St. Joseph's College of Arts & Science (Autonomous)
Cuddalore – 607001

QUESTION BANK

CLASS: II-CHD., SEMESTER-IV
SUBJECT: INTRODUCTION TO MOLECULAR STRUCTURE
SUBJECT CODE: CH408T
NAME OF THE STAFF : Mr F.PAUL AROKIADOSS, Mr S. ALBERT NIKSON
……………………………………………………………………………………………
UNIT-I
PART – A

1. A Crooke's Tube (a tube containing rarefied gas through which a current is passed between a cathode and an anode) was used in the discovery of the electron by:
   (A) R. A. Millikan   (B) J. J. Thomson   (C) J. S. Townsend
   (D) M. Planck   (E) A. H. Compton

2. The electron charge was measured for the first time in the:
   (A) Cathode ray experiment.   (B) Photoelectric effect experiment.
   (C) Oil drop experiment.   (D) Electron diffraction from aluminum foil.
   (E) Compton effect experiment.

3. The charge on an electron is represented by "e." Which of the following charges can exist?
   (A) 2.0 e   (B) 2.5 e
   (C) 3.6 e   (D) 5.2 e
   (E) 5.5 e

4. X-rays are created when:
   (A) protons strike a metal target   .   (B) neutrons strike a metal target.
   (C) photons are incident on a surface.   (D) electrons strike a metal target.
   (E) photons strike electrons.

5. The spontaneous decay of nuclei is called:
   (A) Absorption   (B) Ultraviolet Explosion
   (C) Permittivity   (D) Photoelectric Effect
   (E) Radiation

6. Which of the following are emitted by the nucleus during radioactive decay?
   (A) Alpha particles   (B) Beta particles
   (C) Gamma rays   (D) All of the above
   (E) None of the above

7. Which of the following colors is associated with the lowest temperature of a black body radiator?
   (A) Violet   (B) Blue   (C) Green   (D) Yellow   (E) Red

8. Classical physics could not explain the behavior of a black body radiator at very short wavelengths. What was this problem called?
   (A) Absorption failure   (B) Ultraviolet Explosion
   (C) Wavelength decrease   (D) Photoelectric Effect
   (E) Radiation

9. What did Max Planck propose to solve the black body radiator problem?
   (A) Radiation is made up of waves.   (B) Light changes its speed in different media.
   (C) Light comes in packets of energy.   (D) Light has a continuous energy profile.
   (E) Objects do not radiate energy.

10. Which of the following photons has the greatest energy?
    (A) Infrared   (B) Blue light (C) X-ray   (D) Gamma ray   (E) Ultraviolet

11. The energy of a photon depends on its:
    (A) Amplitude   (B) Speed   (C) Temperature   (D) Pressure (E) Frequency

12. How does the energy of a photon change if the wavelength is doubled?
    (A) Doubles   (B) Quadruples   (C) Stays the same
    (D) Is cut to one-half   (E) Is cut to one-fourth

13. How does the momentum of a photon change if the wavelength is halved?
    (A) Doubles   (B) Quadruples   (C) Stays the
    same
    (D) Is cut to one-half   (E) Is cut to one-fourth

14. The photoelectric effect was explained by Albert Einstein by assuming that:
    (A) light is a wave.   (B) light is a particle.
    (C) an electron behaves as a wave.   (D) an electron behaves as a particle.
    (E) light does not interact with matter.

15. The kinetic energy of photoelectrons depends on the:
    (A) speed of light.   (B) angle of illumination.   (C)
    intensity of the light.
    (D) number of incident photons.   (E) photon frequency.

16. The maximum kinetic energy of photoelectrons depends on which of the
    following?
    I. The light intensity   II. The frequency of the light   III. The material of the
    photoelectric cell

       (A) Only I   (B) Only II   (C) Only III   (D) Only I and II   (E) Only II and III
17. Rutherford's Gold Foil experiment caused a modification of which of the
    following?
    (A) Plum-pudding model of the atom   (B) Planetary model of the atom
    (C) de Broglie hypothesis   (D) Wave nature of light
    (E) Quantum theory of light

18. In Rutherford's Gold Foil experiment, most of the alpha particles passed through
    the foil undeflected. Which of the following properties of the atom can be
    explained from this observation?
    (A) The atom's negative charge is concentrated in the nucleus.
    (B) The nucleus has electrons and protons.
    (C) The atomic mass is distributed evenly throughout the atom.
    (D) The alpha particles can't be deflected by electrons.
    (E) The size of the nucleus is much less than the size of the atom.
19. Which of the following statement(s) can be associated with Bohr's theory of the
    atom?
              I. An electron orbiting the nucleus can change its energy
                  continuously.
             II. An electron orbiting the nucleus emits energy and falls into the
                  nucleus.

III. An electron orbits the nucleus without radiating energy and can change its energy only by a specific, quantized amount, when it moves between the orbits.

IV. Electrons can only orbit the nucleus in specific circular orbits with fixed angular momentum and energy.

(A) I and II   (B) II and IV   (C) II and III   (D) III and IV
(E) I, II, III and IV

20. When an electron falls from an orbit where n = 2 to n = 1:
   (A) A photon is emitted.   (B) A photon is absorbed.   (C) No change in atomic energy. (D) The atomic energy decreases to zero. (E) The atomic energy increases.

21. When an electron jumps from an orbit where n = 1 to n = 4, its energy in terms of the energy of the ground level (E_1) is:
   (A) $E_1/9$ (B) $E_1/16$ (C) $2 E_1$ (D) $4 E_1$ (E) $16 E_1$

22. Which of the following is a limitation of the Bohr Model of the atom?
   (A) It does not explain atomic spectra.
   (B) It successfully predicts the intensity of the photons emitted when electrons change energy levels.
   (C) The model only applies to Hydrogen like atoms.
   (D) The model only applies to light atoms.

23. The Compton Effect supports which of the following theories?
   (A) Special Theory of Relativity.   (B) Light is a wave. (C) Thomson model of the atom.
   (D) Light is a particle.   (E) The Coulomb force.

24. Neutrons have a:
   (A) positive charge and a mass approximately equal to a proton.
   (B) positive charge and a mass approximately equal to an electron.
   (C) neutral charge and a mass approximately equal to a proton.
   (D) neutral charge and a mass approximately equal to an electron.
   (E) negative charge and a mass approximately equal to a proton.

25. Which of the following formulas can be used to determine the de Broglie wavelength?
   (A) $\lambda = hmv$ (B) $\lambda = h/mv$ (C) $\lambda = mv/h$ (D) $\lambda = hm/c$ (E) $\lambda = mc/h$

26. Which one of the following objects, moving at the same speed, has the greatest de Broglie wavelength?
    (A) Neutron   (B) Electron   (C) Tennis ball   (D) Bowling ball
    (E) Alpha particle

27. Heisenberg's Uncertainty Principle states:
    (A) The more precise a particle's energy can be measured, the less precise its position can be measured.
    (B) A particle's position can be measured exactly.
    (C) A particle's energy can be measured exactly.
    (D) The more precise a particle's momentum can be measured, the less precise its position can be measured.
    (E) The more precise a particle's momentum can be measured, the less precise its energy can be measured.

28. Knowledge of the wave function of a particle enables the probabilities of the particle's position, momentum, energy and other characteristics to be calculated. In classical physics, what is the analogue of the wave function?
    (A) The particle's momentum.   (B) The particle's energy.   (C) The particle's mass.
    (D) The particle's size.   (E) The sum of the forces on the particle.

29. Which theory explains the interaction of photons with matter (electrons)?
    (A) Quantum Chromodynamics.   (B) The Standard Model.   (C) String Theory.
    (D) The Grand Unified Theory.   (E) Quantum Electrodynamics.

30. Which theory explains the attraction between protons and neutrons?
    (A) Quantum Chromodynamics.   (B) The Standard Model.   (C) String Theory.
    (D) The Grand Unified Theory.   (E) Quantum Electrodynamics.

PART-B

1. Write the physical concept of the uncertainty principle ?

2. Name the factors affecting the number and kinetic energy of photo electrons emitted in photo electric effect. ?
3. Calculate the frequency of radiation with a wavelength of 442 nm ?
4. What is meant by angular momentum quantum number? How it will represent?
5. Calculate the velocity of photo electron, if its kinetic energy is 0.97eV?
6. Write molecular orbital wave function for H2- molecule anion ?
7. A cricket ball weighing 50 g is to be located within 0.1Å, calculate the uncertainty in its velocity ?
8. Explain photo-electric effect ?
9. Draw the shape of S-orbitals ?
10. Draw the shapes of p-orbitals ?

PART-C

SECTION – C
1. Write all quantum numbers of Beryllium atom **?**
2. Calculate the bond order for O2 and N2 ?
3. Write the value of Laplacian operator in Polar coordinates **?**
4. Calculate the energy and frequency of black body radiation having wavelength (λ) 445 nm ?
5. Calculate the wavelength of black body radiation at 298K (b=0.0029mK) ?
6. Assuming the ionic character in HBr is 11%, calculate the fraction of contribution of ionic character to the valence bond wave function ?
7. Write the molecular orbital electronic arrangement for Li2, He2+ molecule ?
8. Why does He2+ exist?
9. Calculate the energy and frequency of black body radiation having wavelength (λ) 523 nm ?
10. Write the value of Laplacian operator in Cartesian coordinates?
11. Calculate the wavelength of black body radiation at 360K (b=0.0029mK) ?
12. Explain the failures of classical physics ?
13. Draw the shapes of p and d-orbitals ?

UNIT-II

PART-A

1. Mixing of orbitals of the different elements leads to the formation of………………
.
2. Among the following which requires least energy?………….. .
3. C-H bond is formed by overlap of _____ orbitals.
4. The C-C bond length is maximum in………… .
5. The axial overlap between the two Orbitals lead to the formation of a………… .
6. The number of photo electrons emitted in photoelectric effect depends on……………… .
7. In Schrödinger's equation 'Ĥ' Stands for…………. .
8. The kinetic energy of photo electrons in photoelectric effect _____.
9. The product of uncertainty in position and velocity for particle in motion predicted by Heisenberg's Uncertainty principle is …………

10. In Schrödinger's equation 'ψ' stands for ……….. .
11. In photoelectric effect, the amount of energy required to remove electron from an element is called _____.

PART-B

1. What is meant by hybridization?
2. Draw the molecular orbital diagram for H_2 molecule.

3. Calculate the bond order for O_2 and O_2^+.
4. Draw the MOT diagram of oxygen molecule.
5. Find the bond order of CO molecule.

PART-C

1. Explain VBT with examples ?
2. Compare the bond order , bond length and magnetic character of N2 and O2 species with the help of MOT ?

3. Write molecular orbital wave function for H2- molecule anion **?**
4. Why does He2+ exist whereas He2 does not?

PART-A

1. If the dipole moment for bromobenzene is 1.7 D, the dipole moment
2. for meta-dibromobenzene will be……….
3. Dipole moment of para dibromo benzene is ____Debye.
4. Molar polarization is given by……….

5. Dipole moment is defined as the product of _____ and _____
6. Dipolemoment of carbon tetrachloride is………….
7. Diamagnetic is presence of ………….. electrons
8. …………… balance is used for determine magnetic susceptibility

PART-B

1. What is meant by magnetic permeability?
2. Write Clausius-Mosotti equation ?
3. Write Debye equation for polarizability of molecules ?
4. How the susceptibility of para and diamagnetic material vary with temperature?
5. Derive Debye equation ?
6. Explain molar refractivity ?
7. Explain guoy methods of determination ?
8. Define para magnetic ?
9. Define diamagnetic ?
10. Discuss the dipolemoment of carbon tetrachloride ?

PART-C

1. a) Write Debye equation for polarizability of molecules ?
   b) For bromobenzene, if the dipole moment is 1.9 D, what could be the dipole moment for ortho ,meta and para dibromobenzene?
c) For gaseous AB2 molecule, nr = 1.00518;εr = 1.001, is it nonlinear?

2. a) Write Clausius-Mosotti equation ?
   b) For chlorobenzene, if the dipole moment is 1.8 D, what could be the dipole moment for ortho, meta and para   dichlorobenzene ?
   c) For gaseous AB2 molecule, nr = 1.00518;εr = 1.001, is it linear?

3. Explain the concept of para and diamagnetic with example ?

5. Briefle discuss about magnetic susceptibility using guoy method ?

6. Derive Debye equation ?

UNIT –IV

PART-A

1. In antifluorite structure, the negative ions
   a) Occupy tetrahedral voids
   b) Occupy octahedral voids
   c) Are arranged in ccp
   d) are arranged in hcp
2. In a solid AB having NaCl structure, A atoms occupy the corners of the cubic unit cell. If all
   the face – centered atoms along one of the axes are removed, then the resultant stoichiometry
   of the solid is:
   a) A_2B b) AB_2 c) A_4B_3 d) A_3B_4
3. The structure of Wurtzite is
   a) Simple cube   b) Body-centered cube   c) Hexagonal close packed   d) Cubic close packed
4. Silicon doped with indium is an example of
   a) p-typed semiconductor b) intrinsic semiconductor   c) Both of these two d) n-type semiconductor
5. Due to Frenkel defect, the density of the ionic solids:
   a) Increases b) Decreases c) Does not change   d) Change

FILL IN THE BLANKS:
1. NaCl and CsCl is example for …….. defects.
2. An electron trapped in anion vacancy within the crystal is called……………..

3. Which has C_{2v} point group……… .
4. Which has D_{6h} point group……… .
5. The point group of CH_4 is _____
6. The unsymmetrical distribution of charge leads to the formation of………… .
7. Point group of Water molecule is…………… .
8. An example for cubic crystal is……………. .
9. The point group of CO_2 is _____

10. Which has C_{2h} point group? ………… .

11. Which has D$_{4h}$ point group? ....

PART-B

1. Draw the structure of rutile ?
2. What are superconductors? Give one example ?
3. Give any two consequences of Frenkel defect?
4. Differentiate a crystal lattice and an unit cell ?
5. The diffraction of a crystal with X-rays of wavelength 2.29A^{o} gives a first order diffraction at
   27^{0} 8'. Find the distance between the diffracted planes.
6. ZnO os yellow while hot and white when cold. Explain ?
7. Define Frenkel defects in crystals ?
8. Write a note on superconductors ?
9. Non stoichiometric NaCl is yellow. Explain ?
10. Explain the electron conduction mechanism in silicon doped with phosphorous ?
11. Discuss F-center with an example ?
12. Give the symmetry elements ?
13. What is meant by unit cell? Explain the types of crystals with examples ?
14. What is meant by abilien group? Give an example ?
15. What is the point group for cis & trans 1,2-difluoroethene?
16. What is the point groups for 1,2 and 1,4-difluoro benzene?

17. Prove the associate law holds good for C2V point group ?
18. 28. What is the point group for boat & chair form of cyclohexane?
19. What is the point groups for furan and hydrogen chloride?

PART-C

1. Explain the crystal defects with suitable example ?

2. Derive bragg's equation ?

3. Explain the X-ray diffraction ?

4. Explain band theory ?

5. Explain n-type and p-type semiconductor ?

6. Give brief explanation about semiconductors and superconductors?

7. Explain frenkel and schottky defect with example ?

8. Discuss non-stoichiometric defects ?

9. Draw crystal structure of ionic crystal like NaCl and CsCl ?

10. Draw crystal structure of rutile, wurzite,zincblende and flurite ?

11. Explain band theory ?

12. discuss about semiconductor and superconductor ?

UNIT-V

PART-A

1. Visible light's wavelength range _____.

(a) 0.39 – 0.77 mm   (b) 0.39 – 0.77 µm (c) 0.39 – 0.77 nm   (d) 0.39 – 0.77 cm

2. Planck's constant

(a) 6.62×10^{-34} J.sec   (b) 6.62×10^{-34} J.min   (c) 6.62×10^{-34} Cal.sec   (d) 6.62×10^{-34} Cal.min

3. Sum of these is unity

(a) Reflectivity (b) Reflectivity + Refractivity   (c) Reflectivity + Refractivity + Transmitivity (d) Any

4. Metals can _____ the light beams.

(a) Reflect (b) Refract (c) Transmit (d) Any

5. Metals are _____.

(a) Transparent (b) Opaque (c) Translucent (d) None

6. Metals can transmit these ____.

(a) Radio ways (b) Visible light (c) Microwaves (d) x-rays

7. Reflectivity of metals

(a) 0.05 (b) 0.50 (c) 0.95 (d) None

8. Refractive index of materials is approximately equal to square root of

(a) electrical permittivity   (b) magnetic permeability (c) electrical permittivity x magnetic permeability (d) None

9. Snell's law relates _____.

(a) Light relfection (b) Light refraction (c) Light transmission (d) Light Absorption

10. Bouguer's law relates _____.

(a) Light relfection (b) Light refraction (c) Light transmission (d) Light Absorption

11. Sky looks blue because the sun light is subjected to _____.

(a) Rayleigh scattering (b) Compton scattering (c) Both (d) None

12. Luminescence is because of

(a) Photons emitted while excited electrons drops down (b) Knocking out of electrons by photons (c) Photons stimulated by photons (d) All

13. Fluorescence occurs within _____.

(a) 10-5 s. (b) 10-5 ms. (c) 10-5 µs. (d) 10-5ns.

14. Electro-luminescence occurs in _____.

(a) Electrical conductors (b) Electrical insulators (c) p-n junctions (d) all

15. Pyrometer works based on

(a) Laser technology (b) Photo-conduction (c) Thermal emission (c) Tyndall effect

16. Solar cell works based on

(a) Laser technology (b) Photo-conduction (c) Thermal emission (c) Tyndall effect

17. Optical fiber operates on the principle of

(a) Total internal reflectance (b) Tyndall effect (c) Photo-electric effect (d) Laser technology

PART-B

I. What is spectroscopy? Discuss the various types of spectroscopy with respectelectromagneticradiation ?

2. What arc electromagnetic radiations? Name different parts of them. How can different parts of electromagnetic radiations be differentiated ?

3. Define the Beer-Lambert law. Give their limitations.

4. Explain the difference between:

(a) Allowed transition and forbidden transition ?

(b) Chromophore and auxochrome ?

(c) Bathochromic shift and hypsocluomic shift ?

5. Describe the various parts of a.uv-visible spectrometer- and their working ?

6. How will you measure the concentration of $KMnO_4$ solution by uv-visible spectroscopy?

7. How is IR spectrometer different from a uv-visible spectronieter?

8. Discuss the vibrational modes of molecules responsible for an IR spectrum ?

9. Give the IR stretching wave number of C- N, C=0, N-H and O-H groups ?

10. Discuss the interpretation of different peaks of 1-hexene ?

11. Write down the applications of uv-visible and IR spectroscopy ?

PART-C

1. The force constant of CO is 1840 Nm-1. Calculate the vibrational frequency in cm-1 and the spacing between the vibrational levels in eV. Compare this spacing with the thermal energy at room temperature. The atomic masses of C=19.9 ×10-27 kg and O=26.6×10-27kg ?

2. a)How the susceptibility of para and diamagnetism vary with temperature ?
   b) Define curie's law for paramagnetic materials ?
   c) Predict the type of electronic transitions for Propane and Propanal ?

3. a) Draw the electronic transition for a molecule according to Franck-Condon principle which is
   stable and slightly deviated in its excited state ?
   b) What is the S.I unit for dipole moment? For water if the dipole moment is 1.85 D, calculate its bond moment if the bond angle is 104.5° ?
   c) Calculate the number of fundamental modes of vibrations for gaseous CO_2 ?

11.   a) State Franck-Condon principle
      b) Define curie's law for paramagnetic materials ?
      c) Predict the type of electronic transitions for Ethane and Ethanol ?