Exercise 2 (Going step-by-step)

Fundamental Aspects

1. If m_n is the mass of the neutron and m_e that of the electron then $\frac{m_n}{m_e}$ is

   (a) 1836 **(b) 1839** (c) 1 (d)∞

2. Scientist associated with discoveries are given below at random in two columns.

Scientist		Discovery	
I	Goldstein	A	Charge on electron
II	Millikan	B	Neutron
III	Chadwick	C	Proton
IV	Thomson	D	Charge/mass ratio of the electron

   Correct matching is given by

   I II III IV I II III IV

   (a) A B C D (b) A B C A

   (c) C A B D (d) C A D B

3. Some sub-nuclear particles are

   I: antiproton; II: μ-meson; III: π-meson;

   IV: neutrino; V: positron.

   Increasing order of year of discovery is (starting from the earliest)

   (a) V < II < III < I < IV (b) V < IV < III < II < I

   (c) I < II < III < IV <V (d) V < III < IV < II < I

4. Mass of proton is

   (a) 1.0000 amu **(b) 1.0073 amu**

   (c) 1.0087 amu (d) 5.486×10^{-4} amu

5. Select the correct statement based on Rutherford's model.

   (a) Most of the space in an atom between the nucleus and the revolving electron is empty

   (b) Electrons are called planetary electrons

   (c) Protons give positive charge on the nucleus but nuclear mass is determined by proton and neutron both

   (d) All of the above are correct statements

6. Which has maximum spin?

   (a) Electron (b) Proton

(c) Neutron **(d) Equal spin**

7. Which is heaviest compared to the of electron?

(a) π- meson (b) μ-meson

(c) Neutrino (d) Positon

8. Ratio of radius of atom to that of nucleus is of the order of

(a) 10^{-10} (b) 10^{-15}

(c) 10^{5} (d) 10^{-5}

9. The application of electric and magnetic fields deflected certain rays in the discharge tube towards cathode. This proved that

(a) electrons are negatively charged particles

(b) protons are positively charged particles

(c) neutrons are neutral particles

(d) none of the above statements is true

10. Mass of the proton is equal to that of

(a) Positron (b) neutrino

(c) pion **(d) anti-proton**

11. A near UV photon of 300 nm is absorbed by a gas and then re-emitted as two photons. One photon is red with the wavelength 760 nm. Hence, wavelength of the second photon is

(a) 460 nm (b) 1060 nm

(c) 496 nm (d) 300 nm

12. Which of the recent developments has proved the existence of atoms?

(a) Scanning tunnelling microscopy

(b) X-ray diffraction

(c) Infrared spectroscopy

(d) Mass spectroscopy

13. Select the correct statement.

(a) Visible light consists of electromagnetic waves of oscillating electric and magnetic fields

(b) In vacuum, types of all electromagnetic radiation travel at the same speed

(c) Both (a) and (b) are correct statements

(d) None of the above is correct statements

14. Select the correct statement.

(a) The ideal body, which emits and absorbs all frequencies, is called a black body

(b) The exact fr4equency distribution of the emitted radiation from a black body depends upon its temperature

(c) The radiation emitted goes from a lower frequency to a higher frequency as the temperature increases

(d) All of the above are correct statements

15. A wavelength of 400 nm corresponds to

(a) frequency (v) =7.5×10^{14} Hz

(b) wave number ($\bar{\nu}$)=2.5×10^{6} m^{-1}

(c) momentum (mv)=1.66×10^{-27} kg ms^{-1}

(d) all of the above are correct values

Photoelectric Effect

16. Threshold energy is also called

(a) work function (b) potential energy (PE)

(c) kinetic energy (KE) (d) sum of (PE) and (KE)

17. If in Moseley's equation, given constants a = b = 1, then for the frequency v=400 s^{-1}, element will be

(a) K **(b) Na**

(c) Rb (d) Cs

18. Frequency of matter wave is equal to

(a) (KE)/2 h **(b) 2 (KE)/h**

(c) (KE)/h (d) λ

19. An ion (X^-) with mass number 37 contains 11.1% more neutrons than electrons. Thus, number of electrons in the ion is

(a) 17 **(b) 18**

(c) 35 (d) 36

20. M^{3+} (mass number 56) contains 30.4% more neutrons than electrons. Thus, atomic number of the ion is

(a) 23 (b) 24

(c) 25 **(d) 26**

Bohr's Theorem

21. There is a transition from n=1 to n=2 and then n=2 to n=3, then

(a) ΔE values as well as frequency are additive

(b) wavelength as well as frequency are additive

(c) ΔE values as well as wavelength are additive

(d) all of the parameters, (ΔE, frequency and wavelength) are additive.

22. Number of waves made by a Bohr electron in one complete revolution in its fourth orbit is

(a) 2 (b) 3

(c) 4 (d) ∞

23. An electron in H-atom in its ground state absorbs 1.50 times as much as energy as the minimum required for its escape (13.6 eV) from the atom. Thus KE given to emitted electron is

(a) 13.6 eV **(b) 20.4 eV**

(c) 34.0 eV (d) 6.8 eV

24. Which of the following electronic transitions requires that the greatest quantity of energy be absorbed by a hydrogen atom?

(a) n=1 to n=2 (b) n=2 to n=4

(c) n=3 to n=6 **(d) n=1 to n=∞**

25. Wave number of a spectral line for a given transition is x cm^{-1} for He^{+}, then its value for Be^{3+}(isoelectronic of He^{+}) for same transition is

(a) x cm^{-1} **(b) 4x cm^{-1}**

(c) $\frac{x}{4}$ cm^{-1} (d) 2x cm^{-1}

26. Electron falls from seventh energy level and lower energy level to give bands in Paschen series. Total number of bands obtained are

(a) 4 (b) 3

(c) 2 (d) 1

27. The potential energy of an energy of an electron in the first Bohr orbit in the He^+ ion is

(a) -13.6 eV (b) -27.2 eV

(c) -54.4 eV **(d) -108.8 eV**

28. 'Hartree' is the atomic unit of energy and is equal to

(a) -13.6 eV $atom^{-1}$ **(b) -27.12 eV $atom^{-1}$**

(c) +13.6 eV $atom^{-1}$ (d) +27.12 eV $atom^{-1}$

29. R_y (Rydberg constant) is x m^{-2} for H-atom. For He^+ ion corresponding value for this constant is

(a) 100 x cm^{-1} (b) 400 x cm^{-1}

(c) 4 x cm^{-1} **(d) 0.04 x cm^{-1}**

30. A continuum in spectrum is observed due to the following.

(a) Once an electron is completely free from the nucleus, it is no longer restricted to quantised discrete energy satates

(b) electron takes up continuously the ordinary kinetic energy corresponding to its speed in free space

(c) Both the reasons are correct

(d) None of the two reasons are correct.

Quantum Numbers

31. Which of the pair of orbitals have electronic density along the axis?

(a) d_{xz} , d_{yz} **(b) $d_xz - _yz$, d_zz**

(c) d_{xy} , d_{yz} (d) d_{xy} , d_zz

32. Given this set of quantum numbers for a multi-electron atom 2, 0, 0, $\frac{1}{2}$ and 2, 0, 0, $-\frac{1}{2}$. What is the next higher allowed set of n and l quantum number for this atom in its ground state?

(a) n = 2, 1 = 0 **(b) n = 2, l = 1**

(c) n = 3, 1 = 0 (d) n = 3, l = 1

33. Which property of an element is most dependent on the shielding effect?

(a) Atomic number (b) Atomic mass

(c) Atomic radius (d) Number of stable isotopes

34.In a suborbit, there are three radial nodes. This suborbit can be

(a) 4s or 5p (b) 4d or 5p

(c) 4s or 4p (d) 3s or 3p

35. Number of nodal planes in 4p suborbit will be

(a) 0 **(b) 1**

(c) 2 (d) 3

36. Which is a possible set of quantum numbers for a valence electron in ground state atom of phosphorus (Z =15)?

	n	l	m_1	m_s
(a)	2	1	0	$+\frac{1}{2}$
(b)	3	0	0	0
(c)	**3**	**1**	**-1**	$\mathbf{+\frac{1}{2}}$
(d)	3	2	0	$-\frac{1}{2}$

37. Which of the quantum numbers determines orientation of the orbital?

(a) n (b) l

(c) m_l (d) m_s

38. Consider the following statements

I: The spin angular momentum of the electron is constant and cannot be changed.

II: For spin=+ $\frac{1}{2}$, spin angular momentum is $\frac{\sqrt{3}h}{4\pi}$.

III: Spin angular momentum is a vector quantity and car have only two orientations relative to a chosen axis.

Of these the correct state,emts are

(a) I, II (b) II, III

(c) I, III **(d) I, II, III**

39. Select the correct statement.

(a) m_s determines orientation of the spin of the electron

(b) An electron spin angular momentum vector of length

$\frac{\sqrt{3}}{2}$ units can take only two orientations with respect to a specified axis

(c) Both the statements are correct

(d) None of the above statements is correct

40. If angular momentum quantum number can take value of n also (in addition to other possible values) then total number of electrons in first orbit would have been

(a) 2 (b) 6

(c) 8 (d) 10

41. Which of these ions is expected to be coloured in aqueous solution?

I : Fe^{3+}; II : Ni^{2+}; III : Al^{3+}

(a) I only **(b) I and II only**

(c) II and III only (d) I and III only

42. Electrons in various degenerate orbitals of a sub-shell can be filled (by changing spins etc.) by following arrangements,

$$\frac{x!}{(x-y)!\,y!}$$

Where, x=2 x number of orbitals

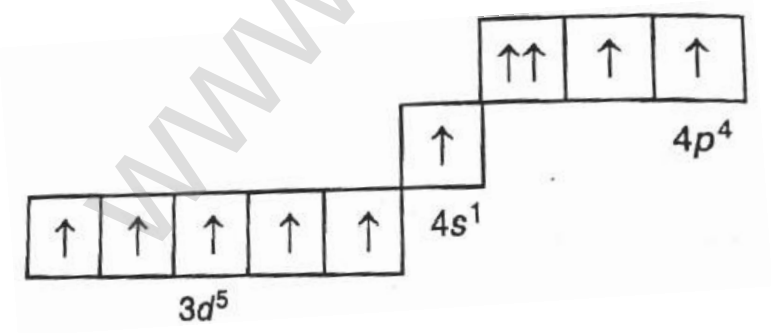
y= number of electrons

A p^2- configuration can be written as many as

(a) 15 ways (b) 6 ways

(c) 45 ways (d) 10 ways

43. In the following electronic configuration, some rules have been violated



I: Hund II: Pauli's exclusion III: Aufbau

(a) I and II (b) I and III

(c) II and III **(d) I, II and III**

44. If azimuthal quantum number could have value of n also (in addition to normal value). Then EC of V (Z =23) would have been

(a) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^3$

(b) $1s^2, 1\ p^6, 2s^2, 2p^6, 2d^7$

(c) $1s^2, 1\ p^6, 2s^2, 2p^6, 3s^2, 2d^5$

(d) $1s^2, 1\ p^6, 2s^2, 2p^6, 3s^1, 2d^6$

45. Under the condition given above, magnetic moment of Ti (Z =22) would have been

(a) $\sqrt{24}$ BM **(b) $\sqrt{48}$ BM**

(c) $\sqrt{35}$ BM (d) 0

46. $1s^2, 2s^2, 2p^6$ represents

(a) macroscopic property of an element

(b) microscopic property of an element

(c) both (a) and (b)

(d) none of the above

47. Which of the following species contains only three electrons in valence shell?

Li, B, N, F, Al

(a) Li, B (b) B, N

(c) B, Al (d) N

48. Which of the following has two unpaired electrons?

(a) Si, Mg (b) S, Mg

(c) S, Si (c) S, Fe

49. The following elements are in the fourth period of the Periodic Table

Ca V Co Zn As

Of those listed the ones that have unpaired electrons in the ground state electronic configuration are

(a) Ca, V and Co (b) V, Co and Zn

(c) Ca, Zn and As **(d) V, Co and As**

50. (I) n=3, l=2, m_1=-2 (II) n=3, l=1, m_1=0

(III) n=3, l=0, m_1=-1 (IV) n=3, l=2, m_1=0

(V) n=3, l=3, m_1=-2

Of these quantum state designations which does not describe an allowed state for an electron in an atom?

(a) I and IV **(b) III and V**

(c) II and V (d) IV and V

Wave Mechanics

51. A standing wave in a string 35cm long has a total of six nodes, (including those at the ends). Hence, wavelength of the standing wave is

(a) 14 cm (b) 5.826 cm

(c) 7 cm (d) 17.5 cm

52. In some regions of space around nucleus Ψ^2=0; this region is called

(a) nucleus **(b) spherical nodes**

(c) orbital (d) orbit

53. Highest electron probability in 1s orbital exists at a point in the vicinity of

(a) spherical nodes

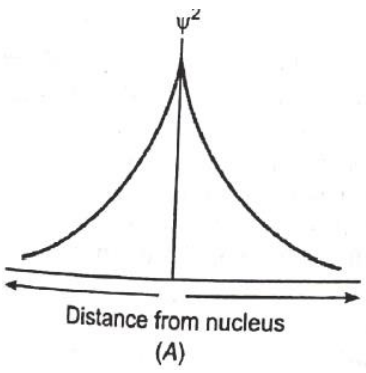
(b) circumference

(c) nucleus

(d) plane

54. Consider the following figures A and B indicating distribution of charge density (electron probability Ψ^2) with distance r.

Select the correct statement (s).



(a) A and B both are for 1s
(b) A and B both are for 1s
(c) A is for 2s, B is for 1s
(d) A is for 1s, B is for 2s

55. If there are total of (n+1) nodes in a string of length l, then correct relationship is

(a) $\mathbf{l = \frac{n\lambda}{2}}$ (b) $l=(n+1)\frac{\lambda}{2}$

(c) $l = \frac{(n-1)\lambda}{2}$ (d) $l = 2n\lambda$

56. Select the correct statement.

(a) $|\Psi|^2$ measures the electron probability density at a point in an atom

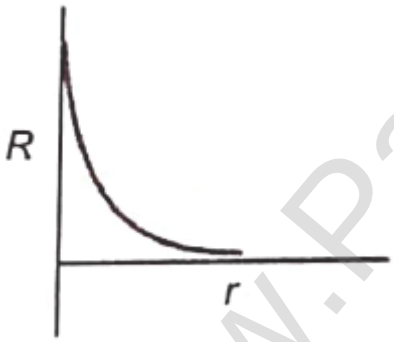
(b) Ψ and $|\Psi|^2$ vary as a function of the three coordinates r (radial part), Θ and ϕ (angular part)

(c) Both are correct

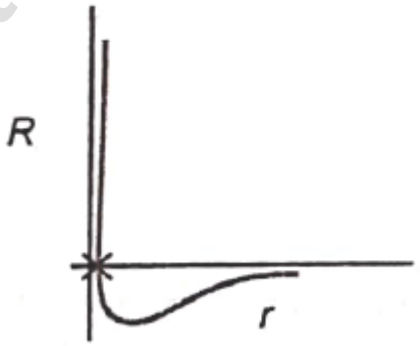
(d) None of the above is correct

57. The plot of the radial wave function R as a function of distance r of the electron from the nucleus for 2p orbital is

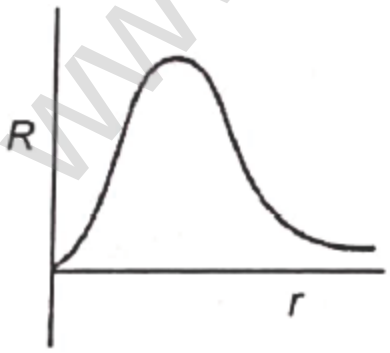
(a)



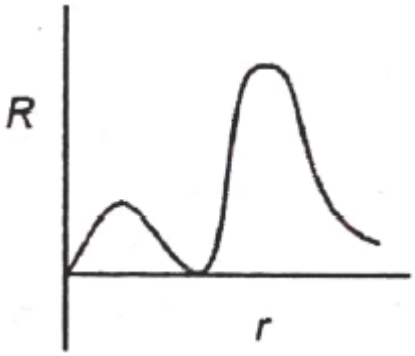
(b)



(c)



(d)



58. The plot of the radial density function $4\pi^2R^2$ as a function of distance r of the electron from the nucleus for 2s orbital is [given in questions (27) above].

59. The plot of the radial probability density R^2 as a function r for 1s orbital is [given in question (27) above]

60. Select the correct alternate.

(a) Radial probability function gives the probability of finding the electron at a distance r from the nucleus

(b) The maximum in the curve corresponds to the distance at which the probability of finding the electron is maximum

(c) This distance is called the radius of maximum probability (52.9 pm for hydrogen)

(d) All the above statements are correct statements