2/4/2020 Structure of atom chemistry

1. An electron beam can undergo diffraction by crystals. Through what potential should be a beam of electrons be accelerated so that its wavelength becomes equal to 1.54 Å

1. 63.3 V 2. 33.6 V 3. 36.3 V 4. 40.6 V

Solution $\frac{1}{2}mu^2 = eV \Rightarrow \lambda = \frac{h}{mu}$

$u = \frac{h}{m\lambda}$ or $u^2 = \frac{h^2}{m^2\lambda^2}$

$\frac{1}{2}m \times \frac{h^2}{m^2\lambda^2} = eV$

$V = \frac{1}{2}m \times \frac{h^2}{m^2\lambda^2 \times e}$

$= \frac{1}{2} \times \frac{h^2}{m\lambda^2 e}$

$= \frac{1}{2} \times \frac{(6.62 \times 10^{-34})^2}{9.1 \times 10^{-31} \times (1.54 \times 10^{-10})^2 \times 1.6 \times 10^{-19}}$

$= 63.3$ V

2. Of the following, which has the shortest de Broglie wavelength?

1) A nitrogen molecule moving at a velocity of 4000 mph.
2) A nitrogen molecule moving at a velocity of 1100 mph.
3) A He nucleus moving at a velocity of 1200 mph
4) An airplane moving at a velocity of 200 mph

Solution $\lambda \propto \frac{1}{m} \Rightarrow m \uparrow \lambda \downarrow$

3. The increasing order for the values of e/m for e, p, n & α is.

1. n, p, α, e 2. n, p, e, α 3. n, α, p, e 4. e, p, n, α

Solution m ↑ e/m value ↓

4. If uncertainity in position & momentum are equal then uncertainity in velocity is.

1. $\frac{1}{m}\sqrt{\frac{h}{\pi}}$ 2. $\sqrt{\frac{h}{\pi}}$ 3. $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$ 4. $\sqrt{\frac{h}{2\pi}}$

Solution $\Delta p \cdot \Delta x \geq \frac{h}{4\pi}$

$m\Delta v \cdot \Delta x \geq \frac{h}{4\pi}$

$(m\Delta v)^2 \geq \frac{h}{4\pi}$

$\Delta v \geq \frac{1}{2m}\sqrt{\frac{h}{\pi}}$

5. Photoelectric emission is observed from a surface for frequencies v_1 & v_2 of the incident radiation ($v_1 > v_2$). If the maximum kinetic energies of the photoelectrons in the two cases are in the ratio 1:k then the threshold frequency v_0 is given by.

1. $\frac{kv_2 - v_1}{k-1}$ 2. $\frac{v_2 - v_1}{k}$ 3. $\frac{v_2 - v_1}{k-1}$ 4. $\frac{kv_1 - v_2}{k-1}$

Solution $hv_1 = hv_0 + \frac{1}{2}mu_1^2$

$hv_2 = hv_0 + \frac{1}{2}mu_2^2$

$\frac{1}{2}mu_1^2 = \frac{1}{k}\left(\frac{1}{2}mu_2^2\right)$

$hv_1 = hv_0 + \frac{1}{2k}mu_2^2$

$\frac{1}{2}mu_2^2 = khv_1 - khv_0$

$$h\nu_1 = h\nu_0 - k h\nu_0 + k h\nu_1$$

$$\nu_0(1-k) = \nu_2 - k\nu_1$$

$$\nu_0 = \frac{k\nu_1 - \nu_2}{(k-1)}$$

6. A light source of wavelength (λ) illuminates a metal & ejects photoelectrons with $(KE)_{max} = 1eV$. Another light source of wavelength $\lambda/3$, ejects photoelectrons from same metal with $(KE)_{max} = 4eV$. Find the work function?

1) 1eV ~~2) 0.5eV~~ 3) 1.5eV 4) 2.5eV

Solution $\frac{hc}{\lambda} = 1 + W_0$

$$3 \times \frac{hc}{\lambda} = 4 + W_0$$

$$\Rightarrow W_0 = 0.5\,eV$$

7. ~~Energy of H-atom in ground state is -13.6eV~~ hence energy in the second e.s. is.

1) -6.8eV 2) -3.4eV ~~3) -1.51eV~~ 4) -4.53eV

$$E_n = -\frac{13.6}{n^2} = -\frac{13.6}{9} = -1.51\,eV$$

8. The numerical value $\psi_{4,2,0}$ denotes

1) $4d_{x^2-y^2}$ ~~2) $4d_{z^2}$~~ 3. $4p_z$ 4. $4f_{xyz}$

Solution $n = 4$, $l = 2$, $m = 0$

9. The no. of photons of light having wave no. 'a' in 3J of energy source is.

1) $\frac{hc}{3a}$ 2) $3hca$ 3) $\frac{3a}{hc}$ 4) $\frac{3}{hca}$

Solution $E = nh\nu = nhc\bar{\nu}$

$3 = nhc\bar{\nu}$

$n = \frac{3}{hc\bar{\nu}} = \frac{3}{hca}$

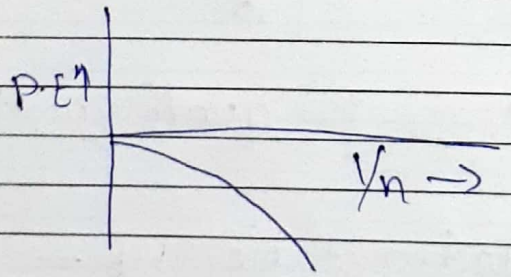
10. Select the incorrect curves

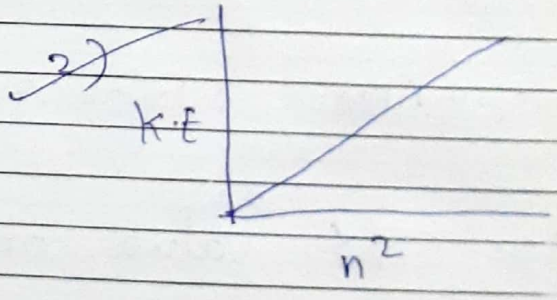
If v = Velocity of e^- in Bohr's orbit ~~Radius of electron in Bohr's orbit P.E.~~

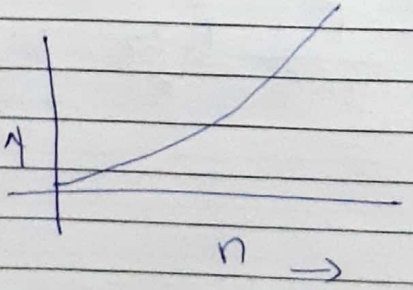
r = Radius of electron in Bohr's orbit.

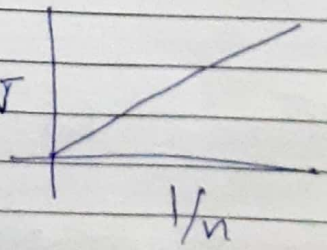
P.E. = Potential energy of electron in Bohr's orbit.

K.E = K.E. of e^- in Bohr's orbit.

1) 

2) 

3) 

4) 

Solution $K.E \propto \frac{1}{n^2}$

11. Which of the following statements is or are correct for orbital angular momentum of 2p & 3p electron?

Orbital angular momentum of 3p e⁻ is more than that of 2p e⁻

2) Orbital angular momentum of 2p e⁻ is more than that of 3p e⁻

3) Orbital angular momentum of 2p e⁻ is equal to 2s e⁻ & 3p e⁻ is equal to 3s e⁻

4) Orbital angular momentum of 2p e⁻ is same as that of 3p e⁻

Solution as they are from same subshell

12. The angular momentum of any electron can't have the values

1) $3\frac{h}{\pi}$ 2) $2.5\frac{h}{2\pi}$ 3) $0.5\frac{h}{\pi}$ 4) $\frac{h}{\pi}$

Solution Bohr's theory is quantized

13. The value of electro static P.E =

1) mv^2 2. $\frac{ze^2}{r}$ 3. $\frac{1}{4\pi\epsilon}\frac{q_1q_2}{r}$ 4. $\frac{1}{4\pi\epsilon}\frac{ze^2}{r}$

Solution fact.

14. Same wavelength is observed with respect to Li^{2+} from a transition of $n_2 = 6$ to $n_1 = 3$

3. 4 → 2 of Be^{3+} 2. 3 → 1 of H-atom

1. 4 → 2 of He^{+} 4. 4 → 2 of He atom

Solution

$$\lambda_{Be^{3+}} = \lambda_{He^{+}}$$

$$\frac{1}{\lambda_{Be^{3+}}} = \frac{1}{\lambda_{He^{+}}}$$

$$\left[\frac{1}{3^2} - \frac{1}{6^2}\right] 4^2 = \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] 2^2$$

$$\lambda_{Li^{2+}} = \lambda_{He^{+}}$$

$$\frac{1}{\lambda_{Li^{2+}}} = \frac{1}{\lambda_{He^{+}}}$$

$$\left[\frac{1}{3^2} - \frac{1}{6^2}\right] 3^2 = \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] 2^2$$

$$\left[\frac{1}{1^2} - \frac{1}{2^2}\right] \frac{1}{2^2} = \frac{1}{n_1^2} - \frac{1}{n_2^2}$$

$n_1 = 2 \qquad n_2 = 4$

5. Which have the largest number of unpaired electrons in p-orbitals in their ground state electronic configurations?

1) Te, I, Xe 2) F, Cl, Br

3) Ne, Ar, Kr 4) N, P, As

Solution 15th group 3 unpaired pe⁻s

16. What will be no. of quanta of radiation of frequency $5.23 \times 10^{-11}\ s^{-1}$ that must be absorbed in order to melt 3g of ice. The energy required to melt 1g of ice is 333 J

1. 1.7×10^{22}
2. 2.9×10^{22}
2. 3.6×10^{22}
4. 4.8×10^{22}

Solution

E req^d to melt 3g of ice $= 3 \times 333$
$= 999$ J

$E = Nh\nu$

$N = \frac{E}{h\nu} = \frac{999}{6.6 \times 10^{-34} \times 5.23 \times 10^{-11}}$

$= 2.9 \times 10^{22}$

17. A gas absorbs a photon of 355 nm & emits at two wavelength if one of the emission is at 680 nm the other is at.

1) 743 2) 518 3) 1035 4) 325

$E_{Res} = E_1 + E_2$

$\frac{hc}{\lambda_{res}} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}$

$hc\left[\frac{1}{\lambda_{res}}\right] = hc\left[\frac{1}{\lambda_1} + \frac{1}{\lambda_2}\right]$

$\frac{1}{355} = \frac{1}{680} + \frac{1}{\lambda_2}$

$\lambda_2 = 743$

18. The Energy of last e⁻ in Li will be

1) -30.6 eV 2) -13.6 eV 3) -24.6 eV

4) -28.6 eV

Solution $E_n = \frac{-13.6 \times Z^2}{n^2}$

$= \frac{-13.6 \times 9}{4}$

$= -30.6\ eV$

19. K.E. of an electron in 2nd Bohr orbit of a hydrogen atom is [a_0 is Bohr radius]

1) $\frac{h^2}{4\pi^2 m a_0^2}$ 2) $\frac{h^2}{16\pi^2 m a_0^2}$ 3) $\frac{h^2}{32\pi^2 m a_0^2}$ 4) $\frac{h^2}{64\pi^2 m a_0^2}$

Solution $KE = \frac{1}{2} mv^2$ $\quad mvr = \frac{nh}{2\pi}$

$KE = \frac{1}{2} m \times \frac{n^2 h^2}{4\pi^2 m^2 a_0^2 \times n^4}$ $\quad v = \frac{nh}{2\pi mr}$

$v = \frac{nh}{2\pi a_0 n^2}$

$KE = \frac{h^2}{8\pi^2 m a_0^2 n^2}$

second orbit is given.

$K.E. = \frac{h^2}{8\pi^2 m a_0^2 2^2}$

$= \frac{h^2}{32\pi^2 m a_0^2}$

20. Two particles of masses 'm' & '2m' ha equal K.E. Their de Broglie wavelength are in the ratio.

1) 1:1 2) 1:2 3) 1:$\sqrt{2}$ 4) $\sqrt{2}$:1

Solution $\lambda \propto \frac{1}{\sqrt{m}}$ $\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{m_2}{m_1}} = \sqrt{\frac{2}{1}}$

21. The de-Broglie wavelength of a neutron at 927°c is λ be its wavelength at 27°c.

1) $\lambda/2$ 2) λ 3) 2λ 4) 4λ

Solution $\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{1200}{300}}$ $\Rightarrow \lambda_1 = 2\lambda_2$

22. E_1, E_2 & E_3 represent respectively the K.E. of e⁻, α & p each having same de Broglie wavelength. then.

1) $E_1 > E_3 > E_2$ 2) $E_2 > E_3 > E_1$

3) $E_1 > E_2 > E_3$ 4) $E_1 = E_2 = E_3$

Solution K.E $\propto \frac{1}{m}$

23. An electron in a Hydrogen atom in its G.S absorbs 1.5 times as much energy as the min. required for it to escape from the atom. What is the wavelength of the emitted e⁻

1) 4.7 Å 2) 4.7 nm 3) 9.4 Å 4) 9.4 nm

Solution Absorbed Energy = 13.6 × 1.5
= 20.4 eV

K.E. of e^- = 20.4 − 13.6 = 6.8 eV

$$\lambda = \frac{h}{\sqrt{2Km}} = 4.7\,\text{Å}$$

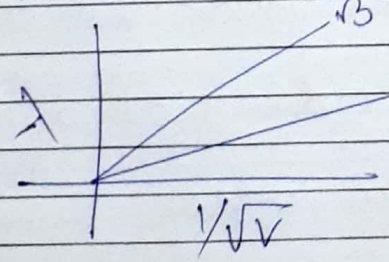
24. A proton & α-particle are accelerated through the same potential difference The ratio of de Broglie wavelength of the proton to that of α-particle will be

1) 2:1 2) 1:1 3) 1:2 4) $2\sqrt{2}:1$

Solution $\lambda_p = \frac{0.286}{\sqrt{V}}$ $\lambda_{He} = \frac{0.101}{\sqrt{2}}$

$$\frac{\lambda_p}{\lambda_{He}} = \frac{0.286}{0.101} = 2.83 \Rightarrow 2\sqrt{2}:1$$

25. de Broglie wavelengths of two practides A & B are plotted against $\left(\frac{1}{\sqrt{V}}\right)$ where V is the potential on the particles which of the following relation is correct about the mass of the particles



1) $m_A = m_B$ 2) $m_A > m_B$ 3) $m_A < m_B$ 4) $m_A \leq m_B$

Solution

$$\lambda = \frac{h}{\sqrt{2m_e V}}$$

$$= \frac{1}{\sqrt{2m_e}} \times \frac{1}{\sqrt{V}}$$

$$\text{slope} \propto \frac{1}{\sqrt{V}}$$

Heavier part less will be the slope.

26. An e^- travels with a velocity of x m/sec For a proton to have the same deBroglie wavelength, the velocity will be.

1) $\frac{1840}{x}$ 2) $\frac{x}{1840}$ 3) $1840x$ 4) x

Solution

$$\lambda = \frac{h}{m_e x} = \frac{h}{m_p V}$$

$$\frac{h}{m_e x} = \frac{h}{1840 m_e V}$$

$$v \propto \frac{x}{1840}$$

27. The wavelength associated with a golf ball weighing 200g & moving at a speed of 5 m/hr is of the order.

1) 10^{-10} m 2) 10^{-20} m 3) 10^{-30} m 4) 10^{-40} m

Solution

$$\lambda = \frac{h}{mv}$$

$$= \frac{6.6 \times 10^{-34}}{200 \times 10^{-3} \times \frac{5}{3600}}$$

$$= 2 \times 10^{-30} \text{ m}$$

28. A Energy of 24.6 eV is required to remove one the of the electrons from a He atom. The energy required to remove both electrons from He atom is.

1) 38.2 eV 2) 49.2 eV 3) 51.8 eV 4) 79 eV

Solution required Energy = $E_1 + E_2$

$= 24.6 + (13.6 \times 2^2)$

$= 79$ eV

29. The ratio of area of orbit of first E.S. of e^- to the area of orbit of ground level, for H-atom will be,

1) 16:1 2) 4:1 3) 8:1 4) 2:1

Solution

$$\frac{A_2}{A_1} = \frac{\pi r_2^2}{\pi r_1^2} = \frac{16}{1}$$

30. Two electrons are revolving around a nucleus at distance r & 4r. The ratio of their periods is

1) 1:4 2) 4:1 3) 8:1 4) 1:8

$T \propto \frac{n^3}{Z^2}$ $r \Rightarrow$ orbit no. = 1

$4r \Rightarrow$ orbit no = 2

$T \propto n^3 \Rightarrow \frac{T_1}{T_2} = \frac{1^3}{2^3}$

$\frac{T_1}{T_2} = \frac{1}{8}$

31. The ratio of time periods T_1/T_2 is 2^{nd} orbit of hydrogen to third orbit of He^+ ion

1) $\frac{8}{27}$ 2) $\frac{32}{27}$ 3) $\frac{27}{32}$ 4) $\frac{24}{36}$

Solution $T \propto \frac{n^3}{Z^2}$

$\frac{T_1}{T_2} = \frac{2^3}{3^3} \times \frac{2^2}{1^2} = \frac{32}{27}$

32. The probability of finding e^- in XY plane for p_z orbital is

1) 100% 2) 50% 3) 99.9% 4) 0%

Solution fact

33. Which of the following orbitals is not associated with the angular nodes?

1) s-orbitals 2) p-orbitals

3) d-orbitals 4) f-orbitals.

34 The de Broglie equation applies

1) to e^- only 2) to proton only

3) to neutrons only 4) To all the material objects in motion

35. Which of the following relates to photons both as wave motion & as a stream of particles?

1) Interference
2) $E = mc^2$
3) Diffraction.
4) $E = h\nu$

Solution $E = h\nu$ tells dual nature of light

36. Which of the following has max. no of unpaired electrons?

1) Zn 2) Fe^{2+} 3) Ni^{3+} 4) Cu^{+}

Solution $Zn, Cu^{+} \rightarrow$ 0 unpaired e⁻

$Ni^{3+} \rightarrow$ 3 unpaired e⁻

$Fe^{2+} \rightarrow$ 4 unpaired e⁻

37. The total no of orbitals in a shell having principal quantum no n is.

1) 2n 2) n^2 3) $2n^2$ 4) n+1

Solution fact

38. The ion that is isoelectronic with CO is

1) O_2^- 2) N_2^+ 3) CN^- 4) O_2^+

Solution $CN^-, CO \Rightarrow$ total e⁻s = 14

39. The maximum no of e⁻ in an orbit with $l = 2$ $n = 3$ is

1) 2 2) 6 3) 12 4) 10

Solution $3d = 10\ e^-s$.

10. Which is the correct statement about proton?

1) Proton is nucleus of deuterium
2) Proton is α-particle
3) Proton is Ionized hydrogen molecule
4) Proton is ionized hydrogen.

Solution fact.

41. The no. of nodal planes in a p_x orbital is

1) 1 2) 2 3) 3 4) 0

Solution nodal plane = l.

42. For which of the following species, Bohr's theory is not applicable?

1) Be^{3+} 2) Li^{2+} 3) He^{2+} 4) H

Solution zero e^- in He^{2+}

43. Which of the following is not possible?

1) $n=3$ $l=0$ $m=0$ 2) $n=3$ $l=1$ $m=-1$
3) $n=2$ $l=0$ $m=-1$ 4) $n=2$ $l=1$ $m=0$

Solution if $l=0$ m can't be -1

43. The no. of d-electrons retained in Fe^{2+} ion

1) 4 2) 5 3) 6 4) 3

Solution Fe^{2+} $3d^6$

44. For $n = 4$ & $l = 3$ no of orbitals is.

1) 3 4) 5 3) 7 4) 9

Solution $f \Rightarrow (2l+1) = (2 \times 3 + 1) = 7$

45. The no. of 2p electrons having spin quantum no. $s = -1/2$ are.

1) 6 2) 0 3) 2 4) 3

Solution in an orbital only one can form have only $-1/2$ value.