kd education academy (9582701166

Time : 5 Hour | STD 11 Science NEET | Total Marks : 800

kd 700+ neet ch-2 structure of atom

* SECTION - A [800]

1. Match List I with List II

List I(Quantum Number)	List II(Information provided)
A. mı	I. Shape of orbital
B. m_s	II. Size of orbital
C. 1	III. Orientation of orbital
D. n	IV. Orientation of spin of electron

Choose the correct answer from the options given below :

(A) $A-III, B-IV, C-I, D-II$

(B) $A-III, B-IV, C-II, D-I$

(C) $A-II, B-I, C-IV, D-III$

(D) $A-I, B-III, C-II, D-IV$

Ans. : a

- Magnetic quantum number m_1 informs about orientation of orbital.
- Spin quantum number ms informs about orientation of spin of electron.
- Azimuthal quantum number (l) informs about shape of orbital
- Principal quantum number (n) informs about size of orbital

2. If radius of second Bohr orbit of the He^{+}ion is $105.8\,pm$, what is the radius of third Bohr orbit of Li^{2+} ion?

(A) $15.87\,pm$ (B) $1.587\,pm$ (C) $158.7\,\mathring{A}$ (D) $158.7\,pm$

Ans. : d

Acc. to Bohr's atomic model

$r \propto \frac{n^2}{z}$ 3^{rd} orbit of Li^{+2} $n_1 = 3, Z_1 = 3$

$\Rightarrow$ 2^{nd} orbit of He^{+} $n_2 = 2, Z_2 = 2$

$\frac{(r_3)_{L^{+2}}}{(r_2)_{He^{+}}} = \frac{n_1^2}{n_2^2} \times \frac{Z_2}{Z_1}$

$\frac{(r_3)_{Li^{+2}}}{105.8pm} = \frac{3\times3}{2\times2} \times \frac{2}{3}$

$(r_3)_{Li^{+2}} = 158.7\,pm$

3. A particular station of All India Radio, New Delhi, broadcasts on a frequency of $1,368\,\mathrm{kHz}$ $(kilohertz)$. The wavelength of the electromagnetic radiation emitted by the transmitter is : [speed of light $c = 3.0 \times 10^8\ \mathrm{ms}^{-1}$]

(A) $219.3\ \mathrm{m}$ (B) $219.2\ \mathrm{m}$ (C) $2192\ \mathrm{m}$ (D) $21.92\ \mathrm{cm}$

Ans. : a

$\gamma=\frac{C}{\lambda}$

$\lambda=\frac{C}{\gamma}$

$\lambda=\frac{3\times10^{8}}{1368\times10^{3}}$

$\lambda=219.29=219.3\ \mathrm{m}$

4. From the following pairs of ions which one is not an iso-electronic pair?

(A) O^{2-},F^{-}

(B) Na^{+},Mg^{2+}

(C) Mn^{2+},Fe^{3+}

(D) Fe^{2+},Mn^{2+}

Ans. : d

Not isoelectronic

Fe^{+2}

$\downarrow$

$24e^{-}$

Mn^{+2}

$\downarrow$

$23e^{-}$

5. The number of angular nodes and radial nodes in $3s$ orbital are

(A) 0 and 1, respectively

(B) 0 and 2, respectively

(C) 1 and 0, respectively

(D) 3 and 0, respectively

Ans. : b

Number of radial nodes $=n-1-1$

Number of angular nodes $=1$

For 3 s orbital, Number of radial nodes $=3-0-1=2$

Number of angular nodes $=0$

6. The number of protons, neutrons and electrons in ${}_{71}^{175}Lu$, respectively, are :

(A) $175,104$ and 71 (B) $71,104$ and 71 (C) $104,71$ and 71 (D) $71,71$ and 104

Ans. : b

${}_{71}^{175}Lu$

$p^{+}=71$

$n^{0}=175-71=104$

$e^{-}=71$

7. Orbital having 3 angular nodes and 3 total nodes is

(A) $5p$ (B) $3d$

(C) $4f$ (D) $6d$

Ans. : c

Orbital having angular node $(\ell)=3$

$\text{Total node } = \text{ Radial node } + \text{ angular node}$

$=n-\ell-1+\ell$

$3=n-1$

$n=4$

$\text{Subshell } n\ell=4\text{f}$

8. $4d, 5\text{p}, 5\text{f}$ and 6p orbitals are arranged in the order of decreasing energy. The correct option is

(A) $5f>6p>5p>4d$ (B) $6p>5f>5p>4d$

(C) $6p>5f>4d>5p$ (D) $5f>6p>4d>5p$

Ans. : a

According to $(n+l)$ rule, correct order of energy is $5f>6\text{p}>5\text{p}>4\text{d}$

For same value of $(n+l)$; higher is the value of n, higher will be the energy.

9. Which of the following series of transitions in the spectrum of hydrogen atom falls in visible region ?

(A) Lyman series (B) Balmer series (C) Paschen series (D) Brackett series

Ans. : b

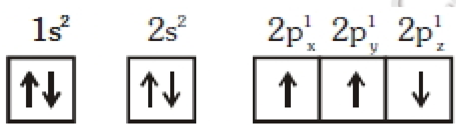
In spectrum of hydrogen atom, spectral lines of Balmer series lie in visible region

10. Which one is a wrong statement ?

(A) Total orbital angular momentum of electron in 's' orbital is equal to zero

(B) An orbital is designated by three quantum numbers while an electron in an atom is designated by four quantum numbers

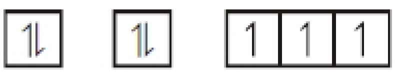
(C) The electronic configuration of N atom is



(D) The value of m for d_z^2 is zero

Ans. : c

The correct configuration of 'N' is



11. The total number of orbitals present for principle quantum number, $n=4$ is

(A) 12 (B) 15 (C) 16 (D) 30

Ans. : c

કક્ષકોની સંખ્યા $= n^2 = 4^2 = 16$

12. How many electrons can fit in the orbital for which $n = 3$ and $l = 1$?

(A) 6

(B) 2

(C) 10

(D) 14

Ans. : a

For $n = 3$ and $l = 1$, the subshell is $3p$ and a particular $3p$ orbital can accommodate only 6 electrons.

13. Which of the following pairs of $d-$ orbitals will have electron density along the axes ?

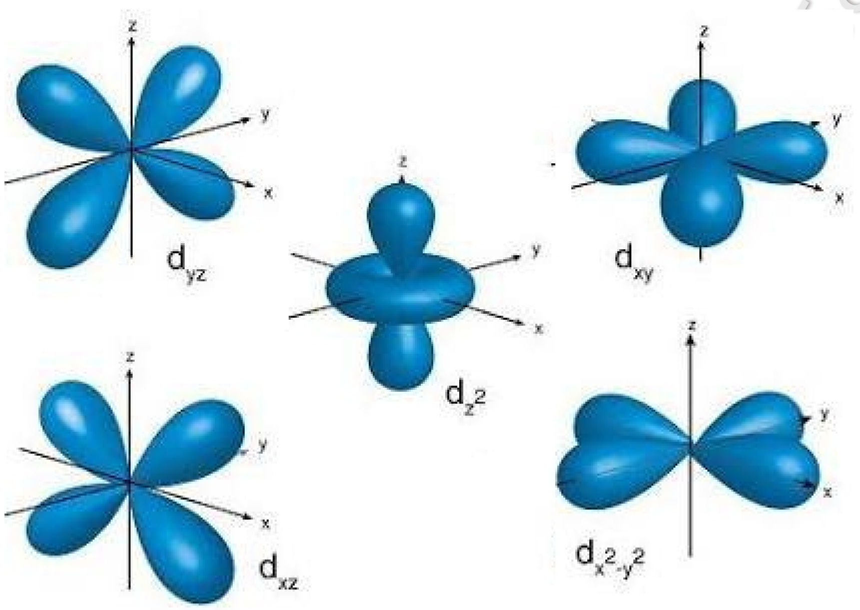
(A) d_{z^2}, d_{xz}

(B) d_{xz}, d_{yz}

(C) $d_{z^2}, d_{x^2-y^2}$

(D) $d_{xy}, d_{x^2-y^2}$

Ans. : c



14. Calculate the energy in joule corresponding to light of wavelength $45\,nm$. (Planck's constant, $h = 6.63 \times 10^{-34}\ J\ s$, speed of light, $c = 3 \times 10^8\ m\ s^{-1}$)

(A) 6.67×10^{15}

(B) 6.67×10^{11}

(C) 4.42×10^{-15}

(D) 4.42×10^{-18}

Ans. : d

The wavelength of light is related to its energy by the equation,

$E = \frac{hc}{\lambda} \cdot (E = hv)$

Given, $\lambda = 45nm = 45 \times 10^{-9}m \left[\because 1nm = 10^{-9}m\right]$

Hence, $E = \frac{6.63 \times 10^{-34} Js \times 3 \times 10^8 ms^{-1}}{45 \times 10^{-9} m} = 4.42 \times 10^{-18} J$

Hence, the energy corresponds to light of wavelength $45\ nm$ is 4.42×10^{-18}J

15. Be^{2+} is isoelectronic with which of the following ions?

(A) H^{+} (B) Li^{+} (C) Na^{+} (D) Mg^{2+}

Ans. : b

Isoelectronic species contain same number of electrons. Be^{2+} contains 2 electrons. Among the given options, only Li^{+} contains 2 electrons and therefore, it is isoelectronic with Be^{2+} $H^{+} \rightarrow$ no eletron $Na^{+} \rightarrow 10e^{-}$

$Li^{+} \rightarrow 2e^{-}$

$Mg^{2+} \rightarrow 10e^{-}$

Hence, Be^{2+} is isoelectronic with Li^{+}

16. According to law of photochemical equivalence the energy absorbed (in ergs/mole) is given as $(h = 6.62 \times 10^{-27}\, ergs,\, c = 3 \times cms^{-1},\, N_A = 6.02 \times 10^{-23}\, mol^{-1})$

(A) $\frac{1.196 \times 10^{8}}{\lambda}$ (B) $\frac{2.859 \times 10^{5}}{\lambda}$

(C) $\frac{2.859 \times 10^{16}}{\lambda}$ (D) $\frac{1.196 \times 10^{16}}{\lambda}$

Ans. : a

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

$= \frac{6.62 \times 10^{-27} \times 3 \times 10^{10} \times 6.02 \times 10^{23}}{\lambda}$

$= \frac{1.1955 \times 10^{8}}{\lambda} = \frac{1.196 \times 10^{8}}{\lambda}\, ergsl\ mol^{-1}$

17. The outer electronic configuration of $Gd\,(At.\ No.\ 64)$ is

(A) $4f^{5}\ 5d^{4}\ 6s^{1}$ (B) $4f^{7}\ 5d^{1}\ 6s^{2}$ (C) $4f^{3}\ 5d^{5}\ 6s^{2}$ (D) $4f^{4}\ 5d^{5}\ 6s^{1}$

Ans. : (B) $4f^{7}\ 5d^{1}\ 6s^{2}$

18. Based on equation $E = -2.178 \times 10^{-18}\, J \left(\frac{Z^2}{n^2}\right)$ certain conclusions are written. Which of themis not correct?

(A) Equation can be used to calculate the change in energy when the electron changes orbit.

(B) For $n = 1$, the electron has a more negative energy than it does for $n = 6$ which means that the electron is more loosely bound in the smallest allowed orbit.

(C) The negative sign in equation simply means that the energy of electron bound to the nucleus is lower than it would be if the electrons were at the infinite distance from the nucleus.

(D) Larger the value of n, the larger is the orbit radius.

Ans. : b

for $n = 1$ the electron has more negative energy than it does for $n = 6$ which means that the electrons less loosely bound in the smallest allowed orbit.

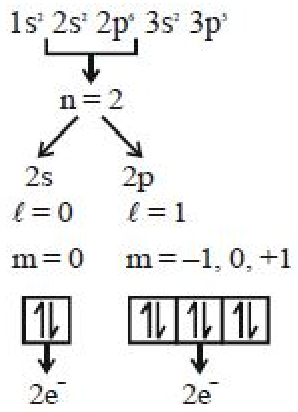
19. An atom has 35 nucleons and has atomic number equal to 17 . The number of electrons with $n = 2$, $m = 0$ in it is

(A) 2 (B) 4 (C) 6 (D) 3

Ans. : b

A = 35

Z = 17



20. If there is 2 nodal surfaces in third excited state. Find the orbital angular momentum

(A) $\sqrt{3}\hbar$ (B) $\sqrt{2}\hbar$ (C) $4\hbar$ (D) $\frac{1}{\sqrt{2}\hbar}$

Ans. : b

Third excited state $n=4$

$n-\ell-1=2$

$4-\ell-1=2$

$C=1$

$=\sqrt{\ell(\ell+1)}\hbar$

$=\sqrt{1(1+1)}h=\sqrt{2}\hbar$

21. Match the columns and choose correct option

Column $-I$	Column $-II$
(a) $4s$	(p) Circular orbit around nucleus
(b) $4p$	(q) Non directional orbital
(c) $1s$	(r) Angular momentum $=2h/\pi$
(d) $3d$	(s) Radial node is zero

(A) $a-p, b-q, c-r, d-s$ (B) $a-q, b-r, c-p, d-s$

(C) $a-s, b-r, c-q, d-p$ (D) $a-p, b-r, c-s, d-q$

Ans. : (B) $a-q, b-r, c-p, d-s$

22. In H atom, an orbit has diameter of about $16.92\overset{o}{A}$. What is the maximum number of electrons that can be accommodated?

(A) 16 (B) 32

(C) 64 (D) 8

Ans. : b

diameter of orbit $= 16.92$

radius of orbit $= 8.46\overset{o}{A} = 0.529 \cdot \frac{n^2}{1}$

No. of $e^- = 2n^2 = 32e^-$

23. If the aufbau principle had not been foll owed. $Ca(Z=20)$ would have been placed in the

(A) $s-block$ (B) $p-block$ (C) $d-block$ (D) $f-block$

Ans. : c

Electronic configuration of Ca is $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2$.

Filling of $3d$ orbital starts after the filling of $4s$ orbitals. If the Aufbau principle had not been followed, the filling of $3d$ orbital would have been prior to filling of $4s$ orbital and the electronic configuration of Ca would have been $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^2$ and it would have been placed in the d-block.

24. In Niobium $(Z=41)$ the number of electrons with $m=-1$ will be

(A) 7 or 8 (B) 8 or 9 (C) 1 or 2 (D) 3 or 4

Ans. : b

$Nb = 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^6\,4d^4\,5s^1$ The electrons with $m=-1$ are present in $2p_y, 3p_y, 3d_{yz}, 4p_y$ and $4d_{yz}$ orbitals therefore such electrons will be 8 or 9

25. If the n^{th} specific period of periodic table contain $\frac{(n+2)^2}{2}$ elements then maximum value of azimuthal quantum number associated with that period is

(A) $\frac{(n-1)}{2}$

(B) $\frac{n}{2}$

(C) $\frac{n+1}{2}$

(D) $\frac{n+2}{2}$

Ans. : (B) $\frac{n}{2}$

26. For $3d_{z^2}$ calculate the value of n, ℓ, m and s

(A) $n \to 5,\, l \to 2,\, m \to -1,\, s \to +\frac{1}{2}\ or -\frac{1}{2}$

(B) $n \to 3,\, l \to 2,\, m \to 0,\, s \to +\frac{1}{2}\ or -\frac{1}{2}$

(C) $n \to 3,\, l \to 1,\, m \to +1,\, s \to +\frac{1}{2}\ or -\frac{1}{2}$

(D) None of these

Ans. : (B) $n \to 3,\, l \to 2,\, m \to 0,\, s \to +\frac{1}{2}\ or -\frac{1}{2}$

27. The orbital angular momentum of $3p$ electron is

(A) $\sqrt{3}h$

(B) $\sqrt{6}h$

(C) zero

(D) $\sqrt{3}\frac{h}{2\pi}$

Ans. : (D) $\sqrt{3}\frac{h}{2\pi}$

28. If the sum of $(n+l)$ is 6 ; how many $e^{-1}s$ would have clock wise spin associated with this energy leval

(A) 18 (B) 9 (C) 6 (D) 32

Ans. : (B) 9

29. Arrange in decreasing order, the energy of $2s-$ orbital in following atoms H, Li, Na, K

(A) $E_{2s(H)} < E_{2s(Li)} < E_{2s(Na)} < E_{2s(K)}$

(B) $E_{2s(H)} = E_{2s(Li)} = E_{2s(Na)} = E_{2s(K)}$

(C) $E_{2s(H)} > E_{2s(Li)} > E_{2s(Na)} > E_{2s(K)}$

(D) $E_{2s(H)} > E_{2s(Li)} > E_{2s(Na)} = E_{2s(K)}$

Ans. : c

As we go down the group IA, there is increase in the number of shells so size of atom increases and energy of $2s$ orbital decreases.

30. Which statement is not true, regarding $2s$ orbital.

(A) Number of radial nodes is greater than zero

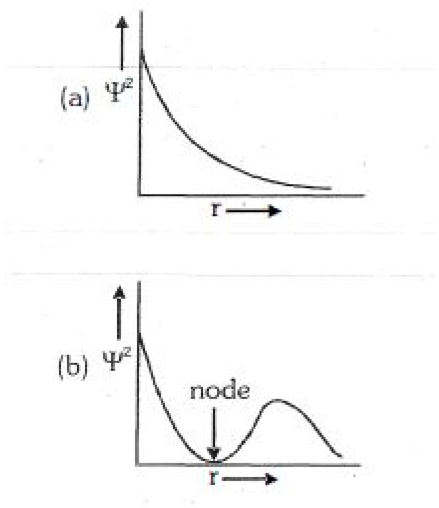
(B) Angular nodes is equal to zero

(C) $\Psi(\theta, \phi) =$ constant

(D) Probability density is zero at nucleus

Ans. : (D) Probability density is zero at nucleus

31. In following two plots, ψ^2 is plotted against the distance $'r'$ from nucleus select the correct statement



(A) $'a'$ is for $1s$ and $'b'$ for $2s$

(B) $'a'$ is for $2s$ and $'b'$ for $1s$

(C) $'a'$ is for $2s$ and $'b'$ for $2P$

(D) $'a'$ is for $2p$ and $'b'$ for $2s$

Ans. : a

$'A'$ is for $1s$ because $1s$ has no node; $'B'$ is for $2s$ because this orbital has single node

32. Choose the correct altenatives. The number of unpaired electrons in an atom of

(A) ${}_{14}Si$ is 2

(B) ${}_{14}Si$ is 0

(C) ${}_{15}P$ is 3

(D) ${}_{15}P$ is 1

Ans.: (A) ${}_{14}Si$ is 2

33. The electronic configurations of Cr^{24} and Cu^{29} are abnormal

(A) Due to extra stability of exactly half filled and exactly fully filled sub shells

(B) Because they belong to $d-$ block

(C) Both the above

(D) None of the above

Ans. : a

Expected electronic configuration

$24Cr : [Ar]3d^4 4s^2$

$29Cu : [Ar]3d^9 4s^2$

Observed electronic configuration

$24Cr : [Ar]3d^5 4s^1$

$29Cu : [Ar]3d^{10} 4s^1$

Due to extra stability of half filled and fully filled subshell, the electron from $4s$ orbital jumps to $3d$ orbital. Therefore the chromium and copper show abnormal electronic configuration.

34. The electrons, identified by quantum by numbers n and l, $(i)\, n=4, l=1$ $(ii)\, n=4, l=0$ $(iii)\, n=3, l=2$ $(iv)\, n=3, l=1$ can be placed in order of increasing energy, from the lowest to highest, as

(A) $(iv) < (ii) < (iii) < (i)$

(B) $(ii) < (iv) < (i) < (iii)$

(C) $(i) < (iii) < (ii) < (iv)$

(D) $(iii) < (i) < (iv) < (ii)$

Ans.: (A) $(iv) < (ii) < (iii) < (i)$

35. The set of quantum number for the 19^{th} electrons in chromium is

(A) $n=4, l=0, s=+1/2$ or $-1/2$

(B) $n=3, l=2, m=1, s=+1/2$ or $-1/2$

(C) $n=3, l=2, m=-1, s=+1/2$ or $-1/2$

(D) $n=4, l=1, m=0, s=+1/2$ or $-1/2$

Ans.: (A) $n=4, l=0, s=+1/2$ or $-1/2$

36. The quantum numbers $+1/2$ and $-1/2$ for the electron spin represent

(A) rotation of the electron in clockwise and anticlockwise derection respectively

(B) rotation of the electron in anticlockwise and clockwise direction respectively

(C) magnetic moment of the electron pointing up and down respectively

(D) two quantum mechanical spin states which have no classical analogue

Ans. : d

Just like the earth rotates around its axis, the electron spins about its axis either clockwise or anti-clockwise manner. The two types of rotation are $+\frac{1}{2}$ and $-\frac{1}{2}$. These two quantum mechanical spin states which have no classical analogue.

37. The spin of the electron

(A) increases the angular momentum

(B) can be backward (anti-clockwise) relative to the direction of the path of the electron

(C) can be forward (clockwise) relative to the direction of the path of the electron.

(D) Both (b) and (c)

Ans. : (D) Both (b) and (c)

38. Quantum No. $l=2$ and $m=0$ represent which orbital :

(A) d_{xy} (B) $d_x^2-y^2$ (C) d_z^2 (D) d_{zx}

Ans. : c

Quantum numbers $1=2$ and $m=0$ represent d_{z^2} orbital.

Note: For s, p, d and f orbitals, the value of the azmithual quantum number $'l'$ is $0,1,2,3$

When $l=2$, m can have values $-2,-1,0,+1,+2$.

A d-subshell can have five different orientations and orbitals corresponding to these orientations are $d_{xy}, d_{xz}, d_{yz}, d_{x^2-y^2} d_{z^2}$

39. The maximum number of electrons in subshell is given by the expression :

(A) $4l+2$ (B) $4l-2$ (C) $2l+1$ (D) $2n^2$

Ans. : a

The maximum number of electrons in a given subshell is given by $2(2l+1)$ or $(4l+2)$

Thus,

s - subshell $(1=0)$ contains 2 electrons.

p - subshell $(1=1)$ contains 6 electrons.

d - subshell $(1=2)$ contains 10 electrons.

f - subshell $(1=3)$ contains 14 electrons.

40. The atomic orbital is:

(A) the circular path of the electron

(B) elliptical shaped orbit

(C) three-dimensional field around nucleus

(D) the region in which there is maximum probability of finding an electron

Ans. : d

Atomic orbitals are regions of space around the nucleus of an atom where an electron is likely to be found. Thus Atomic Orbitals are region around the nucleus where the probability of finding the electron is maximum.

41. For a d electron, the orbital angular momentum is

(A) $\sqrt{6\hbar}$ (B) $\sqrt{2\hbar}$ (C) $\hbar$ (D) $2\hbar$

Ans. : a

We know that the orbital angular momentum $(L)=\sqrt{1(1+1)}\frac{h}{2\pi}$

For $d-$ orbital, $1=2$

Thus, the orbital angular momentum is $=\sqrt{6}\frac{h}{2\pi}$

$\sqrt{6\hbar}$

42. The orbital angular momentum of an electron in an s orbital is

(A) 1 (B) 0 (C) $\frac{\sqrt{2h}}{2\prod}$ (D) all of these

Ans. : b

Angular momentum in an orbital $=\frac{h}{2\pi}\sqrt{\ell(\ell+1)}$

$\ell=0$ for s orbital, hence orbital angular momentum $=0$

$\ell=1$ for p orbital

Angular momentum $=\frac{h}{2\pi}\sqrt{(1+1)\times 1}=\frac{h}{\sqrt{2}\pi}$

43. What is the value of azimuthal quantum number for 'g' sub shell ?

(A) 3 (B) 4 (C) 6 (D) 5

Ans. : (D) 5

44. For an electron, with $n=3$ has only one radial node. The orbital angular momentum of the electron will be

(A) 0 (B) $\sqrt{6}\frac{h}{2\pi}$ (C) $\sqrt{2}\frac{h}{2\pi}$ (D) $3(\frac{h}{2\pi})$

Ans. : c

No. of radial nodes $=n-\ell-1=1$

$3-\ell-1=1 \qquad \therefore \ell=1$

Orbital angular momentum

$=\sqrt{\ell(\ell+1)\frac{\mathrm{h}}{2\pi}}=\sqrt{2}\frac{\mathrm{h}}{2\pi}$

45. For an electron, with $n=3$ has only one radial node. The orbital angular momentum of the electron will be

(A) 0

(B) $\sqrt{6}\frac{h}{2\pi}$

(C) $\sqrt{2}\frac{h}{2\pi}$

(D) $3\left(\frac{h}{2\pi}\right)$

Ans. : c

No. of radial nodes $= n-\ell-1=1$

$3-\ell-1=1$

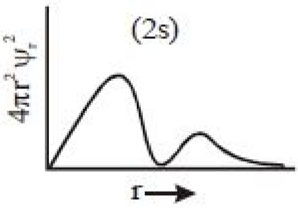
$\therefore\ \ell=1$

Orbital angular momentum $=\sqrt{\ell(\ell+1)\frac{\mathrm{h}}{2\pi}}$

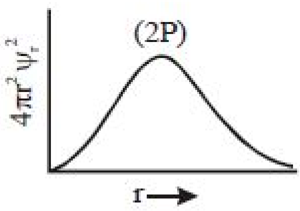
$=\sqrt{2}\frac{\mathrm{h}}{2\pi}$

46. Which of the following plots of radial probability function $4\pi r^2\Psi_r^2$ is incorrectly labelled

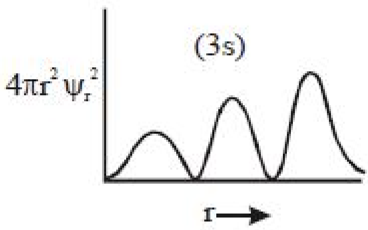
(A)



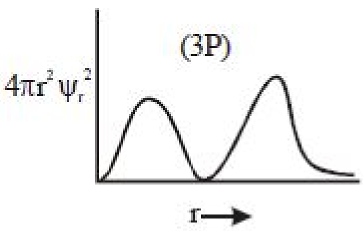
(B)



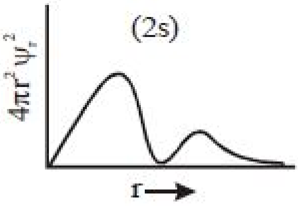
(C)



(D)



Ans.: (A)



47. Pauli's exclusion principle states that

(A) Nucleus of an atom contains no negative charge

(B) Electrons move in circular orbits around the nucleus

(C) Electrons occupy orbitals of lowest energy

(D) All the four quantum numbers of two electrons in an atom cannot be equal

Ans. : d

(d) According to Pauli's exclusion principle no two electrons in the same atom can have all the set of four quantum numbers identical.

48. A filled or half-filled set of p or d-orbitals is spherically symmetric. Point out the species which has spherical symmetry

(A) Na (B) C (C) Cl^- (D) Fe

Ans. : c

(c) Due to full filled d-orbital Cl^- has spherical symmetry.

49. For sodium atom the number of electrons with $m = 0$ will be

(A) 2 (B) 7 (C) 9 (D) 8

Ans. : b

(b) For $m = 0$, electron must be in $s-$ orbital.

50. The maximum number of electrons that can be accommodated in $'f'$ sub shell is

(A) 2 (B) 8 (C) 32 (D) 14

Ans. : d

(d) Maximum no. of electrons in a subshell $= 2(2l + 1)$ for $f-$ subshell, $l = 3$ so 14 electrons accommodated in $f-$ subshell.

51. Number of orbitats in h sub-shell is

(A) 11 (B) 15 (C) 17 (D) 19

Ans. : a

(a) $s \quad p \quad d \quad f \quad g \quad h$

$l = 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5$

Number of orbitals $= 5 \times 2 + 1 = 11$

52. What is the maximum number of electrons which can be accommodated in an atom in which the highest principal quantum number value is 4

(A) 10 (B) 18 (C) 32 (D) 54

Ans. : c

(c) Maximum number of electron $= 2n^2(\text{where} n = 4) = 2 \times 4^2 = 32$.

53. In a potassium atom, electronic energy levels are in the following order

(A) $4s > 3d$ (B) $4s > 4p$ (C) $4s < 3d$ (D) $4s < 3p$

Ans. : c

(c) According to Aufbau's principle.

54. Which electronic configuration is not observing the $(n+l)$ rule

(A) $1s^2$, $2s^2 2p^6$, $3s^2 3p^6 3d^1$, $4s^2$

(B) $1s^2$, $2s^2 sp^6$, $3s^2 3p^6 3d^7$, $4s^2$

(C) $1s^2$, $2s^2 2p^6$, $3s^2 3p^6 3d^5$, $4s^1$

(D) $1s^2$, $2s^2 2p^6$, $3s^2 3p^6 3d^8$, $4s^2$

Ans. : c

(c) $3d$ subshell filled with 5 electrons (half-filled) is more stable than that filled with 4 electrons. 1, $4s$ electrons jumps into $3d$ subshell for more sability.

55. The maximum number of electrons that can be accommodated in the M^{th} shell is

(A) 2 (B) 8 (C) 18 (D) 32

Ans. : c

(c) For M^{th} shell, $n = 3$; so maximum no. of electrons in M^{th} shell $= 2n^2 = 2 \times 3^2 = 18$.

56. The maximum energy is present in any electron at

(A) Nucleus

(B) Ground state

(C) First excited state

(D) Infinite distance from the nucleus

Ans. : d

(d) As a result of attraction, some energy is released. So at infinite distance from the nucleus energy of any electron will be maximum. For bringing electrons from ∞ to the orbital of any atom some work has to be done be electrons hence it bill loose its energy for doing that work.

57. The four quantum number for the valence shell electron or last electron of sodium $(Z = 11)$ is

(A) $n = 2$, $l = 1$, $m = -1$, $s = -\frac{1}{2}$

(B) $n = 3$, $l = 0$, $m = 0$, $s = +\frac{1}{2}$

(C) $n=3,\, l=2,\, m=-2,\, s=-\frac{1}{2}$

(D) $n=3,\, l=2,\, m=2,\, s=+\frac{1}{2}$

Ans. : b

(b) $Na_{11}=2,8,1=1s^2,2s^2\,2p^6,\; 3s^1$

$n=3,\, l=0,\, m=0, s=+1/2$

58. Which set of quantum numbers are not possible from the following

(A) $n=3,\, l=2,\, m=0,\, s=-\frac{1}{2}$

(B) $n=3,\, l=2,\, m=-2,\, s=-\frac{1}{2}$

(C) $n=3,\, l=3,\, m=-3,\, s=-\frac{1}{2}$

(D) $n=3,\, l=0,\, m=0,\, s=-\frac{1}{2}$

Ans. : c

(c) If $n=3$ then $l=0$ to $n-1$ & $m=-l$ to $+l$

59. The number of orbitals in the fourth principal quantum number will be

(A) 4 (B) 8 (C) 12 (D) 16

Ans. : d

(d) No. of electrons$=2n^2$ hence no. of orbital $=\frac{2n^2}{2}=n^2$.

$\Rightarrow 4^2=16$

60. Chromium has the electronic configuration $4s^1 3d^5$ rather than $4s^2 3d^4$ because

(A) $4s$ and $3d$ have the same energy

(B) $4s$ has a higher energy than $3d$

(C) $4s^1$ is more stable than $4s^2$

(D) $4s^1 3d^5$ half-filled is more stable than $4s^2 3d^4$

Ans. : d

(d) Cr has $[Ar]\, 4s^1 3d^5$ electronic configuration because half filled orbital are more stable than other orbitals.

61. Electronic configuration of H^- is

(A) $1s^0$ (B) $1s^1$ (C) $1s^2$ (D) $1s^1\, 2s^1$

Ans. : c

(c) Electronic configuration of H^- is $1s^2$. It has 2 electrons in extra nuclear space.

62. The electronic configuration of silver atom in ground state is

(A) $[Kr]3d^{10}\, 4s^1$ (B) $[Xe]\, 4f^{14}\, 5d^{10}\, 6s^1$ (C) $[Kr]\, 4d^{10}\, 5s^1$ (D) $[Kr]\, 4d^9\, 5s^2$

Ans. : c

(c) The electronic configuration of Ag in ground state is $[Kr]\, 4d^{10}\, 5s^1$.

63. Orbital is

(A) Circular path around the nucleus in which the electron revolves

(B) Space around the nucleus where the probability of finding the electron is maximum

(C) Amplitude of electrons wave

(D) None of these

Ans. : b

Atomic orbital is used to calculate the probability of finding any electron of an atom in any specific region around the atom's nucleus.

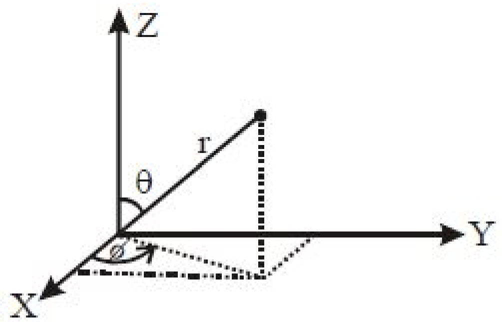
64. Which quantum number is not related with Schrodinger equation

(A) Principal (B) Azimuthal (C) Magnetic (D) Spin

Ans. : d

(d) Spin quantum number does not related with Schrodinger equation because they always show $+1/2$,$-1/2$ value.

65. Angular wave function $A(\theta, \phi)$ for any atomic orbital is " $\frac{1}{2}\sqrt{\frac{3}{\pi}\cos\theta}$ " in polar co-ordinate system



(A) $2s$ (B) $2P_x$ (C) $2P_y$ (D) $2P_Z$

Ans. : d

For P_Z4 orbital nodal plane is XY plane i.e. $cos\,90^o = 0$

66. Angular part of wave function for an orbital is = $\left(\frac{15}{4\pi}\right)^{\frac{1}{2}} \sin\theta \cos\theta \sin\phi$ where θ = angle from $z-$ axis Angular node (s) are

(A) XY plane only (B) YZ plane only

(C) XY & XZ plane only (D) XY , YZ & ZX plane

Ans. : c

$\psi_{(\theta,\phi)} = \left(\frac{15}{4\pi}\right)^{1/2} \sin\theta \cos\theta \sin\phi$

It is angular part of dyz oxbital

How we identified that it is d_{yz} See Power of θ. Here it is $2 \Rightarrow d$ orbital

$\text{For } yz, \text{ it is } \frac{\sin\theta \sin\phi \cos\theta}{y} \Rightarrow d_{yz} \text{ orbital}$

xy and xz are the nodal plane

(nodal plane is the plane where probability of finding electron is minimum)

$\Rightarrow$ C option

67. The uncertainty in the position of a moving bullet of mass $10\ gm$ is $10^{-5}\,m$. Calculate the uncertainty in its velocity

(A) $5.2 \times 10^{-28}\,m/sec$ (B) $3.0 \times 10^{-28}\,m/sec$ (C) $5.2 \times 10^{-22}\,m/sec$ (D) $3 \times 10^{-22}\,m/sec$

Ans. : a

(a) Uncertainty of moving bullet velocity

$\Delta v = \frac{h}{4\pi \times m \times \Delta v} = \frac{6.625 \times 10^{-34}}{4 \times 3.14 \times .01 \times 10^{-5}}$

$= 5.2 \times 10^{-28}\,m/sec$.

68. Simultaneous determination of exact position and momentum of an electron is

(A) Possible

(B) Impossible

(C) Sometimes possible sometimes impossible

(D) None of the above

Ans. : b

(b) According to the Heisenberg's uncertainty principle momentum and exact position of an electron can not be determined simultaneously.

69. The two particles A and B have de Broglie wavelengths $1\,nm$ and $5\,nm$ respectively. If mass of A is four times the mass of B, the ratio of kinetic energies of A and B would be

(A) $5:1$ (B) $25:4$ (C) $20:1$ (D) $5:4$

Ans. : b

$\lambda = \frac{\mathrm{h}}{\sqrt{2\mathrm{mKE}}}; \frac{\lambda_\mathrm{A}}{\lambda_\mathrm{B}} = \frac{\sqrt{\mathrm{m_B(KE)_B}}}{\sqrt{\mathrm{m_B(KE)_B}}}$

$\frac{1}{5} = \sqrt{\frac{\mathrm{m_B}}{4\mathrm{m_B}} \times \frac{\mathrm{KE_B}}{\mathrm{KE_A}}}; \frac{\mathrm{(KE)_A}}{\mathrm{(KE)_B}} = \frac{25}{4}$

70. Number of waves produced by an electron in one complete revolution in n^{th} orbit is

(A) n (B) n^2 (C) $(n+1)$ (D) $(2n+1)$

Ans. : a

$\text{Number of waves } = \frac{\text{Circumference of electrons orbital}}{\text{wavelength}}$

$= \frac{2\pi r}{\lambda}$

$\because \lambda = h/mV \Rightarrow \text{ Number of waves } = \frac{2\pi(mVr)}{h}$

$\therefore mVr = \frac{nh}{2\pi} = \frac{2\pi mVr}{h} = n$

Number of waves $= n$

71. The momentum (in $kg - m/s$) of photon having $6\ MeV$ energy is

(A) 3.2×10^{-21} (B) 2.0 (C) 1.6×10^{-21} (D) 3.2×10^{-18}

Ans. : a

$E = 6\,MeV = 6 \times 10^6\,eV$

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

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

$p = \frac{h}{\lambda} = \frac{E}{C}$

$= \frac{26 \times 10^6 \times 1.6 \times 10^{-13}}{3 \times 10^7}$

$= 3.2 \times 10^{-21}$

72. The radius of second Bohr orbit is x. The de-Broglie wavelength of electron in 4^{th} orbit is nearly

(A) $2\pi x$ (B) $6\pi x$ (C) $9x$ (D) $x/3$

Ans. : a

For any element

$r_n \alpha n^2$

Where n is the principal quantum no.

$\frac{r_2}{r_4} = \frac{(2)^2}{(4)^2} = \frac{4}{16} = \frac{1}{4}$

$\frac{r_2}{r_4} = \frac{1}{4}$

Given $r_2 = x$

$\frac{x}{r_4} = \frac{1}{4}$

$r_4 = 4x$

For 4^{th} shell

$mvr_4 = n\frac{h}{2\pi}$

$mvr_4 = 4 \times \frac{h}{2\pi}$

$\frac{h}{mv} = \frac{2\pi r_4}{4} = \frac{2\pi \times 4x}{4}$

$= 2\pi x$

$\lambda = \frac{h}{mv} = 2\pi x$

73. Calculate the λ of CO_2 molecule moving with a velocity $440\,m/s$.

(A) $\lambda = 1.03 \times 10^{-11}$ (B) $\lambda = 2.06 \times 10^{-10}$ (C) $\lambda = 4.12 \times 10^{-11}$ (D) $\lambda = 2.06 \times 10^{-11}$

Ans. : d

The wavelength is calculated from the de-Broglie's equation.

$\lambda = \frac{h}{mu} = \frac{6.626 \times 10^{-34}}{\frac{44}{1000 \times 6.023 \times 10^{23}} \times 440} = 2.06 \times 10^{-11}$

Thus, the wavelength of CO_2 is $2.06 \times 10^{-11}\mathrm{m}$

74. The $K.E.$ of an electron is $4.55 \times 10^{-25}\,J$ Calculate its λ.

(A) $1.944 \times 10^{-7}\,m$ (B) $19.44 \times 10^{-7}\,m$ (C) $97.2 \times 10^{-8}\,m$ (D) $97.2 \times 10^{-7}\,m$

Ans. : (D) $97.2 \times 10^{-7}\,m$

75. How fast is an electron moving if it has a wavelength equal to the distance it travels in one second ?

(A) $\sqrt{\frac{h}{m}}$ (B) $\sqrt{\frac{m}{h}}$ (C) $\sqrt{\frac{h}{p}}$ (D) $\sqrt{\frac{h}{2(KE)}}$

Ans. : a

As we know,

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

But $v^2=\frac{h}{m}$

By putting this in the equation, we get

$\lambda=\sqrt{\frac{h}{m}}$

76. The ratio of the energy of the electrons in ground state of hydrogen to the electrons in first excited state of Be^{3+} is :

(A) $1:4$ (B) $1:8$ (C) $1:16$ (D) $16:1$

Ans. : a

Formula,

$E=E_0\frac{z^2}{n^2}$

hydrogen,

$E=E_0\frac{z^2}{n^2}=E_0\frac{1^2}{1^2}$

$E=E_0$

Be^{3+}

$E=E_0\frac{z^2}{n^2}=E_0\frac{4^2}{2^2}$

$E=4E_0$

Ratio $=\frac{E_0}{4E_0}$

1: 4

77. If a_0 be the Bohr radius, then de-Broglie's wavelength of an electron revolving in the second excited state of $H-$ atom will be

(A) $6\pi a_0$ (B) $4\pi a_0$ (C) $2\pi a_0$ (D) πa_0

Ans. : a

$\mathrm{mor}=nh/2\pi \quad - \quad -(1)$

$p=\frac{h}{\lambda}=mv \quad -(2)$

Placing the value of mv from Eq. (2) into Eq. (1) for 3 rd orbit

$\frac{hr_3}{\lambda}=3h/2\pi$

$\lambda=2\pi\frac{r_3}{3}$

$r_3=n^2a_0=9r_0$

So $\lambda=2\pi\times 9a_0/3=6\pi a_0$

78. If electron, hydrogen, helium and neon nuclei are all moving with the velocity of light, then the wavelengths associated with these particles are in the order

(A) Electron > hydrogen > helium > neon

(B) Electron > helium > hydrogen > neon

(C) Electron < hydrogen < helium < neon

(D) Neon < hydrogen < helium < electron

Ans. : a

(a) $\lambda \propto \frac{1}{m}, m_e < m_H < m_{He} < m_{Ne.}$

79. A cricket ball of $0.5\,kg$ is moving with a velocity of $100\,m/\sec$. The wavelength associated with its motion is

(A) $1/100\,cm$ (B) $6.6\times10^{-34}\,m$ (C) $1.32\times10^{-35}\,m$ (D) $6.6\times10^{-28}\,m$

Ans. : c

(c) From de Broglie equation

$\lambda = \frac{h}{mv} = \frac{6.62\times10^{-34}}{0.5\times100} = 1.32\times10^{-35}\,m.$

80. A $200\,g$ golf ball is moving with a speed of $5\ m$ per hour. The associated wave length is $(h = 6.625\times10^{-34}\,J{-}sec)$

(A) $10^{-10}\,m$ (B) $10^{-20}\,m$ (C) $10^{-30}\,m$ (D) $10^{-40}\,m$

Ans. : c

(c) $\lambda = \frac{h}{mv} = \frac{6.625\times10^{-34}}{0.2\ kg\times\frac{5}{60\times60\ ms^{-1}}} = 10^{-30}\,m.$

81. If 'X'' is ionization energy of hydrogen then the energy required for excitation of Li^{2+} electron from 2^{nd} excited state to 5^{th} excited state is

(A) $\frac{3X}{4}$ (B) $\frac{4}{3X}$ (C) $\frac{X}{12}$ (D) $\frac{12}{X}$

Ans. : a

$(IE.)_{H_2} = -(E_1)_H = x$

$E \propto Z^2$

$\Delta E = E_5 - E_2$

82. Wave number of a spectral line for a given transition is $y\,cm^{-1}$ for He^+, then its value for Li^{2+} for the same transition is

(A) $4y\,cm^{-1}$ (B) $y\,cm^{-1}$ (C) $\frac{3y}{4}\,cm^{-1}$ (D) $\frac{9y}{4}\,cm^{-1}$

Ans. : d

$(\bar{v}_1)_{\mathrm{He^+}} = \mathrm{y} = \mathrm{R_H}2^2\left(\frac{1}{\mathrm{n}_1^2} - \frac{1}{\mathrm{n}_2^2}\right)$

$(\bar{v}_2)_{L^{2+}} = R_H \times 3^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)\ldots\ldots(ii)$

$(ii)\ \div(1)$

$(\bar{v}_2)_{L_1^{2+}} = y \times \frac{9}{4}$

83. The energy of an electron in the 3^{rd} orbit of a hydrogenic atom is $-E$. The energy of an electron in the first orbit will be

(A) $-3E$ (B) $-E/3$ (C) $-E/9$ (D) $-9E$

Ans. : d

According to Bohr's theory, energy of electron in nth orbit is inversely proportional to square of n^2.

e.g.

given, energy of electron in 3rd orbit, $\mathrm{E}_3 = -\mathrm{E} - -(1)$ Let energy in 1 st orbit is E_1

Then, $E_1/E_3 = (3)^2/(1)^2 = 9$

$E_1 = 9E_3$

from equation (1), $E_1 = -9E$

Hence, option (d) is correct

84. The wavelngth of radiation emitted when electron falls from 4^{th} Bohr orbit to 2^{nd} in H atom is .... nm

(A) 972 (B) 486 (C) 243 (D) 182

Ans. : b

$\frac{1}{\lambda} = R_n \times z^2 \times \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

85. An electron in an atom jumps in such a way that its kinetic energy changes from x to $\frac{x}{4}$. The change in potential energy will be

(A) $+\frac{3}{2}x$ (B) $-\frac{3}{8}x$ (C) $+\frac{3}{4}x$ (D) $-\frac{3}{4}x$

Ans. : a

$\mathrm{KE}_1 = \mathrm{x} \Rightarrow \mathrm{PE}_1 = -2\mathrm{x}$

$\mathrm{KE}_2 = \frac{\mathrm{x}}{4} \Rightarrow \mathrm{PE}_2 = -\frac{\mathrm{x}}{2}$

$\Delta\mathrm{PE} = \mathrm{PE}_2 - \mathrm{PE}_1$

$= +\frac{3x}{2}$

86. Which of the following is correct for Humphrey lines of hydrogen spectrum?

(A) $n_2 = 7 \rightarrow n_1 = 2$

(B) $n_2 = 10 \rightarrow n_1 = 6$

(C) $n_2 = 5 \rightarrow n_1 = 1$

(D) $n_2 = 11 \rightarrow n_1 = 3$

Ans. : b

Different names are used for various lines of the hydrogen spectrum.

For $n_1 = 1$ Lyman series

$n_1 = 2$ Balmer series

$n_1 = 3$ Paschen series

$n_1 = 4$ Brackett series
$n_1 = 5$ Pfund series
$n_1 = 6$ Humphrey series

87. What is the shortest wavelength for Paschen series of Li^{2+} ion

(A) $\frac{R}{9}$ (B) $\frac{9}{R}$ (C) $\frac{1}{R}$ (D) $\frac{9R}{4}$

Ans. : c

$\frac{1}{\lambda} = \mathrm{R}Z^2\left[\frac{1}{\mathrm{n}_1^2} - \frac{1}{\mathrm{n}_2^2}\right] = \mathrm{R} \times 3^2\left[\frac{1}{3^2} - \frac{1}{\infty^2}\right]$

$\Rightarrow \mathrm{R}$ or $\lambda = \frac{1}{\mathrm{R}}$

88. If in Bohr's model, for unielectronic atom, time period of revolution is represented as $T_{n,Z}$ where n represents shell no. and Z represents atomic number then the value of $T_{1,2} : T_{2,1}$ will be

(A) $8:1$ (B) $1:8$ (C) $1:1$ (D) $1:32$

Ans. : d

$T \propto \frac{n^3}{Z^2}; \frac{T_{1,2}}{T_{2,1}} = \frac{1}{4} \times \frac{1}{8} = \frac{1}{32}$

89. Which is correct for any $H-$ like species

(A) $(E_2 - E_1) > (E_3 - E_2) > (E_4 - E_3)$

(B) $(E_2 - E_1) < (E_3 - E_2) < (E_4 - E_3)$

(C) $(E_2 - E_1) = (E_3 - E_2) = (E_4 - E_3)$

(D) $(E_2 - E_1) = \frac{1}{4}(E_3 - E_2) = \frac{1}{9}(E_4 - E_3)$

Ans. : a

$E_1 = -13.6, E_2 = -3.4, E_3 = -1.51, E_4 = -0.85$

$(E_2 - E_1) = 10.2, (E_3 - E_2) = 1.89, (E_4 - E_3) = 0.66$

90. Ratio of velocities of e^{Θ} of hydrogen atom in 1^{st}, 2^{nd}, 3^{rd} orbit is

(A) $1:2:3$ (B) $1:1:1$ (C) $1:1/2:1/3$ (D) $3:2:1$

Ans. : c

Velocity is inversely proportional to orbit number. $V\alpha\frac{1}{n}$
Thus, the ratio of velocities of orbit I, II and III is given as:
$\frac{1}{1} : \frac{1}{2} : \frac{1}{3}$
Hence, the correct option is B

91. If ratio of Area of two orbits of H atom is $4:1$ then the ratio of frequency of e^- in these two orbits is

(A) $\frac{8}{1}$ (B) $\frac{2\sqrt{2}}{1}$ (C) $\frac{1}{2\sqrt{2}}$ (D) $\frac{1}{8}$

Ans. : c

$\frac{A_1}{A_2} = \frac{4}{1} = \left(\frac{n_1}{n_2}\right)^4$

$\frac{n_1}{n_2} = \left(\frac{4}{1}\right)^{\frac{1}{4}} = \sqrt{2}$

Freq. $\propto \frac{1}{n^3}$

$\frac{r_1}{r_2} = \left(\frac{n_2}{n_1}\right)^3 \quad \frac{r_1}{r_2} = \left(\frac{1}{\sqrt{2}}\right)^3$

$\frac{r_1}{r_2} = \frac{1}{2\sqrt{2}}$

92. The shortest wavelength of He^+ ion in Balmer series is x, then longest wavelength in the paschen series of Li^{2+} is

(A) $\frac{36x}{5}$ (B) $\frac{16x}{7}$ (C) $\frac{9x}{5}$ (D) $\frac{5x}{9}$

Ans. : b

The wavelength of H -like an atom is given by

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

For shortest wavelength x of Paschen series $n_2 = \infty$ and $n_1 = 3$

$\frac{1}{x} = R(3)^2\left[\frac{1}{3^2} - \frac{1}{\infty^2}\right]$

$\Rightarrow x = \frac{9}{9R} = \frac{1}{R}$

For longest wavelength of Paschen series $n_2 = 4$ and $n_1 = 3$

$\frac{1}{\lambda} = R(3)^2\left[\frac{1}{3^2} - \frac{1}{4^2}\right]$

$\Rightarrow \frac{1}{\lambda} = R(3)^2\left[\frac{(16-9)}{16\times 9}\right]$

$\Rightarrow \lambda = \frac{16}{7R} = \frac{16x}{7}$

Hence, the correct option is B

93. The angular momentum of an electron in a given orbit is J its kinetic energy will be

(A) $\frac{1}{2}\frac{J^2}{mr^2}$ (B) $\frac{JV}{r}$ (C) $\frac{J^2}{2m}$ (D) $\frac{J^2}{2\pi}$

Ans. : a

Formula $KE = \frac{1}{2}mv^2$ Formula for $L = mvr$ angular momentum

$(a)\frac{1}{2}\frac{J^2}{mr^2} = \frac{1}{2}\frac{m^2v^2r^2}{mr^2} = \frac{1}{2}mv^2$

(b) $\frac{JV}{r} = \frac{\text{mor}\times v}{r} = mv^2$

$(c)\frac{J^2}{2m} = \frac{m^2v^2r^2}{2m} = \frac{1}{2}mv^2r^2$

$(d)\frac{J^2}{2\pi} = \frac{m^2v^2r^2}{2\pi}$

Clearly option (a) gives the KE of electron

94. The frequency of first line of paschen series in spectrum of Be^{+3} ion is

(A) $\frac{7RC}{9}$ (B) $\frac{7RC}{144}$ (C) $\frac{9RC}{25}$ (D) $\frac{20RC}{9}$

Ans. : a

$v = \mathrm{RCZ}^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

Here $\mathrm{n}_1=3, \mathrm{n}_2=4$

$v=\mathrm{RC} \times 16\left(\frac{1}{9}-\frac{1}{16}\right)=16 \mathrm{RC} \times \frac{7}{144}$

$=\frac{7 \mathrm{RC}}{9}$

95. The potential energy of electron in third excited state of He^{+} ion is .... eV

(A) -12.08 (B) -3.4 (C) -6.8 (D) -1.7

Ans. : c

$\mathrm{E}_{4\left(\mathrm{He}^{+}\right)}=-0.85 \times 4=-3.4 \mathrm{eV}$

$\therefore \quad \mathrm{P.E.}=2 \times \mathrm{E}_4=-6.8 \mathrm{eV}$

96. The total energy of the electron of $H-$ atom in the second quantum state is $-E_2$. The total energy of the He^{+} atom in the third quantum state is

(A) $-\frac{3}{2} E_2$ (B) $-\frac{2}{3} E_2$ (C) $-\frac{16}{9} E_2$ (D) $-\frac{4}{9} E_2$

Ans. : d

Energy of electron in nth state

$=\frac{-Z^2 \times 13.6 \, eV}{n^2}$

$E_2(H)=-13.6 / 1 \, eV$

$E_3\left(He^{+}\right)=-13.6 \times \frac{4}{9} \, eV$

$E_2 / E_3=-9 / 4$

$E_3=-\frac{4}{9} E_2$

For negative value of E_2, E_3 will also be negative.

97. What is the ratio of time periods $\left(T_1 / T_2\right)$ in second orbit of hydrogen atom to third orbit of He^{+} ion?

(A) $8/27$ (B) $32/27$ (C) $27/32$ (D) $16/18$

Ans. : b

$\frac{T_H}{T_{He}}=\frac{n_1^3 t_2^2}{n_2^3 t_1^2}$

$=\frac{8 \times 4}{3^3}=\frac{32}{27}$

The ratio is 32: 27 .

98. Find the value of wave number of $(\bar{v})$ in terms of Rydberg's constant, when transition of electron takes place between two levels of He^{+} ion whose sum is 4 and difference is 2

(A) $\frac{8R}{9}$ (B) $\frac{32R}{9}$ (C) $\frac{3R}{4}$ (D) None of these

Ans. : b

Rydberg's formula is $\frac{1}{\lambda}=R Z^2\left(\frac{1}{n_f^2}-\frac{1}{n_i^2}\right) \quad \bar{V}=\frac{1}{\lambda}$

We have given that $n_f-n_i=2$ And $n_f+n_i=4$

Solving these equation $n_f=3 \quad n_i=1$

For helium, $Z=2-$

Using rydberg's formula, $\frac{1}{\lambda} = R \times 2^2 \left(\frac{1}{1^2} - \frac{1}{3^2}\right)$

$\bar{v} = \frac{32R}{9}$

Therefore, the answer is B.

99. What is the maximum wavelength line in the Lyman series of He^+ ion ?

(A) $3R$ (B) $1/3R$ (C) $4/4R$ (D) None of these

Ans. : b

For $He^+, Z = 2$

Wave number, $\bar{v} = \frac{1}{\lambda} = RZ^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

For Lyman series, $n_1 = 1$ and for maximum wavelength, n_2 has to be the smallest possible energy level.

$\therefore n_2 = 2$

Therefore,

$\frac{1}{\lambda_{\max}} = 4R\left[\frac{1}{1} - \frac{1}{4}\right]$

$\Rightarrow \lambda_{\max} = \frac{1}{3R}$

100. The ratio of difference between 1^{st} and 2^{nd} Bohr orbits energy to that between 2^{nd} and 3^{rd} orbits energy is

(A) 0.5 (B) $\frac{1}{3}$ (C) 5.4 (D) $\frac{5}{27}$

Ans. : c

For H-atom

$E_3 = -\frac{13.6}{(3)^2} = -13.69$

$= -1.5\text{eV}$

$E_2 = -\frac{13.6}{(2)^2} = -13.64$

$= -3.4\text{eV}$

$E_1 = -13.6(1)^2 = -13.61$

$= -13.6\text{eV}$

$Now E_2 - E_1 = (-3.4) - (-13.6)$

$= 13.6 - 3.4 = 10.2\text{eV}$

$E_3 - E_2 = (-1.5) - (3.4)$

$= 3.4 - 1.5 = 1.9\text{eV}$

$\therefore \quad \frac{E_2 - E_1}{E_3 - E_2} = \frac{10.2}{1.9} = 5.36$

$= 5.4 = \frac{27}{5}$

101. If shortest wavelength of He^+ ion in Balmer series is $X\,metres$ then longest wavelength in Paschen series of Li^{+2} ion is

(A) $\frac{36}{5}X$ (B) $\frac{16}{7}X$ (C) $\frac{9}{5}X$ (D) $\frac{5}{9}X$

Ans. : b

$\frac{1}{\lambda_{\mathrm{He}^+}} = \mathrm{R} \times 4\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right) = \mathrm{R} = \frac{1}{\mathrm{X}}$

$\frac{1}{\lambda_{\mathrm{Li}^{2+}}} = \mathrm{R} \times 9\left(\frac{1}{3^2} - \frac{1}{4^2}\right) = \mathrm{R} \times \frac{7}{16}$

$\lambda_{Li^{2+}} = \frac{16}{7} X$

102. A photon of $300\,nm$ is absorbed by a gas and then re-emits two photons. One re-emitted photon has wavelength $496\,nm$, the wavelength of second re-emitted photon is

(A) 759 (B) 857 (C) 957 (D) 657

Ans. : a

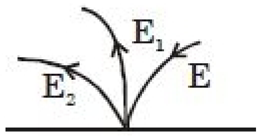
$\mathrm{E} = \mathrm{E}_1 + \mathrm{E}_2$

$\therefore \frac{\mathrm{hc}}{\lambda} = \frac{\mathrm{hc}}{\lambda_1} + \frac{\mathrm{hc}}{\lambda_2}$

$\frac{1}{300} = \frac{1}{496} + \frac{1}{\lambda_2}$

$\frac{1}{\lambda_2} = \frac{1}{300} - \frac{1}{496} = \frac{196}{300 \times 496}$

$\therefore \lambda_2 = \frac{300 \times 496}{196} = 759\,\mathrm{nm}$



103. The ratio of the radius of the first three Bohr orbits is

(A) $1 : \frac{1}{2} : \frac{1}{3}$ (B) $1 : 2 : 3$ (C) $1 : 4 : 9$ (D) $1 : 8 : 27$

Ans. : c

Radius of n^{th} Bohr orbit, $r_n = 0.529 \frac{n^2}{Z} \mathring{A}$

$\Longrightarrow r_n \propto n^2$

Thus ratio of first three Bohr orbit is $r_1 : r_2 : r_3 = 1^2 : 2^2 : 3^2$

$\Longrightarrow r_1 : r_2 : r_3 = 1 : 4 : 9$

104. In the transition of electron in an atom, its kinetic energy changes from y to $y/4$. The change in $P.E$ will be :-

(A) $\frac{-3}{4} y$ (B) $\frac{3}{4} y$ (C) $\frac{-3}{8} y$ (D) $\frac{3}{2} y$

Ans. : d

$K.E. : P.E = 1 : -2$

105. If the shortest wavelength of $H-$ atom in Lyman series is x , then longest wavelength in Balmer series of He^+ is

(A) $\frac{9x}{5}$ (B) $\frac{36x}{5}$ (C) $\frac{x}{4}$ (D) $\frac{5x}{9}$

Ans. : a

$\frac{1}{\lambda} = R_{\mathrm{H}} Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

For Lyman series,

$n_1=1$ and λ is shortest if $n_2=\infty$
$\therefore R_{\mathrm{H}}=\frac{1}{\mathrm{x}}$, for $\mathrm{H}-$ atom $(Z=1)$
For Balmer series,
$n_1=2$ and λ is longest if $n_2=3$
$(\text{For He}^{+}\text{ion } Z=2)$

$\frac{1}{\lambda_{\max}}=R_H(2)^2\left[\frac{1}{2^2}-\frac{1}{3^2}\right]$

$=\frac{1}{x}\times 4\left[\frac{5}{36}\right]$

$\lambda_{\max}=\frac{9x}{5}$

106. When electron jumps from $n=5$ to $n=2$ with all possible transitions then correct answer is

(A) Number of lines in ultraviolet region is equal to 3

(B) Number of lines in visible region is equal to 2

(C) Number of lines in infrared region is equal to 3

(D) All of these

Ans. : (C) Number of lines in infrared region is equal to 3

107. When Z is doubled in an atom, which of the following statements are consistent with Bohr's theory?

(A) Energy of a state is doubled

(B) Radius of an orbit is doubled

(C) Velocity of electron in an orbit is doubled

(D) Energy of a state is halved

Ans. : c

$\mathrm{E}\propto \mathrm{Z}^2$

$\mathrm{R}\propto \frac{1}{\mathrm{Z}}$

$\mathrm{V}\propto \mathrm{Z}$

108. The ratio of two of the first four Bohr’s orbits of the hydrogen atom are in the ratio $1:4$ The energy difference between them may be

(A) Either $12.09\ eV$ or $10.2\ eV$
(B) Either $2.55\ eV$ or $10.2\ eV$
(C) Either $13.6\ eV$ or $3.4\ eV$
(D) Either $3.4\ eV$ or $0.85\ eV$

Ans. : b

$\frac{\mathrm{R}_{\mathrm{n}_1}}{\mathrm{R}_{\mathrm{n}_2}}=\frac{\mathrm{n}_1^2}{\mathrm{n}_2^2}=\frac{1}{4},\therefore \frac{\mathrm{n}_1}{\mathrm{n}_2}=\frac{1}{2},\frac{2}{4},\frac{3}{6}\mathrm{etc}$

Among the first four orbits n_1 and n_2 can be 1 and 2 or 2 and 4
Energy difference can be :
$\mathrm{E}_{2\to 1}=10.2\,\mathrm{eV}$
$\mathrm{E}_{4\to 2}=2.55\,\mathrm{eV}$

109. The masses of photons corresponding to the first lines of Lyman and Balmer series of the spectrum of hydrogen atom are in the ratio of

(A) $27:5$ (B) $3:2$ (C) $2:3$ (D) $4:9$

Ans. : a

since energy is directly proportional to mass and mass is inversely proportional to wavelength ($\lambda=\frac{h}{mv}$ Deleroglie's wavelength Equation)

Lyman Series: $\frac{1}{\lambda_1}=R_H\left(1-\frac{1}{4}\right)=\frac{3R_H}{4}$ where R_H =Rydberg Constant

Balmer Series: $\frac{1}{\lambda_2}=R_H\left(\frac{1}{4}-\frac{1}{9}\right)=\frac{5R_H}{36}$

$\lambda_1:\lambda_2=\frac{5R_H}{36}\times\frac{4R_H}{3}=\frac{5}{27}$

$m_1:m_2=27:5$

110. The wave number of the first Lyman transition in H atom spectrum is equal to the wave number of second balmer transition in the spectrum of

(A) Li^{2+} (B) Be^{3+} (C) He^{+} (D) B^{4+}

Ans. : (C) He^{+}

111. Total number of spectral lines when electron jumps from 8^{th} orbit to 2^{nd} orbit :

(A) 6 (B) 36 (C) 21 (D) 38

Ans. : c

$n_1=8, n_2=2$

The total number of the spectral line is given by the equation:

$N=(n_2-n_1)(n_2-n_1+1)/2$

So,

$N=(8-2)(8-2+1)/2$

$N=6\times 7/2$

$N=42/2$

$N=21$

112. The ionization potential of sodium is $5.48\,eV$. The $I.P.$ of potassium is .... eV

(A) Equal to that of sodium (B) 5.68 (C) 4.68 (D) 10.88

Ans. : c

The Ionization potential decreases as we move down the group in peeiodic table. This is due to increase in atomic size that reduces attraction force between the nucleus and valance electrons. Moreover, Shielding or Screening effect plays important role to affect lonization potential.

113. In Bohr’s model of atom when an electron jumps from $n=1$ to $n=3$, how much energy will be absorbed

(A) $2.15\times 10^{-10}\,ergs$ (B) $0.1911\times 10^{-10}\,ergs$

(C) $2.389\times 10^{-10}\,ergs$ (D) $0.239\times 10^{-10}\,ergs$

Ans. : b

Energy of an atom when $n=1$

$E_1=-\frac{1312}{(1)^2}=-1312 \mathrm{kJmol}^{-1}$

Similarly energy when $n=3,(E_3)$

$=-\frac{1312}{(3)^2}$

$=-145.7 \mathrm{kJmol}^{-1}$

The energy absorbed when an electron jumps from $n=1$ to $n=3$

$E_3-E_1=-145.7-(-1312)=1166.3 \mathrm{kJmol}^{-1}$

$=\frac{1166.3}{6.023 \times 10^{23}}=193.6 \times 10^{-23} \mathrm{kJ}$

$=193.6 \times 10^{-20} \mathrm{J}\left[1 \text{ Joule }=10^7 \mathrm{ergs}\right]$

$\Rightarrow 193.6 \times 10^{-13}$ ergs $=0.1936 \times 10^{-10} \mathrm{ergs}$

114. In an atom two electrons move around the nucleus in circular orbits of radii R & $4R$. The ratio of the time taken by them to complete one revolution is :

(A) $1:4$ (B) $4:1$ (C) $1:8$ (D) $8:7$

Ans. : c

If the electron is moving with a velocity v around the nucleus the time taken by it to

complete one revolution would be given by $T=2\pi r/v$

Now from Bohr's theory we have

$\mathrm{r} \alpha \mathrm{n}^2$ and $\mathrm{v} \propto \frac{1}{\mathrm{n}}$

Hence $\mathrm{T} \propto \mathrm{n}^3 \mathrm{T}^2 \propto \mathrm{n}^6$ or $\mathrm{T}^2 \propto \mathrm{r}^3$

Hence we write

$\left(\frac{T_1}{T_2}\right)^2=\left(\frac{R}{4R}\right)^3=\frac{1}{64}$ or $\frac{T_1}{T_2}=\frac{1}{8}$

115. Supposing the energy (in arbitrary units) of the energy levels in the hydrogen atom is given as under:

Energy level	K	L	M	N
	$n=1$	$n=2$	$n=3$	$n=4 \ldots . . n=\infty$
Energy	$-864\, a.u.$			Zero

the excitation energy needed to raise the electron from M level to $n=\infty$ would be :

(A) 192 (B) 96 (C) 188 (D) 384

Ans. : b

$z=-864\left(\frac{1}{m^2}-\frac{1}{N^2}\right)$

$=-864\left(\frac{1}{m^2}-\frac{1}{\infty^2}\right)$

$=-864\left(\frac{1}{m^2}-0\right)$

$= -864 \left(\frac{1}{m^2}\right)$

$= -96$

116. If the ionization potential of Li^{+2} is $122.4\, eV$. What is the 5^{th} $I.P.$ of carbon V

(A) 979.2 (B) 97.92 (C) 48.96 (D) 489.6

Ans. : d

Ionization energy : It is defined as the measure of energy from (+1) ground energy level to (infinity) energy level.

Mathematically,

$I \cdot E \cdot = E_{\infty} - E_1$

Energy associated to the n^{th} - energy level will be:

$E_n = \frac{E_o \times Z^2}{n^2}$

For ground state energy level of $Li^{2+} - ion, n = 1$ and $Z = 3$

Ionization energy $= 122.4$ eV (given)

Putting the values in equation 1, we get

$122.4 eV = 0 - \frac{E_o \times 3^2}{1^2}$

$E_o = -13.6 \mathrm{eV}$

Now, we have to calculate the sixth ionization potential for carbon, we must know the principle quantum number for this atom.

Atomic number of Carbon $= 6$

And we are asked to find the 6 th ionization potential which means that 5 electrons are already released and the electronic configuration for C^{5+} is $1s^2$

So, the principle quantum number for the 6 th ionization step $= 1$

Putting the values in equation 1, we get $E_1 = \frac{-13.6 \mathrm{eV} \times (6)^2}{(1)^2} = -489.6 \mathrm{eV}$

$E_1 = -489.6 \mathrm{eV}$

Therefore, 6 th ionization potential for carbon atom is $-489.6 \mathrm{eV}$.

117. Radius of the nucleus is equal to $10^{-12}\, cm$. and that of the atom is equal to $10^{-8}\, cm$. What is the fraction of the volume of the atom occupied by nucleus ?

(A) 10^{12} (B) 10^{-12} (C) 10^{-20} (D) 10^{-4}

Ans. : b

A nucleus is the positively charged center of the atom consisting of protons and neutrons. It's also known as the "atomic nucleus". Nearly all the mass of an atom is contained within the nucleus, since protons and neutrons have much more mass than electrons

according to qes. Volume of nucleus $= \frac{4}{3} \pi r^3 = \frac{4}{3} \pi \left(10^{-12}\right)^3 \mathrm{cm}^3$

Volume of atom $= \frac{4}{3} \pi \left(10^{-8}\right)^3 \mathrm{cm}^3$

$\frac{V_N}{V_{\text{atom}}}=\frac{10^{-36}}{10^{-24}}$
$\frac{V_N}{V_{\text{atom}}}=10^{-12}$

118. The wave no. of the first line of Balmer series of H atom is $15200\,cm^{-1}$. What is wave number of the first line of Lyman series of Li^{2+} .... cm^{-1}

(A) 456200 (B) 136800 (C) 738720 (D) 152000

Ans. : c

$\frac{15200}{\frac{1}{\lambda}}=\frac{R_H\times\left[\frac{1}{4}-\frac{1}{9}\right]}{R_H\times 9\left[\frac{1}{1}-\frac{1}{4}\right]}=\frac{\frac{5}{9\times4}}{\frac{9\times3}{4}}=\frac{5}{9\times9\times3}$

$\frac{1}{\lambda}=\frac{15200}{5}\times9\times9\times3=738720$

119. In Bohr's model, atomic radius of the first orbit is γ, the radius of the 3^{rd} orbit, is

(A) $\gamma/3$ (B) γ (C) 3γ (D) 9γ

Ans. : d

(d) $r\propto n^2$

For I^{st} orbit $\gamma=1$

For III^{rd} orbit = $\gamma\propto3^2=9$

So it will 9γ.

120. Time taken for an electron to complete one revolution in the Bohr orbit of hydrogen atom is

(A) $\frac{4\pi^2mr^2}{nh}$ (B) $\frac{nh}{4\pi^2mr}$ (C) $\frac{nh}{4\pi^2mr^2}$ (D) $\frac{h}{2\pi mr}$

Ans. : a

(a) It will take $\frac{4\pi^2mr^2}{n\,h}$

121. The ratio of area covered by second orbital to the first orbital is

(A) $1:2$ (B) $1:16$ (C) $8:1$ (D) $16:1$

Ans. : d

(d) $r_n\propto n^2$: $A_n\propto n^4$

$\frac{A_2}{A_1}=\frac{n_2^4}{n_1^4}=\frac{2^4}{1^4}=\frac{16}{1}=16:1$

122. Energy of electron of hydrogen atom in second Bohr orbit is

(A) $-5.44\times10^{-19}J$ (B) $-5.44\times10^{-19}\,kJ$ (C) $-5.44\times10^{-19}\,cal$ (D) $-5.44\times10^{-19}\,eV$

Ans. : a

(a) $E=-\frac{2.172\times10^{-18}}{n^2}=\frac{-2.172\times10^{-18}}{2^2}$

$=-5.42\times10^{-19}J$.

123. If electron falls from $n=3$ to $n=2$, then emitted energy is .... eV

(A) 10.2 (B) 12.09 (C) 1.9 (D) 0.65

Ans. : c

(c) $\Delta E = E_3 - E_2 = 13.6\left[\frac{1}{(2)^2} - \frac{1}{(3)^2}\right] = 1.9\,eV$

124. The energy of an electron revolving in n^{th} Bohr's orbit of an atom is given by the expression

(A) $E_n = -\frac{2\pi^2 m^4 e^2 z^2}{n^2 h^2}$ (B) $E_n = -\frac{2\pi^2 me^2 z^2}{n^2 h^2}$ (C) $E_n = -\frac{2\pi^2 me^4 z^2}{n^2 h^2}$ (D) $E_n = -\frac{2\pi m^2 e^2 z^4}{n^2 h^2}$

Ans. : (C) $E_n = -\frac{2\pi^2 me^4 z^2}{n^2 h^2}$

125. The expression for Bohr's radius of an atom is

(A) $r = \frac{n^2 h^2}{4\pi^2 me^4 z^2}$ (B) $r = \frac{n^2 h^2}{4\pi^2 me^2 z}$ (C) $r = \frac{n^2 h^2}{4\pi^2 me^2 z^2}$ (D) $r = \frac{n^2 h^2}{4\pi^2 m^2 e^2 z^2}$

Ans. : b

It's Obvious

126. The energy of an electron in n^{th} orbit of hydrogen atom is

(A) $\frac{13.6}{n^4}\,eV$ (B) $\frac{13.6}{n^3}\,eV$ (C) $\frac{13.6}{n^2}\,eV$ (D) $\frac{13.6}{n}\,eV$

Ans. : c

It's Obvious

127. The energies E_1 and E_2 of two radiations are $25\,eV$ and $50\,eV$ respectively. The relation between their wavelengths i.e., λ_1 and $\lambda_2$will be

(A) $\lambda_1 = \lambda_2$ (B) $\lambda_1 = 2\lambda_2$ (C) $\lambda_1 = 4\lambda_2$ (D) $\lambda_1 = 1/2\lambda_2$

Ans. : b

Given the value of $E_1 = 25\text{eV}$ and $E_2 = 50\text{eV}$

$E_1 = \frac{hc}{\lambda_1}, E_2 = \frac{hc}{\lambda_2}$

By divide E_1 and E_2

$\Rightarrow \frac{25}{50} = \frac{\lambda_2}{\lambda_1}$

$\lambda_1 = 2\lambda_2$

128. Two radiations having energies E_1 and E_2 as $15\,eV$ and $45\,eV$ respectively then the relationship in between λ_1 and λ_2 will be

(A) $\lambda_1 = \lambda_2$ (B) $\lambda_1 = 3\lambda_2$ (C) $\lambda_1 = \lambda_2/3$ (D) $\lambda_1 = 9\lambda_2$

Ans. : b

$\mathrm{E_1} = 15\,\mathrm{eV} \Rightarrow \frac{\mathrm{hc}}{\lambda_1} = 15\,\mathrm{eV}\ldots\ldots\ldots(i)$

$\mathrm{E_2} = 45\,\mathrm{eV} \Rightarrow \frac{\mathrm{hc}}{\lambda_2} = 45\,\mathrm{eV}\ldots\ldots\ldots(ii)$

$\frac{\lambda_2}{\lambda_1} = \frac{1}{3}$

$\lambda_1 = 3\lambda_2$

129. A $150\,Watt$ bulb emits light of wavelength $6600\,\overset{o}{A}$ and only 8% of the energy is emitted as light. How many light photons are emitted by the bulb per second?

(A) 4×10^{19} (B) 3.24×10^{19} (C) 4.23×10^{20} (D) 3×10^{20}

Ans. : a

8% energy emitted

$\text{emitted energy } = \frac{8}{100} \times 150 = 12\,\text{Watt}$

Now, $\mathrm{E} = \frac{\mathrm{nhc}}{\lambda}$

$\therefore 12 = \frac{n \times 6.6 \times 10^{-34} \times 3 \times 10^{8}}{6600 \times 10^{-10}}$

$\therefore \mathrm{n} = 4 \times 10^{19}$

130. A bulb of $40\,W$ is producing a light of wavelength $620\,nm$ with 80% of efficiency then the number of photons emitted by the bulb in 20 seconds are $(1eV = 1.6 \times 10^{-19}\,J, hc = 12400\,eV\,\overset{o}{A})$

(A) 2×10^{18} (B) 10^{18} (C) 10^{21} (D) 2×10^{21}

Ans. : d

Energy of one photon $= \frac{12400}{6200} = 2\,\mathrm{eV}$

Let n be the number of photons emitted then $2 \times n \times 1.6 \times 10^{-19} = 40 \times 20 \times 0.8$

$\Rightarrow n = 2 \times 10^{21}$

131. The work function for a metal is $4\,eV$. To emit a photo electron of zero velocity from the surface of the metal, the wavelength of incident light should be : .... $\mathrm{\overset{o}{A}}$

(A) 2700 (B) 1700 (C) 5900 (D) 3100

Ans. : d

$hv = hv_0 + KE$ for zero velocity $KE = 0$

$hv = hv_0$

$hv = 4eV$

$\frac{hc}{\lambda} = 4eV$

$\lambda = \frac{h \times c}{4eV}$

$= \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{4 \times 1.6 \times 10^{-19}} = 3100\mathrm{A}^{\circ}$

Hence, the correct option is D

132. An atom emits energy equal to $4 \times 10^{-12}\,erg$. To which part of electromagnetic spectrum it belongs :

(A) UV region (B) Visible region

(C) IR region (D) Microwave region

Ans. : b

The wavelength corresponding to energy 4×10^{-12} ergs is

$\lambda = \frac{hC}{\Delta E} = \frac{6.62 \times 10^{-34} \times 3 \times 10^{8}}{4 \times 10^{-12} \times 10^{-7}}$

$= 4.965 \times 10^{-7} m = 4965\,\mathring{A} \ldots$

Visible region extends from $3800\,\mathring{A}\ldots - 7600\,\mathring{A}\ldots$

133. A $124\,W$ bulb converts only $15\,\%$ of the energy supplied to it into visible light of wavelength $640\,nm$. How many photons are emitted by the light bulb in one second

(A) 4×10^{19} (B) 6×10^{19} (C) 8×10^{18} (D) 3×10^{19} photon

Ans. : b

$\frac{124\times0.15}{\frac{1240}{640}\times1.6\times10^{-19}}$

$=\frac{124\times640}{124\times16}\times10^{19}\times0.15$

$=6\times10^{19}$

134. Which of the following isotope of hydrogen has maximum sum of electron $+$ proton $+$ neutron?

(A) P

(B) D

(C) T

(D) All has same value

Ans. : c

	P	D	T
	$\downarrow$	$\downarrow$	$\downarrow$
	${}^1_1H$	${}^2_1H$	${}^3_1H$
p	1	1	1
e^-	1	1	1
n	0	1	2
$p+e^-+n$	2	3	4

135. The expression Ze gives :

(A) The charge of $\alpha-$ particle

(B) The charge on an atom

(C) The charge on the nucleus of atomic number Z

(D) The kinetic energy of an $\alpha-$ particle

Ans. : (C) The charge on the nucleus of atomic number Z

136. The number of electrons in 2.1 gram-ion of Cl^- is

(A) 2.1

(B) 2.1×18

(C) $2.1\times18\times6.023\times10^{23}$

(D) $2.1\times18\times6.023\times10^{22}$

Ans. : (C) $2.1 \times 18 \times 6.023 \times 10^{23}$

137. The atomic weight of an element is 39. The number of neutrons in its nucleus is one more than the number of protons. The number of protons, neutrons and electrons respectively in its atom would be

(A) $19, 20, 19$ (B) $19, 19, 20$ (C) $20, 19, 19$ (D) $20, 19, 20$

Ans. : a

(a) K_{19}^{39}, $P = 19$, $E = 19$, $N = 20$

138. The electronic configuration of a dipositive metal M^{2+} is $2, 8, 14$ and its atomic weight is $56\ a.m.u.$ The number of neutrons in its nuclei would be

(A) 30 (B) 32 (C) 34 (D) 42

Ans. : a

(a) Metal is $_{56}M^{2+}\,(2, 8, 14)$

than $n = A - Z = 56 - 26 = 30$.

139. The compound in which cation is isoelectronic with anion is

(A) $NaCl$ (B) CsF (C) NaI (D) K_2S

Ans. : d

(d) K_2S formed by $K^+$and S^{2-} ion. We know that atomic number of K is 19 and in K^+ion its atomic number would be 18 similarly atomic number of S is 16 and in form S^{2-} ion its atomic number would be 18 so the $K^+$and $S^{2-}$are isoelectronic with each other in K_2S.

140. Iso-electronic species is

(A) F^-, O^{-2} (B) F^-, O (C) F^-, O^+ (D) F^-, O^{+2}

Ans. : a

It's Obvious

141. An isostere is

(A) NO_2^- and O_3 (B) NO_2^- and PO_4^{3-}

(C) CO_2, N_2O, NO_3^- (D) ClO_4^- and OCN^-

Ans. : a

(a) NO_2^- and O_3 are isostere. The number of atoms in these $(= 3)$ and number of electrons (24) are same.

142. Number of protons, neutrons and electrons in the element $^{231}_{89}Y$ is

(A) $89, 231, 89$ (B) $89, 89, 242$ (C) $89, 142, 89$ (D) $89, 71, 89$

Ans. : c

(c) In Xe_{89}^{231} number of protons and electrons is 89 and No. of neutrons $= A - Z = 231 - 89 = 142$.

143. In neutral atom, which particles are equivalent

(A) p^+, e^+ (B) e^-, e^+ (C) e^-, p^+ (D) p^+, n^o

Ans. : c

(c) Electrons and Protons are same in neutral atom.

144. Number of unpaired electrons in inert gas is

(A) 0 (B) 8 (C) 4 (D) 18

Ans. : a

(a) Number of unpaired electrons in inert gas is zero because they have full filled orbitals.

145. The atomic number of an element having the valency shell electronic configuration $4s^2 4p^6$ is

(A) 35 (B) 36 (C) 37 (D) 38

Ans. : b

(b) Complete $E.C. = [Ar]^{18} 3d^{10} 4s^2 4p^6$.

Hence no. of e^- = no. of protons $= 36 = Z$.

146. Compared with an atom of atomic weight 12 and atomic number 6, the atom of atomic weight 13 and atomic number 6

(A) Contains more neutrons (B) Contains more electrons

(C) Contains more protons (D) Is a different element

Ans. : a

(a) ${}_6A^{12}$ and ${}_6X^{13}$ both are isotopes but have different no. of neutrons.

${}_6A^{12}$, For A have $p = 6, e = 6$ and $n = 6$ and

${}_6X^{13}$, For B have $p = 6, e = 6$ and $n = 7$

147. An atom has the electronic configuration of $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^2 4p^5$. Its atomic weight is 80. Its atomic number and the number of neutrons in its nucleus shall be

(A) 35 and 45 (B) 45 and 35 (C) 40 and 40 (D) 30 and 50

Ans. : a

(a) ${}_{35}Br^{80} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$

$A = 80$, $Z = 35$, $N = ?$

$N = A - Z = 80 - 35 = 45$

atomic number (Proton) is 35 and no. of neutron is 45.

148. Which of the following are isoelectronic with one another

(A) Na^+ and Ne (B) K^+ and O (C) Ne and O (D) Na^+ and K^+

Ans. : a

(a) Na^+ and Ne are isoelectronic which contain 10 electrons.

149. Which one of the following pairs is not correctly matched

(A) Rutherford-Proton (B) J.J. Thomsom-Electron

(C) J.H. Chadwick-Neutron (D) Bohr-Isotope

Ans. : d

It’s Obvious

150. The ratio of specific charge of a proton and an α-particle is

(A) $2:1$ (B) $1:2$ (C) $1:4$ (D) $1:1$

Ans. : a

(a) Charge on proton $=+1$ unit, charge on α particle $=+2$ units, $2:1$.

151. Match List I with List II

List $-I$ (Element)		List $-II$ (Electronic Configuration)	
$A.$	N	$I.$	$[\mathrm{Ar}]3\mathrm{~d}^{10}4\mathrm{~s}^{2}4\mathrm{p}^{5}$
$B.$	S	$II.$	$[\mathrm{Ne}]3\mathrm{~s}^{2}3\mathrm{p}^{4}$
$C.$	Br	$III.$	$[\mathrm{He}]2\mathrm{~s}^{2}2\mathrm{p}^{3}$
$D.$	Kr	$IV.$	$[\mathrm{Ar}]3\mathrm{~d}^{10}4\mathrm{~s}^{2}4\mathrm{p}^{6}$

Choose the correct answer from the options given below:

(A) $A-IV, B-III, C-II, D-I$

(B) $A-III, B-II, C-I, D-IV$

(C) $A-I, B-IV, C-III, D-II$

(D) $A-II, B-I, C-IV, D-III$

Ans. : b

(A) ${}_{7}\mathrm{N}:[\mathrm{He}]2\mathrm{~s}^{2}2\mathrm{p}^{3}$

(B) ${}_{16}\mathrm{S}:[\mathrm{Ne}]2\mathrm{~s}^{2}3\mathrm{p}^{4}$

(C) ${}_{35}\mathrm{Br}:[\mathrm{Ar}]3\mathrm{~d}^{10}4\mathrm{~s}^{2}4\mathrm{p}^{5}$

(D) ${}_{36}\mathrm{Kr}:[\mathrm{Ar}]3\mathrm{~d}^{10}4\mathrm{~s}^{2}4\mathrm{p}^{6}$

152. Frequency of the de-Broglie wave of election in Bohr's first orbit of hydrogen atom is.......... $\times 10^{13}\ \mathrm{Hz}$ (nearest integer).

[Given : R_{H} (Rydberg constant) $= 2.18 \times 10^{-18}$ J.
h(Plank's constant)$= 6.6 \times 10^{-34}$ J.s.]

(A) 600 (B) 657 (C) 658 (D) 660

Ans. : c

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

$\lambda = \frac{\mathrm{hv}}{\mathrm{mv}^2}$

$\frac{\mathrm{mv}^2}{\mathrm{h}} = \frac{\mathrm{v}}{\lambda} = \mathrm{v}$ (frequency)

Given $\frac{1}{2}\mathrm{mv}^2 = 2.18 \times 10^{-18}$ J

$\mathrm{h} = 6.6 \times 10^{-34}$

$\mathrm{v} = \frac{4.36 \times 10^{-18}}{6.6 \times 10^{-34}} = 660.60 \times 10^{13}$ Hz

$\approx 661 \times 10^{13}$ Hz

153. The de-Broglie's wavelength of an electron in the 4^{th} orbit is .... πa_0.($a_0 =$ Bohr's radius)

(A) 5 (B) 4 (C) 7 (D) 8

Ans. : d

$2\pi \mathrm{r_u} = \mathrm{n}\lambda_{\mathrm{d}}$

$2\pi \mathrm{a_0} \frac{\mathrm{n}^2}{\mathrm{z}} = \mathrm{n}\lambda_{\mathrm{d}}$

$2\pi \mathrm{a_0} \frac{4^2}{1} = 4\lambda_{\mathrm{d}}$

$\lambda_{\mathrm{d}} = 8\pi \mathrm{a_0}$

154. The value of Rydberg constant (R_H) is 2.18×10^{-18} J. The velocity of electron having mass 9.1×10^{-31} kg in Bohr's first orbit of hydrogen atom $= \ldots\ldots\ldots \times 10^5 \mathrm{~ms}^{-1}$ (nearest integer)

(A) 22 (B) 25 (C) 30 (D) 35

Ans. : a

$\mathrm{V} = 2.18 \times 10^6 \times \frac{\mathrm{Z}}{\mathrm{n}}$

$= 21.8 \times 10^5 \times \frac{1}{1} \approx 22 \times 10^5$ (nearest)

155. The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency ' A ' $\times 10^{12}$ hertz and that has a radiant intensity in that direction of $\frac{1}{'}$ watt per steradian. $'A'$ and $'B'$ are respectively

(A) 540 and $\frac{1}{683}$ (B) 540 and 683 (C) 450 and $\frac{1}{683}$ (D) 450 and 683

Ans. : b

The candela is the luminous intensity of a source that emits monochromatic radiation of frequency radiation of frequency 540×10^{12} Hz and has a radiant intensity in that direction of $\frac{1}{683}$ w/sr. It is unit of Candela.

156. Wavenumber for a radiation having $5800 \AA$ wavelength is $x \times 10 \mathrm{~cm}^{-1}$. The value of x is. . . . .

(A) 1724 (B) 1725 (C) 1727 (D) 1730

Ans. : a

$\bar{v}$ (wave no.) $=\frac{1}{\lambda}=\frac{1}{5800 \times 10^{-8} \mathrm{~cm}}=17241$

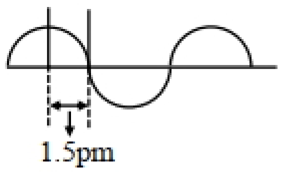
OR

$1724 \times 10 \mathrm{~cm}^{-1} \Rightarrow \mathrm{x}=1724$

157. A hypothetical electromagnetic wave is show below.

(Image)

The frequency of the wave is $\mathrm{x} \times 10^{19} \mathrm{~Hz}$. $x=\ldots .$ (nearest integer)



(A) 5 (B) 7 (C) 9 (D) 10

Ans. : a

$\lambda=1.5 \times 4 \mathrm{pm}$

$=6 \times 10^{-12}$ meter

$\lambda v=\mathrm{C}$

$6 \times 10^{-12} \times v=3 \times 10^{8}$

$v=5 \times 10^{19} \mathrm{~Hz}$

158. Total number of ions from the following with noble gas configuration is__________.

$\mathrm{Sr}^{2+}(\mathrm{Z}=38), \mathrm{Cs}^{+}(\mathrm{Z}=55), \mathrm{La}^{2+}(\mathrm{Z}=57) \mathrm{Pb}^{2+}$

$(\mathrm{Z}=82), \mathrm{Yb}^{2+}(\mathrm{Z}=70)$ and $\mathrm{Fe}^{2+}(\mathrm{Z}=26)$

(A) 2 (B) 7 (C) 9 (D) 11

Ans. : a

Noble gas configuration $=\mathrm{ns}^{2} \mathrm{np}^{6}$

$\left[\mathrm{Sr}^{2+}\right]=[\mathrm{Kr}]$

$\left[\mathrm{Cs}^{+}\right]=[\mathrm{Xe}]$

$\left[\mathrm{Yb}^{2+}\right]=[\mathrm{Xe}] 4 \mathrm{f}^{14}$

$\left[\mathrm{La}^{2+}\right]=[\mathrm{Xe}] 5 \mathrm{~d}^{1}$

$\left[\mathrm{~Pb}^{2+}\right]=[\mathrm{Xe}] 4 \mathrm{f}^{14} 5 \mathrm{~d}^{10} 6 \mathrm{~s}^{2}$

$\left[\mathrm{Fe}^{2+}\right]=[\mathrm{Ar}] 3 \mathrm{~d}^{6}$

159. Number of spectral lines obtained in He^{+}spectra, when an electron makes transition from fifth excited state to first excited state will be

(A) 11 (B) 10 (C) 12 (D) 13

Ans. : b

5^{th} excited state $\Rightarrow n_1 = 6$

1^{st} excited state $\Rightarrow n_2 = 2$

$\Delta n = n_1 - n_2 = 6 - 2 = 4$

Maximum number of spectral lines

$= \frac{\Delta \mathrm{n}(\Delta \mathrm{n}+1)}{2} = \frac{4(4+1)}{2} = 10$

160. Match List I with List II

List I (Spectral Series for Hyddrogen)	List II (Spectral Region/Higher Energy State)
A. Lyman	I. Infrared region
B. Balmer	II. UV region
C. Paschen	III. Infrared region
D. Pfund	IV. Visible region

Choose the correct answer from the options given below :-

(A) $A-II, B-III, C-I, D-IV$

(B) $A-I, B-III, C-II, D-IV$

(C) $A-II, B-IV, C-III, D-I$

(D) $A-I, B-II, C-III, D-IV$

Ans. : c

$A-II, B-IV, C-III, D-I$

Fact based.

161. The ionization energy of sodium in $\mathrm{kJmol^{-1}}$. If electromagnetic radiation of wavelength $242\ \mathrm{nm}$ is just sufficient to ionize sodium atom is____.

(A) 494 (B) 490 (C) 499 (D) 445

Ans. : a

$\mathrm{E} = \frac{1240}{\lambda(\mathrm{nm})}\mathrm{eV}$

$= \frac{1240}{242}\mathrm{eV}$

$= 5.12\mathrm{eV}$

$= 5.12 \times 1.6 \times 10^{-19}$

$= 8.198 \times 10^{-19}$ J/ atom

$= 494\ \mathrm{kJ/mol}$

162. The number of atomic orbitals from the following having 5 radial nodes is ....

$7s, 7p, 6s, 8p, 8d$

(A) 3 (B) 2 (C) 1 (D) 4

Ans. : a

Radial node $= n - \ell - 1$

$7s \Rightarrow R \cdot N = 7 - 0 - 1 = 6$

$7p \Rightarrow R \cdot N = 7 - 1 - 1 = 5$

$6s \Rightarrow R \cdot N = 6 - 0 - 1 = 5$

$8p \Rightarrow R \cdot N = 8 - 1 - 1 = 6$

$8d \Rightarrow R \cdot N = 8 - 2 - 1 = 5$

So, Answer is 3

163. Arrange the following orbitals in decreasing order of energy ?

(A) $n = 3, 1 = 0, m = 0$

(B) $n = 4, l = 0, m = 0$

(C) $n = 3, l = 1, m = 0$

(D) $n = 3, l = 2, m = 1$

The correct option for the order is :

(A) $B > D > C > A$ (B) $D > B > C > A$ (C) $A > C > B > D$ (D) $D > B > A > C$

Ans. : b

(A) $n = 3; 1 = 0; m = 0; 3s$ orbital

(B) $n = 4; 1 = 0; m = 0; 4s$ orbital

(C) $n = 3; 1 = 1; m = 0; 3p$ orbital

(D) $n = 3; 1 = 2; m = 0; 3d$ orbital

As per Hund's rule energy is given by $(n + l)$ value.

If value of $(n + l)$ remains same then energy is given by n only.

164. The wave function (Ψ) of $2s$ is given by

$$\Psi_{2s} = \frac{1}{2\sqrt{2\pi}}\left(\frac{1}{a_0}\right)^{1/2}\left(2 - \frac{r}{a_0}\right)e^{-r/2a_0}$$

At $r = r_0$, radial node is formed. Thus, r_0 in terms of a_0

(A) $r_0 = a_0$ (B) $r_0 = 4a_0$ (C) $r_0 = \frac{a_0}{2}$ (D) $r_0 = 2a_0$

Ans. : d

At node $\Psi_{2s} = 0$

$\therefore 2 - \frac{r_0}{a_0} = 0$

$\therefore r_0 = 2a_0$

165. The wavelength of an electron of kinetic energy $4.50 \times 10^{-29}\, J$ is $\ldots\ldots \times 10^{-5}\, m$. (Nearest integer)Given : mass of electron is $9 \times 10^{-31}\, kg, h = 6.6 \times\ 10^{-34}\, Js$

(A) 6 (B) 5 (C) 4 (D) 7

Ans. : d

$\lambda_d = \frac{h}{mv} = \frac{h}{\sqrt{2mKE}} = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9 \times 10^{-31} \times 4.5 \times 10^{-29}}}$

$= \frac{6.6 \times 10^{-34}}{\sqrt{9^2 \times 10^{-60}}}$

$= \frac{6.6 \times 10^{-34}}{9 \times 10^{-30}} = \frac{6.6}{9} \times 10^{-4}$

$= 7.3 \times 10^{-5}\, m$

$\text{Therefore Ans } = 7$

166. The energy of an electron in the first Bohr orbit of hydrogen atom is $-2.18 \times 10^{-18}\, J$. Its energy in the third Bohr orbit is ....

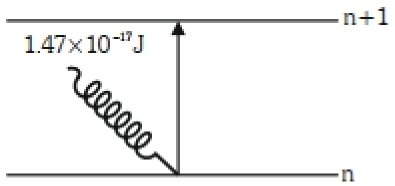
(A) $\frac{1}{27}$ of this value (B) One third of this value (C) Three times of this value (D) $\frac{1}{9}$ th of this value

Ans. : d

$E_n = \frac{-2.18 \times 10^{-18} Z^2}{n^2}$

i.e. $E_n \propto \frac{1}{n^2}$

167. The electron in the n^{th} orbit of Li^{2+} is excited to $(n+1)$ orbit using the radiation of energy $1.47 \times 10^{-17}\, J$ (as shown in the diagram). The value of n is .....Given $R_H = 2.18 \times 10^{-18}\, J$



(A) 2 (B) 3 (C) 1 (D) 4

Ans. : c

$\Delta E = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$1.47 \times 10^{-17} = 2.18 \times 10^{-15} \times 9 \left(\frac{1}{n^2} - \frac{1}{(n+1)^2}\right)$

$\frac{1.47}{1.96} = \frac{3}{4} = \frac{1}{n^2} - \frac{1}{(n+1)^2}$

So, $n = 1$

168. Which transition in the hydrogen spectrum would have the same wavelength as the Balmer type transition from $n=4$ to $n=2$ of He^{+}spectrum

(A) $n=2$ to $n=1$ (B) $n=1$ to $n=3$ (C) $n=1$ to $n=2$ (D) $n=3$ to $n=4$

Ans. : a

He^{+}ion :

$\frac{1}{\lambda(H)} = R(1)^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\frac{1}{\lambda(He^{+})} = R(2)^2 \left[\frac{1}{2^2} - \frac{1}{4^2}\right]$

Given $\lambda(H) = \lambda(He^{+})$

$R(1)^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = R(4) \left[\frac{1}{2^2} - \frac{1}{4^2}\right]$

$\frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{1}{1^2} - \frac{1}{2^2}$

On comparing $n_1=1$ and $n_2=2$

169. Assume that the radius of the first Bohr orbit of hydrogen atom is $0.6\mathring{A}$. The radius of the third Bohr orbit of $He^{+}$is ……………… picometer. (Nearest Integer)

(A) 170 (B) 180 (C) 270 (D) 250

Ans. : c

$r \propto \frac{n^2}{Z}$

$r_{He^+}=r_H \times \frac{n^2}{Z}$

$r_{He^+}=0.6 \times \frac{(3)^2}{2}$

$=2.7\mathring{A}$

$r_{He^+}=270\,pm$

170. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R:

Assertion A: In the photoelectric effect, the electrons are ejected from the metal surface as soon as the beam of light of frequency greater than threshold frequency strikes the surface.

Reason R : When the photon of any energy strikes an electron in the atom, transfer of energy from the photon to the electron takes place.

In the light of the above statements, choose the most appropriate answer from the options given below :

(A) Both A and R are correct but R is NOT the correct explanation of A

(B) A is correct but R is not correct

(C) Both A and R are correct and R is the correct explanation of A

(D) A is not correct but R is correct

Ans. : b

There is a characteristic minimum frequency, or "threshold frequency," for each metal below which the photoelectric effect is not seen. The ejected electrons leave with a specific amount of kinetic energy at a frequency $v>v_0$ with an increase in light frequency of these electron kinetic energies also rise.

171. The total number of isoelectronic species from the given set is …….

$O^{2-}, F^{-}, Al, Mg^{2+}, Na^{+}, O^{+}, Mg, Al^{3+}, F$

(A) 5 (B) 4 (C) 3 (D) 2

Ans. : a

Isoelectronic species $O^{2\ominus}, F^{\ominus}, Mg^{2+}, Na^{\oplus}, Al^{3+}$

172. The orbital angular momentum of an electron in $3s$ orbital is $\frac{xh}{2\pi}$. The value of x is ………. .

(A) 1 (B) 2 (C) 3 (D) 0

Ans. : d

Orbital angular momentum $=\sqrt{1(1+1)}\frac{h}{2\pi}$ Value of 1 for $s=0$

173. The shortest wavelength of hydrogen atom in Lyman series is λ. The longest wavelength in Balmer series of $He^{+}$is

(A) $\frac{5}{9\lambda}$ (B) $\frac{9\lambda}{5}$ (C) $\frac{36\lambda}{5}$ (D) $\frac{5\lambda}{9}$

Ans. : b

For $H: \frac{1}{\lambda}=R_H\times 1^2\left(\frac{1}{1^2}-\frac{1}{\infty^2}\right)$

$\frac{1}{\lambda_{He^+}}=R_H\times 2^2\times\left(\frac{1}{4}-\frac{1}{9}\right)$

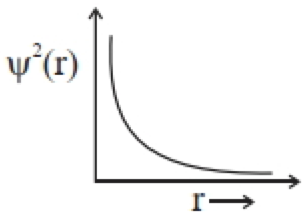
From (1) and (2) $\frac{\lambda_{He^+}}{\lambda}=\frac{9}{5}$

$\lambda_{He^+}=\lambda\times\frac{9}{5}$

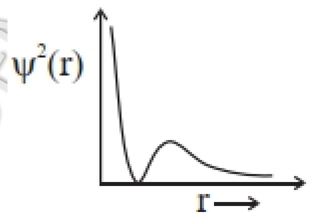
$\lambda_{He^+}=\frac{9\lambda}{5}$

174. Which of the following is the correct plot for the probability density $\psi^2(r)$ as a function of distance ' r ' of the electron form the nucleus for $2s$ orbital?

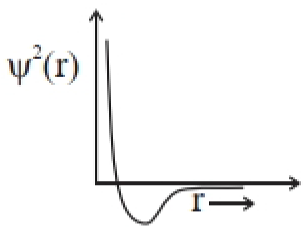
(A)



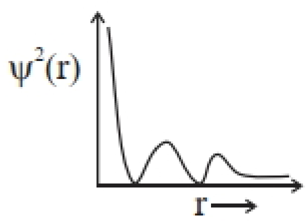
(B)



(C)



(D)



Ans. : b

For $2s$, number of radial nodes $=2-0-1=1$ and value of ψ^2 is always positive.

175. The wavelength of an electron and a neutron will become equal when the velocity of the electron is x times the velocity of neutron. The value of x is (Nearest Integer)(Mass of electron is $9.1\times10^{-31}kg$ and mass of neutron is $1.6\times10^{-27}\,kg$)

(A) 1757 (B) 1758 (C) 1756 (D) 1755

Ans. : b

$v_e=xv_N$

$\lambda_e=\lambda_N$

$\Rightarrow \frac{h}{m_e v_c} = \frac{h}{m_N v_N}$

$v_e = \frac{m_N}{m_e} \cdot v_N$

$= \frac{1.6\times10^{-27}}{9.1\times10^{-31}} v_N$

$v_e = 1758.24 \times v_N$

176. If the radius of the 3^{rd} Bohr's orbit of hydrogen atom is r_3 and the radius of 4^{th} Bohr's orbit is r_4. Then ....

(A) $r_4 = \frac{9}{16} r_3$ (B) $r_4 = \frac{16}{9} r_3$ (C) $r_4 = \frac{3}{4} r_3$ (D) $r_4 = \frac{4}{3} r_3$

Ans. : b

$r = 0.529 \times \frac{n^2}{Z}$

$r_3 = 0.529 \times \frac{3^2}{1}$

$r_4 = 0.529 \times \frac{4^2}{1}$

$\frac{r_4}{r_3} = \frac{4^2}{3^2} = \frac{16}{9}$

$r_4 = \frac{16 r_3}{9}$

177. Consider an imaginary ion ${}^{48}_{22}X^{3-}$. The nucleus contains 'a'% more neutrons than the number of electrons in the ion. The value of 'a' is ..... [nearest integer]

(A) 4 (B) 3 (C) 8 (D) 5

Ans. : a

${}^{48}_{22}X^{3-}$

No. of neutrons $= 26$

No. of electrons $= 25$

$\%$ of extra neutrons

than electrons $= \frac{26-25}{25} \times 100 = 4$

178. The number of radial and angular nodes in $4d$ orbital are, respectively ....

(A) 1 and 2 (B) 3 and 2 (C) 1 and 0 (D) 2 and 1

Ans. : a

Radial node $= n - l - 1$

$= 4 - 2 - 1$

$= 1$

Angular node $(l) = 2$

179. The minimum energy that must be possessed by photons in order to produce the photoelectric effect with platinum metal is .... $\times 10^{-19}\, J$

[Given: The threshold frequency of platinum is $1.3 \times 10^{15}\, s^{-1}$ and $h = 6.6 \times 10^{-34}\, J\, s$.]

(A) 32.1 (B) 0.624 (C) 8.58 (D) 976

Ans. : c

$W = hv$

$= 6.6 \times 10^{-34} \times 1.3 \times 10^{15}$

$= 8.58 \times 10^{-19}\, J$

180. The pair, in which ions are isoelectronic with Al^{3+} is ..... .

(A) Br^{-} and Be^{2+} (B) Cl^{-} and Li^{+} (C) S^{2-} and K^{+} (D) O^{2-} and Mg^{2+}

Ans. : d

Isoelectronic species have same no. of electrons Al^{+3},O^{2-},Mg^{+2} all have 10 electrons.

181. If the uncertainty in velocity and position of a minute particle in space are, $2.4 \times 10^{-26}\left(m\, s^{-1}\right)$ and $10^{-7}\,(m)$ respectively. The mass of the particle in g is .... (Nearest integer)

(Given : $h = 6.626 \times 10^{-34} Js$)

(A) 22 (B) 45 (C) 89 (D) 63

Ans. : a

$\Delta V = 2.4 \times 10^{-26} ms^{-1}$

$\Delta x = 10^{-7} m$

$\because \Delta p \cdot \Delta x = \frac{h}{4\pi}$

$\therefore m \Delta V \Delta x = \frac{h}{4\pi}$

$\Rightarrow m \times 2.4 \times 10^{-26} \times 10^{-7} = \frac{6.626 \times 10^{-34}}{4 \times \pi}$

$m = \frac{6.626}{9.6 \times \pi} \times 10^{-1}$

$m = 0.02198\, kg$

$m = 21.98\, gm$

nearest integer $= 22$

182. If the wavelength for an electron emitted from H atom is $3.3 \times 10^{-10}\, m$, then energy absorbed by the electron in its ground state compared to minimum energy required for its escape from the atom, is .... times. (Nearest integer).

[Given : $h = 6.626 \times 10^{-34}\, Js$,Mass of electron $= 9.1 \times 10^{-31}$]

(A) 1 (B) 3 (C) 2 (D) 0

Ans. : c

$\lambda = \frac{h}{\sqrt{2mK}}$

$K = \frac{h^2}{2m\lambda^2}$

$K = \frac{h^2}{2m\lambda^2} = \frac{43.9 \times 10^{-68}}{2 \times 9.1 \times 10^{-31} \times 10.89 \times 10^{-20}}$

$K = 2.215 \times 10^{-18}$

$E_{abs} = E_{\text{req}} + K$

$\frac{E_{\text{abs}}}{E_{\text{req}}} = 1 + \frac{K}{E_{\text{req}}} = 1 + \frac{2.215 \times 10^{-18}}{13.6 \times 1.602 \times 10^{-19}} = 2.0166$

183. Which of the following pair is not isoelectronic species? (At. no. $Sm, 62; Er, 68 : Yb, 70 : Lu, 71; Eu, 63 : Tb$, 65; $\mathrm{Tm}, 69)$

(A) Sm^{2+} and Er^{3+}

(B) Yb^{2+} and Lu^{3+}

(C) Tb^{2+} and Tm^{4+}

(D) both (A) and (C) are true

Ans. : d

$Sm^{2+} \rightarrow$ electron $= 60$

$Er^{3+} \rightarrow$ electron $= 65$

$Tb^{2+} \rightarrow$ electron $= 63$

$Tm^{4+} \rightarrow$ electron $= 65$

all are $(not\, isoelectronic)$

184. A $50\, watt$ bulb emits monochromatic red light of wavelength of 795 nm. The number of photons emitted per second by the bulb is $\mathrm{x} \times 10^{20}$. The value of x is ....

[Given : $\mathrm{h} = 6.63 \times 10^{-34}\,\mathrm{Js}$ and $\mathrm{c} = 3.0 \times 10^{8}\ \mathrm{ms}^{-1}$]

(A) 1 (B) 4 (C) 2 (D) 3

Ans. : c

Total energy per sec. $= 50$ J

$50 = \frac{\mathrm{n} \times 6.63 \times 10^{-34} \times 3 \times 10^{8}}{795 \times 10^{-9}}$

$\mathrm{n} = 1998.49 \times 10^{17} [\mathrm{n} = \mathrm{no.}$ of photons per second]

$= 1.998 \times 10^{20}$

$\simeq 2 \times 10^{20}$

$= \mathrm{x} \times 10^{20}$

$\mathrm{x} = 2$

185. Radius of 1^{st} orbit of H and some orbit of Be^{3+} is same . Energy of their orbit of Be^{3+} is ....eV

(A) -54.4 (B) -13.6 (C) -108.8 (D) -27.2

Ans. : a

The radius of n^{th} orbit is,

$r_n \propto \frac{n^2}{Z}$

$(r_1)_H = (r_n)_{Be^{3-}}$

$\frac{1^2}{1} = \frac{n^2}{4}$

$n = 2$

The energy of their orbit is,

$(E)_{Be^{3+}} = -13.6\left(\frac{Z^2}{n^2}\right)$

$= -13.6\left(\frac{4^2}{2^2}\right)$

$= -54.4\, e.V$

186. How many spectral line of Balmer series present in visible region :

(A) 5 (B) 4 (C) 2 (D) 3

Ans. : b

For balmer series,

$n_1 = 2$ and $n_2 = 3, 4, 5, 6, \ldots\ldots$

In balmer series, four spectral lines are available in visible region. These spectral lines have wavelengths greater than $400\, nm$ and smaller than $700\, nm$.

187. Which of the following elements outermost orbit's last electron has magnetic quantum number $m = 0$?

(A) Na (B) O (C) Cl (D) N

Ans. : a

m equals to zero corresponds to the s electron, which is the last electron of the element should be an s electron.

For Na, $1s^2 2s^2 2p^6 3s^1$

188. If $n = 2$ for He^+ ion than ....$\overset{o}{A}$ out the wave length

(A) 3.33 (B) 6.42 (C) 1.47 (D) 2.37

Ans. : a

Asn $= 2$ and $Z = 2$ for He^+ ion, so the wave length is calculated below.

$2\pi r = n\lambda \quad \because r = 0.529\frac{n^2}{Z}$

$2\pi \times 0.529\frac{n^2}{Z} A = n\lambda$

$\lambda = \frac{2 \times 3.14 \times 0.529 \times 2}{2} A$

$\lambda = 3.33\, \overset{o}{A}$

189. In which one of the following pairs of experimental observations and phenomenon does the experimental observation correctly account for phenomenon

(A) X-ray spectraCharge on the nucleus

(B) α-particle scatteringQuantized electron orbit

(C) Emission spectraThe quantization of energy

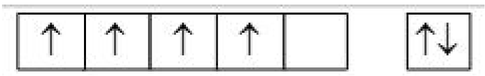
(D) The photoelectric effectThe nuclear atom

Ans. : c

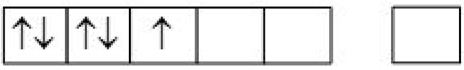
(c) Emission spectra of different λ accounts for quantisation of energy.

190. Which one is the correct outer configuration of chromium

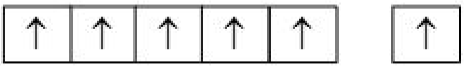
(A)



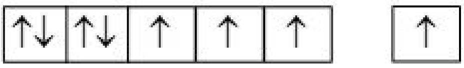
(B)



(C)



(D)



Ans. : c

(c) $Cr_{24} = (Ar)\,3d^5\,4s^1$ electronic configuration because half filled orbital are more stable than other orbitals.

191. The following sets of quantum numbers represent four electrons in an atom

$(i)\ n = 4, l = 1$ $\quad$ $(ii)\ n = 4, l = 0$

$(iii)\ n = 3, l = 2$ $\quad$ $(iv)\ n = 3, l = 1$

The sequence representing increasing order of energy, is

(A) $(iii) < (i) < (iv) < (ii)$

(B) $(iv) < (ii) < (iii) < (i)$

(C) $(i) < (iii) < (ii) < (iv)$

(D) $(ii) < (iv) < (i) < (iii)$

Ans. : b

$(i)\ 4p$ $\quad$ $(ii)\ 4s$

$(iii)\ 3d$ $\quad$ $(iv)\ 3p$

According to Bohr Bury's $(n+l)$ rule, increasing order of energy will be $(iv) < (ii) < (iii) < (i)$.

Note : If the two orbitals have same value of $(n+l)$ then the orbital with lower value of n will be filled first.

192. The electrons identified by quantum numbers n and l :

$(A)\, n = 4, l = 1$ $\quad$ $(B)\, n = 4, l = 0$

$(C)\, n = 3, l = 2$ $\quad$ $(D)\, n = 3, l = 1$

can be placed in order of increasing energy as :

(A) $(C) < (D) < (B) < (A)$

(B) $(D) < (B) < (C) < (A)$

(C) $(B) < (D) < (A) < (C)$

(D) $(A) < (C) < (B) < (D)$

Ans. : b

$(a) n = 4, l = 1 (p-\text{ subshell }),$ so $4p$

$(b) = 4, l = 0$ ($s-$ subshell), so $4s$

$(c) n = 3, l = 2 (d\text{-subshell}), \text{so } 3d$

$(d) n=3, l=1$ ($p-$ subshell), so $3p$

Accroding to the Bohr $(n+l)$ rule, Enery order of the subshell : $3p<4s<3d<4p$

193. If the radius of first orbit of H atom is a_0, the de-Broglie wavelength of an electron in the third orbit is

(A) $4\pi a_0$ (B) $8\pi a_0$ (C) $6\pi a_0$ (D) $2\pi a_0$

Ans. : c

$r_H=a_0 n^2$

$r=a_0\times(3)^2=9a_0$

$mvr=\frac{nh}{2\pi};$

$mv=\frac{nh}{2\pi r}=\frac{3h}{2\pi\times 9a_0}=\frac{h}{6\pi a_0}$

$\lambda=\frac{h}{mv}=\frac{h}{h}\times 6\pi a_0=6\pi a_0$

194. If the kinetic energy of an electron is increased four times, the wavelength of the de-Broglie wave associated with it would become

(A) one fourth (B) half (C) four times (D) two times

Ans. : b

de-Broglie wavelength is given by :

$\lambda=\frac{h}{mv}\ldots(i)$

$K.E.=\frac{1}{2}mv^2$

$v^2=\frac{2KE}{m}$

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

Substituting this in equation (i)

$\lambda=\frac{h}{m}\sqrt{\frac{m}{2KE}}$

$\lambda=h\sqrt{\frac{1}{2m(K.E.)}}\ldots(i)$

i.e. $\lambda\propto\frac{1}{\sqrt{KE}}$

$\therefore$ when KE become 4 times wavelength become $1/2$

195. The energy required to break one mole of $Cl-Cl$ bonds in Cl_2 is $242\,kJ\,mol^{-1}$. The longest wavelength of light capable of breaking a single $Cl-Cl$ bond is .... nm

($C=3\times10^8\,ms^{-1}$ and $N_A=6.02\times mol^{-1}$).

(A) 594 (B) 640 (C) 700 (D) 494

Ans. : d

Energy required to break one $\mathrm{Cl_2}$ molecule $=\frac{242\times10^3}{6.02\times10^{23}}\ \mathrm{J}$

As $\mathrm{E}=\frac{hc}{\lambda}$

So $\lambda=\frac{hc}{E}$

$= \frac{6.626\times10^{-34}\times3\times10^{8}\times6.02\times10^{23}}{242\times10^{3}}$

$= 494\times10^{-9}\,\mathrm{m}$

$= 494\,\mathrm{nm}$

196. Calculate the wavelength (in nanometer) associated with a proton moving at $1.0\times10^{3}\,ms^{-1}$. .... nm

(Mass of proton $= 1.67\times10^{-27}\,kg$ and $h = 6.63\times10^{-34}\,Js$)

(A) 0.40 (B) 2.5 (C) 14 (D) 0.32

Ans. : a

Wavelength $(\lambda) = \frac{h}{mv}$

$= \frac{6.63\times10^{-34}}{1.67\times10^{-27}\times10^{3}}$

$= 0.4\times10^{-9}$

$= 0.4\,\mathrm{nm}$

197. In an atom, an electron is moving with a speed of $600\,m/s$ with an accuracy of 0.005%. Certainity with which the position of the electron can be located is $(h = 6.6\times10^{-34}\,kg\,m^{2}s^{-1}$, mass of electron, $e_m = 9.1\times10^{-31}\,kg)$:

(A) $5.10\times10^{-3}\,m$ (B) $1.92\times10^{-3}\,m$ (C) $3.84\times10^{-3}\,m$ (D) $1.52\times10^{-4}\,m$

Ans. : b

% error in velocity $= \frac{\Delta V}{V}\times100$

$\therefore 0.005 = \frac{\Delta V}{600}\times100$

$\Rightarrow \Delta v = 3\times10^{-2}$

According to Heisenberg uncertainty principle,

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

$\Rightarrow \Delta x = \frac{h}{4\pi m\Delta V}$

$\Rightarrow \Delta x = \frac{6.63\times10^{-34}}{4\times3.14\times9.1\times10^{-31}\times3\times10^{-2}}$

$= 1.92\times10^{-3}\,\mathrm{m}$

198. Which one of the following constitutes a group of the isoelectronic species?

(A) $C_2^{2-}, O_2^{-}, CO, NO$ (B) $NO^{+}, C_2^{2-}, CN^{-}, N_2$

(C) $CN^{-}, N_2, O_2^{2-}, C_2^{2-}$ (D) N_2, O_2^{-}, NO^{+}, CO

Ans. : b

Isoelectronic species possess same number of electrons. NO^{+}, C_2^{2-}, CN^{-} and N_2 , each have 14 electrons and thus are isoelectronic.

199. Consider the ground state of $(Z = 24)$. The numbers of electrons with the azimuthal quantum numbers, $l = 1$ and 2 are, respectively

(A) 16 and 4 (B) 12 and 5 (C) 12 and 4 (D) 16 and 5

Ans. : b

(b) ${}_{24}Cr \rightarrow 1s^2, 2s^2, \underset{l=1}{2p^6}, 3s^2, \underset{l=1}{3p^6}, \underset{l=2}{3d^5}, 4s^1$

(We know that for p the value of $l=1$ and for d, $l=2$)

For $l=1$ total number of electron $=12$

For $l=2$ total number of electron $=5$.

200. Which one of the following sets of ions represents the collection of isoelectronic species

(A) $K^+, Cl^-, Mg^{2+}, Sc^{3+}$

(B) $Na^+, Ca^{2+}, Sc^{3+}, F^-$

(C) $K^+, Ca^{2+}, Sc^{3+}, Cl^-$

(D) $Na^+, Mg^{2+}, Al^{3+}, Cl$

Ans. : c

(c) Isoelectronic species are those which have same no. of electrons.

$K^+ = 19 - 1 = 18$; $Ca^{+2} = 20 - 2 = 18$

$Sc^{3+} = 21 - 3 = 18$; $Cl^- = 17 + 1 = 18$

----- "Success is not the result of spontaneous combustion. You must set yourself on fire." — Arnold H. Glasow -----