1. (c) The species CO, NO^+, CN^- and C_2^{2-} contain 14 electrons each.

2. (d) NaCl: No. of e^- in Na^+ = At. No. of Na–1 $= 11 - 1 = 10$

No. e^- in Cl^- = At. No. of Cl + 1 $= 17 + 1 = 18$

CsF : No. of e^- in $Cs^+ = 55 - 1 = 54$

No. of e^- in $F^- = 9 + 1 = 10$

NaI : No. of e^- in $Na^+ = 11 - 1 = 10$

No. of e^- in $I^- = 53 + 1 = 54$

K_2S : No. of e^- in $K^+ = 19 - 1 = 18$

No. of e^- in $S^{2-} = 16 + 2 = 18$

3. (c) For electron in the ground state,

$$mvr = \frac{h}{2\pi} \Rightarrow mv = \frac{h}{2\pi r}$$

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

So, $\frac{h}{\lambda} = \frac{h}{2\pi r} \Rightarrow \lambda = 2\pi r$

$\lambda = 2 \times 3.14 \times 0.53Å = 3.328Å$

$= 3.328 \times 10^{-10}$ m

$= 0.3328 \times 10^{-9}$ m $= 0.3328$ nm

4. (a) For He^+,

$$\bar{v} = \frac{1}{\lambda} = R_H Z^2\left(\frac{1}{2^2} - \frac{1}{4^2}\right)$$

$$= R_H (2)^2\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = R_H\left(\frac{1}{(1)^2} - \frac{1}{(2)^2}\right)$$

For H,

$$\bar{v} = \frac{1}{\lambda} = R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

For same frequency,

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

$$\therefore \quad \frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{1}{1^2} - \frac{1}{2^2}$$

$\therefore \quad n_1 = 1$ & $n_2 = 2$

5. (d) For Balmer $n_1 = 2$ and $n_2 = 3$;

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

6. (c) Series limit is the last line of the series, i.e. $n_2 = \infty$.

$$\therefore \bar{\upsilon} = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = R\left[\frac{1}{n_1^2} - \frac{1}{\infty^2}\right] = \frac{R}{n_1^2}$$

$$\because \bar{\upsilon} = 12186.3 = \frac{109677.76}{n_1^2}$$

$$\Rightarrow n_1^2 = \frac{109677.76}{12186.3} = 9 \Rightarrow n_1 = 3$$

$\therefore$ The line belongs to Paschen series.

7. (d) de Broglie wavelength, $\lambda = \frac{h}{mv}$

$$\frac{\lambda_1}{\lambda_2} = \frac{m_2 v_2}{m_1 v_1};\ \frac{1}{4} = \frac{1}{9} \times \frac{v_2}{v_1}$$

$$\frac{v_2}{v_1} = \frac{9}{4}$$

$$\frac{v_1}{v_2} = \frac{4}{9}$$

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

$$\frac{KE_1}{KE_2} = \frac{m_1}{m_2} \times \frac{v_1^2}{v_2^2} = \frac{9}{1} \times \left(\frac{4}{9}\right)^2 = \frac{16}{9}$$

8. (c) Fe(III) = [Ar] $3d^5$ unpaired electrons = 5;

Magnetic moment = $\sqrt{5(5+2)}$;

Ratio = $\sqrt{7} : \sqrt{3}$

Co(II) = [Ar] $3d^7$ unpaired electrons = 3;

Magnetic moment = $\sqrt{3(3+2)}$

Ratio = $\sqrt{7} : \sqrt{3}$

9. (b) $E = h\upsilon = \frac{ch}{\lambda}$; and $\upsilon = \frac{c}{\lambda}$

$$8 \times 10^{15} = \frac{3.0 \times 10^8}{\lambda}$$

$$\therefore \lambda = \frac{3.0 \times 10^8}{8 \times 10^{15}} = 0.37 \times 10^{-7} = 37.5 \times 10^{-9}\ \text{m} = 4 \times 10^1$$

10. (d) $\lambda_p = \frac{h}{\sqrt{2eVm_p}}$; $\lambda_{Li} = \frac{h}{\sqrt{2 \times 3eVm_{Li}}}$

$$= \frac{h}{\sqrt{2 \times 3eV \times 9m_p}}$$

Hence, $\frac{\lambda_{Li^{3+}}}{\lambda_p} = \sqrt{\frac{2eVm_p}{2 \times 3eV \times 9m_p}} = \frac{1}{3\sqrt{3}}$

11. (b) From the given data, we have

$$(E_C - E_B) + (E_B - E_A) = (E_C - E_A)$$

or $\left(\frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}\right) = \frac{hc}{\lambda_3}$ $\left[\text{or } \frac{1}{\lambda_1} + \frac{1}{\lambda_2} = \frac{1}{\lambda_3}\right]$

or $\boxed{\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}}$ $\left[\because \frac{\lambda_1 + \lambda_2}{\lambda_1 . \lambda_2} = \frac{1}{\lambda_3}\right]$

12. (a) We know $\Delta p . \Delta x \geq \frac{h}{4\pi}$

since $\Delta p = \Delta x$ (given)

$$\therefore \Delta p . \Delta p = \frac{h}{4\pi}$$

or $m\Delta v\, m\Delta v. = \frac{h}{4\pi}$ $[\therefore \Delta p = m\Delta v]$

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

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

13. (a) (n + *l*) rule the higher the value of (n + *l*), the higher is the energy. When (n + *l*) value is the same see value of n.

16. (a) $\Delta E = 2.178 \times 10^{-18}\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{hc}{\lambda}$

$$\Rightarrow 2.178 \times 10^{-18} \times \frac{3}{4} = \frac{hc}{\lambda}$$

$$= \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{\lambda}$$

$$\lambda = \frac{6.62 \times 10^{-34}}{2.178 \times 10^{-18}} \frac{3 \times 10^8 \times 4}{\times 3}$$

$= 1.214 \times 10^{-7}$m

17. (c) Not more than two electrons can be present in same atomic orbital. This is Pauli's exclusion principle.

18. (a) 2^{nd} excited state will be the 3^{rd} energy level

value of n.

	I	II	III	IV
$(n+l)$	$(4+1)$	$(4+0)$	$(3+2)$	$(3+1)$
	5	4	5	4

$\therefore$ IV < II < III < I

14. (b) I. $E = \frac{Z^2}{n^2} \times 13.6\,\text{eV}$ ...(i)

or $\frac{I_1}{I_2} = \frac{Z_1^2}{n_1^2} \times \frac{n_2^2}{Z_2^2}$ ...(ii)

Given $I_1 = -19.6 \times 10^{-18}, Z_1 = 2,$

$n_1 = 1, Z_2 = 3$ and $n_2 = 1$

Substituting these values in equation (ii).

$$-\frac{19.6 \times 10^{-18}}{I_2} = \frac{4}{1} \times \frac{1}{9}$$

or $I_2 = -19.6 \times 10^{-18} \times \frac{9}{4}$

$= -4.41 \times 10^{-17}$ J/atom

15. (c) As per Bohr's postulate,

$$mvr = \frac{nh}{2\pi}$$

So, $v = \frac{nh}{2\pi mr}$

$$\text{KE} = \frac{1}{2}mv^2$$

So, $\text{KE} = \frac{1}{2}m\left(\frac{nh}{2\pi mr}\right)^2$

Since, $r = \frac{a_o \times n^2}{z}$

So, for 2nd Bohr orbit

$$r = \frac{a_o \times 2^2}{1} = 4a_o$$

$$\text{KE} = \frac{1}{2}m\left(\frac{2^2 h^2}{4\pi^2 m^2 \times (4a_o)^2}\right)$$

$$\text{KE} = \frac{h^2}{32\pi^2 m a_o^2}$$

18. (a) 2nd excited state will be the 3rd energy level.

$$E_n = \frac{13.6}{n^2}\text{eV} \text{ or } E = \frac{13.6}{9}\text{eV} = 1.51 \text{ eV}.$$

19. (b) Calculating number of electrons

1. $BO_3^{3-} \longrightarrow 5 + 8 \times 3 + 3 = 32$
$CO_3^{2-} \longrightarrow 6 + 8 \times 3 + 2 = 32$
$NO_3^{-} \longrightarrow 7 + 8 \times 3 + 1 = 32$
} iso-electronic species

2. $SO_3^{2-} \longrightarrow 16 + 8 \times 3 + 2 = 42$
$CO_3^{2-} \longrightarrow 32$
$NO_3^{-} \longrightarrow 32$
} not iso-electronic species

3. $CN^{-} \longrightarrow 6 + 7 + 1 = 14$
$N_2 \longrightarrow 7 \times 2 = 14$
$C_2^{-} \longrightarrow 6 \times 2 + 2 = 14$
} iso-electronic species

4. $PO_4^{3-} \longrightarrow 15 + 8 \times 4 + 3 = 50$
$SO_4^{2-} \longrightarrow 16 + 8 + 2 = 50$
$ClO_4^{-} \longrightarrow 17 + 8 \times 4 + 1 = 50$
} iso-electronic species

Hence the species in option (b) are not isoelectronic.

20. (d) (ΔE), The energy required to excite an electron in an atom of hydrogen from n = 1 to n = 2 is ΔE (difference in energy E_2 and E_1)

Values of E_2 and E_1 are,

$$E_2 = \frac{-1.312 \times 10^6 \times (1)^2}{(2)^2} = -3.28 \times 10^5 \text{ J mol}^{-1}$$

ΔE is given by the relation,

$E_1 = -1.312 \times 10^6 \text{ J mol}^{-1}$

$\therefore \Delta E = E_2 - E_1 = [-3.28 \times 10^5] - [-1.312 \times 10^6] \text{ J mol}^{-1}$

$= (-3.28 \times 10^5 + 1.312 \times 10^6) \text{ J mol}^{-1}$

$= 9.84 \times 10^5 \text{ J mol}^{-1}$

Thus the correct answer is (d)

21. (a) $\bar{\nu} = \frac{1}{\lambda} = R_H Z = \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

In Balmer series $n_1 = 2$ & $n_2 = 3, 4, 5$.... Last line of the spectrum is called series limit.

Limiting line is the line of shortest wavelength and high energy when $n_2 = \infty$

$$\therefore \bar{\nu} = \frac{1}{\lambda} = \frac{R_H}{n_1^2} = \frac{3.29 \times 10^{15}}{2^2} = \frac{3.29 \times 10^{15}}{4}$$

$= 8.22 \times 10^{14} \text{ s}^{-1}$

22. (d) Energy required to break one mole of Cl – Cl bonds in Cl_2

$$= \frac{242 \times 10^3}{6.023 \times 10^{23}} = \frac{hc}{\lambda}$$

$$= \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{\lambda}$$

$$\therefore \lambda = \frac{6.626 \times 10^{-34} \times 3 \times 10^8 \times 6.023 \times 10^{23}}{242 \times 10^8}$$

$= 0.4947 \times 10^{-6} \text{ m} = 494.7 \text{ nm}$

23. (b) $\lambda = \frac{h}{mv}$

$h = 6.6 \times 10^{-34}$ J/s

$m = 1000$ kg

26×10^3

Substituting this in equation (i)

$$\lambda = \frac{h}{m}\sqrt{\frac{m}{2KE}}$$

$$\lambda = h\sqrt{\frac{1}{2m(K.E.)}} \quad ...(i)$$

i.e. $\lambda \propto \frac{1}{\sqrt{KE}}$

$\therefore$ when KE become 4 times wavelength become 1/2.

27. (a) The electronic configuration of Rubidium (Rb = 37) is

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

Since last electron enters in 5*s* orbital

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

28. (c) The kinetic energy of the ejected electron is given by the equation

$$h\nu = h\nu_o + \frac{1}{2}mv^2 \quad \because \nu = \frac{c}{\lambda}$$

or $\frac{hc}{\lambda} = \frac{hc}{\lambda_o} + \frac{1}{2}mv^2$

$$\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \frac{hc}{\lambda_o}$$

$$= hc\left(\frac{\lambda_o - \lambda}{\lambda\lambda_o}\right)$$

$v = 36\text{ km/hr} = \dfrac{36\times10^3}{60\times60}\text{ m/sec} = 10\text{ m/sec}$

$\therefore\ \lambda = \dfrac{6.6\times10^{-34}}{10^3\times10} = 6.6\times10^{-38}\text{ m}$

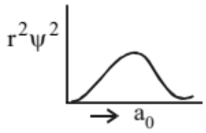
24. **(c)** $r_n = a_0 n^2$

$r = a_0 \times (3)^2 = 9a_0$

$mvr = \dfrac{nh}{2\pi};\quad mv = \dfrac{nh}{2\pi r} = \dfrac{3h}{2\pi\times9a_0} = \dfrac{h}{6\pi\, a_0}$

$\lambda = \dfrac{h}{mv} = \dfrac{n}{h}\times6\pi a_0 = 6\pi a_0$

25. **(c)** $l = 2$ represent d orbital for which



26. **(b)** de – Broglie wavelength is given by :

$\lambda = \dfrac{h}{mv}$ ... (i)

K.E. $= \dfrac{1}{2}mv^2$

$v^2 = \dfrac{2KE}{m}$

$v = \sqrt{\dfrac{2KE}{m}}$

$\therefore\quad v^2 = \dfrac{2hc}{m}\left(\dfrac{\lambda_o - \lambda}{\lambda\lambda_o}\right)$

or $\quad v = \sqrt{\dfrac{2hc}{m}\left(\dfrac{\lambda_o - \lambda}{\lambda\lambda_o}\right)}$

29. **(d)** Total energy of a revolving electron is the sum of its kinetic and potential energy.

Total energy = K.E. + P. E.

$= \dfrac{e^2}{2r} + \left(-\dfrac{e^2}{r}\right)$

$= -\dfrac{e^2}{2r}$

30. **(b)** Energy of 1 mole of photons,

$E = N_0 \times h\upsilon$

$= \dfrac{N_0 \times h \times c}{\lambda}$

$= \dfrac{6.023\times10^{23}\times6.63\times10^{-34}\times3\times10^8}{253.7\times10^{-9}}$

$= 472.2$ kJ

Energy converted into KE = (472.2 – 430.53) kJ

% of energy converted into KE $= \dfrac{(472.2 - 430.53)}{472.2}$

$= 8.76\,\%$