

6/H-24 (viii) (Syllabus-2015)

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(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) Calculate the Binding energy per nucleon of U^{238} in MeV. Taking—

mass of neutron = 1.0087 a.m.u.

mass of proton = 1.0078 a.m.u.

mass of U^{238} = 238.0508 a.m.u.

- (b) Find the maximum kinetic energy of the electron emitted in the beta decay of free neutron. The neutron-proton mass difference is 1.30 MeV.

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- (c) Calculate the value of force constant of the bond in CO molecule. The spacing between vibrational energy level is 8.45×10^{-2} eV. 3
- (d) Calculate the Lande g -factor for the level 3D_3 . 3
2. (a) Describe the effect of the earth magnetic field on cosmic ray trajectories. 6
- (b) What are baryon and lepton number? Show with example, that in any nuclear reaction they are conserved. 4
- (c) What do you understand by mean, hard and soft component of cosmic rays? 1
3. (a) Discuss Gamow's theory of alpha decay. 6
- (b) Both U^{235} and Pu^{239} are fissionable elements but Pu^{239} is preferred in nuclear reactor. Why? 3
- (c) What are Thermal reactor and breeder reactor? 2
4. (a) Using Pauli's exclusion principle, show that the P sub-shell ($l=1$) in an atom can contain a maximum of 6 electrons. 3
- (b) In L-S coupling, show how many number of transitions is permitted from $2P_{3/2}$ to $2S_{1/2}$ due to weak magnetic field. 3

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- (c) Give the reason why for any filled shell of an atom the total magnetic moment is zero. 2
- (d) What is the wavelength of photon emitted by hydrogen atom during transition from $2S \rightarrow 1S$? 3
5. (a) Give the theory of rotation-vibration spectra of diatomic molecule. 5
- (b) Explain which of the following molecules are expected to show rotation spectra in infrared region : 4
- NO, N_2, HCl, CH_4
- (c) What is 'null line' in vibrational spectra? 1
- (d) Write the wave-number for R -branch and P -branch. 1
6. (a) Find the expression for the moment of inertia of two nuclei about their common centre of mass in the case of HCl molecule. 4
- (b) Obtain the frequency of spectral line and the relevant selection rule for rigid rotator. 4
- (c) When acetylene is irradiated with 4358 \AA mercury line, a Raman line attributed to the symmetrical stretching when vibration is observed at 4768 \AA . Calculate the fundamental frequency of the vibration. 3

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7. (a) Describe the Stern-Gerlach experiment. How does it support the concept of vector atom model? $6+2=8$
- (b) Explain the fine structure of Alkali spectra. 3
8. (a) What is Geiger-Nuttall law? 4
- (b) What is artificial radioactivity? How can stable nuclei be made radioactive? $1+2=3$
- (c) Show that 1 atomic mass unit is equivalent to 931.5 MeV. 3
- (d) What is the range of an alpha particle? 1

2019

(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) The number of conduction electrons per c.c. is 24.2×10^{22} in beryllium and 0.91×10^{22} in cesium. If the Fermi energy of conduction electrons in Be is 14.44 eV, calculate that of cesium. 4

- (b) Find out the reciprocal lattice vectors for a space lattice defined by the following primitive translation vectors :

$$\vec{a} = 5\hat{i} + 5\hat{j} - 5\hat{k}, \quad \vec{b} = -5\hat{i} + 5\hat{j} + 5\hat{k} \text{ and} \\ \vec{c} = 5\hat{i} - 5\hat{j} + 5\hat{k}$$

Also find out the volume of the primitive cell. 4

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- (c) Calculate the change in boiling point of water when the pressure is increased by 1 atmosphere. Boiling point of water is 373 K, specific volume of steam $= 1.671 \text{ m}^3 \text{ kg}^{-1}$ and latent heat of steam $= 2.268 \times 10^6 \text{ J kg}^{-1}$. 4
2. (a) Explain extensive and intensive variables. Give examples. $1\frac{1}{2} + 1\frac{1}{2} = 3$
- (b) Deduce Clausius-Clapeyron equation from Maxwell's thermodynamic relations. 4
- (c) Derive first and second $T dS$ equations. 4
3. (a) What is Gaussian distribution? Obtain an expression for it. $2 + 5 = 7$
- (b) State and explain the principle of equal a priori probability. 2
- (c) Explain the concept of ensembles in statistical physics. 2
4. (a) State and prove Liouville's theorem. $1 + 5 = 6$
- (b) State the distribution law of Bose-Einstein statistics and use it to deduce Planck's law of radiation. $1 + 4 = 5$
5. (a) Explain in detail symmetry operations in crystal. 5

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- (b) Prove that reciprocal lattice to an f.c.c. lattice is a b.c.c. lattice. 3
- (c) What are Brillouin zones? 2
- (d) What is a phonon? 1
6. (a) Define Fermi energy E_F . Explain the classification of solids, conductors, semiconductors and insulators on the basis of band theory. $1 + 3 = 4$
- (b) Explain (i) Hall effect, (ii) Meissner effect. $2 + 2 = 4$
- (c) Explain London interaction in inert gas crystals. 3
7. (a) Explain antiferromagnetism and ferrimagnetism. $2 + 2 = 4$
- (b) Describe in detail Langevin's theory of paramagnetism. 5
- (c) Explain isotope effect in superconductivity. 2
8. (a) Describe in detail about type-I and type-II superconductors. Give examples. $3 + 1 = 4$
- (b) Explain BCS theory of superconductivity. 3

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- (c) Explain high temperature superconductivity. 2
- (d) The critical temperature of a superconductor at zero magnetic field is T_c . Determine the temperature at which the critical field becomes half of its value at 0K. 2

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