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(4th Semester)

PHYSICS

FOURTH PAPER

**(Atomic, Nuclear Physics—I and
Solid-State Physics—I)**

[2014 Batch (Revised)]

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(Marks : 35)

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

1. (a) What are positive rays? Mention any two properties of positive rays. 1+1=2
- (b) In Thomson's experiment for the study of positive rays, show that all the positive ions possessing the same value of e/m will lie along the arc of the same parabola. 5

Or

- (a) Discuss Bohr's theory of hydrogen atom and show that the value of Bohr radius is nearly 0.53 \AA . 2+3=5
- (b) The wavelength of the first line of Balmer series in hydrogen spectrum is 6561 \AA . Calculate the wavelength of the first line of Lyman series in the same spectrum. 2

2. (a) What are mass defect and binding energy of a nucleus? 2
- (b) Show that the density of all nuclei is independent of mass number and is of the order of $10^{17} \text{ kg-m}^{-3}$. 2
- (c) Calculate the binding energy per nucleon of a helium nucleus (${}^4_2\text{He}$). Given

Mass of He nucleus = 4.00276 amu $m_p = 1.00728 \text{ amu}$ $m_n = 1.00867 \text{ amu}$ $1 \text{ amu} = 931 \text{ MeV}$

3

Or

- (a) What are half-life and mean life of a radioactive element? 2
- (b) Mention at least two properties each of alpha, beta and gamma rays. 3

(3)

- (c) The decay constant (λ) of a radioactive element is 0.00231 per day. Find its half-life and mean lifetime. 2
3. (a) Amorphous solids are isotropic but crystals are anisotropic. Explain. 2
- (b) What do you mean by Miller indices and atomic packing factor? 2
- (c) Find an expression for the density of crystalline material in terms of lattice constant for a cubic lattice. 3
- Or*
- (a) All primitive cells are unit cells but all unit cells may or may not be primitive cell. Justify. 2
- (b) What do you mean by lattice constant and coordination number? 2
- (c) If the lattice constant of a cubic crystal is a , find the atomic radii for SC lattice, BCC lattice and FCC lattice. 3
4. (a) Derive Laue equations and hence deduce Bragg's law of X-ray diffraction. 4+1=5
- (b) How does the Laue approach differ from the Bragg approach? 2
- Or*
- (a) What do you mean by reciprocal lattice? 1

(4)

- (b) Prove the following : 3×2=6
- (i) Every reciprocal lattice vector is normal to a lattice plane of the crystal lattice.
- (ii) The direct lattice is the reciprocal of its own reciprocal lattice.
5. (a) Describe Einstein's theory of specific heat of a solid. 5
- (b) Discuss the success and failures of Einstein's theory. 2
- Or*
- (a) Obtain the expression for thermal conductivity of a metal based on classical free-electron theory. 5
- (b) What are Fermi energy and Fermi temperature? How are those related? 2

Subject Code : PHY/IV/04 (R)

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Booklet No. **A**

Date Stamp

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To be filled in by the Candidate

DEGREE 4th Semester
(Arts / Science / Commerce /
.....) Exam., **2016**
Subject
Paper

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To be filled in by the Candidate

DEGREE 4th Semester
(Arts / Science / Commerce /
.....) Exam., **2016**

Roll No.

Regn. No.

Subject

Paper

Descriptive Type

Booklet No. B

INSTRUCTIONS TO CANDIDATES

- 1. The Booklet No. of this script should be quoted in the answer script meant for descriptive type questions and vice versa.**
- 2. This paper should be ANSWERED FIRST and submitted within 45 minutes of the commencement of the Examination.**
- 3. While answering the questions of this booklet, any cutting, erasing, overwriting or furnishing more than one answer is prohibited. Any rough work, if required, should be done only on the main Answer Book. Instructions given in each question should be followed for answering that question only.**

Signature of
Scrutiniser(s)

Signature of
Examiner(s)

Signature of
Invigilator(s)

PHY/IV/04 (R)

2 0 1 6

(4th Semester)

PHYSICS

FOURTH PAPER

(Atomic, Nuclear Physics—I and Solid-State Physics—I)

[2014 Batch (Revised)]

(PART : A—OBJECTIVE)

(Marks : 20)

The figures in the margin indicate full marks for the questions

SECTION—A

(Marks : 5)

Tick (✓) the correct answer in the brackets provided : 1×5=5

- 1.** When the energy of the incident beam is 5 eV, the maximum kinetic energy (K_{\max}) of emitted photoelectrons from a metal surface is 2.3 eV. If the incident source is replaced by another source of energy 4.7 eV, what will be the value of K_{\max} ?

- (a) 2.7 eV ()
(b) 2 eV ()
(c) 0.3 eV ()
(d) 2.4 eV ()

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(2)

2. If the nuclear radius of Al^{27} is 3.6 F, the approximate nuclear radius of Cu^{64} in Fermi (F) unit is

(a) 4.8 ()

(b) 3.6 ()

(c) 2.4 ()

(d) 1.2 ()

3. Most of the solids prefer to be in the crystalline state, because

(a) crystal has definite shape and size ()

(b) crystal has generally high rigidity ()

(c) crystalline state is the low-energy state ()

(d) volume is generally minimum in crystalline state than liquid or gaseous state ()

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(3)

4. X-rays are used for diffraction studies in crystals because

- (a) X-rays penetrate the crystals ()
- (b) crystals have atoms/molecules capable of scattering X-rays ()
- (c) X-rays are high-energy electromagnetic waves ()
- (d) the wavelength of X-rays is of the same order as that of interatomic spacing ()

5. At any temperature other than absolute zero, the probability of finding an electron at Fermi level is

- (a) 1 ()
- (b) 0 ()
- (c) 0.5 ()
- (d) Any positive value ()

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(4)

SECTION—B

(Marks : 15)

Write very short answers to the following questions : 3×5=15

1. State Moseley's law and mention its importance.

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(5)

2. Discuss radiocarbon dating.

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(6)

3. Show that the inter-planar spacing (d) of planes (111) in an SCC lattice of side a is $a / \sqrt{3}$.

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(7)

4. Discuss the advantages of reciprocal lattice over direct space lattice. Mention at least three points.

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(8)

5. Mention any three basic assumptions of classical free- electron theory of metals.

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