

**6/H—24 (vii) (Syllabus—2015)**

**2 0 1 8**

( April )

**PHYSICS**

( Honours )

**( Condensed Matter Physics )**

[ PHY-07 (T) ]

Marks : 56

Time : 3 hours

*The figures in the margin indicate full marks  
for the questions*

Answer Question No. **1** and *any four* from the rest

1. (a) Find the Fermi energy of copper on the assumption that each copper atom contributes one free electron to the electron gas. 4

Density of copper is  $8.94 \times 10^3 \text{ kg/m}^3$

$h = 6.63 \times 10^{-34} \text{ Js}$

Mass of the electron =  $9.11 \times 10^{-31} \text{ kg}$

Atomic weight of copper = 63.54

- (b) The primitive translation vectors of a two-dimensional lattice are  $\vec{a} = 2\hat{i} + \hat{j}$ ,  $\vec{b} = 2\hat{j}$ . Determine the primitive translation vectors of its reciprocal lattice. 4
- (c) The resistivity of an intrinsic semiconductor is 4.5 ohm-m at 20 °C and 2.0 ohm-m at 32 °C. What is the energy band gap? 4
2. (a) Derive Maxwell's thermodynamical general relations connecting the thermodynamic quantities. 6
- (b) Explain Joule-Thomson effect using the Maxwell's thermodynamical relations. 5
3. (a) Explain Poisson's distribution. Obtain the distribution formula  

$$P(x) = \frac{x^n}{n!} e^{-x}$$
 1+5=6
- (b) Explain the concept of ensembles in statistical physics. 2
- (c) Obtain the probability distribution for a canonical ensemble. 3
4. (a) Deduce an expression for the Fermi-Dirac distribution. 5

- (b) State and prove the law of equipartition of energy. 4
- (c) Explain what you understand by the term 'partition function'. 2
5. (a) What are point group and space group? Give their numbers for two- and three-dimensional lattices. List all the point groups of a two-dimensional lattice. 2+2+1+2=7
- (b) What are Brillouin zones? 1
- (c) Prove that fcc lattice is reciprocal to bcc lattice. 3
6. (a) Explain Madelung energy and Madelung constant in ionic crystals. 1+2=3
- (b) Explain in detail Einstein's theory of lattice heat capacity. 6
- (c) What do you mean by structure factor and atomic form factor? 1+1=2
7. (a) Describe in detail Weiss theory of ferromagnetism. 6
- (b) Distinguish between dia-, para- and ferromagnetic materials. 2
- (c) Explain Hall effect. 2
- (d) State Wiedemann-Franz law. 1

8. (a) Explain Meissner effect. 2
- (b) Explain the difference between type I and type II superconductors using the Meissner effect. 4
- (c) Give a qualitative description of the BCS theory. How does it account for the superconducting state? 2+1=3
- (d) Explain isotope effect. 2

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**6/H—24 (viii) (Syllabus—2015)**

**2018**

**( April )**

**PHYSICS**

**( Honours )**

**( Atomic and Molecular Spectroscopy,  
Nuclear Physics )**

**[ PHY-08(T) ]**

**Marks : 56**

**Time : 3 hours**

*The figures in the margin indicate full marks  
for the questions*

**Answer Question No. 1 and any four  
from the rest**

- 1. (a)** An element is placed in magnetic field of flux density  $0.3 \text{ weber/m}^2$ . Calculate the Zeeman shift of a spectral line of wavelength  $4500 \text{ \AA}$ .

**3**

- (b) The exciting line in an experiment is 2530 Å, a Raman line for a sample is observed at 2600 Å. Calculate the Raman shift in  $\text{m}^{-1}$  units. 3
- (c) Calculate the Q-value of the reaction  ${}_1\text{H}^3(d, n){}_2\text{He}^4$  in MeV.  
 mass of neutron = 1.0087 amu  
 mass of deuterium = 2.0141 amu  
 mass of tritium = 3.0160 amu  
 mass of helium = 4.0026 amu 3
- (d) A  $\pi^+$  meson of rest mass 139.6 MeV decays at rest into a  $\mu^+$  meson rest mass 106 MeV and a neutrino. Calculate the kinetic energy of  $\mu^+$  meson. 3
2. (a) What is space quantisation? Explain by drawing a suitable diagram. 1+6=7
- (b) Write down the values of quantum numbers  $l$  and  $s$  for a  $d$ -electron, and enumerate for it the possible values of the quantum numbers  $j$  and  $m_j$ . 4
3. (a) What is X-ray fluorescence (XRF)? Explain the basic principle of XRF. Write the two useful applications of XRF. 1+2+2=5

- (b) On the basis of quantum theory, derive the energy levels of rigid body rotator. 6
4. (a) What is artificial transmutation? Explain with example. 1+3=4
- (b) What is  $\beta$ -decay? Explain the difficulties encountered to explain the continuous spectrum of  $\beta$ -decay. How were they overcome by Neutrino hypothesis? 1+3+3=7
5. (a) What are cosmic ray showers? 2
- (b) Explain with example, various conservation laws governing elementary particles. 6
- (c) The nucleus of an atom  ${}^9\text{Be}_4$  consists of how many up-quark and down-quark? 3
6. (a) What are normal and anomalous Zeeman effects? 1+1=2
- (b) With the help of Zeeman effect, show how you can determine the value of specific charge ( $e/m$ ) of an electron. 3
- (c) Explain what is Larmor's precession. 3
- (d) Calculate the Landé  $g$ -factor for  ${}^3\text{P}_1$  level of an atom. 3

7. (a) What are magic numbers? How is the stability of nuclei explained on the basis of magic numbers? 1+5=6

(b) Check if the following reactions are allowed or forbidden :

(i)  $p = e^+ + \pi^0$

(ii)  $\bar{p} + n = \pi^- + \pi^0$  1½+1½=3

(c) A  $\mu^-$  meson collides with a proton; a neutron plus another particle are created. What is the other particle? 2

8. (a) What is Raman effect? Explain why Stokes lines are more intense than anti-Stokes lines. 1+2=3

(b) In what respect Raman effect differs from Compton effect? 2

(c) State and explain Franck-Condon principle. 6

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