HINTS & SOLUTIONS

EXERCISE - 1

NEET LEVEL

1. **(D)** Neutrons and protons in the nucleus and electrons in the extranuclear region.

2. **(A)** It consists of proton and neutron and these are also known as nucleones.

3. **(C)** Radius of nucleus $\simeq 10^{-15}$m.

4. **(C)** Positive ions are formed from the neutral atom by the loss of electrons.

5. **(B)** The β-ray particle constitute electrons.

6. **(B)** The number of electrons in an atom is equal to its atomic number i.e. number of protons.

7. **(A)** No. of protons = Atomic no. = 25 and no. of neutron = 55 - 25 = 30.

8. **(B)** No. of neutrons = mass number - no. of protons. = W - N.

9. **(B)** $_{30}Zn^{70}, Zn^{2+}$ has No. of Neutrons = 70 - 30 = 40.

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

11. **(A)** One molecule of CO_2 have 22 electrons.

12. **(C)** Cl and Cl^- differs in number of electrons. Cl has $17e^-$ while Cl has $18e^-$.

13. **(B)** CO and CN^- are isoelectronic.
 CO = 6 + 8 = 14 and CN^- = 6 + 7 +1 = 14.

14. **(C)** Mass of an atom is due to nucleus (neutron + proton).

15. **(B)** Atomic number is defined as the number of protons in the nucleus.

16. **(B)** $_{26}X^{56}$ $A = P + N = Z + N = E + N$
 $N = A - E = 56 - 26 = 30$

17. **(C)** Most probable radius = a_0 / Z
 where a_0 = 52.9 pm. For helium ion, Z = 2.
 r_{mp} = = 26.45 pm.

18. **(B)** Four unpaired electron are present in the Fe^{2+} ion
 $Fe^{2+}_{26} = [Ar]3d^6, 4s^0$

19. **(C)** Na^+ has 10 electron and Li^+ has 2 electron so these are different number of electron from each other.

20. **(C)** 21. **(C)**

22. **(A)** The central part consisting whole of the positive charge and most of the mass caused by nucleus, is extremely small in size compared to the size of the atom.

23. **(B)** Electrons in an atom occupy the extra nuclear region.

24. **(B)** According to the Bohr model atoms or ions contain one electron.

25. **(D)** The nucleus occupies much smaller volume compared to the volume of the atom.

26. **(B)**

27. **(C)** α-particles pass through because most part of the atom is empty.

28. **(B)** An electron jumps from L to K shell energy is released.

29. **(C)** Neutron is a chargeless particles, so it does not deflected by electric or magnetic field.

30. **(A)** Energy is always absorbed or emitted in whole number or multiples of quantum.

31. **(B)** Both He and Li^+ contain 2 electrons each.

32. **(A)** 33. **(D)** 34. **(B)** 35. **(B)**

36. **(C)** 37. **(A)**

38. **(C)** During the experimental verification of de-Broglie equation, Davisson and Germer confirmed wave nature of electron.

39. **(A)** Increases due to absorption of energy and it shows absorption spectra.

40. **(D)** Rutherford -Scattering experiment.

41. **(C)** According to de-Broglie equation $\lambda = \frac{h}{mv}$ or $\frac{h}{p}$ or $\frac{h}{mc}$.

42. **(A)** 43. **(A)**

44. **(B)** $\lambda = \frac{h}{p}$ or $\frac{h}{mv}$ or $\frac{h}{mc}$ de-Broglie equation.

45. **(C)** Emission spectra of different λ accounts for quantisation of energy.

46. (C) **47. (A)**

48. (B) The shape of an orbital is given by azimuthal quantum number 'l'.

49. (D)

50. (C) Hund's rule states that pairing of electrons in the orbitals of a subshell (orbitals of equal energy) starts when each of them is singly filled.

51. (C) $1s^2, 2s^2, 2p^6$ represents a noble gas electronic configuration.

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

53. (A) n, l and m are related to size, shape and orientation respectively.

54. (A) Electronic configuration of $Rb_{(37)}$ is

$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$

So for the valence shell electron $(5s^1)$

$$n = 5, l = 0, m = 0, s = +\frac{1}{2}$$

55. (A) 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.

56. (C) In 2p - orbital, 2 denotes principal quantum number (n) and p denotes azimuthal quantum number (l = 1).

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

58. (A) The electronic configuration must be $1s^2 2s^1$. Hence, the element is lithium $(z = 3)$.

59. (A) Principal quantum no. tells about the size of the orbital.

60. (D) An element has the electronic configuration $1s^2, 2s^2 2p^6, 3s^2 3p^2, (Si)$. It's valency electrons are four.

EXERCISE - 2

AIIMS LEVEL

1. (D)Photoelectric effect is a random phenomena. So, electron It may come out with a kinetic energy less than $(h\nu - w)$ as some energy is lost while escaping out.

2. (C)For photoelectric effect to take place, $E_{light} \geq W$

$\therefore \frac{hc}{\lambda} \geq \frac{hc}{\lambda_0}$ or $\lambda \leq \lambda_0$.

3. (D)Power $= \frac{nhC}{\lambda \times t} \Rightarrow 40 \times \frac{80}{100}$

$= \frac{n \times 6.62 \times 10^{-34} \times 3 \times 10^{8}}{620 \times 10^{-9} \times 20} \Rightarrow n = 2 \times 10^{21}$

4. (C)$E_n = -78.4$ kcal/mole $= -78.4 \times 4.2 = -329.28$ kJ/mole

$= -\frac{329.28}{96.5}$ eV $= -3.4$ eV.

(energy of II orbit of H atom).

5. (A) $r \alpha \left(\frac{n^2}{Z}\right)$ As Z increases, radius of I orbit decreases.

6. (B)Radius $= 0.529 \frac{n^2}{Z}$ Å $= 10 \times 10^{-9}$ m

So, $n^2 = 189$ or, $n \approx 14$ **Ans.**

7. (B)$E_1(H) = -13.6 \times \frac{1^2}{1^2} = -13.6$ eV ;

$E_2(He^+) = -13.6 \times \frac{2^2}{2^2} = -13.6$ eV

$E_3(Li^{2+}) = -13.6 \times \frac{3^2}{3^2} = -13.6$ eV ;

$E_4(Be^{3+}) = -13.6 \times \frac{4^2}{4^2} = -13.6$ eV

$\therefore E_1(H) = E_2(He^+) = E_3(Li^{2+}) = E_4(Be^{3+})$

8. (A)$V = 2.188 \times 10^6 \frac{Z}{n}$ m/s

Now, $V \propto \frac{Z}{n}$ so, $\frac{V_{Li^{2+}}}{V_H} = -\frac{Z_1/n_1}{Z_2/n_2} = \frac{3/3}{1/1} = 1$

or, $V_{Li^{2+}} = V_H$

9. (A)$r_1 - r_2 = 24 \times (r_1)_H$

$\frac{0.529 \times n_1^2}{1} - \frac{0.529 \times n_2^2}{1} = 24 \times 0.529$

$\therefore \left(n_1^2 - n_2^2\right) = 24$

So, $n_1 = 5$ and $n_2 = 1$

10. (C)I.P. = 340 V so, I.E. = 340 eV = $13.6 \frac{Z^2}{(1)^2}$

so, $Z^2 = 25$ so, $Z = 5$ Therefore, (B) is correct option.

11. (D)Velocity $\propto \frac{Z}{n}$; Frequency $\propto \frac{Z^2}{n^3}$;

Radius $\propto \frac{n^2}{Z}$; Force $\propto \frac{Z^2}{n^4}$.

12. (B)S1 : Potential energy of the two opposite charge system decreases with decrease in distance,

S4 : The energy of I[st] excited state of He^+ ion

$= -3.4 Z^2 = -3.4 \times 2^2 = -13.6$ eV.

S_2 and S_3 are correct statement.

13. (C)S1 : Be^{2+} ion has 2 electron so Bohr model is not applicable.

S_2, S_3 and S_4 are correct statement.

14. (C)(a) Energy of ground state of He^+ $= -13.6 \times 2^2 = -54.4$ eV (iv)

(b) Potential energy of I orbit of H-atom $= -27.2 \times 1^2 = -27.2$ eV (ii)

(c) Kinetic energy of II excited state of He^+ $= 13.6 \times \frac{2^2}{3^2} = 6.04$ eV (i)

(d) Ionisation potential of He^+ $= 13.6 \times 2^2 = 54.4$ V (iii)

15. (D) $\lambda = \frac{hc}{\Delta E} \therefore \lambda \alpha \frac{1}{\Delta E}$

16. (B)When electron falls from n to 1, total possible number of lines = n – 1.

17. (A)$E_n = E_1 \frac{Z^2}{n^2}$ $E_5 = -13.6 \times \frac{(1)^2}{(5)^2} = -0.54$ eV

18. (D)According to energy, $E_{4\to1} > E_{3\to1} > E_{2\to1} > E_{3\to2}$.

According to energy, Violet > Blue > Green > Red.

$\therefore$ Red line $\Rightarrow$ $3 \to 2$ transition.

19. (D) For 1st line of Balmer series

$$\bar{v}_1 = R_H(3)^2\left[\frac{1}{(2)^2}-\frac{1}{(3)^2}\right] = 9R\left(\frac{5}{36}\right) = \frac{5}{4}R$$

For last line of Pachen series

$$\bar{v}_2 = R_H(3)^2\left[\frac{1}{(3)^2}-\frac{1}{(\infty)^2}\right] = R$$

so, $\bar{v}_1 - \bar{v}_2 = \frac{5}{4}R - R = \frac{R}{4}$.

20. (A) Li^{2+}, H and He^{+} are single electron species.

21. (C) Visible lines $\Rightarrow$ Balmer series ($5\to2, 4\to2, 3\to2$). So, 3 lines.

22. (C) Infrared lines = total lines – visible lines – UV lines

$$= \frac{6(6-1)}{2} - 4 - 5 = 15 - 9 = 6.$$

(visible lines = 4 $6\to2, 5\to2, 4\to2, 3\to2$)
(UV lines = 5 $6\to1, 5\to1, 4\to1, 3\to1, 2\to1$)

23. (B) $r_1 = 0.529$ Å
$r_3 = 0.529 \times (3)^2$ Å $= 9x$

so, $\lambda = \frac{2\pi r}{n} = \frac{2\pi(9x)}{3} = 6\pi x$.

24. (D) $\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}} = \sqrt{\frac{200}{50}} = \frac{2}{1}$.

25. (C) $\lambda = \frac{h}{mv} = \frac{6.625\times10^{-34}}{0.2\times5} \times 3600 \approx 10^{-30}$ m.

26. (A) For a charged particle $\lambda = \frac{h}{\sqrt{2mqV}}$, $\therefore$ $\lambda \propto \frac{1}{\sqrt{V}}$.

27. (C) $\Delta p \,.\, \Delta x = \frac{h}{4\pi}$ $\Rightarrow$ $\Delta x = \frac{6.62\times10^{-34}}{4\times3.14\times1\times10^{-5}}$

$= 5.27 \times 10^{-30}$ m.

28. (C) For an α particle, $\lambda = \frac{0.101}{\sqrt{V}}$ Å.

29. (B) $\lambda \propto \frac{n}{Z}$ $\therefore$ $\frac{n_1}{Z_1} = \frac{n_2}{Z_2}$ or $\frac{2}{3} = \frac{4}{6}$ (n = 4 of C^{5+} ion)

30. (D) d^7 : 3 unpaired electrons. $\therefore$ Total spin $= \pm\frac{n}{2} = \pm\frac{3}{2}$.

31. (B) Zn^{2+} : [Ar] $3d^{10}$ (0 unpaired electrons).
Fe^{2+} : [Ar] $3d^6$ (4 unpaired electrons) maximum.
Ni^{3+} : [Ar] $3d^7$ (3 unpaired electrons).
Cu^{+} : [Ar] $3d^{10}$ (0 unpaired electrons).

32. (A) Orbital angular momentum $= \sqrt{\ell(\ell+1)}\,\frac{h}{2\pi} = 0$.

$\therefore$ $\ell = 0$ (s orbital).

33. (D) Cu : $1s^22s^22p^63s^23p^63d^{10}4s^1$.
$\therefore$ Cu^{2+} : $1s^22s^22p^63s^23p^63d^9$ or $[Ar]3d^9$.

34. (A) Magnetic moment $= \sqrt{n(n+2)} = \sqrt{24}$ B.M.
$\therefore$ No. of unpaired electron = 4.
X_{26} : $1s^2\,2s^22p^63s^23p^63d^64s^2$.
To get 4 unpaired electrons, outermost configuration will be $3d^6$.
$\therefore$ No. of electrons lost = 2 (from $4s^2$).
$\therefore$ n = 2.

35. (B) Cr (Zn = 24)
electronic configuration is : $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1\,3d^5$
so, no of electron in $\ell = 1$ i.e. p subshell is 12 and no of electron in $\ell = 2$ i.e. d subshell is 5.

36. (A) X_{23} : $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^3\,4s^2$.
No. of electron with $\ell = 2$ are 3 ($3d^3$).

37. (B) Orbital angular momentum $= \sqrt{\ell(\ell+1)}\,\frac{h}{2\pi} = 0$

(since $\ell = 0$ for s orbital).

38. (D) Cl_{17}^{-} : [Ne] $3s^2\,3p^6$.
Last electron enters 3p orbital.
$\therefore$ $\ell = 1$ and m = 1, 0, –1.

39. (C) Number of radial nodes $= n - \ell - 1 = 1$, n = 3. $\therefore$ $\ell = 1$.

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

40. (C) Cl_{17} : [Ne] $3s^2\,3p^5$.
Unpaired electron is in 3p orbital.
$\therefore$ n = 3, $\ell = 1$, m = 1, 0, – 1.

41. (A) $_{24}Cr$: $[Ar]3d^54s^1$

(B) $m = -\ell$ to $+\ell$ through zero.

(C) ${}_{47}Ag : 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1 4d^{10}$.
Since only one unpaired electron is present.

42. (A) F^- have the same number of electrons with the neon atom.

43. (D) No change by doubling mass of electrons however by reducing mass of neutron to half total atomic mass becomes 6 + 3 instead of 6 + 6. Thus reduced by 25%.

44. (D) $\frac{e}{m}$ for (i) neutron $= \frac{0}{1} = 0$

(ii) $\alpha -$ particle $= \frac{2}{4} = 0.5$

(iii) Proton $= \frac{1}{1} = 1$

(iv) electron $= \frac{1}{1/1837} = 1837$.

45. (A) Metal is ${}_{56}M^{2+}$ $(2,8,14)$ than $n = A - Z = 56 - 26 =$ 30

46. (D) $E = hv = h\frac{c}{\lambda}$ i.e. $E \propto \frac{1}{\lambda}$

$$\frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1} = \frac{4000}{2000} = 2.$$

47. (C) Rutherford discovered nucleus.

48. (B) According to Bohr's model $\Delta E = E_1 - E_3$

$$= 2.179 \times 10^{-11} - \frac{2.179 \times 10^{11}}{9}$$

$$= \frac{8}{9} \times 2.179 \times 10^{-11} = 1.91 \times 10^{-11} = 0.191 \times 10^{-10} \text{erg}$$

Since electron is going from $n = 1$ to $n = 3$ hence energy is absorbed.

49. (D) Radius of nucleus $= 1.25 \times 10^{-13} \times A^{1/3}$ cm

$$= 1.25 \times 10^{-13} \times 64^{1/3} = 5 \times 10^{-13} \text{ cm}$$

Radius of atom = $1Å = 10^{-8}$ cm.

$$\frac{\text{Volume of nucleus}}{\text{Volume of atom}} = \frac{(4/3)\pi(5 \times 10^{-13})^3}{(4/3)\pi(10^{-8})^3}$$

1.25×10^{-13}.

50. (A) Values of energy in the excited state $= -\frac{13.6}{n^2}$eV

$$= \frac{-13.6}{4} = -3.4\,\text{eV} \text{ in which } n = 2, 3, 4 \text{ etc.}$$

51. (C) $E_{1\,He^+} = E_{1\,H} \times z^2$

$$-871.6 \times 10^{-20} = E_{1H} \times 4$$

$$E_{1\,H} = -217.9 \times 10^{-20}\,\text{J}$$

52. (A) 42g of N_3^- ions have $16\,N_A$ valence electrons 4.2g of N_3^- ion have $= \frac{16\,N_A}{42} \times 4.2 = 1.6\,N_A$.

53. (D) I^{st} excited state means $n = 2$

$$r = r_0 \times 2^2 = 0.53 \times 4 = 2.12\,Å$$

54. (D) Frequency $\nu = 12 \times 10^{14}\,s^{-1}$ and velocity of light $c = 3 \times 10^{10}\,\text{cm}\,s^{-1}$. We know that the wave number

$$\bar{\nu} = \frac{v}{c} = \frac{12 \times 10^{14}}{3 \times 10^{10}} = 4 \times 10^4\,\text{cm}^{-1}$$

55. (C) The last line in any series is called series limit. Series limit for Balmer series is 3646 Å.

56. (B) $E = \frac{-13.6}{n^2} = \frac{-13.6}{4} = -3.4\,\text{eV}$

We know that energy required for excitation $\Delta E = E_2 - E_1 = -3.4 - (-13.6) = 10.2\,\text{eV}$

Therefore energy required for excitation of electron per atom

$$= \frac{10.2}{6.02 \times 10^{23}} = 1.69 \times 10^{-23}\,\text{J}$$

EXERCISE - 3

P-1 (Matrix Match)

1. A → (u), B → (s), C → (p), D → (t), E → (q), F → (r)

2. $f_n = \frac{v_n}{2\pi r_n}$, $f_n \propto \frac{Z^2}{n^3}$, $T_n = \frac{2\pi r_n}{v_n}$, $T_n \propto \frac{n^3}{Z^2}$.

$E_n = -13.6\frac{Z^2}{n^2}$, $E_n \propto \frac{Z^2}{n^2}$, $r_n \propto \frac{n^2}{Z}$.

3. **(i)** : For Lyman series, $\bar{v}$ for second line (3 → 1)

$= R(1)^2\left[\frac{1}{1^2}-\frac{1}{3^2}\right] = \frac{8R}{9}$ **(c)**.

(ii) : For Balmer series, $\bar{v}$ for second line (4 → 2)

$= R(1)^2\left[\frac{1}{2^2}-\frac{1}{4^2}\right] = \frac{3R}{16}$ **(d)**.

(iii) : In a sample of H-atom for 5 → 2 transition, maximum number of spectral lines observed

$= \frac{(5-2)(5-2+1)}{2} = 6$ **(a)**.

(iv) : In a single isolated H-atom for 3→1 transition, maximum number of spectral lines observed

= 2 (3→2, 2→1) **(b)**.

4. A → (t), B → (s), C → (u), D → (q), E → (p), F → (r)

EXERCISE - 3

P-2 (Assertion & Reason)

1. $q_\alpha = 2q_p$ and $m_\alpha = 4m_p$

2. For principle quantum number n

ℓ = 0 to (n – 1) and m = – ℓ to ℓ including zero.

3. $\lambda = \sqrt{\frac{150}{V}}$ Å

4. **Assertion :** Correct statement.

Reason : $\frac{1}{\lambda} = R_H Z^2\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$.

5. For Humphry series, (n_2 = 7,8,9.......) and n_1 = 6.

6. Since interaction between a photon and a molecule is always one to one, so a photon of energy 12eV can break only one molecule of A_2 into atoms and remaining 8eV energy becomes kinetic energy of atoms.

7. e/m ratio for particles in cathode rays comes out to be same for all gases.

$e/m = 1.76 \times 10^{11}$ C/kg.

This led to the conclusion that electrons were fundamental particles.

8. e/m ratio for particles in anode rays is different for different gases as different gases produce different positively charged particles upon ionisation.

9. **(C)** Assertion is true but reason is false. Spin angular momentum of the electron, a vector quantity, can have two orientations (represented by + and - sign) relative to a chosen axis. These two orientation are distinguished by the spin quantum number s equals to $+\frac{1}{2}$ or $-\frac{1}{2}$.

These are called the two spin states of the electron and are normaly represented by the two arrows ↑ (spin up) and ↓ (spin down) respectively.

10. **(E)** Both assertion and reason are false. Total number of orbitals associated with Principal quantum number n = 3 is 9. One 3s orbital + three 3p orbital + five 3d orbitals. Therefore there are a total number of nine orbitals. ∴ Number of orbitals in a shell equals to n^2.

11. (C) Assertion is true but reason is false. The order $1s < 2s = 2p < 3s = 3p = 3d < ....$ is true for the energy of an electron in a hydrogen atom and is solely determined by Principal quantum number. For multielectron system energy also depends on azimuthal quantum number. The stability of an electron in a multi electron atom is the net result of the attraction between the electron and the uncleus and the repulsion between the electron and the rest of the electron present. Energies of different subshell (azimuthal quantum number) present within the same principal shell are found to be in order of s < p < d < f.

12. (D) Assertion is false but reason is true. Splitting of the spectral lines in the presence of a magnetic field is known as Zeeman effect or in electric field it is known as stark effect. The splitting of spectral lines is due to different orientations which the orbitals can have in the presence of magnetic field.

13. (A) Both assertion and reason are true and reason is the correct explanation of assertion.

14. (D) Assertion is false but reason is true. Atomic orbital is designated by n, l and m while state of an electron in an atom is specified by four quantum numbrs n, l, m and s.

15. (B) Both assertion and reason are true but reason is not the correct explanation of assertion. The difference between the energies of adjacent energy levels decreases as we move away from the nucleus. Thus in H atom

$E_2 - E_1 > E_3 - E_2 > E_4 - E_3 ......$

16. (E) Both assertion and reason are false. Cathode rays are stream of electrons. They are generated through gases at low pressure and high voltage.

17. (E) Both assertion and reason are false. In case of isoelectronic, i.e., ions, having the same number of electrons and different nuclear charge, the size decreases with increase in atomic number.

Ion	At. No.	No. of electrons	Ionic radii
Na^+	11	10	0.95Å
Mg^{2+}	12	10	0.65Å
Al^{3+}	13	10	0.50Å

EXERCISE - 4

P-1 (NEET/AIPMT)

1. **(C)** : Ionisation energy of H = 2.18×10^{-18} J atom^{-1}

$\therefore$ E_1 (Energy of Ist orbit of H-atom)

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

$$\therefore \quad E_n = \frac{-2.18\times10^{-18}}{n^2} \text{J atom}^{-1}$$

Z = 1 for H-atom

$\Delta_E = E_4 - E_1$

$$= \frac{-2.18\times10^{-18}}{4^2} - \frac{-2.18\times10^{-18}}{1^2}$$

$$= -2.18\times10^{-18} \times \left[\frac{1}{4^2} - \frac{1}{1^2}\right]$$

$$\Delta E = -2.18 \times 10^{-18} \times -\frac{15}{16}$$

$= +2.0437 \times 10^{-18}$ J atom^{-1}

$$\therefore \quad v = \frac{\Delta E}{h}$$

$$= \frac{2.0437\times10^{-18}\,\text{Jatom}^{-1}}{6.625\times10^{-34}\,\text{Js}}$$

$= 3.084 \times 10^{15}$ s^{-1} atom^{-1}

2. **(D)** : The energy of second Bohr orbit of hydrogen atom (E_2) is –328 kJ mol–1

$$E_n = -\frac{1312}{n^2} \text{kJ mol}^{-1}$$

$$\therefore \quad E_n = -\frac{1312}{2^2} \text{kJ mol}^{-1}$$

If n = 4

$$\therefore \quad E_4 = -\frac{1312}{4^2} \text{kJ mol}^{-1}$$

$= -82$ kJ mol^{-1}

3. **(A)** : By Heisenberg's uncertainty principle

$$\Delta x \times \Delta p_x \geq \frac{h}{4\pi}$$

or $$\Delta x \times \Delta(mv_x) \geq \frac{h}{4\pi}$$

$$\Delta x \times \Delta v_x \geq \frac{h}{4\pi m}$$

Δp = uncertainty in momentum

Δx = uncertainty in position

Δv = uncertainty in velocity

m = mass of particle

Given that,

$\Delta x = 0.1$ Å $= 0.1 \times 10^{-10}$ m

$m = 9.11 \times 10^{-31}$ kg

h = Planck's constant = 6.626×10^{-34} Js

$\pi = 3.14$

Thus,

$$\Delta v \times 0.1\times10^{-10} = \frac{6.626\times10^{-34}}{4\times3.14\times9.11\times10^{-31}}$$

$$\Delta v = \frac{6.626\times10^{-34}}{4\times3.14\times9.11\times10^{-31}\times0.1\times10^{-10}} \text{ms}^{-1}$$

$= 5.785 \times 10^6$ ms^{-1} $= 5.79 \times 10^6$ ms^{-1}

4. **(C)** : The orientation of an atomic orbital governed by magnetic quantum number.

5. **(D)** : The value of l varies from 0 to (n - 1) and the value of m varies from $-l$ to $+l$ through zero.

The value of 's' $\pm\frac{1}{2}$ which signifies the spin of electron.

The correct sets of quantum number are following

	n	l	m	s
(ii)	2	1	1	$-\frac{1}{2}$
(iv)	1	0	0	$-\frac{1}{2}$
(v)	3	2	2	$+\frac{1}{2}$

6. **(A)** : According to Heisenberg's uncertainty principle

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

Given, $\Delta x = \Delta p$ (Δx = uncertainty in position)

$$(\Delta p^2) = \frac{h}{4\pi} \qquad (\Delta p = m \times \Delta v)$$

$$m^2 \Delta v^2 = \frac{h}{4\pi} \qquad m = \text{mass}$$

$$\Delta v^2 = \frac{h}{m^2 4\pi} \Rightarrow \Delta v = \frac{1}{2m}\sqrt{\frac{h}{\pi}}$$

(Δv = uncertainty in velocity)

7. **(A)** : Given, $\Delta p = 1 \times 10^{-18}$ g cm s^{-1} (uncertainty in momentum)

Mass = 9×10^{-28} g

$\Delta p = m\Delta v$

$1 \times 10^{-18} = 9 \times 10^{-28} \times \Delta v$ (uncertainty in velocity)

$\Delta v = 1 \times 10^9$ cm s^{-1}

8. (A) : Total number of subshells = (2l + 1)

∴ Maximum number of electrons in the subshell

$$= 2(2l + 1) = 4l + 2$$

9. (A) : Kinetic energy (KE) of molecule = energy absorbed by molecule – bon energy per molecule

$= (4.4 \times 10^{-19}) - (4.0 \times 10^{-19})\ J = 0.4 \times 10^{-19}\ J$

$$\text{KE per atom} = \frac{0.4\times10^{-19}}{2} J = 2.0\times10^{-20} J$$

10. (C) : If n = 3,

$l = 0$ to $(3 - 1) = 0, 1, 2$

$m = -l$ to $+1 = -2, -1, 0, +1, +2$

$$s = \pm\frac{1}{2}$$

Therefore, option **(C)** is not a permissible set of quantum numbers.

11. (D) : $6s \to 4f \to 5d \to 6p$ for n = 6

12. (A) : $E_1 = 25$ eV, $E_2 = 50$ eV

$$E_1 = \frac{hc}{\lambda_1} \text{ and } E_2 = \frac{hc}{\lambda_2}$$

$$\text{or } \frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1} \text{ or } \frac{25}{50} = \frac{\lambda_2}{\lambda_1} \text{ or } \lambda_1 = 2\lambda_2$$

13. (C) : ${}_{37}Rb = {}_{36}[Kr]5s^1$

Its valence electron is $5s^1$.

n = 5

l = 0 (For s-orbital)

m = 0 (As m = – l to + l)

$$s = +\frac{1}{2}$$

14. (A) : n represents the main energy level and l represents the subshell.

If n = 4 and l = 3, the subshell is 4f.

In f-subshell, there are 7 orbitals and each orbital can accommodate a maximum number of two electrons, so maximum number of electrons in 4f subshell = 7 × 2 = 14.

15. (D) : The orbital of the electron having n = 3, λ = 1 and m = – 1 is $3p_z$ (as nl_m) and an orbital can have a maximum number of two electrons with opposite spins.

∴ $3p_z$ orbital contains only two electrons or only 2 electrons are associated with n = 3, l = 1, m = – 1.

16. (C) : Given, Planck's constant,

$$h = 6.63 \times 10^{-34}\ Js$$

Spped of light, $c = 3 \times 10^{17}\ nm\ s^{-1}$

Frequency of quantum light

$$v = 6 \times 10^{15}\ s^{-1}$$

Wavelength, λ = ?

We know that, $v = \frac{c}{\lambda}$

$$\text{or} \quad \lambda = \frac{c}{v} = \frac{3\times10^{17}}{6\times10^{15}} = 0.5\times10^2 \text{ nm}$$

$= 50$ nm

17. (D) : The wavelength of light is related to its energy by the equation, $E = \frac{hc}{\lambda}(E = hv)$

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

$$\text{Hence, } E = \frac{6.63\times10^{-34}\,Js\times3\times10^{8}\,m\,s^{-1}}{45\times10^{-9}\,m}$$

$= 4.42 \times 10^{-18}$ J

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

18. (A) : The value of n = 3 and l = 1 suggestes that it is a 3p-orbital while the value of m_l = 0 [magnetic quantum number] shows that the given 3 p-orbital is $3p_z$ in nature.

$3p_z \leftarrow l = 1$

$\quad\ \leftarrow m_l = 0$

$\nearrow$ n = 3

Hence, the maximum number of orbitals identified by the given quantum number is only 1, i.e. $3p_z$.

19. (A) : Angular momentum of electron in d-orbital is

$$= \sqrt{l(l+1)}\frac{h}{2\pi}; \quad \text{for d - orbital, } l = 2$$

$$= \sqrt{2(2+1} \qquad \left(\because \hbar = \frac{h}{2\pi}\right)$$

$$h = \sqrt{6}\ h$$

20. (B) : Electronic configuration of Fe^{2+} is $[Ar]3d^6\,4s^0$.

∴ Number of electrons = 6

Mg – $1s^2 2s^2 2p^6 3s^2$ (6s electrons)

It matches with the 6d electrons of Fe^{2+}

Cl – $1s^2 2s^2 2p^6 3s^2 3p^5$ (11p electrons)

It does not match with the 6 d electrons of Fe^{2+}

Ne – $1s^2 2s^2 2p^6$ (6 p electrons)

It matches with the 6d electrons of Fe^{2+}

Hence, Cl has 11p electrons which does not matches in number with 6 d electrons of Fe^{2+}.

21. (C) : According to Aufbau rule

$$3s < 3p < 3d < 4s$$

22. (A) : According to Hund's rule of mximum multiplicity, An orbital can accommodate a maximum number of 2 electrons of exactly opposite spin. Hence option **(A)** is correct.

Caution Remember, maximum number of electrons in an orbital do not depend upon the quantum numbers as given in the question.

23. (C) : Two electrons occupying the same orbital has equal spin but the directions of their spin are opposite. Hence, spin quantum number, s, (represented + 1/2 and – 1/2) distinguishes them.

24. (D) :

(A) According to de-Broglie equation,

$$\text{Wavelength } (\lambda) = \frac{h}{mv}$$

where, h = Planck's constant.

Thus, statement **(A)** is correct.

(B) According to Heisenberg uncertainty principle, the uncertainties of position (ΔX) and momentum ($p = m\Delta v$) are related as

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

or, $$\Delta x.m\Delta v \geq \frac{h}{4\pi}$$

$$\Delta x.m\Delta a.\Delta t \geq \frac{h}{4\pi}$$

$$\left[\frac{\Delta v}{\Delta t} = \Delta a,\ a = \text{acceleration}\right]$$

or, $$\Delta x \cdot F \cdot \Delta t \geq \frac{h}{4\pi} \qquad [\because F = m \cdot \Delta a]$$

or, $$\Delta E \cdot \Delta t \geq \frac{h}{4\pi}$$

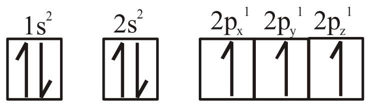
$$[\because \Delta E = F.\Delta x,\ E = \text{energy}]$$

Thus, statement **(B)** is correct.

(C) The half and fully filled orbitals have greater stability due to greater exchange energy, greater symmetry and more balanced arrangement. Thus statement **(C)** is correct.

(D) For a single electronic species like H, energy depends on value of n and does not depend on l. Hence energy of 2s-orbital. and 2p-orbital is equal in case of hydrogen like species Therefore, statement **(D)** is incorrect.

25. (A) : The correct electronic configurationof N-atom is



All e^- should be in same spin

26. (C) :

	Co^{3+}	Cr^{3+}	Fe^{3+}	Ni^{2+}
	$3d^6$	$3d^3$	$3d^5$	$3d^8$
unpaired e–	4	3	5	2
$\mu =$	$\sqrt{24}$	$\sqrt{15}$	$\sqrt{35}$	$\sqrt{8}$

$$\mu = \sqrt{n(n+2)}\,BM$$

EXERCISE - 4

P-2 (AIIMS)

1. **(C) :** This quantum number describes the orientation or distribution of electron colud.

2. **(B) :** n = 4
$1s^2\ 2s^2\ 2p^6\ 3s^2\ sp^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}$
$l = 3$ only for f orbital.
Thus, the total number of orbitals for $l = 3$ is equal to 7 (because f contains seven orbitals).

3. **(C) :** Most probable radius = a_0/Z
where a_0 = 52.9 pm.For helium ion, Z = 2
$$r_{mp} = \frac{52.9}{2} = 26.45 \text{ pm}$$

4. **(D) :** Number of electrons in $ClO_2^- = 17 + 2 \times 8 + 1 = 34$
Number of electrons in $ClF_2^+ = 17 + 2 \times 9 - 1 = 34$

5. **(C) :** ${}_{92}U^{238} \xrightarrow[-6\beta]{-8\alpha} {}_{82}X^{206}$
Number of protons = 82
Number of neutrons = 124
Neutron/prioton ratio in the product nucleus
$$= \frac{124}{82} = \frac{62}{41}$$

6. **(C) :** Rutherford first of all used zinc sulphide (ZnS) as phosphor in detection of α-particles.

7. **(A) :** Kinetic energy $= \frac{1}{2}mv^2$
[m = mass, v = velocity]
or, $0.5 = \frac{1}{2} \times 1 \times v^2$ or, $v = 1\ ms^{-1}$
de Broglie wavelength, $\lambda = \frac{h}{mv}$
or, $\lambda = \frac{6.626 \times 10^{-34}\ Js}{1\,kg \times 1\,ms^{-1}} = 6.626 \times 10^{-34}\ m$

8. **(B) :** In certain nucleus, the nucleus capture an electron from the K-shell (being nearest to the nucleus). The vacancy created is filled up with the electron from the higher shells thereby emitting X-rays. As a result of K-electron capture, a proton in the nucleus is converted into a neutron ($P^+ + e^- \rightarrow n$).

9. **(D) :** Rediation (γ-rays) emitted by the radioactive substance (${}_{27}Co^{60}$) destroys the cells. Hence, it is used in treatment of cancer in which the malignant cell are wiped out.

10. **(A) :** $1 \xrightarrow{t_{1/2}} \frac{1}{2} \xrightarrow{t_{1/2}} \frac{1}{4} \xrightarrow{t_{1/2}} \frac{1}{8} \xrightarrow{t_{1/2}} \frac{1}{16}$
So, $t_{1/16} = 4t_{1/2}$
$$= 4 \times \frac{0.693}{\lambda} = 4 \times \frac{0.693}{69.3} = 4 \times 10^{-2} \text{ sec}$$

11. **(C) :** $Cu^+ = 1s^2\, 2s^2\, 2p^6 3s^2 3p^6 3d^{10}$.
Shells occupied = 3, sub-shells occupied = 6, filled orbitals = 14. Unpaired e^- = 0.

12. **(B) :** $$\Delta x \geq \frac{h}{(4\pi)(m\Delta v)}$$
$$\Delta x \geq \frac{6.626 \times 10^{-34}}{(4 \times 3.14 \times 1050)(0.9)\left(\frac{1}{3600}\right)\left(\frac{1000}{1}\right)}$$
$Dx \geq x \times 10^{-37}$ m
The uncertainty in the position of the car is far smaller than the uncertainty in the position of an electron in a hydrogen atom (3×10^{-10} m) and far too small a value to have any measurable consequences.

13. **(A) :** Series → Lyman, Balamer, Paschen, Brackett, Pfund
$\xrightarrow{\hspace{6cm}}$ Increasing wavelength

14. **(D) : (A)** it successfully explained the stability of atoms.
(B) It is not in agreement with Heisenberg's uncertainty principle.
(C) It does not explain the spectra of multi-electron atoms.

15. **(B) :** Following the conservation of energy principle,
Kinetic energy $\left(\frac{1}{2}m_e v^2\right) = h(\upsilon - \upsilon_0)$
$= (6.626 \times 10^{-34}\ J\ s)\ (1 \times 10^{14}\ s^{-1} - 5 \times 10^{13}\ s^{-1})$
$= (6.626 \times 10^{-34}\ J\ s)\ (5 \times 10^{13}\ s^{-1})$
$= 3.313 \times 10^{-20}$ J

16. (D) : $mvr = \frac{nh}{2\pi}$

17. (A) : Given : $\frac{\lambda_{particle}}{\lambda_{electron}} = 1.8 \times 10^{-4}$

and $\frac{v_{particle}}{v_{electron}} = 3$

According to de-Broglie equation.

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

$$\frac{\lambda_{particle}}{\lambda_{electron}} = \frac{h}{m_{particle} \times v_{particle}} \times \frac{m_{electron} \times v_{electron}}{h}$$

$$= \frac{m_{electron}}{m_{particle}} \times \frac{v_{electron}}{v_{particle}}$$

$$\Rightarrow \quad 1.8 \times 10^{-4} = \frac{9.1 \times 10^{-31} kg}{m_{particle}} \times \frac{1}{3}$$

$$m_{particle} = \frac{9.1 \times 10^{-31}}{1.8 \times 10^{-4} \times 3} = 1.6852 \times 10^{-27} kg$$

Actual mass of neutron is 1.67493×10^{-27} kg.
Hence, the particle is neutron.

18. (A) : Isotones have the same number of neutrons.
As = 77 – 33 = 44 ; Se = 78 – 34 = 44

19. (A) : When n = 5, then l = 0, 1, 2, 3, 4.
Again when l = 2, then m = –2, –1, 0, +1, +2.
the 's' value can be $\pm$ 1/2
Hence the arrangement, n = 5, l = 2, m = 2, 2 = +1/2 is possible for an electron.

20. (B) : ${}^{A}_{Z}X \rightarrow {}^{A}_{Z-1}Y + {}^{0}_{1}e \,(\text{or } \beta^{+})$

21. (A) : The lines falling in the visible region comprise Balmer series. Hence the third line would be $n_1 = 2$, $n_2 = 5$ i.e. $5 \rightarrow 2$.

22. (B) : $\frac{1}{\lambda} = R\left(\frac{1}{m^2} - \frac{1}{n^2}\right) \times Z^2$

$$\text{for } \lambda_{He^+} = \frac{400}{2^2} = \frac{400}{4} = 100\,\text{nm}$$

23. (D) : ${}_{11}Na^{22} \rightarrow {}_{12}Mg^{22} + {}_{-1}\beta^{0}$
It involves β-particle emission.
While positron emission is due to the conversions of proton into neutron.

$${}^{1}_{1}p \rightarrow {}^{1}_{0}n + {}^{0}_{1}\beta$$

24. (C) : ${}_{24}Cr \rightarrow [Ar]3d^4\,4s^2$
$Cr \rightarrow [Ar]\,3d^5\,4s^1$
Fully-filled s-orbital has greater stability.

25. (D) : Bindin energy per nucleon of ${}_{3}Li^{7}$ (5.38 MeV) is leser than ${}_{2}He^{4}$ (7.08 MeV) as helium is found to be more stable than Li. As the atomic mass number increases, the binding energy per nucleon decreases. As the atomic number and the atomic mass number increase, the repulsive electrostatic forces within the nucleus increase due to the greater number of protons in the heavy elements. To overcome this increased repulsion, the proportion of neutrons in the nucleus must increase to maintain stability. This increase in the neutron-to-proton ratio only partially compensates for the growing proton-proton repulsive force in the heavier, naturally occuring elements. Because the repulsive force are increasing, less energy must be suplied, on the average, to remove a nucleon from the nucleus. The BE/A has decreased. The BE/A of a nucleus is an indication of its degree of stability. Generally, the more stable nuclides have higher BE/A than the less stable ones. The increase in BE/A as the atomic mass number decreases from 260 to 60 is the primary reason for the energy liberation in the fission process. The increase in the BE/A as the atomic mass number increases from 1 to 60 is the reason for the energy liberation in the fusion process, which is the opposite reaction of fission.

26. (A) : The loss of one a-particle will reduce the mass number by four and atomic number by two. Subsequent two β-emissions will increase the atomic number by two without affecting the mass number. Hence, the new element will be only an isotope of the parent nucleide and hence its position in the periodic table remains unchaned.

27. (A) : $E = -\frac{2\pi^2 k^2 m_e^4}{n^2 h^2}$

where n = principal quantum number which has only integral value, it follows that total energy is quantized.

28. (A) : The nuclear isomerism in the nuclei of same mass number and same atomic number arises due to different radioactive properties. The reason for nuclear isomerism is the different energy states of two isomeric nuclei. One may be in the ground state and other in an excited state. The nucleus in the excited state will have different half-life.

29. (B) : Bohr model does not explain the spectra of multi-electron atoms.

30. (A) : All species like He^+, Li^{2+}, Be^{3+} having one electron are expected to have similar spectrum as that of hydrogen.

31. (C) : For 3p-orbital, number of radial nodes

$= n - l - 1 = 3 - 1 - 1 = 3 - 2 = 1$

Numer of angular nodes = $l = 1$

Number of radial and angular nodes depend on both n and l.

32. (C) : The wavelength of the line can be calculated by the Rydberg formula :

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right), \ R = \text{Rydberg constant}$$

Therefore, wavelength will be highest in Balmer series ($n_1 = 2$) when n_2 is 3.

33. (A) : Both assertion and reason are true and reason is the correct explanation of assertion.

$$\text{Radius, } r_n = \frac{n^2h^2}{4\pi^2 mkZe^2} = \frac{n^2}{Z} \times 0.529\text{Å}. \ r_n$$

For first orbit of H-atom

$n = 1$

$$r_1 = \frac{(1)^2}{1} \times 0.529\text{Å} = 0.529\text{Å}$$

MOCK TEST

1. **(D)** In the given figure if line ‘E’ is in visible region then line belongig to ultraviolet region will have moe energy than ‘E’ i.e. line A

2. **(A)** Let n be the number of Photons emitted

$$\Rightarrow \frac{12400}{6000} \times 1.6 \times 10^{-19} \times n = 60 \times 10 \times 60 \times 60$$

$$\Rightarrow n = 6.5 \times 10^{24}$$

3. **(A)** $\frac{f_1}{f_2} = \frac{z_1^2}{n_1^3} \times \frac{n_2^3}{z_2^2}$

$\Rightarrow$ $n_1 = 3, n_2 = 3, z_1 = 2, z_2 = 1$

$\therefore$ putting these values in the equation we get

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

4. **(D)** $\lambda = \frac{h}{\sqrt{2m_p eV}}$ $\qquad \lambda_\alpha = \frac{h}{\sqrt{2m_\alpha (2e)V\alpha}} = 2m_p$ eV

$= 2 \times 4 \times m_p \times 2eV\alpha$

$$\Rightarrow V_\alpha = \frac{V}{8}$$

5. **(C)** $\bar{v} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$$x = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{36}$$

$$\bar{v}_1 = R \times 2^2\left(1 - \frac{1}{2^2}\right) = 3R = \frac{36}{5} x \times 3 = \frac{108x}{5}$$

6. **(B)** $\ell = 1$ for p and $\ell = 2$ for d.
Now $_{24}Cr$ hs configuration
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$
Hence there are 12, p-electrons and 5, d-electrons.

7. **(C)** Energy of one photon $= \frac{12400}{4000}$

$= 3.1$ ev

Energy supplied by one mole photon in KJ/mole $= 3.1 \times 1.6 \times 10^{-19} \times 6 \times 10^{23} \times 10^{-3} \approx 297\ \text{kJmol}^{-1}$

$\therefore$ % of energy converted to K.E. $= \frac{297 - 246.5}{297}$ □ 17%

8. **(A)** $r_3 = r_1 \frac{3^2}{3}$

$$\Rightarrow r_1 = \frac{r_3}{3} = \frac{x}{3}\ \text{cm}$$

$\therefore$ De-broglies wavelength $= \frac{2\pi x}{3}$

9. **(A)** $\nu \propto \frac{1}{n^2} - \frac{1}{(n+1)^2}$

$$\propto \frac{(n+1)^2 - n^2}{(n+1)^2 n^2} \qquad \propto \frac{n}{n^4} \propto n^{-3}$$

10. **(D)** $\Delta P . \Delta x \geq \frac{h}{4\pi}$

$\because$ $2\Delta x = \Delta P$ (given)

$\therefore$ $\frac{\Delta P^2}{2} \geq \frac{h}{4\pi}$

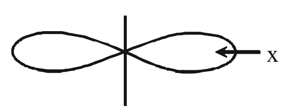
$\therefore$ $m^2 (\Delta V)^2 \geq \frac{h}{2\pi}$ $\qquad \{\because \Delta P = m\Delta V\}$

$$\Delta V \geq \sqrt{\frac{h}{2m^2\pi}}$$

$\therefore$ $\Delta V \geq \frac{1}{m}\sqrt{\frac{h}{2\pi}}$ $\qquad$ or $\qquad \Delta V \geq \frac{1}{m}\sqrt{\hbar}$

11. **(D)**

12. **(A)** The number of nodal plane are present in a p_x is one or no. of nodal place = 1
for p_x orbital $l = 1$



Nodal plane

13. **(B)** In Balmer series of hydrogen atomic spectrum which electronic transition causes third line O $\to$ L

$n_2 = 5 \to n_1 = 2,$

14. **(C)**

15. **(B)** $\bar{\nu} = \frac{1}{\lambda} = R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$= \frac{1}{\lambda} = R_H\left[\frac{1}{3^2} - \frac{1}{n_2^2}\right] = n_2 = 3$ for Paschen series.

16. (A) $E \propto \left[\frac{1}{n_2^2} - \frac{1}{n_1^2}\right]$

17. (A)

18. (D) $\lambda = \frac{c}{v} = \frac{3\times10^8}{8\times10^{15}} = 3.75\times10^{-8}$

$= 3.75\times10^{-8}\times10^9\,\text{nm} = 4\times10^1\text{nm}.$

19. (A)

20. (D) Total number of electrons in an orbital $= 2(2\ell+1)$.
The value of ℓ varies from 0 to n – 1.
$\therefore$ Total numbers of electrons in any orbit

$$= \sum_{\ell=0}^{\ell=n-1} 2(2\ell+1).$$

21. (C) $\Delta x = 2\Delta p$

$$\Delta x\,.\,\Delta p = \frac{\hbar}{2} = \frac{h}{4\pi} \quad \Rightarrow \quad 2\,\Delta p\,.\,\Delta p = \frac{\hbar}{2}$$

$$\Rightarrow \quad 2(m\Delta V)^2 = \frac{\hbar}{2} \qquad ; (\Delta V)^2 = \frac{\hbar}{4m^2}$$

$$\Rightarrow \quad \Delta V = \frac{\sqrt{\hbar}}{2m}.$$

22. (C) The lobes of d_{xy} orbital are at an angle of 45° with X and Y axis. So along the lobes, angular probability distribution is maximum.

23. (C) $\left.\begin{matrix} n_1 + n_2 = 4 \\ n_1 - n_2 = 2 \end{matrix}\right\}$ so $n_1 = 3$ and $n_2 = 1$.

$$\bar{v} = R\,(3)^2 \left\{\frac{1}{(1)^2} - \frac{1}{(3)^2}\right\} = 8R.$$

24. (D) $2\pi r = n\lambda =$ circumference

25. A→ s, B → p, C → p, D → q

(A) $T_n = -\frac{kze^2}{2r} \qquad \Rightarrow \quad T_n \,\alpha\, r^{-1}$

(B) $T_n = \frac{P_n}{2} \qquad \Rightarrow \quad \frac{T_n}{P_n} = 1/2$

(C) $\frac{1}{f_n^{-x}} \,\alpha\, z \qquad \Rightarrow \quad f_n^{\,x} \,\alpha\, z$

$f_n \,\alpha\, z^2 \quad \Rightarrow \quad x = 1/2$

(D) $T_n \times V_n = \frac{2\pi}{v_n} r \times v_n \qquad \Rightarrow \quad t = 1$

26. A→ rs, B → ps, C → qr, D → pq

(A) $6 \to 3 \qquad \Delta n = 3$

$\therefore$ no. of lines $= \frac{3(3+1)}{2} = 6$

All lines are in infrared region

(B) $7 \to 3 \qquad \Delta n = 4$

$\therefore$ no. of lines $= \frac{4(4+1)}{2} = 10$

All lines are in infrared region

(C) $5 \to 2 \qquad \Delta n = 3$

All lines are in visible region

(D) $6 \to 2 \qquad \Delta n = 4$

All lines are in visible region

27. (E) The assertion is false but the reason is true exact position and exact momentum of an electron can never be determined as according to Hesenberg's uncertainity principle even with the help of electron microscope because when e^- beam of electron microscope strikes the target e^- of atom, the impact causes the change in velocity of e^- thus attempt to locate the e^- changes ultimately, the momentum & position of e^-.

$$\Delta x.\Delta p \geq \frac{h}{4\pi} \approx 0.57\,\text{ergs sec/ gm.}$$

28. (E) Both assertion and reason are false. $2p_x$ and $2p_x$ orbitals are degenerate orbitals, i.e., they are of equal energy and hence no possibility of transition of electron.

29. (A) We know that principal quantum number represent the main energy level or energy shell. Since each energy level is associated with a definite amount of energy, this quantum number determines to a large extent te energy of an electron. It also determines the average distance of an electron around the nucleus. Therefore both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.

30. (A) It is observed that a nucleus which is made up of even number of nucleons (No. of n & p) is more stable than nuclie which consist of odd number of nucleons. If number of neutron or proton is equal to some numbers i.e., 2,8, 20, 50, 82 or 126 (which are called magic numbers), then these passes extra stability.