Time Allowed- 3 Hours

PHYSICS– PAPER-II

Full Marks – 200

If the questions attempted are in excess of the prescribed number, only the questions attempted first up to the prescribed number shall be valued and the remaining ones ignored.

Answers may be given either in English or in Bengali but all answers must be in one and same language.

Group - A

Answer any six questions

1. (a) Explain the concept of wave particle dualism. What led de-Broglie to suggest that matter has wave characteristic.

(b) Calculate the de-Broglie wavelength of an electron moving with velocity $\frac{3}{5}$C. 2+3

2. (a) State and explain uncertainty principle. Discuss its significance and importance. 5

(b) Assume that the uncertainty in the position of a particle is equal to its de-Broglie wavelength. Show that uncertainty in the velocity is equal to its velocity. 2+3

3. (a) A linear harmonic oscillator moves with a constant enerty along the x-axis. What will be the phase trajectory. 5

(b) The single particle partition function of a system of N distinguishable particles is $F=CV T^{3/2}$, When c is a constant. Calculate the internal energy and the pressure of the system. 5

4. (a) What is Binding Energy and why the BE curve is so significant. Why do we get maxima and minima peaks in BE curve. 5

(b) Explain the term atomic mass unit. Compute the energy of 1 a.m.u. in MeV. 3+2

5. (a) What are the similarities and dissimilarities between nuclear fission and fusion. Explain with examples. 5

(b) Calculate the energy released by fission of 1 Kg of u^{235} in KWH. The energy released per fission is 200 MeV and Avogadro's number is 6.023×10^{23}. 5

6. (a) Why X-rays are used for crystal structure analysis. Derive Bragg's law of crystal diffraction. 5

(b) Prove that in determining lattice parameters, the greater the diffraction angle, the greater is the accuracy. 2+3

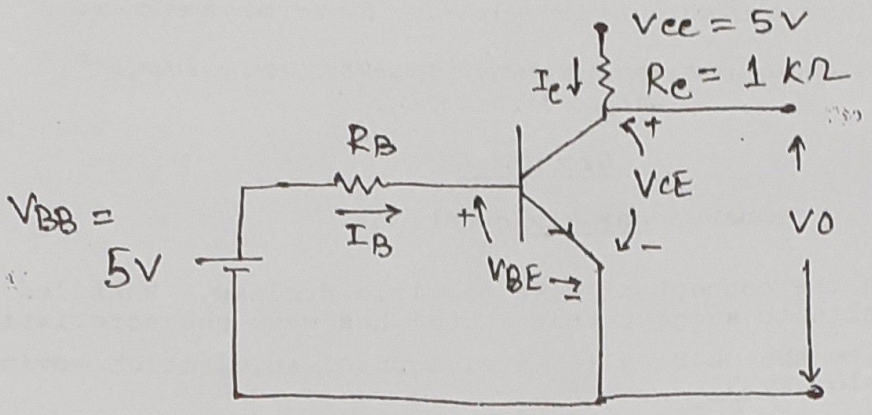
7. (a) Derive the low temperature behaviour of lattice contribution to the specific heat of solid. 5

(b) The molar specific heat of solid at constant volume is 2.77 $JK^{-1}\ mol^{-1}$ at 36.8K. Determine the debye temperature of the solid. 5

8. (a) What is an OPAMP? Why is it so called? What is CMRR of an OPAMP? 2+1+2

(b) Draw the circuit using two OPAMPs whose output V_o is given as $V_o = 4V_1 + 6V_2$, where V_1 and V_2 are two input singals. 5

9. (a) For the transistor in the Circuit $B=h_{FE}=50$, $V_{BE,Sat}=0.8v$ and $V_{CE,Sat}=0.2v$. Find the limiting value of R_B for which the transistor will be driven into saturation



5

(b) (i) Convert the decimal 263 into a number system consisting of five digits 0,1,2,3,4.

(ii) Prove that $A \oplus B = \bar{A} \oplus B$ 2½x2

Group - B

Answer any seven questions

10. (a) Establish Schrödinger equation of a linear harmonic oscillator and solve it for different eigenvalues. Discuss significance of zero point energy. 8+2

(b) Show, by solving Schrödinger equation that a free particle cannot have negative energy. 5

(c) Using the operator representation of the x - component of the momentum of a particle prove that,

$(x\hat{p}_x - \hat{p}_x x)\Psi = i\hbar\Psi$, where Ψ is an wave function. 5

11. (a) State and explain pauli's exclusion principle. How does a knowledge of symmetric and anti-symmatric wave functions lead to this principle. 2+6

(b) Show that no two electrons have same quantum state. 2

(c) What is Raman effect? How is Raman effect explained on the basis of quantum thery? Explain the origin of stokes and Anti-stokes lines in Raman Spectrum. Why are the anti-stokes line fainter than stokes lines. 2+3+3+2

12. (a) Write down Bose-Einstein and Fermi-Dirac distribution functions. What are the basic assumptions used in the derivation of these distribution functions. Sketch the FD distribution Function for T=0 K and T> OK. 3+3+4

(b) If f is the FD distribution functiin, show that

$$\frac{df}{dE} = -\frac{f(1-f)}{K_B T}$$ 4

(c) Show that at a high temperature and low concentrations the FD distribution reduces to the MB distribution. 6

Contd.. P/3..

13. (a) Starting from Bose-Einstein distribution formula Establish Planck's law of black body radiation and hence derive Wier's displacement law.

(b) Calculate the Fermi energy at OK of metallic silver containing one free electron per atom. The density and atomic weight of silver is 10.5 g/cm^3 and 108 respectively. 8+2

(c) At the same temperature, which will exert the greatest and the least pressure - a gas obeying MB statistics, a gas of Bosons, and a gas of fermions? 6

14. (a) Give the main assumptions of liquid drop model of the nucleus. Justify the name liquid drop model. 4

(b) Obtain the expression for binding energy of a nucleus based on liquid drop model. State semi-emperical formula of Weizacker. 2+3

(c) Using the semi-emprical binding energy formula calculate binding energy of $^{40}_{20}Ca$.

(Given a_v = 14 Mev, a_s = 13 Mev, a_c = 0.60 Mev, a_a = 19 Mev, a_p = -34 Mev) 10

15. (a) What do you mean by Q-value of a nuclear reaction? Discuss the energetics of endoergic and exoergic reactions. Define threshold energy of an endoergic reaction. 2+2+6

(b) Calculate the Q value for the formation of P^{30} in the ground state in the reaction $Si^{29}(d,n)P^{30}$ from the following cycles of nuclear reactions.

$$P^{31} + \gamma \longrightarrow P^{30} + n - 12.37 \text{ Mev}$$

$$P^{31} + P \longrightarrow Si^{28} + He^4 + 1.909 \text{ Mev}$$

$$Si^{28} + d \longrightarrow Si^{29} + P + 6.246 \text{ Mev}$$

$$2d = He^4 + 23.834 \text{ Mev}.$$

10

16. (a) Explain the motion of electron in one dimension accending to the Bond theory and show how the energy, velocity and effective mass vary as a function of wave vector. 2+(3+3+2)

(b) What are valence and conduction bands? What do you mean by forbidden energy gap. 2+3

(c) What are Brillouin Zones? Discuss the importance of the first Brillouin Zone. 2+3

17. (a) What is ferromagnetism? Derive the Curie-Weiss law of ferromagnetism and explain how magnetic susceptibility varies with temperature. 2+8

(b) What is superconductivity? Explain the effect of an external magnetic field on the superconducting state of a material. 2+6

(c) What is the difference between a conductor cooled at OK and super-conductor. 2

18. (a) What do you mean by feed back in Amplifiers. Derive the expression for the overall transfer gain of a negative feed back amplifier. 2+6

(b) Find the expression for the frequency of oscillation of Wien Bridge Oscillator. Show that the voltage gain of the amplifier used in this oscillator must be greater than 3. 4+4

(c) A Wien Bridge Oscillator is to be operated in the frequency range 30 Hz to 3 KHZ. The variable capacitance has a range 50 PF to 500 PF. Find the resistance values required. If the resistances in the other arms are in the 5:1, find out the gain of the amplifier. 4

19. (a) Define positive and negative logic systems. Draw the circuit diagram of a positive diode logic AND gate. Explain its operation. Show that a negative logic OR gate is the same circuit as a positive logic AND gate. 2+3+2+3

(b) Draw a logic circuit using NOR gates to implement the Boolean expression $Y = AB + \bar{B}\bar{C}$ 5

(c) Prove the following using Boolean algebraic theorems

(i) $\bar{A}BC + A\bar{B}C + AB\bar{C} + ABC = AB+BC+CA$

(ii) $\overline{AB} + \bar{A} + AB = 1$. $2\frac{1}{2} \times 2$