# M.SC. ENTRANCE QUESTIONS
## SUBJECT: PHYSICS

1. In case of a GM counter, which of the following statement is correct?
   (a) Multiplication factor of the detector is of the order of $10^{10}$.
   (b) Type of the particles detected can be identified.
   (c) Energy of the particles detected can be distinguished.
   (d) Operating voltage of the detector is few tens of volts.

   Answer: (c) Energy of the particles detected can be distinguished.

2. Choose the correct statement from the following:
   (a) Neutron interacts through electromagnetic interaction.
   (b) Electron does not interact through weak interaction.
   (c) Neutrino interacts through weak and electromagnetic interaction.
   (d) Quark interacts through strong interaction but not through weak interaction.

   Answer: (d) Quark interacts through strong interaction but not through weak interaction.

3. The number of distinct spectral lines that are observed in the resultant ZeemanSpectrum is
   (a) 2
   (b) 3
   (c) 4
   (d) 5

   Answer: (c) 4

4. The spectral line corresponding to the transition

$$2P_{\frac{1}{2}}\left(m_j=+\frac{1}{2}\right) \rightarrow 2S_{\frac{1}{2}}\left(m_j=-\frac{1}{2}\right)$$

   (a) Linearly polarized
   (b) Circularly polarized
   (c) Unpolarized
   (d) Not emitted along the magnetic field direction

   Answer: (b) Circularly polarized

5. A neutron passing through a detector is detected because of
   (a) The ionization it produces.
   (b) The Scintillation light it produces.
   (c) The electron-hole pairs it produces.

(d) The Secondary particlesproduced in a nuclear reaction inthe detector.
Answer: (b) The Scintillation light it produces.

6. The ground state of sodium atom $(11_{\mathrm{Na}})$ is a $2_{S_{\frac{1}{2}}}$ state. The difference in energy levels arising in the presence of a weak external magnetic field B, given in terms of Bohr magnet on, $\mu_{\mathrm{B}}$ is
   (a) $\mu_{\mathrm{B}}\mathrm{B}$
   (b) $2\mu_{\mathrm{B}}\mathrm{B}$
   (c) $4\mu_{\mathrm{B}}\mathrm{B}$
   (d) $10\mu_{\mathrm{B}}\mathrm{B}$
   Answer: (b) $2\mu_{\mathrm{B}}\mathrm{B}$
7. In a normal Zeeman effect experiment, spectral splitting of the line at the wave length 643.8 nm corresponding to the transition $5\,1_{\mathrm{D}_2} \rightarrow 5\,1_{\mathrm{P}_1}$ ofCadmium atoms is to be observed. The spectrometer has a resolution of 0.01 nm. Minimum magnetic field needed to observe this is $(\mathrm{m_e} = 9.1 \times 10^{-31}\mathrm{Kg}, \mathrm{C} = 3 \times 10^{8}\mathrm{m/s}$
   $\mathrm{e} = 1.6 \times 10^{-19}\mathrm{C}$ )
   (a) 0.25 T
   (b) 0.52 T
   (c) 0.0052 T
   (d) 5.2 T
   Answer: (b) 0.52 T
8. There are four electrons in the 3d shell of an isolated atom. The total magnetic moment of the atom in unit of Bohr magneton is
   (a) 1
   (b) 0
   (c) 2
   (d) 5
   Answer: (b) 0
9. An atomic transition $1_{\mathrm{P}} \rightarrow 1_{\mathrm{S}}$ in a magnetic field of 1 Tesla shows Zeeman splitting. Given that the Bohr magneton $\mu_{\mathrm{B}} = 9.27 \times 10^{-24}\mathrm{J/T}$ and the wave length conresponding to the transition is 250 nm, the separation in the Zeeman spectral lines is approximately
   (a) 0.01 nm
   (b) 0.1 nm
   (c) 10 nm
   (d) 1 nm
   Answer: (a) 0.01 nm
10. An atomic spectral line is observed to split in to nine components due to a

Zeeman shift. If the upper state of the atom is $3_{D_2}$ then the lower state will be

(a) $3_{F_2}$
(b) $3_{F_1}$
(c) $3_{P_1}$
(d) $3_{P_2}$

Answer: (c) $3_{P_1}$

11. If the binding energy of electron in the K and L shells of silver atom are 25.4 Kev and 3.34 KeV respectively, then the kinetic energy of the Auger electron will be approximately.

(a) 22 KeV
(b) 9.3 KeV
(c) 10.5 KeV
(d) 18.7 KeV

Answer: (d) 18.7 KeV

12. The value of the Lande g-factor for a fine structure level defined by the quantum number. L=1, J=2 and S=1 is

(a) $\frac{11}{6}$
(b) $\frac{4}{3}$
(c) $\frac{8}{3}$
(d) $\frac{3}{2}$

Answer: (d) $\frac{3}{2}$

13. The direction of orbital magnetic moment in hydrogen atom is

(a) Same as the direction of orbital angular momentum.
(b) Opposite to that of the orbital angularmomentum.
(c) Perpendicular to the direction of orbital angular momentum.
(d) In a direction making an angle of $45^{\circ}$ with the direction of orbital angularmomentum.

Answer: (b) Opposite to that of the orbital angularmomentum.

14. Stern – Gerlach's experiment confirms

(a) Electron spin and associated magnetic moment.
(b) Orbital motion of the electron and associated magnetic moment.
(c) Specific charge of the electron.
(d) Spin – orbit interaction of the electron.

Answer: (a) Electron spin and associated magnetic moment.

15. On which of the following levels of hydrogen the spin-orbit interaction has on effect

(a) s-level
(b) p-level
(c) d-level

(d)f-level

Answer: (a) s-level

16. How many orientations of $\mu_l$ are possible for the d-state?

(a)2

(b)3

(c)4

(d)5

Answer: (d) 5

17. The value of Lande splitting factor $g_j$ for S-state is

(a)0

(b)1

(c)2

(d)$\frac{1}{2}$

Answer: (c) 2

18. The constant $\propto = \frac{1}{137}$ is called

(a)Planck's constant

(b)Rydberg constant

(c)Fine structure constant

(d)Boltzmann constant

Answer: (c) Fine structure constant

19. If the azimuthal number K=0, the electron orbit is Sommerfeld model becomes a

(a)Circle

(b)Ellipse

(c)Straight line

(d)None of the above

Answer: (c) Straight line

20. The orbital angular momentum (P) of electron in a closed sub-shell with Z→ large value is

(a)P>0

(b)P<0

(c)P=0

(d)P=α

Answer: (c) P=0

21. The frequency of $K_\alpha$ line of characteristic X-ray spectrum is proportional to

(a)Z

(b)$Z^{\frac{1}{2}}$

(c)$Z^2$

(d)$Z^{\frac{3}{2}}$

Answer: (c) $Z^2$

22. If an electron has orbital angular momentum quantum number L=7, then it will have an orbital angular momentum

(a) $7\hbar$

(b) $42\hbar$

(c) $\sqrt{7}\hbar$

(d) $\sqrt{56}\hbar$

Answer: (d) $\sqrt{56}\hbar$

23. The Lande 'g' factor for the level $3_{D_3}$ is

(a) $\frac{2}{3}$

(b) $\frac{3}{2}$

(c) $\frac{3}{4}$

(d) $\frac{4}{3}$

Answer: (d) $\frac{4}{3}$

24. Given that the ground state energy of the hydrogen atom is $-13.6$ eV, the ground state energy of positronium (which is a bound state of an electron and a positron) is

(a) 6.8 eV

(b) $-6.8$ eV

(c) $-13.6$ eV

(d) $-27.2$ eV

Answer: (b) $-6.8$ eV

25. The ratio of intensities of the $D_1$ and $D_2$ lines of sodium at high temperature is

(a) 1:1

(b) 2:3

(c) 1:3

(d) 1:2

Answer: (d) 1:2

26. The total spin of a hydrogen atom is due to the contribution of the spins of the electron and the proton. In the high temperature limit, the ratio of the number of atoms in the Spin-1 state to the number in the Spin-0 state is

(a) 2

(b) 3

(c) $\frac{1}{2}$

(d) $\frac{1}{3}$

Answer: (b) 3

27. An atomic spectral line is observed to split in to nine components due to a

Zeeman shift. If the upper state of the atom is $3_{D_2}$ then the lower state will be

(a) $3_{F_2}$
(b) $3_{F_1}$
(c) $3_{P_1}$
(d) $3_{P_2}$

Answer: (c) $3_{P_1}$

28. The binding energy of the electrons in the K and L shells of the silver atom are25.4 KeV and 3.34 KeV, then the kinetic energy of the Auger electron will be approximately

(a) 22 KeV
(b) 9.3 KeV
(c) 10.5 KeV
(d) 18.7 KeV

Answer: (d) 18.7 KeV

29. If the fine structure splitting between the $2\,2_{P_{\frac{3}{2}}} \rightarrow 2\,2_{P_{\frac{1}{2}}}$ levels in the hydrogen atom is $0.4\ \text{cm}^{-1}$, the corresponding splitting in $Li^{2+}$ will approximately be

(a) $1.2\ \text{cm}^{-1}$
(b) $10.8\ \text{cm}^{-1}$
(c) $32.4\ \text{cm}^{-1}$
(d) $36.8\ \text{cm}^{-1}$

Answer: (c) $32.4\ \text{cm}^{-1}$

30. The radius of a $^{64}_{29}\text{Cu}$ nucleus is measured to be $4.8 \times 10^{-13}$ cm. The radius of $^{27}_{12}\text{Mg}$ nucleus can be estimated to be

(a) $2.5 \times 10^{-13}$ cm
(b) $5.1 \times 10^{-13}$ cm
(c) $3.6 \times 10^{-13}$ cm
(d) $7.6 \times 10^{-13}$ cm

Answer: (c) $3.6 \times 10^{-13}$ cm

31. The sodium doublet lines are due to transition from $2_{P_{\frac{3}{2}}}$ to $2_{P_{\frac{1}{2}}}$ levels to $3_{S_{\frac{1}{2}}}$ level. On application of a weak magnetic field the total number of allowed transitions are

(a) 4
(b) 6
(c) 8
(d) 10

Answer: (d) 10

32. The spectral line results from the transition n=2 to n=1 in the atoms/species below. Which one of these will produce the shortest wavelength emission

(a) Hydrogen atom
(b) Single ionised helium
(c) Doubly ionised lithium
(d) Deuterium atom

Answer: (c) Doubly ionised lithium

33. If the magnetic quantum number $m_l$ of an electron in a particular excited state of hydrogen atom is 5, then the possible choice of quantum numbers n, l, $m_l$, $m_s$ would respectively

(a) 8, 6, 5, $\frac{1}{2}$
(b) 6, 6, 5, $-\frac{1}{2}$
(c) 7, 7, 5, $\frac{1}{2}$
(d) 5, 5, 5, $-\frac{1}{2}$

Answer: (a) 8, 6, 5, $\frac{1}{2}$

34. According to Pauli's principle $2n^2$ electrons can occupy the major shell with principal quantum number 'n'. Out of 50 electrons in the major shell, n=5, the number of electrons having magnetic quantum number $m_l = 1$ would be

(a) 5
(b) 10
(c) 8
(d) 2

Answer: (c) 8

35. A hydrogen atom is in the $n = 2, j = \frac{3}{2}, m_l = \frac{3}{2}$ state. What is the change in the energy of the state when it is placed in a magnetic field B in the Z-direction?

(a) $\frac{e\hbar B}{m}$
(b) $\frac{e\hbar B}{2\pi m}$
(c) $\frac{e\hbar B}{\pi m}$
(d) $\frac{e\hbar B}{2m}$

Answer: (b) $\frac{e\hbar B}{2\pi m}$

36. What can be the value of total angular momentum of p electron?

(a) $\frac{\sqrt{3}h}{4\pi}$
(b) $\frac{3h}{4\pi}$

(c) $\frac{h}{4\pi}$

(d) $\frac{\sqrt{2}h}{2\pi}$

Answer: (a) $\frac{\sqrt{3}h}{4\pi}$

37. What type of magnetic field is needed in a Stern – Gerlach experiment to act upon the beam of silver atom?

(a) Highly uniform

(b) Non-uniform but slowly varying

(c) Uniform but varying with time

(d) Highly non-uniform

Answer: (d) Highly non-uniform

38. If an atom is in the $3_{D_3}$ state, the angle between its orbital and spin angular momentum vectors $\vec{L}$ and $\vec{S}$ is

(a) $\cos^{-1}\frac{1}{\sqrt{3}}$

(b) $\cos^{-1}\frac{2}{\sqrt{3}}$

(c) $\cos^{-1}\frac{1}{2}$

(d) $\cos^{-1}\frac{\sqrt{3}}{2}$

Answer: (a) $\cos^{-1}\frac{1}{\sqrt{3}}$

39. The L, S and J quantum numbers corresponding to the ground state electronic configuration of Boron (Z=5) are

(a) $L = 1, S = \frac{1}{2}, J = \frac{3}{2}$

(b) $L = 1, S = \frac{1}{2}, J = \frac{1}{2}$

(c) $L = 1, S = \frac{3}{2}, J = \frac{1}{2}$

(d) $L = 0, S = \frac{3}{2}, J = \frac{3}{2}$

Answer: (b) $L = 1, S = \frac{1}{2}, J = \frac{1}{2}$

40. Assuming L-S coupling scheme is valid, the number of permitted transitions from $2_{P_{\frac{3}{2}}}$ to $2_{P_{\frac{1}{2}}}$ due to weak magnetic field is

(a) 4

(b) 5

(c) 6

(d)10
Answer: (c) 6