from n th shell drops to ground state = $\frac{n(n-1)}{2}$

When n = 6, number of lines produced

$$= \frac{6(6-1)}{2} = \frac{6\times5}{2} = 15$$

Q.4. What do you mean by saying that of the electron is quantised?

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Ans. This means that the electrons in an atom have only definite values of energies.

Q.5. What is the experimental evidence in support of the idea that electronic energies in an atom are quantised?

Ans. The line spectrum of any element has lines corresponding to definite wavelengths. Lines are obtained as a result of electronic transactions between the energy levels. Hence, the electrons in these levels have fixed energy, i.e., quantised values.

Q.6. What is the difference between a quantum and a photon?

Ans. The smallest packet of energy of any radiation is called a quantum whereas that of light is called photon.

Q.7. Calculate the distance of separation between the second and third orbits of hydrogen atom.

Ans. For H – atom, the radius of n th orbit is given by

$$r_n = 0.529 \times n^2 \text{ A}$$

$$\therefore \quad r_3 - r_2 = 0.529\,(3^2 - 2^2) \text{ A}$$

$$= 0.529 \times 5$$

$$= 2.645 \text{ A}$$

Q.8. Why are Bohr's orbits called stationary states?

Ans. This is because the energies of the orbits in which the electron revolve ar fixed.

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Q.9. Chlorophyll present in green leaves of plants absorbs at 4.620 × 10^{14} Hz. Calculate the wavelength of radiation in nanometer. Which part of the electromagnetic spectrum does it belong to?

Ans. $\lambda = \frac{C}{V} = \frac{3.0\times10^{8}ms^{-1}}{4.620\times10^{14}s^{-1}}$ = 649.4 nm

Thus, it lies in the visible light.

Q.10. How long would it take a radiowave of frequency, 6 × 10^{3} s^{-1} to travel from mars to the Earth, a distance of 8 × 10^{7} km?

Ans. All radiations in vacuum travel with the same speed, i.e., 3 × 10^{8} ms^{-1}

Distance to be travelled from Mars to the Earth

= 8 × 10^{7} km = 8 × 10^{7} × 10^{3} m (1 km = 10^{3} m)

∴ Time taken = $\frac{8\times10^{7}\times10^{3}}{3\times10^{8}}$

= 2.66 × 10^{2} s

= 4 min 26 s

Q.11. The Vividh Bharati Station of All India Radio, Delhi, Broadcasts on a frequency of 1368 kHz (kilohertz). Calculate the wavelength of the electromagnetic radiation emitted by transmitter. Which part of the electromagnetic spectrum does it belong to?

Ans. Frequency, v = $\frac{c}{\lambda}$

1368 × 10^{3} Hz = $\frac{3\times10^{8}ms^{-1}}{\lambda}$

or $\lambda = \frac{3\times10^{8}ms^{-1}}{1368\times10^{3}}$ Hz

= 219.3 m, radiowave

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Q.12. Yellow light emitted from a sodium lamp has a wavelength (λ) of 580 nm. Calculate the frequency (v) and wave number ($\bar{v}$) of the yellow light.

Ans. Frequency, v = $\frac{c}{\lambda}$

$\because$ 1 nm = 10^{-9} m

$\therefore$ 580 nm = 580×10^{-9} m

= 580×10^{-7} cm

v = $\frac{3.0\times10^{8} ms^{-1}}{580\times10^{-9} m}$ = $5.17 \times 10^{14}\ s^{-1}$

(Velocity of light = 3×10^{8} ms^{-1})

Wave number, $\bar{v} = \frac{1}{\lambda} = \frac{1}{580\times10^{-7} cm}$

= $1.724 \times 10^{4}\ cm^{-1}$

Q.13. Electromagnetic radiation of wavelength 242 nm is just sufficient to ionise the sodium atom. Calculate the ionisation energy of sodium in kJ mol^{-1}.

Ans. Energy, E = $hv = \frac{hc}{\lambda}$

= $\frac{6.626\times10^{-34} Js\times3.0\times10^{8} ms^{-1}}{242\times10^{-9}\ m}$

E = 0.0821×10^{-17} J/atom

This energy is sufficient for ionisation of one Na atom, so it is the ionization energy of Na.

E = $6.02 \times 10^{23} \times 0.0821 \times 10^{-17}$ J/mol

E = 4.945×10^{5} J/mol

= 4.945×10^{2} kJ/mol

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Q.14. The mass of an electron is 9.1 × 10^{-31} kg. If its KE (kinetic energy) is 3 × 10^{-25} J then calculate its velocity.

Ans. KE = $\frac{1}{2}$ mv^2

or v = $\left(\frac{2KE}{m}\right)^{1/2}$ = $\left(\frac{2\times3\times10^{-25}kg\ m^2s^{-2}}{9.1\times10^{-11}kg}\right)^{1/2}$

= 8.12 × 10^2 ms^{-1}

Q.15. Electrons are emitted with zero velocity from a metal surface when it is exposed to radiation of wavelength 6800 A. Calculate threshold frequency ((v_0) and work function (W_0) of the metal.

Ans. Threshold wavelength,

λ_0 = 6800 A = 6800 × 10^{-10} m

Threshold frequency

v_0 = $\frac{c}{\lambda_0}$ = $\frac{3.0\times10^8 ms^{-1}}{6800\times10^{-10}m}$ = 4.41 × 10^{14} s^{-1}

Work function, W_0 = hv_0

= 6.626 × 10^{-34} Js × 4.41 × 10^{14} s^{-1}

= 2.922 × 10^{-19} J

Q.16. Calculate the wavelength of the radiation which would cause photochemical dissociation of a chlorine molecule. The bond dissociation energy of Cl – Cl bond is 245 kJ mol^{-1}.

Ans. Energy required to break 1 mole of Cl – Cl bonds = 245 kJ

Energy required to break one Cl – Cl bond

= $\frac{245\times10^3}{6.023\times10^{23}} = 4.068\times10^{-19}$ J

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Now, $E = h\upsilon = \frac{hc}{\lambda}$

or $\lambda = \frac{hc}{E} = \frac{6.626 \times 10^{-34} \times 3.0 \times 10^{8}}{4.068 \times 10^{-19}} = 4.89 \times 10^{-7}$ m

Q.17. What is the wavelength of light emitted when the electron in a hydrogen atom undergoes transition from an energy level with n = 4 to an energy level with n = 2 ?

Ans. $\frac{1}{\lambda} = 109677 \left(\frac{1}{2^2} - \frac{1}{4^2}\right)$ cm^{-1}

or $\lambda = 486$ nm

the colour corresponding to this wavelength is blue.

Q.18. The bromine atom possesses 35 electrons. It contains 6 electrons in 2p orbital, 6 electrons in 3p orbital and 5 electrons in 4p orbital. Which of these electron experiences the lowest effective nuclear charge?

Ans. 4p electrons are farthest from the nucleaus and therefore, these electrons will experience the lowest effective nuclear charge.

Q.19. The unpaired electrons is Al and Si are present in 3p orbital. Which electrons will experience more effective nuclear charge from the nucleaus?

Ans. Unpaired electron in case of silicon will experience more effective nuclear charge.

Q.20. An iron with mass number 37 possesses one unit of negative charge. If the ion contains 11.1% more neutrons than the electrons, find the symbol of the ion.

Ans. Since it carries – 1 charge, it will have no electron more than the number of protons.

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Let no. of electrons = x

No. of protons = x – 1

No. of neutrons = x + x × $\frac{11.1}{100}$ = 1.111 x

Now, x – 1 + 1.111x = 37

or 2.111 x = 38

x = 18

No. of electrons = 18, no. of protons = 18 – 1 = 17

No. of neutrons = 35 – 18 = 17

Symbol = $^{35}_{17}Cl^{-}$

Q.21. The longest wavelength doublet absorption transition is observed at 589 and 589.6 nm. Calculate the frequency of each transition and energy difference between two excited states.

Ans. λ_1= 589 nm = 589 × 10^{-9} m

$v_1 = \frac{c}{\lambda_1} = \frac{3.0\times10^{8} ms^{-1}}{589\times10^{-9} m}$ = 5.093 × $10^{14} s^{-1}$

λ_2 = 589.6 nm = 589.6 × 10^{-9} m

$v_2 = \frac{c}{\lambda_2} = \frac{3.0\times10^{8} ms^{-1}}{589.6\times10^{-9} m}$ = 5.088 × $10^{14} s^{-1}$

ΔE = h (v_2 - v_1) = (6.626 × 10^{-35}Js)(5.093 – 5.088) × $10^{14} s^{-1}$

= 3.313 × 10^{-22} J

Q.22. In Rutherford's experiment, generally the thin foil of heavy atoms, like gold, platinum, etc. have been used to be bombarded by the α – particles. If the

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thin foil of light atoms like aluminium, etc. is used, what difference would be observed from the above results?

Ans. In Rutherford's experiment heavy atoms have heavy nucleaus carrying a large amount of positive charge. Therefore, some α - particles even got deflected back after hitting the nucleus. Because of large positive charge on the heavy nucleus, some α- particles are deflected through small angles which passed closer to the nucleus because of repulsion. However, if lighter atoms are used, their nuclei will be light and they will have small positive charge on the nucleus. As, a result, the number of particles deflected back and those deflected through small angles will be very very small, almost negligible.

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