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.

	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 2[nd] Bohr orbit

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

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

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

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.

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