

2015

(4th Semester)

PHYSICS

FOURTH PAPER

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

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(Marks : 35)

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

1. Derive Einstein's photoelectric equation. How will you determine the value of Planck's constant (h) by using Millikan's method? 3+4=7

Or

- (a) What is Compton effect? Derive an equation for Compton shift. 1+4=5
- (b) Differentiate between photoelectric effect and Compton effect. 2

2. Describe the construction and working of a cyclotron. What are its limitations and how have they been overcome? 5+1+1=7

Or

- (a) What is artificial transmutation? How is it produced in the laboratory? 1+4=5
- (b) What is dead time in GM counter? What is its cause? 1+1=2
3. Explain nuclear fission on the basis of liquid-drop model of the nucleus. Why is it possible to produce the fission of ${}_{92}\text{U}^{235}$ with slow neutrons, whereas it is necessary to use fast neutrons to produce the fission of ${}_{92}\text{U}^{238}$? 5+2=7

Or

- (a) What is the source of stellar energy? Explain the carbon-nitrogen cycle for the reaction responsible for stellar energy. 2+3=5
- (b) What are the differences and similarities between nuclear fission and nuclear fusion? 2
4. (a) Explain the terms 'space lattice', 'basis', and 'unit cell' in the description of crystal structure. Draw the two-dimensional representation wherever necessary. 5

- (b) Calculate the longest wavelength that can be analysed by a rock crystal of spacing 2.82 \AA in the first order. 2

Or

- (a) Deduce Bragg's law for X-ray diffraction. 4
(b) How do you determine the Madelung constant for a NaCl crystal? 3

5. Deduce Dulong and Petit's law for the specific heat of solids from the concept of harmonic oscillator. Discuss the agreement of the result with that of experiment. 5+2=7

Or

- (a) Define Fermi energy and Fermi level. 2
(b) Show that the average energy of an electron in an electron gas at 0 K is $\frac{3}{5} E_F(0)$, where $E_F(0)$ is Fermi energy at 0 K. 5

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

(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. K_{α} characteristic X-ray refers to the transition of electrons

- (a) from $n = 2$ to $n = 1$ ()
- (b) from $n = 3$ to $n = 2$ ()
- (c) from $n = 3$ to $n = 1$ ()
- (d) from $n = 4$ to $n = 2$ ()

2. Wilson cloud chamber detects

- (a) α -particles only ()
- (b) β -particles only ()
- (c) γ -particles only ()
- (d) both α - and β -particles ()

3. If each fission of ${}_{92}\text{U}^{235}$ releases an energy of 200 MeV, how many fissions must occur per second to produce a power of 32×10^6 W?

- (a) 3.2×10^{18} ()
- (b) 32×10^{18} ()
- (c) 10^{18} ()
- (d) 10^{20} ()

4. The coordination number of f.c.c. crystal is

(a) 4 ()

(b) 6 ()

(c) 8 ()

(d) 12 ()

5. The ratio of Fermi energy E_F to the Fermi temperature T_F is equal to

(a) Planck's constant ()

(b) Boltzmann's constant ()

(c) Universal constant ()

(d) Rydberg constant ()

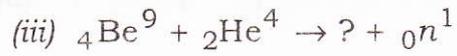
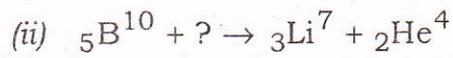
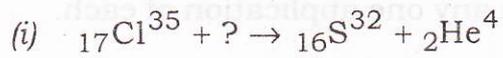
SECTION—B

(Marks : 15)

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

1. Explain the origin of continuous X-ray spectra.

2. Complete the following nuclear reactions :



3. What are controlled and uncontrolled chain reactions? Write down any one application of each.

4. Classify the following crystals according to their bonding :

Na ; NaCl ; Diamond ; KBr ; Cu ; Zn ; Si.

PHYSICS

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[Atomic, Nuclear Physics-I and Solid-State Physics-I]

[PART - A - OBJECTIVE]

[Marks : 20]

The figures in the margin indicate full marks for the questions

SECTION - A

[Marks : 5]

Think of the correct answer in the box given provided to you

1. K_{α} characteristic X-ray refers to the transition of electrons

- (a) from $n = 2$ to $n = 1$ [1]
- (b) from $n = 3$ to $n = 2$ [1]
- (c) from $n = 3$ to $n = 1$ [1]
- (d) from $n = 4$ to $n = 3$ [1]

5. State and explain Wiedemann-Franz law.

4. Classify bonding:

- (a) Na; NaCl; Diamond; KBr; Cu; Zn; Si
- (b) ...
- (c) ...
- (d) both ...

3. If each fission of ^{235}U releases an energy of 200 MeV, how many fissions must occur per second to produce a power of 32×10^6 W?

- (a) 3.2×10^{12}
- (b) 32×10^{12}
- (c) 10^{12}
- (d) 10^{10}
