Shiksha Mandal's

Bajaj College of Science, Wardha

Practice Sheet During Lockdown

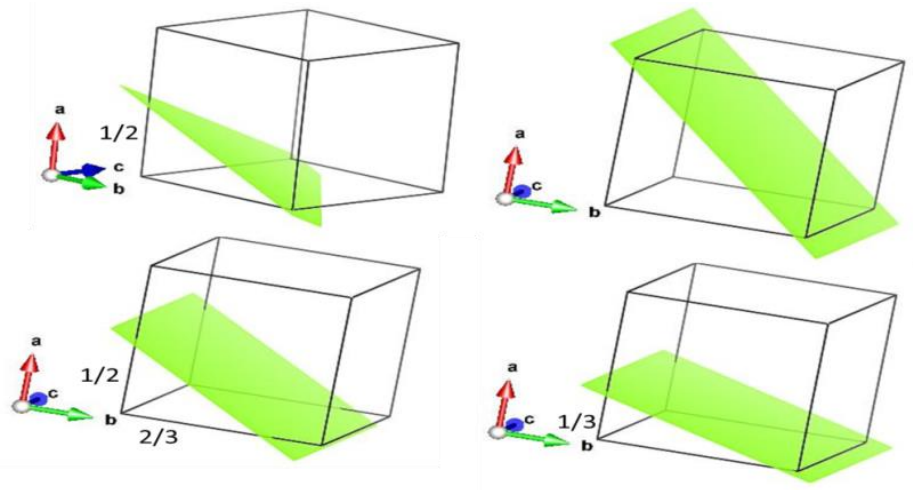
B.Sc. Sem IV

Subject: Physics

Unit 1-3

Long and short answer questions

1. What are the {100} family of planes of the cubic system?
2. Draw the following crystallographic planes in a BCC unit cell and list the position of the atoms whose centers are intersected by each of the planes: (*a*) (100) (*b*) (110) (*c*) (111)
3. Draw the following crystallographic planes in an FCC unit cell and list the position coordinates of the atoms whose centers are intersected by each of the planes: (*a*) (100) (*b*) (110) (*c*) (111)
4. A cubic plane has the following axial intercepts: 1) *a* =1/3, *b* =-2/3, c =1/2: 2) a=-1/2, b=-1/2, c=2/3: 3) a=1, b=2/3, c=-1/2. What are the Miller indices of this plane?
5. Rodium is FCC and has a lattice constant ***a*** of 0.38044 nm. Calculate the following interplanar spacings: (*a*) $d111$ (*b*) $d200$ (*c*) $d220$
6. Tungsten is BCC and has a lattice constant ***a*** of 0.31648 nm. Calculate the following interplanar spacings: (*a*) $d110$ (*b*) $d220$ (*c*) $d310$
7. The d_{310} interplanar spacing in a BCC element is 0.1587 nm. (*a*) What is its lattice constant *a*? (*b*) What is the atomic radius of the element? (*c*) What could this element be?
8. The d_{422} interplanar spacing in an FCC metal is 0.083397 nm. (*a*) What is its lattice constant *a*? (*b*) What is the atomic radius of the metal? (*c*) What could this metal be?
9. What is the difference in the stacking arrangement of close-packed planes in (a) the HCP crystal structure and (*b*) the FCC crystal structure?
10. What are the Miller indices of the cubic crystallographic planes shown in figure?



11. The lattice constant for BCC tantalum at 20° C is 0.33026 nm and its density is 16.6 g/cm^3. Calculate a value for its atomic mass in g/mol.
12. Calculate a value for the density of FCC platinum in grams per cubic centimeter from its lattice constant ***a*** of 0.39239 nm and its atomic mass of 195.09 g/mol.
13. Assuming the letters have their usual meaning , show that the interplanar distance for a simple cubic structure is given by $d_{hkl} = \frac{a}{\sqrt{h^2+k^2+l^2}}$.
14. What do you mean by symmetry operations? Explain the different symmetry operations.
15. Define: Space lattice, crystal lattice, unit cell, primitive and non-premitive unit cell, packing fraction, lattice parameter, Bravais lattice, co-ordination number.
16. Calculate the no. of atoms in: simple cubic, base center cubic, face center cubic and hexagonal closed pack structure.
17. Calculate the relation between the atomic radius and lattice parameter of bcc structure.
18. Show that the packing fraction in case of fcc structure is 0.74.
19. What is Duane Hunt law? Obtain an expression for minimum wavelength of x-ray that can be emitted.
20. What is Mosley's law? How Mosley's law has contributed in development of modern periodic table?
21. Write the essential characteristics required for a x-ray target material.
22. Explain the construction and working of Coolidge's Tube with neat labeled diagram.
23. Write any one application of x-rays.
24. What are x-rays, and how are they produced?
25. Draw a schematic diagram of an x-ray tube used for x-ray diffraction, and indicate on it the path of the electrons and x-rays.
26. What is the characteristic x-ray radiation? What is its origin?
27. A sample of BCC metal was placed in an x-ray diffractometer using x-rays with a wavelength of λ = 0.1541 nm. Diffraction from the {221} planes was obtained at 2θ = 88.838°. Calculate a value for the lattice constant *a* for this BCC elemental metal. (Assume first-order diffraction, *n* = 1.)
28. X-rays of an unknown wavelength are diffracted by a gold sample. The 2θ angle was 64.582° for the {220} planes. What is the wavelength of the x-rays used? (The lattice constant of gold = 0.40788 nm; assume first-order diffraction, *n* = 1.)
29. An x-ray diffractometer recorder chart for an element that has either the BCC or the FCC crystal structure showed diffraction peaks at the following 2θ angles: 41.069°, 47.782°, 69.879°, and 84.396°. (The wavelength of the incoming radiation was 0.15405 nm.)
    (*a*) Determine the crystal structure of the element.
    (*b*) Determine the lattice constant of the element.

30. An x-ray diffractometer recorder chart for an element that has either the BCC or the FCC crystal structure showed diffraction peaks at the following 2θ angles: 38.60°, 55.71°, 69.70°, 82.55°, 95.00°, and 107.67°. (Wavelength λ of the incoming radiation was 0.15405 nm.)
    (*a*) Determine the crystal structure of the element.
    (*b*) Determine the lattice constant of the element.
31. An x-ray diffractometer recorder chart for an element that has either the BCC or the FCC crystal structure showed diffraction peaks at the following 2θ angles: 36.191°, 51.974°, 64.982°, and 76.663°. (The wavelength of the incoming radiation was 0.15405 nm.)
    (*a*) Determine the crystal structure of the element.
    (*b*) Determine the lattice constant of the element.
32. An x-ray diffractometer recorder chart for an element that has either the BCC or the FCC crystal structure showed diffraction peaks at the following 2θ angles: 40.663°, 47.314°, 69.144°, and 83.448°. (The wavelength λ of the incoming radiation was 0.15405 nm.)
    (*a*) Determine the crystal structure of the element.
    (*b*) Determine the lattice constant of the element.
33. Whereas there are pure rotational spectra, there is no such thing as a pure vibrational spectrum. Why?
34. In the Raman spectroscopy of diatomic molecules there is always a single line with large intensity in the middle of the spectrum. What is the origin of this line?
35. Is there any relationship between the force constant and the bond length of a diatomic molecule?
36. The diatomic iodine (I_2) is composed of a single isotope. If you access to a spectrum of this molecule that the distances between consecutive spectral lines are almost constant and around 1 cm^{-1} then what is the rotational constant of this molecule?
37. From the pure rotational spectrum of a diatomic molecule at 300 K it emerges that the maximum population is placed at J = 12. What will be the most populated rotational energy state (J) if one doubles the temperature?
38. If suddenly the masses of atoms of a diatomic molecule are doubled, then what will happen to the mechanical vibrational frequency of the molecule?
39. The distance between spectral lines of pure Raman spectrum of the planar XeF_4 molecule in the Stocks region is 0.2 cm^{-1}. Deduce the Xe-F bond length.
    Use the following information: mass of Fluorine: 32×10^{-27} kg mass of Xenon: 230×10^{-27} kg.
40. The distance between the spectral lines in the rotational Raman spectrum of BCl_3 in Stocks region is almost 2 cm^{-1}? Deduce the rotational constant of this molecule.
41. From what type of spectroscopy one may deduce the rotational constant of methane molecule? Why?

Unit 4-6

Short answer questions

1. Define stimulated absorption, spontaneous emission, stimulated emission and metastable state.
2. Write short note on three level pumping.
3. Write short note on four level pumping.
4. Derive relation between Einstein coefficients.
5. What are characteristic of laser?
6. Write any four applications of laser.
7. What is population inversion? Why it is necessary for lasing action?
8. Describe the term temporal coherence.
9. Write short note on spatial coherence.
10. Describe the term optical cavity, active medium and active center.
11. Explain the necessary condition required for laser action and how can these be obtained?
12. What do you understand by negative temperature state? How can it be achieved?
13. Why is the optical resonator required in laser?
14. Explain the construction and working of light emitting diode.
15. Explain the construction and working of photovoltaic cell.
16. Define alpha and beta derive relation between alpha and beta.
17. Define all four hybrid parameters.
18. What is thermal runaway?
19. Write short note on heat sink.
20. What is bipolar transistor? What are its advantages?
21. Explain the npn and pnp transistor. Draw the circuit diagrams.
22. Explain the working of npn transistor.
23. What are the different mode with which transistor can be connected?
24. What is current gain? Obtain the expression of current gain in CB and CE mode of transistor.
25. What is leakage current? On what factors do it depends?
26. What is load line? Explain with diagram.
27. Why the bias stabilization is necessary in CE amplifier.
28. State the difference between JFET and BJT.
29. Define the parameter of JFET and obtain the relation between them.
30. Describe how characteristic curve of JFET are determined experimentally.
31. Obtain an expression for input impedance, output impedance and voltage gain for JFET amplifier.
32. Why the depletion MOSFET is called dual mode MOSFET?
33. State the special features of MOSFET?

34. State various advantages of JFET and MOSFET over BJT.
35. Draw the circuit symbol for n-channel and p-channel enhancement MOSFET.
36. How does the constructional feature of MOSFET differ from that of JFET?
37. Define the pinch off voltage.
38. Calculate the coherence length of a laser beam for which the bandwidth is 3000 Hz and speed of light is 3×10^8 m/sec.
39. The coherence length of sodium line of wavelength 5890 A^0 is 2.5 cm. Calculate coherence time, half width of spectral line, Purity of spectral line.
40. The ruby laser has two states at 30 K and 500K. If it emits light 7000 A^0 then calculate relative population.
41. Calculate the energy and momentum of photon of a laser beam of wavelength 6328A^0
42. In He-Ne laser, the two plane mirrors forming the resonant cavity are at the distance d of 0.5 m. What is the mode separation of longitudinal cavity in terms of frequency?
43. A LED is made up of gallium-arsenide-phosphide for which the band gap energy E_q =1.9 eV at 300K.Calculate the wavelength of emitted light when it is forward biased.(given that $h=6.623\times10^{-34}$ Js , $q = 1.6\times10^{-19}$C , $c = 3\times10^8$m/sec)
44. A given transistor has α= 0.98 .The transistor is connected with its emitter grounded, If the base current is changed by 0.2 mA, calculate the change in collector current.
45. A given transistor has a current gain β =60.If it is connected in grounded base configuration; what theoretical ac collector current will flow when an ac current of 2mA flows through the emitter?
46. The common base current gain in an NPN transistor is 0.98. The reverse saturation current I_{CBO} =12.5 μA determine the base and collector currents for an emitter current I_E = 2mA
47. In CE transistor amplifier, the load resistance in the collector circuit is 4 kΩ and V_{CC} =12V. Find the co-ordinates of operating point if the zero signal base current is 20μA and β =100
48. Calculate the resistance between gate and source if reverse gate voltage of 15V produces gate current 10 μA in a given JFET.
49. A JFET has a drain current of 6mA.If I_{DSS}=10mA and $V_{GS(off)}$ is -6 V . Find the value of V_{GS} and V_P.
50. Calculate the voltage gain of JFET voltage amplifier having transconductance 4000 μ℧ and the load resistance10kΩ.
51. For the JFET BFW-11, the minimum value of g_m=2.5mA/V and the minimum value of r_d =2×10^4Ω . Calculate the value of amplification factor μ.
52. A JFET has the value of I_{DSS}=10mA and $V_{GS(off)}$ = -3V. Find the value of drain current when V_{GS} = -2V.

53. A common source JFET amplifier uses a load resistance RL=300 kΩ. If the drain resistance and transconductance of JFET are 100kΩ and 0.2mA/V respectively. Calculate the voltage gain of amplifier.
54. The following readings were obtained experimentally for a JFET.

V_{GS} (volts)	0	0	0.2
V_{DS}(volts)	7	16	16
I_D(mA)	10	10.3	9.8

Calculate a.c. drain resistance, transconductance, amplification factor.

Long questions 7 Marks

1. Explain the construction and working of Ruby laser?
2. Explain the construction and working of Helium-Neon laser?
3. Explain the construction and working of semiconductor laser.
4. Draw circuit diagram to study the static characteristics of transistor in CB mode. Explain the input, output and transfer characteristics in CB mode.
5. Draw circuit diagram to study the static characteristics of transistor in CE mode. Explain the input, output and transfer characteristics in CE mode.
6. What is amplifier? Explain the working of CE amplifier with the help of load line concept.
7. Explain self-bias with neat diagram. Define stability factor. Obtain expression for it.
8. Explain the emitter bias with the help of neat diagram and obtain the expression for stability factor in case of emitter bias.
9. Draw a neat diagram of common source JFET amplifier and explain its working.
10. What is JFET? Explain the construction and working of JFET?
11. Explain the construction and working of n-channel depletion MOSFET.
12. What is enhancement MOSFET? Draw the drain and transfer characteristics of enhancement MOSFET
13. Explain the construction and working of enhancement MOSFET.

Note: Check the notification on google classroom regularly and attend the Webinars on popular topics in Physics. For any queries, feel free to contact us on E-mail: jbc.phy@gmail.com