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(April)

PHYSICS

(Elective/Honours)

(Atomic, Nuclear and Solid State Physics)

[PHY 04 (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 *(i)* ionisation potential and *(ii)* first excitation potential of the hydrogen atom taking

$$\hbar c = 197\cdot3 \text{ MeV fm}$$
$$\frac{e^2}{4\pi\varepsilon_0} = 1\cdot44 \quad m = 938 \text{ MeV}/C^2 \qquad 4$$

(b) Calculate the energy generated in MeV when $0\cdot1$ kg of ^7_3Li is converted into ^4_2He by proton

(Turn Over)

bombardment. [Given : masses of ^7_3Li, ^4_2He and ^1_1H in amu are 7·0183, 4·0040 and 1·0081 respectively]   4

(c) Assuming that each silver atom provides one conduction electron, calculate (i) the density of electrons and (ii) the mobility of electrons in silver. [Given : the density of silver = 10.5×10^3 kg/m^3, the atomic weight of silver = 107·9, the resistivity of silver at 20°C is 1.47×10^{-8} Ω m]   4

2. (a) Discuss the construction and theory of Bainbridge mass spectrograph.   2+2=4

(b) What are these quantum numbers which specify the energy state of the electron in an atom? Give their significance.   4

(c) Briefly describe how X-rays are produced in the Coolidge tube.   3

3. (a) Give the theory of Millikan's oil drop method for determination of electronic charge. From the result obtained therein, show that the electron is 1836 times lighter than the lightest hydrogen atom.   4+1=5

(b) Deduce Moseley's law and discuss how it has been utilised in removing some of the defects of periodic table.   2+2=4

(c) Deduce the exponential law for the linear absorption coefficient of X-rays in a material.   2

4. (a) Explain the principle of working and theory of a betatron.   2+3=5

(b) Explain the source of stellar energy and estimate the energy obtained therein.   3

(c) Explain the property of east-west asymmetry of cosmic rays.   3

5. (a) What is the principle of charged particle detectors? Explain the construction and working of an ionization chamber.   1+4=5

(b) What are the basic similarities between a liquid drop and an atomic nucleus? On the basis of liquid-drop model, give a qualitative explanation for nuclear fission.   2+4=6

6. (a) Discuss the similarities and differences of primitive cells and unit cells. What are Miller indices? How are they determined?   2+2+2=6

(b) Discuss Laue's treatment of X-ray diffraction and hence obtain the Laue's equations.   5

7. *(a)* Give the difference between conductors, semi-conductors and insulators in terms of energy bands.   4

(b) What are the inadequacies of the free electron model?   3

(c) What is Meissner effect? Show that a superconductor behaves as a perfectly diamagnetic substance.   1+3=4

8. *(a)* What is population inversion? Describe the methods of pumping. What is the role of the cavity to achieve population inversion in a laser?   1+3=4

(b) Name the three-broad classes of elementary particles and discuss their chief properties.   4

(c) Discuss briefly about symmetry in crystals with reference to translational, rotational and inversion symmetry.   3

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