I PUC CHEMISTRY
STURCTURE OF ATOM

1. The de Broglie wavelength associated with a material particle is
a) Inversely proportional to momentum b) Inversely proportional to its energy
c) Directly proportional to momentum d) Directly proportional to its energy

2. According to Bohr's model of hydrogen atom
a) The linear velocity of the electron is quantised
b) The angular velocity of the electron is quantised
c) The linear momentum of the electron is quantised
d) The angular momentum of the electron is quantised

3. For a 'd' –electron, the orbital angular momentum is
a) $\sqrt{(6)}\frac{h}{2}$ b) $\sqrt{(2)}\frac{h}{2}$ c) $\frac{h}{2}$ d) $\frac{2h}{2}$

4. If each hydrogen atom is excited by giving 8.4 eV of energy, Then the number of spectral lines emitted is equal to
a) None b) Two c) Three d) Four

5. What is the maximum number of electrons in an atom that can have the quantum numbers n = 4, $m_e = +1$?
a) 4 b) 15 c) 3 d) 6

6. The energy associated with photon of light having a wavelength 6000 Å [h = 6.624 x 10^{-27} erg-sec] is
a) 6.02 x 10^{23} erg b) 33.12 x 10^{-12} erg
c) 3.312 x 10^{-12} erg d) 6.012 x 10^{-12} erg

7. The atomic transition gives rise to the radiation of frequency (10^4 MHz). The change in energy per mole of atoms taking place would be
a) 3.99 x 10^{-6} J b) 3.99 J c) 6.62 x 10^{-24} J d) 6.62 x 10^{-30} J

8. The ratio of radii of first orbits of H, He^+ and Li^{2+} is
a) 1 : 2 : 3 b) 6 : 3 : 2 c) 1 : 4 : 9 d) 9 : 4 : 1

9. Which of the following pairs of ions has the same electronic configuration?
a) Cr^{+3}, Fe^{+3} b) Fe^{+3} , Mn^{+2} c) Fe^{+3} , Co^{3+} d) Sc^{3+}, Cr^{3+}

10. The energy of the second Bohr's orbit of hydrogen atom is -328 kJ/mole. The energy of the 4th Bohr's orbit would be
a) -41 kJ b) -82 kJ c) -164 kJ d) -1312 kJ

11. The frequency of radiation emitted when the electron falls from n = 4 to n = 1 in a hydrogen atom will be (given ionisation energy of H = 2.18×10^{-18} J / atom and h = 6.625×10^{-34} Js)

a) $1.03 \times 10^{3}\ s^{-1}$ b) $3.08 \times 10^{15}\ s^{-1}$

c) $2.0 \times 10^{15}\ s^{-1}$ d) $1.54 \times 10^{15}\ s^{-1}$

12. A certain radio station broadcasts at a frequency of 900 kHz. The wavelength of electromagnetic radiation broadcast by the radio station is

a) 100 m b) 270 m c) 270 km d) 330 m

13. The energy of a photon of red light having wavelength 650 nm is (h = 6.6×10^{-34} J s)

a) 3.5×10^{-19} J b) 3.05×10^{-19} J c) 3.05×10^{-18} J d) 3.05×10^{-3} J

14. The possible set of quantum numbers for the 5th electron of boron is

a) 1, 0, 0, - ½ b) 1, 1, 1, +½

c) 2, 0, 0, - ½ d) 2, 1, 0, +½

15. The increasing order of size among p^{3-}, S^{2-} and Cl^{-} ions is

a) Cl^{-}, S^{2-}, P^{3-} b) P^{3-}, S^{2-}, Cl^{-} c) S^{2-}, Cl^{-}, P^{3-} d) S^{2-}, P^{3-}, Cl^{-}

16. How many spectral lines are produced in the spectrum of hydrogen atom from 4th energy level?

a) 3 b) 6 c) 9 d) infinite

17. Which of the following is not possible?

a) n = 3, l = 2, m = 0 b) n = 1, l = 0, m = 0

c) n = 3, l = 3, m = 2 d) n = 4, l = 3, m = –3

18. The magnetic quantum number 'm' is fixed by the azimuthal quantum number 'l'. If l = 2, type and number of orbitals are indicated by

a) 3d, 5 b) 3s, 1 c) 3p, 3 d) 4f, 7

19. When α - particles are sent through a thin metal foil most of them go straight through the foil because

a) α - particles are more heavier than electrons

b) α - particles are positively charged

c) most part of atom is empty space

d) α - particles move with high velocity

20. The ionization energy of the ground state hydrogen atom is 2.18×10^{-18}J. The energy of an electron in second orbit of He^{+} will be

a) -1.09×10^{-18} J b) -4.36×10^{-18}J c) 2.18×10^{-18}J d) -2.18×10^{-18}J

21. A photon of light with wavelength 450nm falls on a metal surface. As a result photoelectrons are ejected with a velocity of 6.4×10^4 m/s. The work function is

a) 4.8×10^{-19} J b) 4.6×10^{-19} J c) 4.4×10^{-19} J d) 4.2×10^{-19} J

22. Energy required to stop the ejection of electrons from Cu plate is 0.24 eV. The work function when radiation of wavelength 253.7 nm strikes the plate is

a) 3.5 eV b) 4.65 eV c) 5.78 eV d) 4.8eV

23. A particle A moving with a certain velocity has a de Brogile wavelength of 1 Å. If particle B has mass 25% of that of A and velocity 75% that of A, the deBroglie wavelength of B will be approximately

(a) 1 Å (b) 5.3 Å (c) 3 Å (d) 0.2 Å

24. In two H atoms A and B the electrons move around the nucleus in circular orbits of radius r and 4r respectively. The ratio of the times taken by them to complete one revolution is

(a) 1: 4 (b) 1 : 2 (c) 1 : 8 (d) 2 : 1

25. Kinetic energy of the electron in ground state is 13.6eV,the de Broglie wavelength of the electron is (1 eV= 1.602×10^{-19}J)

a) 3.3 A^0 b) 4.5 A^0 c) 5.2 A^0 d) 6.3 A^0

26. The I.E. of hydrogen atom is 13.6 eV. The energy required to remove an electron from n = 2 state of hydrogen atom is

a) 27.2 eV b) 13.6 eV c) 6.8 eV d) 3.4 eV

27. A certain metal when irradiate to light ($v = 3.2 \times 10^{16}$ Hz) emits photoelectrons with twice kinetic energy as did photo electrons when the same metal is irradiated by light ($v = 2.0 \times 10^{16}$ Hz). The v_0 of metal is

a) 1.2×10^{14} Hz b) 8×10^{15} Hz

c) 1.2×10^{16} Hz d) 1.2×10^{12} Hz

28. The threshold wavelength of photoelectric effect of a metal is 230 nm. The kinetic energy of the photoelectron ejected from the surface by UV radiation emitted from the second longest wavelength for the downward transition of electron in Lyman series of the atomic spectrum of hydrogen ($R = 1.096 \times 10^7$ m^{-1}) will be

a) 1.07×10^{-18} J b) 1.937×10^{-18} J

c) 2.058×10^{-19} J d) 8.63×10^{-19} J

29. The velocity with which an electron should travel so that its momentum is equal to that of a photon of wavelength 560 nm is

a) 1100 m s^{-1} b) 1200 m s^{-1} c) 1300 m s^{-1} d) 1400 m s^{-1}

30. Uncertainty in the position of an electron (mass = 9.1×10^{-31} kg) moving with a velocity 300 m s^{-1}, accurate upto 0.001 %, will be

a) 1.92×10^{-2} m b) 3.84×10^{-2} m c) 19.2×10^{-2} m d) 5.76×10^{-2} m

31. When a certain metal was irradiated with a light of frequency 3.2×10^{16} Hz, the photoelectrons had twice the kinetic energy as emitted when the same metal was irradiated with light of frequency
2.0×10^{16} Hz. The threshold frequency of the metal is
a) 4×10^{15} Hz b) 1.2×10^{16} Hz c) 5.2×10^{16} Hz d) 8×10^{15} Hz

32. If the binding energy of electrons in a metal is 250 kJ mol^{-1}, the threshold frequency of the striking photons is
a) 6.26×10^{16} s^{-1} b) 6.26×10^{15} s^{-1} c) 6.26×10^{14} s^{-1} d) 6.26×10^{13} s^{-1}

33. If the energy difference between the ground state of an atom and its excited state is 4.4×10^{-14} J, the wavelength of photon required to produce the transition.
a) 2.26×10^{-12} m b) 1.13×10^{-12} m
c) 4.52×10^{-16} m d) 4.52×10^{-12} m

34. The frequency of radiation emitted when the electron falls from n = 4 to n = 1 in a hydrogen atom will be (given ionisation energy of H = 2.18×10^{-18} J / atom and h = 6.625×10^{-34} Js)
a) 1.03×10^{3} s^{-1} b) 3.08×10^{15} s^{-1}
c) 2.0×10^{15} s^{-1} d) 1.54×10^{15} s^{-1}

35. The dissociation energy of H_2 is 430.53 kJ mol^{-1}. If H_2 is exposed to radiation energy of wavelength 253.7nm .What % radiant energy will be converted into kinetic energy.
a) 8.68% b) 6.88% c) 7.68% d) 9.68%

36. Electromagnetic radiation of wavelength 242nm is just sufficient to ionize sodium atom. Calculate the ionization energy of sodium in kJ mol^{-1}
a) 499.5 kJ/mol b) 494.5kJ/mol c) 545.5 kJ/mol d) 464.5 kJ/mol

37. Number of photons of light having a wavelength 4000 Å are necessary to provide 1.00 J of energy is
a) 4.965×10^{-19} b) 2.01×10^{18} c) 2.01×10^{-18} d) 4.965×10^{19}

38. The wavelength of the radiation which would cause the photo dissociation of chlorine molecule if the Cl – Cl bond energy is 243 kJ mol^{-1}
a) 4.90×10^{-8} m b) 490 nm c) 49×10^{-7} m d) 490m

39. The electronic energy in II and III Bohr's orbit of H atom are -5.42×10^{-12} and -2.41×10^{-12} erg respectively. The wavelength of the radiations when the electron jumps from III to II orbit for H atom is
a) 5460 Å b) 6321 Å c) 6603 Å d) 5890 Å

40. The maximum kinetic energy of the photoelectrons is found to be 6.63 x 10^{-19} J, when the metal is irradiated with a radiation of frequency 2 x 10^{15} Hz. The threshold frequency of the metal is about:

a) 1 x 10^{15} s^{-1} b) 2 x 10^{15} s^{-1} c) 3 x 10^{15} s^{-1} d) 1.5 x 10^{15} s^{-1}

41. If an electron is moving with velocity 500 ms^{-1}, which is accurate up to 0.005% then calculate uncertainty in its position. [h = 6.63 x 10^{-34} Js, mass of electron = 9.1 x 10^{-31} kg]

a) 1.4 x 10^{-3} m b) 1.9 x 10^{3} m c) 1.9 x 10^{-3} m d) 2.9 x 10^{-3} m

42. Which transition of the Hydrogen spectrum would have the same wave length as the Balmer transition, n = 4 to n = 2 of He^{+} spectrum -

(a) n_2 = 2 to n_1 = 1 (b) n_2 = 3 to n_1 = 1

(c) n_2 = 4 to n_1 = 2 (d) n_2 = 5 to n_1 = 3

43. The minimum energy required to overcome the attractive forces electron and surface of Ag metal is 7.52 × 10^{-19} J. What will be the maximum K.E. of electron ejected out from Ag which is being exposed to U.V. light of □ = 360 Å

(a) 36.38 × 10^{-19} Joule

(b) 6.92 × 10^{-19} Joule

(c) 57.68 × 10^{-19} Joule

(d) 67.68 × 10^{-19} Joule

44. The number of radial nodes in 4s and 3p orbitals are respectively

(a) 2, 0 (b) 3, 1 (c) 2, 2 (d) 3, 2

45. Two particles A and B are in motion. If the wavelength associated with particle A is 5 × 10^{-8} m; calculate the wavelength associated with particle B if its momentum is half of A.

(a) 5 × 10^{-8} m (b) 10^{-5} cm (c) 10^{-7} cm (d) 5 × 10^{-8} cm

46. The ratio of (E_2 - E_1) to (E_4 – E_3) for the hydrogen atom is approximately equal to

a) 10 b) 15 c) 17 d) 12

47. If λ_o is the threshold wavelength of photoelectric emission, λ is the wavelength of light falling on the surface of metal and m is the mass of electron then velocity of ejected electrons is given by

a) $\left[\frac{2h}{m}(\lambda_o - \lambda)\right]^{1/2}$ b) $\left[\frac{2hc}{m}(\lambda_o - \lambda)\right]^{1/2}$

c) $\left[\frac{2hc}{m}\left(\frac{\lambda_o - \lambda}{\lambda_o \lambda}\right)\right]^{1/2}$ d) $\left[\frac{2h}{m}\left(\frac{1}{\lambda_o} - \frac{1}{\lambda}\right)\right]^{1/2}$

48. The kinetic energy of an electron is 4.55×10^{-25} J. The wavelength of the electron is [h = 6.6×10^{-34} Js, mass of electron = 9.1×10^{-31} kg]

a) 0.72×10^{-8} m b) 0.72×10^{-6} m c) 0.72×10^{-5} m d) 0.72×10^{-4} m

49. The electronic configuration of P in H_3PO_4 is (P = 15)

a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ b) $1s^2\ 2s^2\ 2p^6\ 3s^2$

c) $1s^2\ 2s^2\ 2p^6$ d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$

50. The maximum number of 4d – electrons having spin quantum number s = + 1/2 are

a) 10 b) 7 c) 1 d) 5

solutions

1. Ans: (a)

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

2. Ans: (d)

Conceptual

3. Ans: (a)

$\sqrt{(l(l+1)}\frac{h}{2}$

l=2

4. Ans: (a)

5. Ans: (d)

n = 4, ℓ = 0, m_e = 0

ℓ = 1, m_e = -1, 0, +1

ℓ = 2, m_e = -2, -1, 0, +1, +2

ℓ = 3, m_e = -3, -2, -1, 0, +1, +2, +3

6. Ans: (c)

$E = hv = h \cdot \frac{c}{\lambda}$

$h = 6.624 \times 10^{-27}$ erg-sec; $c = 3 \times 10^{10}$ cm/sec;

$\lambda = 6000\ \mathring{A} = 6000 \times 10^{-8}$ cm

So, $E = \frac{(6.624 \times 10^{-27}) \times (3 \times 10^{10})}{6 \times 10^{-5}} = 3.312 \times 10^{-12}$ erg.

7. Ans: (b)

$E = nhv = 6.023 \times 10^{23} \times 6.626 \times 10^{-34} \times 10^4 \times 10^6 = 3.99$ J

8. Ans: (b)

[Hint: $r = \frac{n^2}{Z} \times 0.529\ \mathring{A}$

$r_H : r_{H^+} : r_{Li^{2+}}$

$1 : \frac{1}{2} : \frac{1}{3}$

6: 3: 2

9. Ans:(b)

Electronic configuration of Fe = $[Ar]4s^2 3d^6$

Electronic configuration of Fe^{+3} = $[Ar]4s^0 3d^5$

Electronic configuration of M_n = $[Ar]4s^2 3d^5$

Electronic configuration of M_n^{+2} = $[Ar]4s^0 3d^5$

10. Ans: (b)

Energy of second Bohr orbit of hydrogen atom (E_2) = -328 kJ mol^{-1}

Energy of electron in the 4^{th} orbit (E_4) = $-\frac{1311.8}{n^2} = -\frac{1311.8}{(4)^2}$ = -82 kJ / mol

11. Ans: (b)

Energy of the electron in the first shell (n_1) = -2.18×10^{-18} J / atom

Energy of the electron in the 4^{th} shell (n_4) = $-\frac{2.18 \times 10^{-18}}{(4)^2} = -0.1362 \times 10^{-18}$

Energy released = $E_4 - E_1$

= $-0.1362 \times 10^{-18} + 2.18 \times 10^{-18}$

= $(-0.1362 + 2.18) \times 10^{-18}$

= 2.04×10^{-18} J / atom

Frequency(ν) = $\frac{E}{h} = \frac{2.04 \times 10^{-18}}{6.625 \times 10^{-34}}$ = $0.3084 \times 10^{-16} = 3.084 \times 10^{-15}\ s^{-1}$

12. Ans: (d)

$\lambda = \frac{\text{Velocity of light}}{\text{Frequency}} = \frac{3 \times 10^8}{900 \times 10^3}$ = 330 m

13. Ans: (b)

Wave length (λ) = 650 nm = 650×10^{-9} m

Plank's constant (h) = 6.6×10^{-34} Js

Velocity (c) = 3×10^8 m/s

Energy (E) = $h\nu = h.\frac{c}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{650 \times 10^{-9}}$ = 3.05×10^{-19} J

14. Ans: (d)

Atomic number of Boron (Z) = 5

Electronic configuration = $1s^2\ 2s^2\ 2p^1$

5^{th} electron present in 2p-orbital

Principal Quantum no. (n) = 2

Azimuthal Quantum no. (ℓ) = 1

Magnetic Quantum no. (m) = -1, 0, +1

Spin Quantum no. (s) = $\pm\frac{1}{2}$

15. Ans: (a)

P^{3-}, s^{2-} and $C\ell^{-}$ ions are example for isoelectronic species (containing 18 electrons each). As the number of protons increases effective nuclear change increases and size decreases.

	P	S	$C\ell$
Atomic No.	15	16	17
No. of protons	15	16	17
	P^{3-}	S^{-2}	$C\ell^{-}$
No. of electrons	18	18	18

16. Ans: (b)

No. of spectral lines = $\frac{n(n-1)}{2} = \frac{4(4-1)}{2} = \frac{4x3}{2} = 6$

17. Ans: (c)

18. Ans: (a)

ℓ = 2, d – orbital

m = -2, -1, 0, +1, +2 [5 orbitals or (2 ℓ + 1)]

19. Ans: (c)

According to Rutherford's model of an atom

20. Ans: (c)

$$En = -\frac{13.6}{n^2} = -\frac{2\pi me^4z^2}{n^2h^2}$$

For hydrogen atom, z = 1, for ground state n = 1

$$E = -\frac{2\pi^2m(1)e^4}{1^2h^2} = -\frac{2\pi^2me^4}{h^2}$$

For He^+ ion z = 2, for second orbit n = 2

$$\therefore E = -\frac{2\pi^2m(2)e^4}{(2)^2h^2} = -\frac{2\pi^2me^4}{h^2}$$

$\therefore$ Energy is same.

21. Ans: (c)

$h\nu = h\nu_o + K.E.$

$\frac{hc}{\lambda} = h\nu_o + \frac{1}{2}mv^2$

$\frac{6.625 \times 10^{-34} \times 3 \times 10^8}{450 \times 10^{-9}} - \frac{1}{2}(9.108 \times 10^{-31}) \times (6.4 \times 10^4)^2 = h\upsilon_o = w$

$4.416 \times 10^{-19} - 1.8653 \times 10^{-21}$

$\simeq 4.416 \times 10^{-19}$ J

22. Ans: (b)

$h\frac{c}{\lambda} = w + KE$

$\frac{6.625 \times 10^{-34} \times 3 \times 10^8}{253.7 \times 10^{-9} \times 1.602 \times 10^{-19}} - 0.24 = w$ ($\because 1.602 \times 10^{-19}$ J = 1 eV)

$= 4.89 - 0.24 = 4.65$ eV

23. Ans: (b)

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

$\lambda_1 = 1 \times 10^{-10} = \frac{h}{m\upsilon}$ for A

$\lambda_2 = \frac{h}{(0.25m)(0.75\upsilon)}$ for B

$\frac{\lambda_1}{\lambda_2} = \frac{(0.25m)(0.75\upsilon)}{m\upsilon}$

$\frac{\lambda_1}{(0.25)(0.75)} = \lambda_2$

$\therefore \lambda_2 = \frac{1 \times 10^{-10}}{0.1875} = 5.33 \times 10^{-10}$ m = 5.33 A°

24. Ans: (a)

The circumference of 1st orbit = $2\pi r$

The circumference of 2nd orbit = $2\pi (4r) = 8\pi r$

$\therefore$ The ratio of times = $\frac{t_1}{t_2} = \frac{2\pi r}{8\pi r} = \frac{1}{4}$

25. Ans:(a)

$\lambda = \frac{h}{m\upsilon} = \frac{h}{\sqrt{2mE}} = \frac{6.625 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 13.6 \times 1.602 \times 10^{-19}}}$

$= 3.329 \times 10^{-10}$

= 3.3 A°

26. Ans: (d)

Energy required to remove electron from

n = 2 is $\frac{13.6}{2^2} = \frac{13.6}{4} = 3.4$ eV

27. Ans:(b)

$h\nu_1 = h\nu_o + 2KE$ .... (1)

$h\nu_2 = h\nu_o + KE$ .... (2)

(1) – (2) gives

$h\nu_1 - h\nu_2 = KE$

$h(\nu_1 - \nu_2) = KE$

$\Rightarrow 6.625 \times 10^{-34} (3.2 \times 10^{16} - 2 \times 10^{16}) = 7.95 \times 10^{-18}$ J

Substituting K.E in equation – (2) we get

$6.625 \times 10^{-34} \times 2 \times 10^{16} - 7.95 \times 10^{-18} = h\nu_o$

$\Rightarrow 13.25 \times 10^{-18} - 7.95 \times 10^{-18} = h\nu_o$

$\Rightarrow \frac{5.3 \times 10^{-18}}{6.625 \times 10^{-34}} = \nu_o$

$\therefore \nu_o = 8 \times 10^{15}$ Hz

28. Ans: (a)

Minimum energy required to eject an electron

$E_0 = h\nu_0 = \frac{hc}{\lambda_0} = \frac{6.6\times10^{-34}\times3\times10^{8}}{230\times10^{-9}} = 8.6 \times 10^{-19}$ J.

For spectral lines of the Lyman series of H atom

$\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{n_2^2}\right)$

For second longest wavelength, $n_2 = 3$.

$\frac{1}{\lambda} = 1.096 \times 10^7 \left(1 - \frac{1}{9}\right) = 1.096 \times 10^7 \times \frac{8}{9} = 9.74 \times 10^6$

Energy of photon of this wavelength

$E = \frac{hc}{\lambda} = \frac{6.6\times10^{-34}\times3\times10^{8}}{1.026\times10^{-7}} = 1.93 \times 10^{-18}$ J

K.E. = $E_{incident} - E_{threshold} = (1.93 \times 10^{-18}) - (8.6 \times 10^{-19}) = 1.07 \times 10^{-18}$ J

29. Ans: (c)

According to de-Broglie equation, $\lambda = \frac{h}{p}$. Thus, if momentum of electron = momentum of photon, then λ of electron = λ of photon = 560 nm

Applying de-Broglie equation to electron,

$\lambda = \frac{h}{mv}$ or $v = \frac{h}{m \times \lambda}$

$= \frac{6.63 \times 10^{-34}\, kg\, m^2 s^{-1}}{(9.11 \times 10^{-31}\, kg)(560 \times 10^{-9}\, m)}$ = 1300 ms^{-1}.

30. Ans: (a)

$\Delta v = \frac{0.001}{100} \times 300\ ms^{-1} = 3 \times 10^{-7}\ ms^{-1}$

$(\Delta x)(m\,\Delta v) = \frac{h}{4\pi}\ \therefore\ \Delta x = \frac{h}{4\pi m \Delta v}$

$= \frac{6.63 \times 10^{-34} kgm^2 s^{-1}}{4 \times 3.14 \times 9.1 \times 10^{-31} kg \times 3 \times 10^{-7}\, ms^{-1}} = 1.93 \times 10^{-2}$ m.

31. Ans: (d)

Kinetic energy of photoelectrons emitted = $hv - hv_0 = h(v - v_0)$

In 1st case, $(K.E.)_1 = h(3.2 \times 10^{16} - v_0)$

In 2nd case, $(K.E.)_2 = h(2.0 \times 10^{16} - v_0)$

But $(K.E.)_1 = 2(K.E.)_2$ (Given)

$\therefore h(3.2 \times 10^{16} - v_0) = 2h(2.0 \times 10^{16} - v_0)$

or $v_0 = 4 \times 10^{16} - 3.2 \times 10^{16} = 0.8 \times 10^{16} = 8 \times 10^{15}$ Hz.

32. Ans: (c)

Binding energy of 1 mole of electrons = 250 kJ

$\therefore$ Binding energy of 1 electron = $\frac{250}{6.022 \times 10^{23}}$ Kj = 4.15×10^{-22} kJ = 4.15×10^{-19} J

Threshold energy (hv_0) = Binding energy $\therefore hv_0 = 4.15 \times 10^{-19}$ J

or $v_0 = \frac{4.15 \times 10^{-19} J}{h} = \frac{4.15 \times 10^{-19} J}{6.626 \times 10^{-34} Js} = 6.26 \times 10^{14}\ s^{-1}$.

33. Ans: (d)

$\Delta E = h\gamma = \frac{hc}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{4.4 \times 10^{-4}} = 4.52 \times 10^{-12}$ m

34. Ans: (b)

Energy of the electron in Ist shell (n – 1) = -2.18×10^{-18} J/atom (E_1)

Energy of the electron in IV shell (n – 4) = $-\frac{2.18 \times 10^{-18}}{n^2} = -\frac{2.18 \times 10^{-18}}{16}$

$= -0.136 \times 10^{-18}$ (E_2)

Energy released = $E_2 - E_1 = -0.136 \times 10^{-18} - (-2.18 \times 10^{-18})$

$= 2.044 \times 10^{-18}$ J/atom

$\nu = \frac{E}{h} = \frac{2.044 \times 10^{18}}{6.6 \times 10^{-34}} = 3.08 \times 10^{15}\ sec^{-1}$.

35. Ans: (a)

Energy required to break H-H bond = $\frac{430.53}{6.022 \times 10^{23}} = 7.15 \times 10^{-19}$ J

Energy of photon used for this purpose = $\frac{hc}{\lambda} = \frac{6.625 \times 10^{-34} \times 3 \times 10^{8}}{253.7 \times 10^{9}} = 7.83 \times 10^{-19}$ J

$\therefore$ Energy left after dissociation of bond = $(7.83 - 7.15) \times 10^{-19} = 0.68 \times 10^{-19}$

Energy converted into K.E. = 0.68×10^{-19}

$\therefore$ % of energy used in K.E = $\frac{0.68 \times 10^{-19}}{7.83 \times 10^{-19}} \times 100 = 8.68\%$

36. Ans: (b)

Energy associated with a photon of 242 nm = $\frac{6.625 \times 10^{-34} \times 3 \times 10^{8}}{242 \times 10^{-9}} = 8.21 \times 10^{-19}$ J

1 atom of Na for ionisation requires = 8.21×10^{-19} J

6.022×10^{23} atoms of Na for ionisation requires = $8.21 \times 10^{-19} \times 6.022 \times 10^{23}$

$= 49.45 \times 10^{4}$ J = 494.5 kJ mol^{-1}

37. Ans: (b)

Energy of one photon = $h\nu = h \cdot \frac{c}{\lambda}$

$= \frac{(6.62 \times 10^{-34})(3.0 \times 10^{8})}{4000 \times 10^{-10}} = 4.965 \times 10^{-19}$ J

Number of photons = $\frac{1.00}{4.965 \times 10^{-19}} = 2.01 \times 10^{18}$

38. Ans: (b)

Energy required to break one Cl – Cl bond

$= \frac{\text{Bond energy per mole}}{\text{Avogadro's number}} = \frac{243}{6.023 \times 10^{23}}\ kJ = \frac{243 \times 10^{3}}{6.023 \times 10^{23}}\ J$

Let the wavelength of the photon to cause rupture of one Cl – Cl bond be λ.

We know that, $\lambda = \frac{hc}{E} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8} \times 6.023 \times 10^{23}}{243 \times 10^{3}}$

$= 4.90 \times 10^{-7}$ m = 490 nm

39. Ans: (c)

E_3 for H = -2.41×10^{-12} erg

E_2 for H = -5.42×10^{-12} erg $\therefore$ For a jump from III to II shell

$\Delta E = E_3 - E_2 = \frac{hc}{\lambda} \qquad \therefore \lambda = \frac{hc}{E_3 - E_2}$

$$= \frac{6.625 \times 10^{-27} \times 3.0 \times 10^{10}}{-2.41 \times 10^{-12} + 5.42 \times 10^{-12}} = 6602.9 \times 10^{-8} \text{ cm} = 6603 \text{ Å}$$

40. Ans: (b)

KE = h (v – v_0)

$$v_0 = v - \frac{KE}{h} = 2 \times 10^{15} - \frac{6.63 \times 10^{-19}}{6.63 \times 10^{-34}} = 1 \times 10^{15} \text{ s}^{-1}$$

41. Ans: (c)

Uncertainty in velocity

$$\Delta v = \frac{600 \times 0.005}{100} = 3 \times 10^{-2} \text{ ms}^{-1}$$

According to Heisenberg's uncertainty principle

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

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

$$\geq \frac{6.63 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31} \times 3 \times 10^{-2}} = 1.9 \times 10^{-3} \text{ m}$$

42.Ans:a

Sol. For He^{+} ion, we have

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

$$= R_H[2]^2 \left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

$$= \frac{3}{4} R_H \qquad \text{...(A)}$$

Now for H atom

$$\frac{1}{\lambda} = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \qquad \text{...(B)}$$

Equating equs (A) and (B) we have

$$\frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{3}{4}$$

Obviously $n_1 = 1$ and $n_2 = 2$. Hence the transition n = 2 to n = 1 in hydrogen atom will have the same wave length as the transition n = 4 to n = 2 in He^+ species.

43. Ans. b

Sol. Energy absorbed $= \frac{hc}{\lambda}$

$$= \frac{6.625 \times 10^{-27} \times 3.0 \times 10^{10}}{360 \times 10^{-8}}$$

$= 5.52 \times 10^{-11}$ erg

= 5.52×10^{-18} Joule

$= (7.52 \times 10^{-19}) - (.552 \times 10^{-19})$

$= 6.92 \times 10^{-19}$ Joule

44. Ans: (b)

Number of radial nodes = (n – 1 – 1)

$$\begin{cases} For\ 4s\ n = 4\ l = 0\ (4-0-1) = 3 \\ For\ 3p\ n = 3\ l = 1\ (3-1-1) = 1 \end{cases}$$

45. Ans: (b)

$\lambda_A = \frac{h}{P_A}$	$\lambda_B = \frac{h}{P_B}$	$P_B = \frac{1}{2} P_A$

$$\frac{\lambda_A}{\lambda_B} = \frac{\frac{h}{P_A}}{\frac{h}{P_B}} = \frac{P_B}{P_A}$$

Putting $P_B = \frac{1}{2} P_A$

$\frac{\lambda_A}{\lambda_B} = \frac{1}{2} \frac{P_A}{P_A}$

$\lambda_B = 2\lambda_A$ [$\lambda_A = 5 \times 10^{-8}$m]

$\lambda_B = 2 \times 5 \times 10^{-8}$

$= 10 \times 10^{-8}$ m $\because$ 1 m = 100 cm

$= 10^{-7}$ m $= 10^{-5}$ cm

46. Ans: (a)

$E_n \propto -\dfrac{Z^2}{n^2}$

as Z is same so $E_n \propto -\dfrac{1}{n^2}$

$$\frac{E_4 - E_3}{E_2 - E_1} = \frac{\left(-\frac{1}{16}\right) - \left(-\frac{1}{9}\right)}{\left(-\frac{1}{4}\right) - (-1)} = \frac{\frac{1}{9} - \frac{1}{16}}{\frac{3}{4}}$$

$$= \frac{7}{144} \times \frac{4}{3} = \frac{7}{78} = \frac{1}{10}$$

47. Ans: (C). $\dfrac{hc}{\lambda} = \dfrac{hc}{\lambda_o} + \dfrac{1}{2}mv^2$

$v^2 = \dfrac{2hc}{m}\left(\dfrac{1}{\lambda} - \dfrac{1}{\lambda_o}\right)$ or $v = \left[\dfrac{2hc}{m}\left(\dfrac{\lambda_o - \lambda}{\lambda\lambda_o}\right)\right]^{1/2}$

48.Ans(b)

K.E = $\dfrac{1}{2}mv^2 = 4.55 \times 10^{-25}$

$\dfrac{1}{2} \times 9.1 \times 10^{-31} \times v^2 = 4.55 \times 10^{-25}$

$v^2 = \dfrac{2 \times 4.55 \times 10^{-25}}{9.9 \times 10^{-31}}$

$= 10^3$ ms^{-1}

Applying the Broglie equation,

$\lambda = \dfrac{h}{mv} = \dfrac{6.6 \times 10^{-34}}{9.1 \times 10^{-31} \times 10^3} = 0.72 \times 10^{-6}$ m

49. Ans: (c)

In H_3PO_4, oxidation state of ‘P’ is +5. Atomic number of P is 15, out of 15 electrons 5 electrons are removed.

For remaining 10 electrons: $1s^2\ 2s^2\ 2p^6$

50. Ans: (d)

Total number of electron in ‘4d’ orbitals = 10, among 10 electrons, 5 electrons have clockwise spin $\left(+\frac{1}{2}\right)$ and other 5 anticlockwise spin $\left(-\frac{1}{2}\right)$