

4 SEM TDC PHYH (CBCS) C 9

2022

(June/July)

PHYSICS

(Core)

Paper : C-9

(Elements of Modern Physics)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

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

1. Choose the correct answer from the following : 1×5=5
- (a) The photocurrent depends on
- (i) frequency of the incident radiation
 - (ii) intensity of the incident radiation
 - (iii) Both (i) and (ii)
 - (iv) None of the above

- (b) The size of the nucleus of an atom of mass number A is proportional to
- (i) $A^{3/4}$
 - (ii) $A^{2/3}$
 - (iii) $A^{1/3}$
 - (iv) A
- (c) The energy eigenvalue of a particle in one-dimensional box of infinite depth is proportional to
- (i) n^2
 - (ii) n
 - (iii) $n^{1/2}$
 - (iv) None of the above
- (d) The rate of spontaneous emission is proportional to
- (i) the number of atoms in the higher energy state
 - (ii) the number of atoms in the lower energy state
 - (iii) Both (i) and (ii)
 - (iv) None of the above
- (e) Gamma radiations are
- (i) deflected by magnetic field only
 - (ii) deflected by electric field only
 - (iii) deflected by both electric field and magnetic field
 - (iv) None of the above

2. Answer the following questions : 2×5=10

- (a) What is blackbody radiation? State the Planck's theory of blackbody radiation.
- (b) What is population inversion? Write at least two methods for achieving population inversion.
- (c) Why is it impossible for an electron to be present inside the nucleus?
- (d) State de Broglie's hypothesis and write down the expression for de Broglie wavelength.
- (e) State the law of radioactive decay. What is half-life period of a radioactive substance?

3. (a) State the Heisenberg's uncertainty principle. Obtain the minimum energy of a particle confined in a one-dimensional box using uncertainty principle. 1+2=3

(b) A wave function is given by

$$\psi(x) = A_n \sin \frac{2n\pi x}{L}$$

in the region $0 \leq x \leq L$. Find the value of A_n using normalization condition. 3

(c) Differentiate between nuclear fission and nuclear fusion. What do you mean by mass deficit? 2+1=3

4. (a) Write down the time-independent and time-dependent forms of Schrödinger equation for non-relativistic particles. What are energy and momentum operators? 2+2=4

- (b) Show that $v_g = v_p - \lambda \frac{dv_p}{d\lambda}$, where the symbols have their usual meanings. 4

Or

How is the probability of a particle related with its wave function? Obtain an expression for the probability current density. 1+3=4

5. (a) Explain Compton scattering and obtain an expression for the Compton shift. 6

- (b) Explain the quantum mechanical tunneling for a particle across a rectangular potential barrier and obtain the expression for transmission coefficient. 6

- (c) Give a brief description of the α -decay, β -decay and γ -ray emission with examples. 2×3=6

6. Write a short note on any *one* of the following : 3

(a) Gamma-ray microscope experiment

(b) Nuclear shell model

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