ATOMIC STRUCTURE

1. The number of electrons present in all the completely filled subshells having n = 4 and $s = +\frac{1}{2}$ is _____.

(Where n = principal quantum number and s = spin quantum number)

2. The correct set of four quantum numbers for the valence electron of rubidium atom (Z = 37) is:

(1) $5, 0, 0, +\frac{1}{2}$ (2) $5, 0, 1, +\frac{1}{2}$

(3) $5, 1, 0, +\frac{1}{2}$ (4) $5, 1, 1, +\frac{1}{2}$

3. Match List-I with List-II.

List-I (Spectral Series for Hydrogen)		**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 :-

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

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

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

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

4. Given below are two statements:

Statement-I: The orbitals having same energy are called as degenerate orbitals.

Statement-II: In hydrogen atom, 3p and 3d orbitals are not degenerate orbitals.

In the light of the above statements, choose the **most appropriate** answer from the options given.

(1) Statement-I is true but Statement-II is false

(2) Both Statement-I and Statement-II are true.

(3) Both Statement-I and Statement-II are false

(4) Statement-I is false but Statement-II is true

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

6. The ionization energy of sodium in kJ mol^{-1}. If electromagnetic radiation of wavelength 242 nm is just sufficient to ionize sodium atom is_____.

7. The four quantum numbers for the electron in the outer most orbital of potassium (atomic no. 19) are

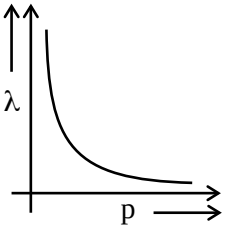
(1) $n = 4,\ l = 2,\ m = -1,\ s = +\frac{1}{2}$

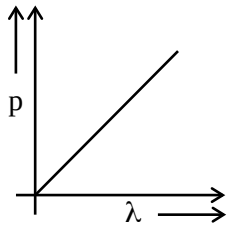
(2) $n = 4,\ l = 0,\ m = 0,\ s = +\frac{1}{2}$

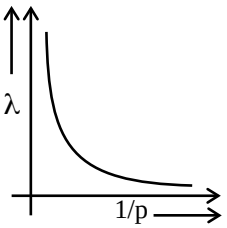
(3) $n = 3,\ l = 0,\ m = 0,\ s = +\frac{1}{2}$

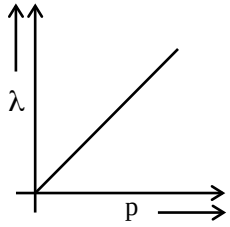
(4) $n = 2,\ l = 0,\ m = 0,\ s = +\frac{1}{2}$

8. According to the wave-particle duality of matter by de-Broglie, which of the following graph plot presents most appropriate relationship between wavelength of electron (λ) and momentum of electron (p) ?

(1) 

(2) 

(3) 

(4) 

9. The number of radial node/s for 3p orbital is:

(1) 1 (2) 4

(3) 2 (4) 3

10. The de-Broglie's wavelength of an electron in the 4th orbit is _____ πa_0. (a_0 = Bohr's radius)

11. Choose the **Incorrect** Statement about Dalton's Atomic Theory

(1) Compounds are formed when atoms of different elements combine in any ratio

(2) All the atoms of a given element have identical properties including identical mass

(3) Matter consists of indivisible atoms

(4) Chemical reactions involve recorganization of atoms

12. The **incorrect** postulates of the Dalton's atomic theory are :

(A) Atoms of different elements differ in mass.

(B) Matter consists of divisible atoms.

(C) Compounds are formed when atoms of different element combine in a fixed ratio.

(D) All the atoms of given element have different properties including mass.

(E) Chemical reactions involve reorganisation of atoms.

Choose the correct answer from the options given below :

(1) (B), (D), (E) only

(2) (A), (B), (D) only

(3) (C), (D), (E) only

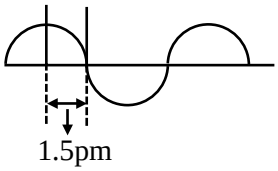
(4) (B), (D) only

13. 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 =….. $\times 10^5$ ms^{-1} (nearest integer)

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

[Given: R_H (Rydberg constant) = 2.18×10^{-18} J. *h* (Plank's constant) = 6.6×10^{-34} J.s.]

15. A hypothetical electromagnetic wave is show below.



The frequency of the wave is $x \times 10^{19}$ Hz.

x = _____ (nearest integer)

16. Wavenumber for a radiation having 5800 Å wavelength is $x \times 10$ cm^{-1}. The value of *x* is _____.

17. 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 $\frac{1}{'B'}$ watt per steradian. 'A' and 'B' are respectively

(1) 540 and $\frac{1}{683}$

(2) 540 and 683

(3) 450 and $\frac{1}{683}$

(4) 450 and 683

18. Based on Heisenberg's uncertainty principle, the uncertainty in the velocity of the electron to be found within an atomic nucleus of diameter 10^{-15} m is _____$\times 10^9$ ms^{-1} (nearest integer)

[Given: mass of electron = 9.1×10^{-31} kg, Plank's constant (h) = 6.626×10^{-34} Js]

(Value of π = 3.14)

SOLUTIONS

1. Ans. (16)

Sol. n = 4 can have,

	4s	4p	4d	4f
Total e^-	2	6	10	14
Total e^- with $S = +\frac{1}{2}$	1	3	5	7

So, Ans.16

2. Ans. (1)

Sol. Rb = $[Kr]5s^1$

n = 5

$l = 0$

m = 0

s = +½ or –½

3. Ans. (3)

Sol. A – II, B – IV, C – III, D – I

Fact based.

4. Ans. (1)

Sol. For single electron species the energy depends upon principal quantum number 'n' only. So, statement II is false.

Statement I is correct definition of degenerate orbitals.

5. Ans. (10)

Sol. 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

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

6. Ans. (494)

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

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

= 5.12 eV

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

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

= 494 kJ/mol

7. Ans. (2)

Sol. $_{19}K$ $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$.

Outermost orbital of potassium is 4s orbital

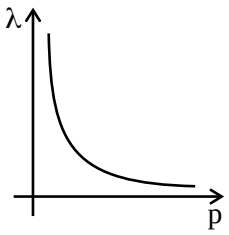
$$n = 4, l = 0, m_l = 0, s = \pm\frac{1}{2}.$$

8. Ans. (1)

Sol. $$\lambda = \frac{h}{p}\left[\lambda \propto \frac{1}{p}\right]$$

$\Rightarrow \lambda p = h$ (constant)

So, the plot is a rectangular hyperbola.



9. Ans. (1)

Sol. For 3p : n = 3, = 1

Number of radial node = n – – 1

= 3 – 1 – 1 = 1

10. Ans. (8)

Sol. $2\pi r_n = n\lambda_d$

$$2\pi a_0\frac{n^2}{Z} = n\lambda_d$$

$$2\pi a_0\frac{4^2}{1} = 4\lambda_d$$

$\lambda_d = 8\pi a_0$

11. Ans. (1)

Sol. In compound atoms of different elements combine in fixed ratio by mass.

12. Ans. (4)

Sol. B, D

13. Ans. (22)

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

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

14. Ans. NTA (658)

Allen (661)

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

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

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

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

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

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

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

15. Ans. (5)

Sol. $\lambda = 1.5 \times 4$ pm

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

$\lambda\nu = C$

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

$\nu = 5 \times 10^{19}$ Hz

16. Ans. (1724)

Sol. $\bar{\nu}$ (wave no.) $= \frac{1}{\lambda} = \frac{1}{5800 \cdot 10^{-8}\text{ cm}} = 17241$

OR

$1724 \cdot 10\ \text{cm}^{-1} \Rightarrow x = 1724$

17. Ans. (2)

Sol. 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.

18. Ans. (58)

Sol. $m\Delta V . \Delta x = \frac{h}{4\pi}$

$\Delta V = \frac{6.626 \cdot 10^{-34}}{9.1 \cdot 10^{-31} \cdot 10^{-15} \cdot 4 \cdot 3.14}$

$= 57.97 \cdot 10^{+9}$ m/sec