Chapter 2. Structure of Atom

1. Which one is the wrong statement?
(a) The uncertainty principle is
$\Delta E \times \Delta t \geq \frac{h}{4\pi}$
(b) Half filled and fully filled orbitals have greater stability due to greater exchange energy, greater symmetry and more balanced arrangement.
(c) The energy of 2s-orbital is less than the energy of 2p-orbital in case of hydrogen like atoms.
(d) de-Broglie's wavelength is given by $\lambda = \frac{h}{mv}$, where m = mass of the particle, v = group velocity of the particle.
(NEET 2017)

2. How many electrons can fit in the orbital for which $n = 3$ and $l = 1$?
(a) 2 (b) 6 (c) 10 (d) 14
(NEET-II 2016)

3. Which of the following pairs of d-orbitals will have electron density along the axes?
(a) d_{z^2}, d_{xz} (b) d_{xz}, d_{yz}
(c) $d_{z^2}, d_{x^2-y^2}$ (d) $d_{xy}, d_{x^2-y^2}$
(NEET-II 2016)

4. Two electrons occupying the same orbital are distinguished by
(a) azimuthal quantum number
(b) spin quantum number
(c) principal quantum number
(d) magnetic quantum number.
(NEET-I 2016)

5. Which is the correct order of increasing energy of the listed orbitals in the atom of titanium? (At. no. $Z = 22$)
(a) $4s\ 3s\ 3p\ 3d$ (b) $3s\ 3p\ 3d\ 4s$
(c) $3s\ 3p\ 4s\ 3d$ (d) $3s\ 4s\ 3p\ 3d$
(2015)

6. The number of d-electrons in Fe^{2+} ($Z = 26$) is not equal to the number of electrons in which one of the following?
(a) d-electrons in Fe ($Z = 26$)
(b) p-electrons in Ne ($Z = 10$)
(c) s-electrons in Mg ($Z = 12$)
(d) p-electrons in Cl ($Z = 17$)
(2015, Cancelled)

7. The angular momentum of electron in 'd' orbital is equal to
(a) $2\sqrt{3}\hbar$ (b) $0\hbar$
(c) $\sqrt{6}\hbar$ (d) $\sqrt{2}\hbar$
(2015, Cancelled)

8. What is the maximum number of orbitals that can be identified with the following quantum numbers?
$n = 3, l = 1, m_l = 0$
(a) 1 (b) 2 (c) 3 (d) 4
(2014)

9. Calculate the energy in joule corresponding to light of wavelength 45 nm. (Planck's constant, $h = 6.63 \times 10^{-34}$ J s, speed of light, $c = 3 \times 10^8$ m s^{-1})
(a) 6.67×10^{15} (b) 6.67×10^{11}
(c) 4.42×10^{-15} (d) 4.42×10^{-18}
(2014)

10. Be^{2+} is isoelectronic with which of the following ions?
(a) H^+ (b) Li^+ (c) Na^+ (d) Mg^{2+}
(2014)

11. What is the maximum numbers of electrons that can be associated with the following set of quantum numbers?
$n = 3, l = 1$ and $m = -1$
(a) 4 (b) 2 (c) 10 (d) 6
(NEET 2013)

12. Based on equation $E = -2.178 \times 10^{-18}\text{ J}\left(\frac{Z^2}{n^2}\right)$, certain conclusions are written. Which of them is not correct?
(a) Equation can be used to calculate the change in energy when the electron changes orbit.
(b) For $n = 1$, the electron has a more negative energy than it does for $n = 6$ which means that the electron is more loosely bound in the smallest allowed orbit.
(c) The negative sign in equation simply means that the energy of electron bound to the nucleus is lower than it would be if the electrons were at the infinite distance from the nucleus.
(d) Larger the value of n, the larger is the orbit radius. *(NEET 2013)*

13. The value of Planck's constant is 6.63×10^{-34} J s. The speed of light is 3×10^{17} nm s^{-1}. Which value is closest to the wavelength in nanometer of a quantum of light with frequency of 6×10^{15} s^{-1}?
(a) 50 (b) 75 (c) 10 (d) 25
(NEET 2013)

14. The outer electronic configuration of Gd (At. No. 64) is
(a) $4f^5\ 5d^4\ 6s^1$ (b) $4f^7\ 5d^1\ 6s^2$
(c) $4f^3\ 5d^5\ 6s^2$ (d) $4f^4\ 5d^5\ 6s^1$
(Karnataka NEET 2013)

15. According to law of photochemical equivalence the energy absorbed (in ergs/mole) is given as ($h = 6.62 \times 10^{-27}$ ergs, $c = 3 \times 10^{10}$ cm s^{-1}, $N_A = 6.02 \times 10^{-23}$ mol^{-1})
(a) $\frac{1.196 \times 10^{8}}{\lambda}$ (b) $\frac{2.859 \times 10^{5}}{\lambda}$
(c) $\frac{2.859 \times 10^{16}}{\lambda}$ (d) $\frac{1.196 \times 10^{16}}{\lambda}$
(Karnataka NEET 2013)

16. Maximum number of electrons in a subshell with $l = 3$ and $n = 4$ is
(a) 14 (b) 16 (c) 10 (d) 12
(2012)

17. The correct set of four quantum numbers for the valence electron of rubidium atom ($Z = 37$) is
(a) 5, 1, 1, +1/2 (b) 6, 0, 0, +1/2
(c) 5, 0, 0, +1/2 (d) 5, 1, 0, +1/2
(2012)

18. The orbital angular momentum of a p-electron is given as
(a) $\frac{h}{\sqrt{2}\pi}$ (b) $\sqrt{3}\frac{h}{2\pi}$ (c) $\sqrt{\frac{3}{2}}\frac{h}{\pi}$ (d) $\sqrt{6}\frac{h}{2\pi}$
(Mains 2012)

19. The total number of atomic orbitals in fourth energy level of an atom is
(a) 8 (b) 16 (c) 32 (d) 4
(2011)

20. The energies E_1 and E_2 of two radiations are 25 eV and 50 eV respectively. The relation between their wavelengths *i.e.*, λ_1 and λ_2 will be
(a) $\lambda_1 = \lambda_2$ (b) $\lambda_1 = 2\lambda_2$
(c) $\lambda_1 = 4\lambda_2$ (d) $\lambda_1 = \frac{1}{2}\lambda_2$ *(2011)*

21. If $n = 6$, the correct sequence for filling of electrons will be
(a) $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$
(b) $ns \rightarrow (n-1)d \rightarrow (n-2)f \rightarrow np$
(c) $ns \rightarrow (n-2)f \rightarrow np \rightarrow (n-1)d$
(d) $ns \rightarrow np(n-1)d \rightarrow (n-2)f$ *(2011)*

22. According to the Bohr theory, which of the following transitions in the hydrogen atom will give rise to the least energetic photon?
(a) $n = 6$ to $n = 1$ (b) $n = 5$ to $n = 4$
(c) $n = 6$ to $n = 5$ (d) $n = 5$ to $n = 3$
(Mains 2011)

23. A 0.66 kg ball is moving with a speed of 100 m/s. The associated wavelength will be ($h = 6.6 \times 10^{-34}$ J s)
(a) 6.6×10^{-32} m (b) 6.6×10^{-34} m
(c) 1.0×10^{-35} m (d) 1.0×10^{-32} m
(Mains 2010)

24. Maximum number of electrons in a subshell of an atom is determined by the following
(a) $2l + 1$ (b) $4l - 2$
(c) $2n^2$ (d) $4l + 2$ *(2009)*

25. Which of the following is not permissible arrangement of electrons in an atom?
(a) $n = 5, l = 3, m = 0, s = +1/2$
(b) $n = 3, l = 2, m = -3, s = -1/2$
(c) $n = 3, l = 2, m = -2, s = -1/2$
(d) $n = 4, l = 0, m = 0, s = -1/2$ *(2009)*

26. If uncertainty in position and momentum are equal, then uncertainty in velocity is

(a) $\frac{1}{m}\sqrt{\frac{h}{\pi}}$ (b) $\sqrt{\frac{h}{\pi}}$
(c) $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$ (d) $\sqrt{\frac{h}{2\pi}}$ *(2008)*

27. The measurement of the electron position is associated with an uncertainty in momentum, which is equal to 1×10^{-18} g cm s^{-1}. The uncertainty in electron velocity is (mass of an electron is 9×10^{-28} g)
(a) 1×10^{5} cm s^{-1} (b) 1×10^{11} cm s^{-1}
(c) 1×10^{9} cm s^{-1} (d) 1×10^{6} cm s^{-1}
(Prelims 2008)

28. Consider the following sets of quantum numbers:

	n	l	m	s
(i)	3	0	0	+1/2
(ii)	2	2	1	+1/2
(iii)	4	3	–2	–1/2
(iv)	1	0	–1	–1/2
(v)	3	2	3	+1/2

Which of the following sets of quantum number is not possible?
(a) (i), (ii), (iii) and (iv)
(b) (ii), (iv) and (v)
(c) (i) and (iii)
(d) (ii), (iii) and (iv). *(2007)*

29. The orientation of an atomic orbital is governed by
(a) principal quantum number
(b) azimuthal quantum number
(c) spin quantum number
(d) magnetic quantum number. *(2006)*

30. Given : The mass of electron is 9.11×10^{-31} kg, Planck constant is 6.626×10^{-34} J s, the uncertainty involved in the measurement of velocity within a distance of 0.1 Å is
(a) 5.79×10^{5} m s^{-1} (b) 5.79×10^{6} m s^{-1}
(c) 5.79×10^{7} m s^{-1} (d) 5.79×10^{8} m s^{-1}
(2006)

31. The energy of second Bohr orbit of the hydrogen atom is –328 kJ mol^{-1}; hence the energy of fourth Bohr orbit would be
(a) – 41 kJ mol^{-1} (b) –82 kJ mol^{-1}
(c) –164 kJ mol^{-1} (d) –1312 kJ mol^{-1}
(2005)

32. The frequency of radiation emitted when the electron falls from $n = 4$ to $n = 1$ in a hydrogen atom will be (Given ionization energy of H = 2.18×10^{-18} J $atom^{-1}$ and $h = 6.625 \times 10^{-34}$ J s)
(a) 1.54×10^{15} s^{-1} (b) 1.03×10^{15} s^{-1}
(c) 3.08×10^{15} s^{-1} (d) 2.00×10^{15} s^{-1}
(2004)

33. The value of Planck's constant is 6.63×10^{-34} J s. The velocity of light is 3.0×10^{8} m s^{-1}. Which value is closest to the wavelength in nanometers of a quantum of light with frequency of 8×10^{15} s^{-1} ?
(a) 2×10^{-25} (b) 5×10^{-18}
(c) 4×10^{1} (d) 3×10^{7} *(2003)*

34. In hydrogen atom, energy of first excited state is –3.4 eV. Then find out *K.E.* of same orbit of hydrogen atom
(a) +3.4 eV (b) +6.8 eV
(c) –13.6 eV (d) +13.6 eV *(2002)*

35. Main axis of a diatomic molecule is z, molecular orbital p_x and p_y overlap to form which of the following orbitals.
(a) π molecular orbital
(b) σ molecular orbital
(c) δ molecular orbital
(d) No bond will form. *(2001)*

36. The following quantum numbers are possible for how many orbitals : $n = 3$, $l = 2$, $m = +2$?
(a) 1 (b) 2 (c) 3 (d) 4
(2001)

37. For given energy, $E = 3.03 \times 10^{-19}$ Joules corresponding wavelength is
($h = 6.626 \times 10^{-34}$ J sec, $c = 3 \times 10^{8}$ m/sec)
(a) 65.6 nm (b) 6.56 nm
(c) 3.4 nm (d) 656 nm *(2000)*

38. Isoelectronic species are
(a) CO, CN^-, NO^+, C_2^{2-}
(b) CO^-, CN, NO, C_2^-
(c) CO^+, CN^+, NO^-, C_2
(d) CO, CN, NO, C_2 *(2000)*

39. The uncertainty in momentum of an electron is 1×10^{-5} kg m/s. The uncertainty in its position will be ($h = 6.62 \times 10^{-34}$ kg m^2/s)
(a) 5.27×10^{-30} m (b) 1.05×10^{-26} m
(c) 1.05×10^{-28} m (d) 5.25×10^{-28} m
(1999)

40. Who modified Bohr's theory by introducing elliptical orbits for electron path?
(a) Rutherford (b) Thomson
(c) Hund (d) Sommerfield
(1999)

41. The de Broglie wavelength of a particle with mass 1 g and velocity 100 m/s is
(a) 6.63×10^{-35} m (b) 6.63×10^{-34} m
(c) 6.63×10^{-33} m (d) 6.65×10^{-35} m
(1999)

42. The Bohr orbit radius for the hydrogen atom ($n = 1$) is approximately 0.530 Å. The radius for the first excited state ($n = 2$) orbit is (in Å)
(a) 4.77 (b) 1.06 (c) 0.13 (d) 2.12
(1998)

43. The position of both, an electron and a helium atom is known within 1.0 nm. Further the momentum of the electron is known within 5.0×10^{-26} kg m s^{-1}. The minimum uncertainty in the measurement of the momentum of the helium atom is
(a) 8.0×10^{-26} kg m s^{-1}
(b) 80 kg m s^{-1}
(c) 50 kg m s^{-1}
(d) 5.0×10^{-26} kg m s^{-1} *(1998)*

44. The ion that is isoelectronic with CO is
(a) CN^- (b) N_2^+ (c) O^{2-} (d) N_2^-
(1997)

45. What will be the longest wavelength line in Balmer series of spectrum?
(a) 546 nm (b) 656 nm
(c) 566 nm (d) 556 nm *(1996)*

46. In a Bohr's model of an atom, when an electron jumps from $n = 1$ to $n = 3$, how much energy will be emitted or absorbed?
(a) 2.389×10^{-12} ergs
(b) 0.239×10^{-10} ergs
(c) 2.15×10^{-11} ergs
(d) 0.1936×10^{-10} ergs *(1996)*

47. Uncertainty in position of an electron (mass $= 9.1 \times 10^{-28}$ g) moving with a velocity of 3×10^4 cm/s accurate upto 0.001% will be (Use $h/(4\pi)$ in uncertainty expression where $h = 6.626 \times 10^{-27}$ erg second)
(a) 5.76 cm (b) 7.68 cm
(c) 1.93 cm (d) 3.84 cm *(1995)*

48. The radius of hydrogen atom in the ground state is 0.53 Å. The radius of Li^{2+} ion (atomic number = 3) in a similar state is
(a) 0.53 Å (b) 1.06 Å
(c) 0.17 Å (d) 0.265 Å *(1995)*

49. For which of the following sets of four quantum numbers, an electron will have the highest energy?

	n	l	m	s
(a)	3	2	1	+1/2
(b)	4	2	– 1	+1/2
(c)	4	1	0	–1/2
(d)	5	0	0	–1/2

(1994)

50. Which one of the following is not isoelectronic with O^{2-}?
(a) Tl^+ (b) Na^+ (c) N^{3-} (d) F^-
(1994)

51. Electronic configuration of calcium atom can be written as
(a) [Ne] $4p^2$ (b) [Ar] $4s^2$
(c) [Ne] $4s^2$ (d) [Kr] $4p^2$ *(1992)*

52. The energy of an electron in the n^{th} Bohr orbit of hydrogen atom is
(a) $\frac{13.6}{n^4}$ eV (b) $\frac{13.6}{n^3}$ eV
(c) $\frac{13.6}{n^2}$ eV (d) $\frac{13.6}{n}$ eV *(1992)*

53. In a given atom no two electrons can have the same values for all the four quantum numbers. This is called
(a) Hund's Rule
(b) Aufbau principle
(c) Uncertainty principle
(d) Pauli's Exclusion principle. *(1991)*

54. For azimuthal quantum number $l = 3$, the maximum number of electrons will be
(a) 2 (b) 6 (c) 0 (d) 14
(1991)

55. The order of filling of electrons in the orbitals of an atom will be
(a) 3*d*, 4*s*, 4*p*, 4*d*, 5*s*
(b) 4*s*, 3*d*, 4*p*, 5*s*, 4*d*
(c) 5*s*, 4*p*, 3*d*, 4*d*, 5*s*
(d) 3*d*, 4*p*, 4*s*, 4*d*, 5*s* *(1991)*

56. The electronic configuration of Cu (atomic number 29) is
(a) $1s^2, 2s^22p^6, 3s^23p^6, 4s^23d^9$
(b) $1s^2, 2s^22p^6, 3s^23p^63d^{10}, 4s^1$
(c) $1s^2, 2s^22p^6, 3s^23p^6, 4s^24p^6, 5s^25p^1$
(d) $1s^2, 2s^22p^6, 3s^23p^6, 4s^24p^63d^3$ *(1991)*

57. The total number of electrons that can be accommodated in all the orbitals having principal quantum number 2 and azimuthal quantum number 1 are
(a) 2 (b) 4
(c) 6 (d) 8 *(1990)*

58. An ion has 18 electrons in the outermost shell, it is
(a) Cu^+ (b) Th^{4+}
(c) Cs^+ (d) K^+ *(1990)*

59. Which of the following statements do not form a part of Bohr's model of hydrogen atom?
(a) Energy of the electrons in the orbits are quantized.
(b) The electron in the orbit nearest the nucleus has the lowest energy.
(c) Electrons revolve in different orbits around the nucleus.
(d) The position and velocity of the electrons in the orbit cannot be determined simultaneously. *(1989)*

60. Number of unpaired electrons in N^{2+} is/are
(a) 2 (b) 0
(c) 1 (d) 3 *(1989)*

61. The maximum number of electrons in a subshell is given by the expression
(a) $4l - 2$ (b) $4l + 2$
(c) $2l + 2$ (d) $2n^2$ *(1989)*

62. The spectrum of He is expected to be similar to that
(a) H (b) Li^+
(c) Na (d) He^+ *(1988)*

63. The number of spherical nodes in $3p$ orbitals are/is
(a) one (b) three
(c) none (d) two *(1988)*

64. If r is the radius of the first orbit, the radius of n^{th} orbit of H-atom is given by
(a) r_0n^2 (b) r_0n
(c) r_0/n (d) $r_0^2n^2$ *(1988)*

Answer Key

1. (c)	**2.** (a)	**3.** (c)	**4.** (b)	**5.** (c)	**6.** (d)	**7.** (c)	**8.** (a)	**9.** (d)	**10.** (b)
11. (b)	**12.** (b)	**13.** (a)	**14.** (b)	**15.** (a)	**16.** (a)	**17.** (c)	**18.** (a)	**19.** (b)	**20.** (b)
21. (a)	**22.** (c)	**23.** (c)	**24.** (d)	**25.** (b)	**26.** (c)	**27.** (c)	**28.** (b)	**29.** (d)	**30.** (b)
31. (b)	**32.** (c)	**33.** (c)	**34.** (a)	**35.** (a)	**36.** (a)	**37.** (d)	**38.** (a)	**39.** (a)	**40.** (d)
41. (c)	**42.** (d)	**43.** (d)	**44.** (a)	**45.** (b)	**46.** (d)	**47.** (c)	**48.** (c)	**49.** (b)	**50.** (a)
51. (b)	**52.** (c)	**53.** (d)	**54.** (d)	**55.** (b)	**56.** (b)	**57.** (c)	**58.** (a)	**59.** (d)	**60.** (c)
61. (b)	**62.** (b)	**63.** (a)	**64.** (a)						

EXPLANATIONS

1. (c) : In case of hydrogen like atoms, energy depends on the principal quantum number only. Hence, $2s$-orbital will have energy equal to $2p$-orbital.

2. (a) : For $n = 3$ and $l = 1$, the subshell is $3p$ and a particular $3p$ orbital can accommodate only 2 electrons.

3. (c) : $d_{x^2-y^2}$ and d_{z^2} orbitals have electron density along the axes while d_{xy}, d_{yz} and d_{xz} orbitals have electron density inbetween the axes.

4. (b) : For the two electrons occupying the same orbital values of n, l and m_l are same but m_s is different, *i.e.*, $+\frac{1}{2}$ and $-\frac{1}{2}$.

5. (c) : Ti(22) : $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$

∴ Order of increasing energy is $3s$, $3p$, $4s$, $3d$

6. (d) : Number of d-electrons in $Fe^{2+} = 6$

Number of p-electrons in Cl = 11

7. (c) : Angular momentum $= \sqrt{l(l+1)}\,\hbar$

For d orbital, $l = 2$

Angular momentum $= \sqrt{2(2+1)}\,\hbar = \sqrt{6}\,\hbar$

8. (a) : Only one orbital, $3p_z$ has following set of quantum numbers, $n = 3$, $l = 1$ and $m_l = 0$.

9. (d) : $E = \frac{hc}{\lambda}$ [Given, $\lambda = 45\text{ nm} = 45 \times 10^{-9}\text{ m}$]

On putting the given values in the equation, we get

$$E = \frac{6.63\times10^{-34}\times3\times10^{8}}{45\times10^{-9}} = 4.42\times10^{-18}\text{ J}$$

10. (b) :

Species	No. of electrons
Be^{2+}	2
H^+	0
Li^+	2
Na^+	10
Mg^{2+}	10

11. (b) : The orbital associated with $n = 3$, $l = 1$ is $3p$. One orbital (with $m = -1$) of $3p$-subshell can accomodate maximum 2 electrons.

12. (b) : The electron is more tightly bound in the smallest allowed orbit.

13. (a) : $c = \upsilon\lambda$

$$\lambda = \frac{c}{\upsilon} = \frac{3\times10^{17}}{6\times10^{15}} = 50\text{ nm}$$

14. (b) : The electronic configuration of Gd_{64} is $[Xe]4f^7 5d^1 6s^2$.

15. (a) : We know that, $E = \frac{hcN_A}{\lambda}$

$$= \frac{6.62\times10^{-27}\times3\times10^{10}\times6.02\times10^{23}}{\lambda}$$

$$= \frac{1.1955\times10^{8}}{\lambda} = \frac{1.196\times10^{8}}{\lambda}\text{ ergs mol}^{-1}$$

16. (a) : $l = 3$ and $n = 4$ represent $4f$. So, total number of electrons in a subshell $= 2(2l + 1) = 2(2 \times 3 + 1) = 14$ electrons. Hence f-subshell can contain maximum 14 electrons.

17. (c) : Rb(37) : $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$

For $5s$, $n = 5$, $l = 0$, $m = 0$, $s = +1/2$ or $-1/2$

18. (a) : Orbital angular momentum

$$(m) = \sqrt{l(l+1)}\,\frac{h}{2\pi}$$

For p-electrons; $l = 1$

Thus, $m = \sqrt{1(1+1)}\,\frac{h}{2\pi} = \frac{\sqrt{2}\,h}{2\pi} = \frac{h}{\sqrt{2}\,\pi}$

19. (b) : Total number of atomic orbitals in any energy level is given by n^2.

20. (b) : $E_1 = \frac{hc}{\lambda_1}$ and $E_2 = \frac{hc}{\lambda_2}$;

$$\frac{E_1}{E_2} = \frac{hc}{\lambda_1}\times\frac{\lambda_2}{hc} = \frac{\lambda_2}{\lambda_1}$$

or $\frac{25}{50} = \frac{\lambda_2}{\lambda_1}$ or $\frac{1}{2} = \frac{\lambda_2}{\lambda_1} \Rightarrow \lambda_1 = 2\lambda_2$

21. (a)

22. (c) : We know that

$$\Delta E \propto \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right], \text{ where } n_2 > n_1$$

∴ $n = 6$ to $n = 5$ will give least energetic photon.

23. (c) : According to de-Broglie equation, $\lambda = \frac{h}{mv}$

Given, $h = 6.6 \times 10^{-34}$ J s ; $m = 0.66$ kg ; $v = 100\text{ m s}^{-1}$

$$\therefore\quad \lambda = \frac{6.6\times10^{-34}}{0.66\times100} = 1\times10^{-35}\text{ m}$$

24. (d) : For a given shell, l,

the number of subshells, $m_l = (2l + 1)$

Since each subshell can accommodate 2 electrons of opposite spin, so maximum number of electrons in a subshell $= 2(2l + 1) = 4l + 2$.

25. (b) : In an atom, for any value of n, the values of $l = 0$ to $(n - 1)$.

For a given value of l, the values of $m_l = -l$ to 0 to $+l$ and the value of $s = +1/2$ or $-1/2$.

In option (b), $l = 2$ and $m_l = -3$

This is not possible, as values of m_l which are possible for $l = 2$ are $-2, -1, 0, +1$ and $+2$ only.

26. (c) : From Heisenberg uncertainty principle

$$\Delta p \cdot \Delta x \geq \frac{h}{4\pi} \quad \text{or} \quad m\Delta v \times \Delta x \geq \frac{h}{4\pi}$$

$$\text{or} \quad (m\Delta v)^2 \geq \frac{h}{4\pi} \qquad (\because \Delta x = \Delta p)$$

$$\text{or} \quad \Delta v \geq \frac{1}{2m}\sqrt{\frac{h}{\pi}}$$

27. (c) : Uncertainty in momentum

$(m\Delta v) = 1 \times 10^{-18}$ g cm s^{-1}

Uncertainty in velocity,

$$(\Delta v) = \frac{1\times10^{-18}}{9\times10^{-28}} = 1.1\times10^{9}\text{cm s}^{-1}$$

28. (b) : (i) represents an electron in $3s$ orbital.

(ii) is not possible as value of l varies from 0, 1, ... $(n-1)$.

(iii) represents an electron in $4f$ orbital.

(iv) is not possible as value of m varies from $-l$ ... $+l$.

(v) is not possible as value of m varies from $-l$ ... $+l$, it can never be greater than l.

29. (d) : Principal quantum number represents the name, size and energy of the shell to which the electron belongs.

Azimuthal quantum number describes the spatial distribution of electron cloud and angular momentum. Magnetic quantum number describes the orientation or distribution of electron cloud. Spin quantum number represents the direction of electron spin around its own axis.

30. (b) : $\Delta x \cdot m\Delta v = h/4\pi$

$$0.1\times10^{-10}\times9.11\times10^{-31}\times\Delta v = \frac{6.626\times10^{-34}}{4\times3.143}$$

$$\therefore \Delta v = \frac{6.626\times10^{-34}}{0.1\times10^{-10}\times9.11\times10^{-31}\times4\times3.143}$$

$= 5.79 \times 10^{6}$ m s^{-1}

31. (b) : $E_n = -K\left(\frac{Z}{n}\right)^2$

$Z = 1$ for hydrogen ; $n = 2$

$$E_2 = \frac{-K\times1}{4} \Rightarrow E_2 = -328 \text{ kJ mol}^{-1} \text{ ; } K = 4\times328$$

$$E_4 = \frac{-K\times1}{16} \Rightarrow E_4 = -4\times328\times\frac{1}{16} = -82 \text{ kJ mol}^{-1}$$

32. (c) : $E = h\upsilon$ or $\upsilon = E/h$

$$\text{For H atom, } E = \frac{-21.76\times10^{-19}}{n^2} \text{ J atm}^{-1}$$

$$\Delta E = -21.76\times10^{-19}\left(\frac{1}{4^2}-\frac{1}{1^2}\right) = 20.40\times10^{-19}\text{ J atm}^{-1}$$

$$\upsilon = \frac{20.40\times10^{-19}}{6.626\times10^{-34}} = 3.079\times10^{15}\text{ s}^{-1}$$

33. (c) : Applying $(\upsilon) = c/\lambda$,

$$\lambda = \frac{c}{\upsilon} = \frac{3\times10^{8}}{8\times10^{15}} = 37.5\times10^{-9}\text{ m} = 37.5\text{nm} \approx 4\times10^{1}\text{nm}$$

34. (a) : Kinetic energy $= \frac{1}{2}mv^2 = \left(\frac{\pi e^2}{nh}\right)^2 \times 2m$

$$\left[\because v = \frac{2\pi e^2}{nh}\right]$$

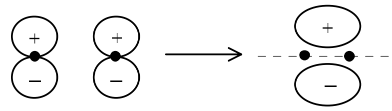
$$\text{Total energy } E_n = -\frac{2\pi^2 me^4}{n^2h^2} = -\left(\frac{\pi e^2}{nh}\right)^2\times2m = -K.E.$$

$\therefore$ Kinetic energy $= -E_n$

Energy of first excited state is -3.4 eV

$\therefore$ Kinetic energy of same orbit ($n = 2$) will be $+3.4$ eV.

35. (a) : For π overlap, the lobes of the atomic orbitals are perpendicular to the line joining the nuclei.



π-overlap

p_x p_y

Hence, only sidewise overlapping takes place.

36. (a) : $n = 3, l = 2, m = +2$

It symbolises one of the five d-orbitals ($3d$).

$m = +2$	$+1$	0	-1	-2

37. (d) : $E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{6\cdot6\times10^{-34}\times3\times10^{8}}{3\cdot03\times10^{-19}}$

$= 656$ nm

38. (a) : Species having same no. of electrons are called isoelectronics.

The no. of electrons in $CO = CN^- = NO^+ = C_2^{2-} = 14$.

So these are isoelectronics.

39. (a) : $\Delta x \times \Delta p = \frac{h}{4\pi}$

(Heisenberg uncertainty principle)

$$\Rightarrow \Delta x = \frac{6.62\times10^{-34}}{4\times3.14\times10^{-5}} = 5.27\times10^{-30}\text{ m}$$

40. (d) : Sommerfield modified Bohr's theory considering that in addition to circular orbits electrons also move in elliptical orbits.

41. (c) : $\lambda = \frac{h}{mv} = \frac{6.63\times10^{-27}\text{erg sec}}{1\text{g}\times10^{4}\text{cm/s}}$

$= 6.63\times10^{-31}$ cm $= 6.63\times10^{-33}$ m

42. (d) : for n^{th} orbit of 'H' atom, $r_n = n^2 \times r_1$

$\Rightarrow$ radius of 2nd Bohr's orbit.

$r_2 = 4\times r_1 = 4\times0.530 = 2.120$ Å

43. (d) : According to uncertainty principle the product of uncertainty in position and uncertainty in momentum is constant for a particle.

i.e., $\Delta x \times \Delta p = \frac{h}{4\pi}$

As, Δx =1.0 nm for both electron and helium atom, so Δp is also same for both the particles.
Thus uncertainty in momentum of the helium atom is also 5.0×10^{-26} kg m s^{-1}.

44. (a) : Since both CO and CN^- have 14 electrons, therefore these are isoelectronic (*i.e.* having same number of electrons).

45. (b) : The longest wavelength means the lowest energy. We know that relation for wavelength

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

here, $n_1 = 2, n_2 = 3$
R_H (Rydberg constant = 109677 cm^{-1}

$$\frac{1}{\lambda} = 109677\left(\frac{1}{(2)^2} - \frac{1}{(3)^2}\right) = 15233$$

or, $\lambda = \frac{1}{15233} = 6.56 \times 10^{-5}\,\text{cm} = 6.56 \times 10^{-7}\,\text{m} = 656\,\text{nm}$

46. (d) : Energy of an atom when $n = 1$

$$E_1 = -\frac{1312}{(1)^2} = -1312\ \text{kJ mol}^{-1}$$

Similarly energy when $n = 3$, $(E_3) = -\frac{1312}{(3)^2}$

$= -145.7$ kJ mol^{-1}

The energy absorbed when an electron jumps from $n = 1$ to $n = 3$

$E_3 - E_1 = -145.7 - (-1312) = 1166.3$ kJ mol^{-1}

$= \frac{1166.3}{6.023 \times 10^{23}} = 193.6 \times 10^{-23}$ kJ

$= 193.6 \times 10^{-20}$ J [1 Joule = 10^7 ergs]

$\Rightarrow 193.6 \times 10^{-13}$ ergs $= 0.1936 \times 10^{-10}$ ergs

47. (c) : Mass of an electron $(m) = 9.1 \times 10^{-28}$ g
Velocity of electron $(v) = 3 \times 10^4$ cm/s

Accuracy = 0.001% = $\frac{0.001}{100}$ and Planck's constant $(h) = 6.626 \times 10^{-27}$ erg-second.

We know that actual velocity of the electron

$(\Delta v) = 3 \times 10^4 \times \frac{0.001}{100} = 0.3$ cm/s

Therefore, uncertainty in the position of the electron

$$(\Delta x) = \frac{h}{4\pi m \Delta v} = \frac{6.626 \times 10^{-27}}{4\pi \times (9.1 \times 10^{-28}) \times 0.3} = 1.93\ \text{cm}$$

48. (c) : Due to ground state, state of hydrogen atom $(n) = 1$
Radius of hydrogen atom $(r) = 0.53$ Å
Atomic no. of Li $(Z) = 3$

Now, radius of Li^{2+} ion $= r \times \frac{n^2}{Z} = 0.53 \times \frac{(1)^2}{3} = 0.17$Å

49. (b) : Energy of electron depends on the value of $(n + l)$. The subshell are $3d$, $4d$, $4p$ and $5s$, $4d$ has highest energy.

50. (a) : The number of electrons in O^{2-}, N^{3-}, F^- and Na^+ is 10 each, but number of electrons in Tl^+ is 80.

51. (b) : Atomic No. of Ca = 20
$\therefore$ Electronic configuration of Ca = $[Ar]4s^2$

52. (c) : Energy of an electron in n^{th} Bohr orbit of hydrogen atom $= \frac{-13.6}{n^2}$ eV

53. (d) : This is a Pauli's Exclusion principle.

54. (d) : $l = 3$ means f-subshell
Maximum no. of electrons in f-subshell = 14

f-subshell = | ↿⇂ | ↿⇂ | ↿⇂ | ↿⇂ | ↿⇂ | ↿⇂ | ↿⇂ |

55. (b) : As per Aufbau Principle.
The principle states : In the ground state of the atoms, the orbitals are filled in order of their increasing energies.

56. (b) : Electronic configuration of Cu
$= 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$

57. (c) : $n = 2, l = 1$
It means $2p$-orbitals
Total no. of electrons that can be accomodated in $2p$ orbitals = 6

58. (a) : Electronic configuration of Cu^+ = $[Ar]3d^{10}$

59. (d) : It is uncertainty principle and not Bohr's postulate.

60. (c) : $N^{2+} = 1s^2 2s^2 2p_x^1$
$\therefore$ No. of unpaired electrons = 1

61. (b) : No. of orbitals in a subshell = $2l + 1$
$\Rightarrow$ No. of electrons = $2(2l + 1) = 4l + 2$

62. (b) : Both He and Li^+ contain 2 electrons each.

63. (a) : No. of radial nodes in $3p$-orbital $= n - l - 1$
$= 3 - 1 - 1 = 1$

64. (a) : Radius of n^{th} orbit of H-atom $= r_0 n^2$
where r_0 = radius of the first orbit