T.Y.B. Sc. (2021-2022)
Department of Physics
PHY 3505 Atomic and Molecular Physics
Question Bank

Chapter-1 Atomic Structure

Objective Questions

1. Which of the following conclusions could not be derived from Rutherford's α -particle scattering experiment?
(i) Most of the space in the atom is empty.
(ii) The radius of the atom is about 10–10 m while that of nucleus is 10–15 m.
(iii) Electrons move in a circular path of fixed energy called orbits.
(iv) Electrons and the nucleus are held together by electrostatic forces attraction.

2. Which of the following options does not represent ground state electronic configuration of an atom?
(i) 1s2 2s2 2p6 3s2 3p6 3d8 4s2
(ii) 1s2 2s2 2p6 3s2 3p6 3d9 4s2
(iii) 1s2 2s2 2p6 3s2 3p6 3d10 4s1
(iv) 1s2 2s2 2p6 3s2 3p6 3d5 4s1

4. Which of the following statement is not correct about the characteristics of cathode rays?
(i) They start from the cathode and move towards the anode.
(ii) They travel in straight line in the absence of an external electrical or magnetic field.
(iii) Characteristics of cathode rays do not depend upon the material of electrodes in cathode ray Tube.
(iv) Characteristics of cathode rays depend upon the nature of gas present in the cathode ray tube.

5. Which of the following statements about the electron is incorrect?
(i) It is a negatively charged particle.
(ii) The mass of electron is equal to the mass of neutron.
(iii) It is a basic constituent of all atoms.
(iv) It is a constituent of cathode rays.

6. Which of the following properties of atom could be explained correctly by Thomson Model of atom?
(i) Overall neutrality of atom.
(ii) Spectra of hydrogen atom.
(iii) Position of electrons, protons and neutrons in atom.
(iv) Stability of atom.

7. Two atoms are said to be isobars if.
(i) they have same atomic number but different mass number.

(ii) they have same number of electrons but different number of neutrons.
(iii) they have same number of neutrons but different number of electrons.
(iv) sum of the number of protons and neutrons is same but the number of Protons is different.

8. The number of radial nodes for 3p orbital is _____.
(i) 3
(ii) 4
(iii) 2
(iv) 1

9. Number of angular nodes for 4d orbital is _____.
(i) 4
(ii) 3
(iii) 2
(iv) 1

10. Which of the following is responsible to rule out the existence of definite paths or trajectories of electrons?
(i) Pauli's exclusion principle.
(ii) Heisenberg's uncertainty principle.
(iii) Hund's rule of maximum multiplicity.
(iv) Aufbau principle.

11. Total number of orbitals associated with third shell will be _____.
(i) 2
(ii) 4
(iii) 9
(iv) 3

12. Orbital angular momentum depends on _____.
(i) l
(ii) n and l
(iii) n and m
(iv) m and s

13. Chlorine exists in two isotopic forms, Cl-37 and Cl-35 but its atomic mass is 35.5. This indicates the ratio of Cl-37 and Cl-35 is approximately
(i) 1:2
(ii) 1:1
(iii) 1:3
(iv) 3:1

14. The pair of ions having same electronic configuration is _____.
(i) Cr^{3+}, Fe^{3+}
(ii) Fe^{3+}, Mn^{2+}
(iii) Fe^{3+}, Co^{3+}

(iv) Sc^{3+}, Cr^{3+}

15. For the electrons of oxygen atom, which of the following statements is correct?
(i) Zeff for an electron in a 2s orbital is the same as Zeff for an electron in a 2p orbital.
(ii) An electron in the 2s orbital has the same energy as an electron in the 2p orbital.
(iii) Zeff for an electron in 1s orbital is the same as Zeff for an electron in a 2s orbital.
(iv) The two electrons present in the 2s orbital have spin quantum numbers ms but of opposite sign.

16. If travelling at same speeds, which of the following matter waves have the shortest wavelength?
(i) Electron
(ii) Alpha particle (He^{2+})
(iii) Neutron
(iv) Proton

In the following questions <u>two or more</u> options may be correct.

17. Identify the pairs which are not of isotopes?
(i) $^{12}_{6}X$, $^{13}_{6}Y$
(ii) $^{35}_{17}\ ^{37}_{17}X, Y$
(iii) $^{14}_{6}\ ^{14}_{7}X, Y$
(iv) $^{8}_{4}\ ^{8}_{5}X, Y$

18. Out of the following pairs of electrons, identify the pairs of electrons present in degenerate orbitals :
(i) (a) n = 3, l = 2, ml = –2, ms= $-\frac{1}{2}$
(b) n = 3, l = 2, ml = –1, ms= $-\frac{1}{2}$
(ii) (a) n = 3, l = 1, ml = 1, ms = $+\frac{1}{2}$
(b) n = 3, l = 2, ml = 1, ms = $+\frac{1}{2}$
(iii) (a) n = 4, l = 1, ml = 1, ms = $+\frac{1}{2}$
(b) n = 3, l = 2, ml = 1, ms = $+\frac{1}{2}$
(iv) (a) n = 3, l = 2, ml = +2, ms = $-\frac{1}{2}$
(b) n = 3, l = 2, ml = +2, ms = $+\frac{1}{2}$

19. Which of the following sets of quantum numbers are correct? n l ml
(i) 1 1 +2
(ii) 2 1 +1
(iii) 3 2 –2
(iv) 3 4 –2

20. In which of the following pairs, the ions are iso-electronic?
(i) Na^{+}, Mg^{2+}
(ii) Al^{3+}, O^{-}
(iii) Na^{+}, O^{2-}
(iv) N^{3-}, Cl^{-}

21. Which of the following statements concerning the quantum numbers are correct?
(i) Angular quantum number determines the three-dimensional shape of the orbital.
(ii) The principal quantum number determines the orientation and energy of the orbital.
(iii) Magnetic quantum number determines the size of the orbital.
(iv) Spin quantum number of an electron determines the orientation of the spin of electron relative to the chosen axis.

Answer in one sentence

22. Arrange s, p and d sub-shells of a shell in the increasing order of effective nuclear charge (Zeff) experienced by the electron present in them.

23. Show the distribution of electrons in oxygen atom (atomic number 8) using orbital diagram.

24. Nickel atom can lose two electrons to form Ni2+ ion. The atomic number of nickel is 28. From which orbital will nickel lose two electrons.

25. Which of the following orbitals are degenerate? xy xy yz yz z z 3 ,4 3 ,3 ,4 ,4 d dd d d d 2 2

26. Calculate the total number of angular nodes and radial nodes present in 3p orbital.

27. The arrangement of orbitals on the basis of energy is based upon their (n+l) value. Lower the value of (n+l), lower is the energy. For orbitals having samem values of (n+l), the orbital with lower value of n will have lower energy.
I. Based upon the above information, arrange the following orbitals in the increasing order of energy.
(a) 1s, 2s, 3s, 2p
(b) 4s, 3s, 3p, 4d
(c) 5p, 4d, 5d, 4f, 6s
(d) 5f, 6d, 7s, 7p
II. Based upon the above information, solve the questions given below :
(a) Which of the following orbitals has the lowest energy?
4d, 4f, 5s, 5p
(b) Which of the following orbitals has the highest energy?
5p, 5d, 5f, 6s, 6p

28. Which of the following will not show deflection from the path on passing through an electric field?
Proton, cathode rays, electron, neutron.

29. An atom having atomic mass number 13 has 7 neutrons. What is the atomic number of the atom?

30. Wavelengths of different radiations are given below :
λ(A) 300 nm = λ μ (B) 300 m = λ(C) 3 nm = λ = 0 (D) 30 A
Arrange these radiations in the increasing order of their energies.

Short notes

Write short note on

1. Spectral lines (hydrogen spectrum)
2. Bohr-sommerfield theory
3. Electron spin
4. Orbital quantum number and Orbital magnetic quantum number

Short answer questions

31. The electronic configuration of valence shell of Cu is 3d104s1 and not 3d94s2. How is this configuration explained?

32. The Balmer series in the hydrogen spectrum corresponds to the transition from 1 n = 2 to 2 n = 3,4,..... This series lies in the visible reg32. The Balmer series in the hydrogen spectrum corresponds to the transition from 1 n = 2 to 2 n = 3,4,..... This series lies in the visible region. Calculate the wave number of line associated with the transition in Balmer series when the electron moves to n = 4 orbit.
(RH = 109677 cm–1)

33. According to de Broglie, matter should exhibit dual behaviour, that is both particle and wave like properties. However, a cricket ball of mass 100 g does not move like a wave when it is thrown by a bowler at a speed of 100 km/h. Calculate the wavelength of the ball and explain why it does not how wave nature.

34. What is the experimental evidence in support of the idea that electronic energies in an atom are quantized?

35. Out of electron and proton which one will have, a higher velocity to produce matter waves of the same wavelength? Explain it.

37. Chlorophyll present in green leaves of plants absorbs light at 4.620 × 1014 Hz. Calculate the wavelength of radiation in nanometer. Which part of the electromagnetic spectrum does it belong to?

38. What is the difference between the terms orbit and orbital?

39. Table-tennis ball has a mass 10 g and a speed of 90 m/s. If speed can be measured within an accuracy of 4% what will be the uncertainty in speed and position?
40. The effect of uncertainty principle is significant only for motion of microscopic particles and is negligible for the macroscopic particles. Justify the statement with the help of a suitable example.

41. Hydrogen atom has only one electron, so mutual repulsion between electrons is absent. However, in multielectron atoms mutual repulsion between the electrons is significant. How does this affect the energy of an electron in the orbitals of the same principal quantum number in multielectron atoms?

Match the following

In some of the following questions, one option of left column may be correlated to more than one option in the right column.

42. Match the following species with their corresponding ground state electronic configuration.

Atom / Ion	Electronic configuration
(i) Cu	(a) 1s2 2s2 2p6 3s2 3p6 3d10
(ii) Cu2+	(b) 1s2 2s2 2p6 3s2 3p6 3d10 4s2
(iii) Zn2+	(c) 1s2 2s2 2p6 3s2 3p6 3d10 4s1
(iv) Cr3+	(d) 1s2 2s2 2p6 3s2 3p6 3d9
	(e) 1s2 2s2 2p6 3s2 3p6 3d3

43. Match the quantum numbers with the information provided by these.

Quantum number	Information provided
(i) Principal quantum number	(a) orientation of the orbital
(ii) Azimuthal quantum number	(b) energy and size of orbital
(iii) Magnetic quantum number	(c) spin of electron
(iv) Spin quantum number	(d) shape of the orbital

45. Match the following

(i) X-rays	(a) ν = Hz 0 4 10 –10
(ii) UV	(b) ν = Hz 10 10
(iii) Long radio waves	(c) ν = Hz 16 10
(iv) Microwave	(d) ν = Hz 18 10

46. Match the following

(i) Photon	(a) Value is 4 for N shell
(ii) Electron	(b) Probability density
(iii) 2 ψ	(c) Always positive value
(iv) Principal quantum number n	(d) Exhibits both momentum and wavelength

47. Match species given in Column I with the electronic configuration given in Column II.

Column I	Column II
(i) Cr	(a) [Ar]3d84s0
(ii) Fe2+	(b) [Ar]3d104s1
(iii) Ni2+	(c) [Ar]3d64s0
(iv) Cu	(d) [Ar] 3d54s1
	(e) [Ar]3d64s2

Chapter-2 and 3
One and Two valence Electron system

Objective Questions

1. Particles that most effects material properties
(a) Neutrons (b) Protons (c) Electrons (d) Valence electrons

2. Mean distance between atoms in the range of
(a) 25 nm (b) 2.5 nm (c) 0.25 nm (d) 0.025 nm

3. Which one of the following is not a strong bond?
(a) van der Waals bond (b) Covalent bond (c) Metallic bond (d) Ionic bond

4. Bond strength of secondary bonds is in the range of
(a) 1 kJ/mol (b) 10 kJ/mol (c) 100 kJ/mol (d) 1000 kJ/mol

5. Electron sea exists in
(a) Polar bonds (b) Ionic bond (c) Covalent bond (d) Metallic bond

6. Repeatable entity of a crystal structure is known as
(a) Crystal (b) Lattice (c) Unit cell (d) Miller indices

7. Coordination number for closest packed crystal structure
(a) 16 (b) 12 (c) 8 (d) 4

8. Atomic packing factor is

(a) Distance between two adjacent atoms
(b) Projected area fraction of atoms on a plane
(c) Volume fraction of atoms in cell
(d) None

9. Coordination number in simple cubic crystal structure
(a) 1 (b) 2 (c) 3 (d) 4

10. The atomic diameter of an BCC crystal (if a is lattice parameter) is
(a) a (b) a/2 (c) a/(4/√3) (d) a/(4/√2)

11. A family of directions is represented by
(a) (hkl) (b) <uvw> (c) {hkl} (d) [uvw]

12. Miller indices for Octahedral plane in cubic crystal
(a) (100) (b) (110) (c) (111) (d) None

13. The plane (1–11) is parallel to
(a) (–11–1) (b) (–1–11) (c) (111) (d) (1–11)

14. The angle between [111] and [11–2] directions in a cubic crystal is (in degrees)
(a) 0 (b) 45 (c) 90 (d) 180

15. Miller indices of the line of intersection of (–1–11) and (110) are
(a) [110] (b) [101] (c) [10–1] (d) [–110]

16. Repeatable unit of polymers
(a) isomer (b) copolymer (c) homopolymer (d) mer

17. Pick the thermo-plast from the following
(a) Vinyls (b) Epoxies (c) Resins (d) Vulcanized rubber

18. For c coordination number of four, anion sits at the center of ……..where corners are occupied by cations
(a) Cube (b) Tetrahedron (c) Triangle (d) Octahedron

19. Layered silicate structures in clays consists the following group
(a) SiO_4^{4-} (b) $Si_2O_5^{2-}$ (c) $Si_2O_7^{6-}$ (d) SiO_4^{4-}

20. Schottky-defect in ceramic material is
(a) Interstitial impurity (b) Vacancy- interstitial pair of cations
(c) Pair of nearby cation and anion vacancies (d) Substitutional impurity

Answers: 1. d 2. c 3. a 4. b 5. d 6. c 7. b 8. c 9. b 10. c 11. b 12. c 13. a 14. c 15. d 16. d 17. a 18. b 19. b 20

1.

Which of the following has a positive charge?
(a) proton
(b) neutron
(c) anion
(d) electron
(e) atom

2.

Rutherford carried out experiments in which a beam of alpha particles was directed at a thin piece of metal foil. From these experiments he concluded that:
(a) electrons are massive particles.
(b) the positively charged parts of atoms are moving about with a velocity approaching the speed of light.
(c) the positively charged parts of atoms are extremely small and extremely heavy particles.
(d) the diameter of an electron is approximately equal to that of the nucleus.
(e) electrons travel in circular orbits around the nucleus.

3.

Consider the species ^{72}Zn, ^{75}As and ^{74}Ge. These species have:
(a) the same number of electrons.
(b) the same number of protons.
(c) the same number of neutrons.
(d) the same number of protons and neutrons.
(e) the same mass number.

4.

The neutral atoms of all of the isotopes of the same element have
(a) different numbers of protons.
(b) equal numbers of neutrons.
(c) the same number of electrons.
(d) the same mass numbers.
(e) the same masses.

5.

What is the atomic weight of a hypothetical element consisting of two isotopes, one with mass = 64.23 amu (26.0%), and one with mass = 65.32 amu?
(a) 65.3 amu
(b) 64.4 amu
(c) 64.9 amu
(d) 65.0 amu
(e) 64.8 amu

6.

Naturally occurring rubidium consists of just two isotopes. One of the isotopes consists of atoms having a mass of 84.912 amu; the other of 86.901 amu. What is the percent natural abundance of the heavier isotope?
(a) 15%
(b) 28%
(c) 37%
(d) 72%
(e) 85%

7.

What is the frequency of light having a wavelength of 4.50×10^{-6} cm?
(a) $2.84 \times 10^{-12}\ s^{-1}$
(b) $2.10 \times 10^{4}\ s^{-1}$
(c) $4.29 \times 10^{14}\ s^{-1}$
(d) $1.06 \times 10^{22}\ s^{-1}$
(e) $6.67 \times 10^{15}\ s^{-1}$

8.

The emission spectrum of gold shows a line of wavelength 2.676×10^{-7} m. How much energy is emitted as the excited electron falls to the lower energy level?
(a) 7.43×10^{-19} J
(b) 5.30×10^{-20} J
(c) 6.05×10^{-19} J
(d) 3.60×10^{-20} J
(e) 5.16×10^{-20} J

9.

Which of the responses contains all the statements that are consistent with the Bohr theory of the atom (and no others)?
(1) An electron can remain in a particular orbit as long as it continually absorbs radiation of a definite frequency.
(2) The lowest energy orbits are those closest to the nucleus.
(3) An electron can jump from the K shell (n = 1 major energy level) to the M shell (n = 3 major energy level) by emitting radiation of a definite frequency.
(a) 1,2,3
(b) 2 only
(c) 3 only
(d) 1,2
(e) 2,3

10.

The Heisenberg Principle states that _____.
(a) no two electrons in the same atom can have the same set of four quantum numbers.
(b) two atoms of the same element must have the same number of protons.
(c) it is impossible to determine accurately both the position and momentum of an electron simultaneously.
(d) electrons of atoms in their ground states enter energetically equivalent sets of orbitals singly before they pair up in any orbital of the set.
(e) charged atoms (ions) must generate a magnetic field when they are in motion.

11.

Which statement about the four quantum numbers which describe electrons in atoms is **incorrect**?
(a) n = principal quantum number, n = 1, 2, 3, ...
(b) l = subsidiary (or azimuthal) quantum number, l = 1, 2, 3, ... , (n+1)
(c) m_l = magnetic quantum number, m_l = (-l), ... , 0, ... , (+l)
(d) m_s = spin quantum number, m_s = +1/2 or -1/2.
(e) The magnetic quantum number is related to the orientation of atomic orbitals in space.

12.

Which atomic orbital is spherical in shape? (Note: you should know and be able to recognize the shapes of the s orbital, p_x, p_y, and p_z orbitals, and d_{xy}, d_{yz}, d_{xz}, d_x2-_y2 and d_z2 orbitals.)
(a) 2s
(b) 3p
(c) 3d
(d) 4f
(e) they are all spherical

13.

The maximum number of electrons that can be accommodated in a sublevel for which l = 3 is:
(a) 2
(b) 10
(c) 6
(d) 14

(e) 8

14.

The ground state electron configuration for arsenic is:
(a) [Ar] $4s^2$ $4p^{13}$
(b) [Kr] $4s^2$ $4p^1$
(c) $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $3d^{12}$ $4s^2$ $4p^1$
(d) $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^2$ $3d^8$ $4p^5$
(e) $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^2$ $3d^{10}$ $4p^3$

15.

Which of the following electron configurations is correct for nickel?
(a) [Ar] $4s^1$ $3d^8$
(b) [Kr] $4s^1$ $4d^8$
(c) [Kr] $4s^1$ $3d^8$
(d) [Kr] $4s^2$ $3d^8$
(e) [Ar] $4s^2$ $3d^8$

16.

The outer electronic configuration ns^2np^4 corresponds to which one of the following elements in its ground state?
(a) As
(b) Ca
(c) Cr
(d) Br
(e) S

17.

In the ground state of a cobalt atom there are _____ unpaired electrons and the atom is _____.
(a) 3, paramagnetic
(b) 5, paramagnetic
(c) 2, diamagnetic
(d) 0, diamagnetic
(e) 2, paramagnetic

18.

Which one of the following sets of quantum numbers **could** be those of the distinguishing (last) electron of Mo?
(a) $n = 4$, $l = 0$, $m_l = 0$, $m_s = +1/2$
(b) $n = 5$, $l = 1$, $m_l = 9$, $m_s = -1/2$
(c) $n = 4$, $l = 2$, $m_l = -1$, $m_s = +1/2$
(d) $n = 5$, $l = 2$, $m_l = +2$, $m_s = -1/2$
(e) $n = 3$, $l = 2$, $m_l = 0$, $m_s = +1/2$

19.

How many p electrons are there in an atom of rubidium?
(a) 12
(b) 18
(c) 24
(d) 9

(e) 6

20.

A neutral atom of an element has 2 electrons in the first energy level, 8 in the second energy level and 8 in the third energy level. This information does **not** necessarily tell us:
(a) the atomic number of the element.
(b) anything about the element's chemical properties.
(c) the total number of electrons in s orbitals.
(d) the total number of electrons in p orbitals.
(e) the number of neutrons in the nucleus of an atom of the element.

Answers:
1. (a) **2.** (c) **3.** (c) **4.** (c) **5.** (d) **6.** (b) **7.** (e) **8.** (a) **9.** (b) **10.** (c) **11.** (b) **12.** (a) **13.** (d) **14.** (e) **15.** (e) **16.** (e) **17.** (a) **18.** (c) **19.** (b) **20.** (e)

Answer in one sentence

1. Define valence electron.
2. Define inner shell electron.
3. How many valence electrons are there in fluorine?
4. What are the 2*s* electrons in nitrogen?
5. How many inner shell electrons are there in beryllium?
6. What is the origin of spin-orbit interaction?

Short Notes

Write short notes on
i) Coupling scheme
ii) Singlet and triplet series in two valence electron atoms
iii) Lande interval rule
iv) spectra of He atom

Short Answer Questions

1. Which molecules will show spin-orbit coupling?
2. What is spin-orbit coupling in nuclear physics?
3. How is spin-orbit split calculated?
4. How is spin-orbit split calculated?
5. Which molecules will show spin-orbit coupling?
6. How do you find the spin-orbit coupling constant?

Long Answer Questions

1. State and explain Paullis exclusion principle?
2. Discuss quantum state of an electron.
3. Derive spin orbit ineraction expression.
4. Describe main feature of doublet character of sodium spectra.
5. Discuss the spectra of sodium atom and draw a) Energy level diagram b) Fine structure
6. What is multiplicity? Explain its importance in spectroscopy.
7. Give the representation of spectral lines of different series in sodium spectrum in terms of symbol.
8. Explain LS and JJ coupling for two valence electron system using neat vector diagram.
9. State and explain Lande interval rule.

Chapter 4 Zeeman Effect
Objective Questions

1. . Zeeman effect is the splitting of spectral line in the presence of _____
    a) Electric Field
    b) Magnetic Field
    c) Inert Environment
    d) Vacuum

2. Zeeman Effect could not be proved by _____
    a) Quantum Mechanics
    b) Bohr's Model
    c) Hamiltonian operators
    d) L-S coupling

3. The Zeeman effect is not used in _____
    a) NMR
    b) MRI
    c) Optical Amplifiers
    d) Laser Cooling

4. Which of the following is the correct expression for the magnetic moment of the electron?
    a) n+1–––––√
    b) n(n+1)–––––––√
    c) n(n+2)–––––––√
    d) m(n+1)–––––––√

5. At-higher magnetic fields, the splitting of spectral lines is disturbed. This effect is called _____
    a) Stark Effect
    b) Inverse Zeeman Effect
    c) Paschen-back effect
    d) Anomalous Zeeman effect

6. The perturbation due to the magnetic field is given by _____
    a) μ.B
    b) μ.E
    c) -μ. E
    d) -μ. B

7. Zeeman effect is used to study which property of sun?
    a) Solar flares
    b) Sun spots
    c) Magnetic fields
    d) Electric fields

8. Zeeman energy is which energy of a magnetized body?
    a) Magnetic Energy
    b) Kinetic Energy
    c) Potential Energy
    d) Total Energy

9. The number of split levels in the magnetic field is _____
    a) 2n
    b) 2n + 1
    c) 2l
    d) 2l + 1

10. The number of splitting levels of in 2p orbital would be _____
    a) 1
    b) 2
    c) 3
    d) 4

11. In which orbital does the splitting occur?
    a) s
    b) p
    c) d
    d) f

12. The lines corresponding to Zeeman effect exhibit polarization effects.
    a) True
    b) False

13. The magnetic moment of Fe^{2+} ion is _____
    a) 1.8
    b) 2.8
    c) 3.8
    d) 4.8

14. Zeeman effect and Stark effect are analogous to each other.
    a) True
    b) False

15. Which of the following have similar magnetic moment: Fe, Fe^{2+} and Fe^{3+}?
    a) Fe and Fe^{2+}
    b) Fe and Fe^{3+}
    c) Fe^{3+} and Fe^{2+}
    d) Fe, Fe^{3+} and Fe^{2+}

Answer in one sentence

1. What is Zeeman Effect? Write formula for Zeeman shift.
2. Define Bohr magneto.
3. What is anomalous Zeeman effect?
4. Write formula for Zeeman shift.

Short answer questions.

1.Differentiate between Normal and anomalous zeeman effect.
2.What is Stark effect?
3. Explain discovery of Zeeman effect.

III Long answer questions.

1. Explain the experimental set up to produce and observe Zeeman effect.
2. Explain the experimental of Stark effect. Explain features of Stark effect.
3. Draw energy level diagram showing transitions in Zeeman effect. Hence write formula for frequency for a spectrum with magnetic field.

Chapter 5 -X-Ray spectroscopy

Objective Questions

T.Y.B.Sc Physics, Semester-V: PHY 3505: Atomic & Molecular Physics Question Bank

1. In X-ray emission tubes, X-ray is emitted by the acceleration of_____
   Atoms
   b)Protons
   c)Electrons
   d)Neutrons
   Answer:c

2. The wavelength range of X-rays is _____
   a) 1 mm to 700 nm
   b) 400 nm to 1 nm
   c) 1 nm to 0.001 nm
   d) 0.1 m to 1 mm
   Answer: c

3. X-Rays are not used in _____
   a) Photographic film
   b) Photocells
   c) Geiger tubes
   d) Ionization Chamber
   Answer: b

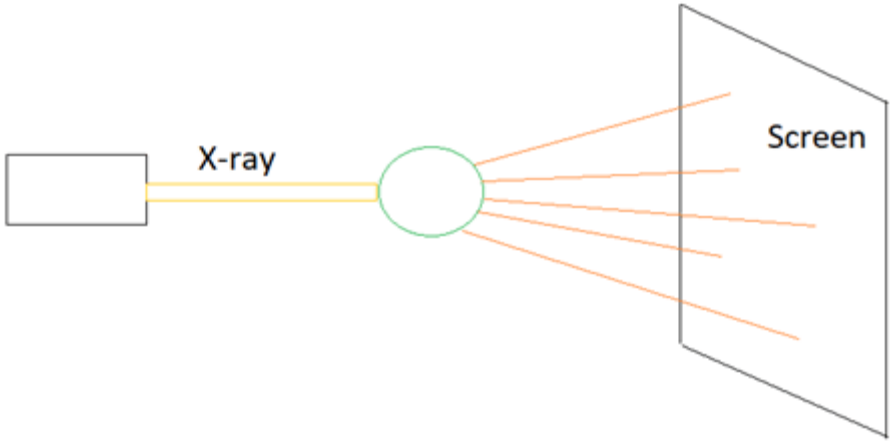
4. X-rays possess electromagnetic character
   a)True
   b) False
   Answer: a
5. X-rays are produced effectively electrons when they strike _____
   a) Dense metal anode
   b) Dense Metal cathode
   c) Fluorescent metal
   d) Non-metal
   Answer: a
6. The synchrotron radiation emitted is Polarized
   a)True
   b) False
   Answer: a

7. The celestial source of X-ray is _____
   a)Stars
   b)Quasars
   c)BlackHoles
   d) Nebula
   Answer: c

8. Which of the following disease can be detected by X-Ray?
   a)Bladder infection

b)Pneumonia
c)Diarrhea
d) Fever
Answer: b

9. X-ray crystallography uses which characteristic of light?
   a)Polarization
   b)Interference
   c)Diffraction
   d) Coherency
   Answer: c
10. Which phenomenon is shown by the given figure?



a) X-ray scan
b) C.T. scan
c) X-ray crystallography
d) X-ray production
Answer: c

Answer in one sentence

1. Which component is used to generate xrays?
2. Who invented XRAY Mcq?
3. Which characteristic of light is used by X-ray crystallography?
4. How much of the energy is actually utilized for taking x-rays?
5. What does X in X-ray stand for?
6. What is X-ray used for?
7. How is X-ray energy calculated?

Short Notes

Write a short note on

1. How are X-rays obtained from an accelerator?
2. Important advantages/characteristics of synchrotron radiation compared to lab X-ray sources?

3. Why is the X-ray diffraction pattern a reciprocal picture instead of a real one, like in electron microscopy for example?
4. Duane and Hunt's rule.

Short Answers Questions

1. What are the different types of spectra?
2. State Duane and Hunt's Rule.
3. What is the importance of Moseley's law?
4. How X-Ray production is inverse of photoelectric effect?
5. State the difference between characteristics and continuous X-rays.
6. Find the shortest wavelength present in the radiation from an x-ray machine whose accelerating potential is 100 K.
7. Estimate the value of the wavelength of K line of silver(Z=47).

Long Answers Questions

1. What are the X-rays ? How they are Produced?
2. State and explain Duane and Hunt's Rule.
3. Discuss origin of continuous X-ray spectrum.
4. What is the characteristics X-ray spectrum? Discuss its Origin.
5. State and explain Moseley's law.Discuss application of Moseley's law.
6. Using energy level diagram obtain the electronic transition for K-series.
7. Compare X-ray spectra with optical spectra.
8. Calculate the maximum velocity of electrons striking the cathode under accelerating potential 20 kV.
9. Compare between X-ray and Optical spectra.

Chapter 6 Raman Spectroscopy

Objective Questions

1. Raman effect is scattering of ___
a)Atoms
b)Molecules
c)Protons
d) Photons
Answer: d
2. The elastic scattering of photons is called as _____
a) Atmospheric scattering
b) Rayleigh Scattering
c) Conserved Scattering
d) Raman Scattering

Answer: b
3. Which of the following cannot be conserved during Raman scattering?

a) Total Energy
b) Momentum
c) Kinetic Energy
d) Electronic Energy
Answer: c

4. How many degrees of freedom does a chemical compound of N atoms have?
a)2N
b)2N+1
c)3N
d) 3N + 1
Answer: c

5. In Raman spectroscopy, the radiation lies in the _____
a) Microwave Region
b) Visible Region
c) UV Region
d) X-ray Region
Answer: b

6. The change in frequency is due to the transition between vibrational or rotational energy levels.
a)True
b) False
Answer: a

7. The Raman spectrum is said to consist of Strokes lines when __
a)$\Delta v>0$
b)$\Delta v<0$
c)$\Delta v=0$
d) Does not depend on Δv
Answer: a

9. Raman lines are _____
a)Weak
b)Strong
c)Curved
d) Blurry
Answer: a

10. The most commonly used laser for Raman spectroscopy is _____
a)ND:YAG
b)Rubylaser
c)He-Nelaser
d) Semiconductor Laser

Answer: c

11. Which of the following lines are most intense?
a) Stokes lines
b) Rayleigh-scattered lines
c) Anti-strokes lines
d) All have same intensity

Answer: b

12.For a particular vibrational mode to appear in the Raman spectrum, what must change?
a) Frequency of radiation
b) Intensity of radiation
c) Molecule's shape
d) Molecule's polarizability

Answer: d

13. Infrared and Raman spectra are complementary to each other.
a)True
b) False

Answer: a

Answer in one sentence

1. Which set of lines, Stokes or anti-stokes , is weaker?
2. What would be the ideal source to use for measuring Raman spectra?
3. Which scattering is the strongest?
4. Who invented Raman spectroscopy?
5. Which wavelength is used in Raman spectroscopy?

Short Notes

1. Write a short note on predissociation
2. Write a short note on factors affecting width of spectral lines.
3. Write a short note on factors affecting intensity of spectral lines.
4. Write in short applications of Raman spectroscopy.
5. Write a short note on course and fine structure.
6. Write a note on Frank- Condon principle.
7. Give the classification of rigid rotors.
8. Write a note on transitions observed in the rotational spectrum.

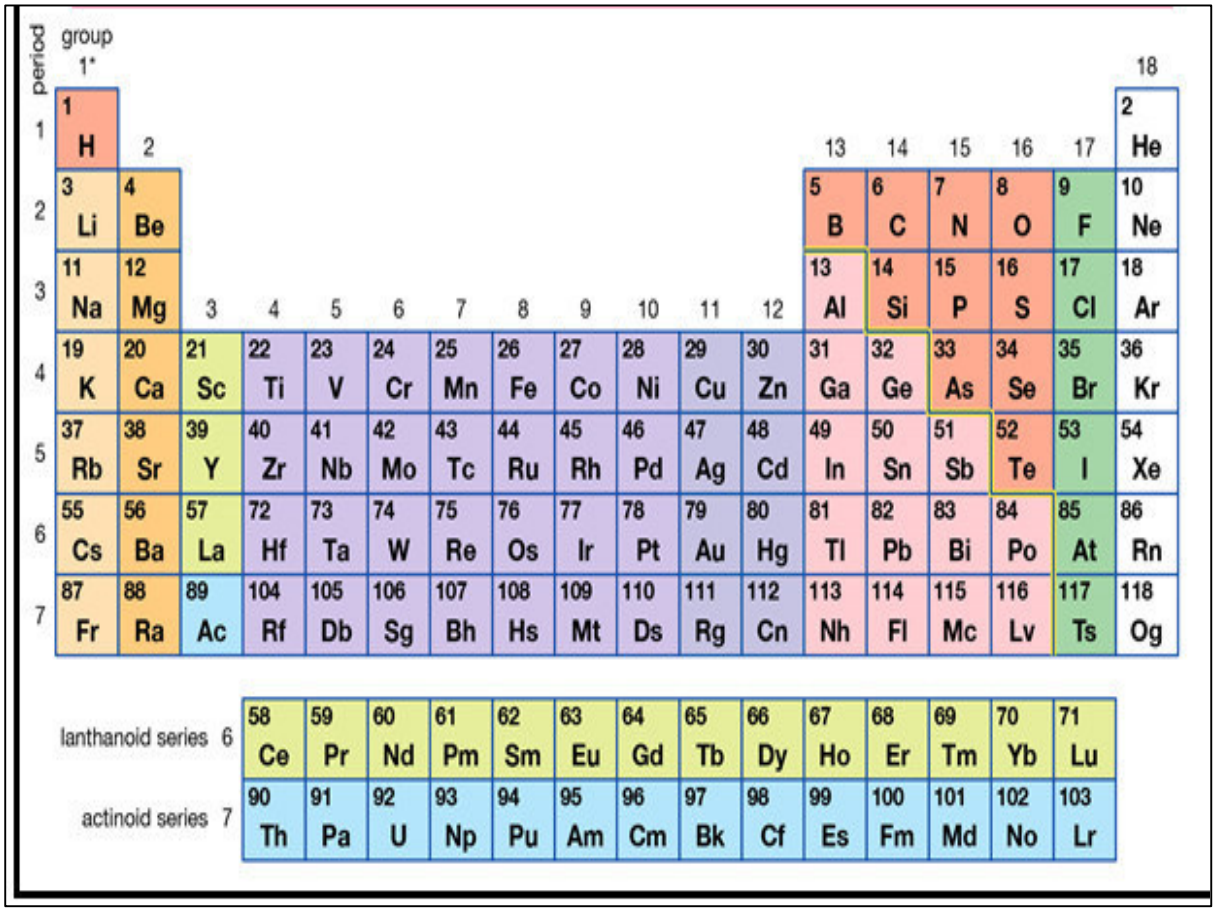
Short Answers Questions

1. What is raman effect?
2. What is molecular polarizability?
3. What are Stoke's lines? What are anti- stoke's line?

4. What is Rayleigh Line?
5. What is Raman shift?
6. What are the applications of Raman effect in Physics?
7. Explain Stokes and antistokes lines.
8. Define and explain predissociation.
9. State Frank-Condon principle.
10. Write down selection rule for pure rotational Raman activity in linear molecules.
11. Explain factors determining the intensity of spectral lines.

Long Answers Questions

1. What is Raman effect? With proper sketch explain occurrence of Stoke's line and anti-stoks's lines.
2. Explain Classical theory of Raman effect.
3. Explain Raman effect o the basis of Quantum theory.
4. Describe the experimental arrangement to obsereve Raman spectra.
5. What are the applications of Raman spectra?
6. At what wavelength would the anti-Stoke's line appear in the Raman spectra?
7. Obtain the expression for moment of inertia for rigid diatomic molecule.
8. The rotational constant for 79Br19F is 0.35717cm-1. What is the value of J for which the most intense line will be seen at 300K?
9. How is the dissociation energy of a diatomic molecule determined from vibrational coarse structure in its electronic spectrum?
10. Calculate the force constant for HCl molecule, as it shows absorption band at 2890 cm-1
11. [Given: Atomic weight: Cl =35.5, H=1.008]
12. 16. What is the effect of breakdown of Born-Oppenheimer approximation on P and R branches of the IR
13. spectrum of a diatomic molecule?
14. . The first line in the rotational spectrum of 12C 16O molecule is 3.84235cm-Find out the bond length of the molecule.
15. The Fundamental vibrational frequency of 1H 35Cl molecule is 86.63×1012Hz.Calculate the zero point energy and force constant of HCl.
16. Explain the factors influencing width and intensity of spectral lines.
17. Explain effect of isotopic substitution on rotational constant B.
18. If band origins at the midpoint of P1 and R(0),is at 2143.26 cm-1.This,then is fundamental vibration frequency of CO, if anharmonicity is ignored. First overtone is observed at 4260.04 cm-1. Calculate ω̃ and xe.
19. The average spacing between successive rotating lines of CO2 is 3.826 cm-1.Determine the transition which gives most intense spectral line at 300K?
20. Explain the activity of the following molecules with respect to IR and microwave spectrum.H2,HCl,CO2,CH4&CH3Cl
21. What are symmetric and asymmetric vibrations? Explain with the example of H2O molecule.


period
group
1*
18
1 H
2 He
2 Li Be B C N O F Ne
3 Na Mg 3 4 5 6 7 8 9 10 11 12 Al Si P S Cl Ar
4 K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr
5 Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe
6 Cs Ba La Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn
7 Fr Ra Ac Rf Db Sg Bh Hs Mt Ds Rg Cn Nh Fl Mc Lv Ts Og
lanthanoid series 6 Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
actinoid series 7 Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr