

2022

PHYSICS

Paper : CC-9

(Elements of Modern Physics)

Full Marks : 60

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 absorptive power of a perfectly blackbody is
- (i) 100%
 - (ii) 50%
 - (iii) 0%
 - (iv) Cannot be predicted
- (b) Which phenomenon exhibits the particle nature of electromagnetic wave?
- (i) Reflection
 - (ii) Diffraction
 - (iii) Polarization
 - (iv) Compton effect

(2)

(c) The wavelength (λ) associated with a material particle is expressed as

(i) $\lambda = \frac{h}{p}$

(ii) $\lambda = \frac{p}{h}$

(iii) $\lambda = \frac{h}{p}$

(iv) $\lambda = \frac{p}{h}$

(d) The total probability of finding the particle in space must be

(i) infinity

(ii) zero

(iii) unity

(iv) None of the above

(e) The nuclear force is the

(i) strongest force in nature

(ii) weakest force in nature

(iii) neither strongest nor weakest

(iv) None of the above

(3)

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

(a) Explain the term 'stopping potential'.

(b) Describe Heisenberg's uncertainty principle for position and momentum.

(c) Define eigenvalue and eigenfunction of an operator.

(d) Half-life of radium is 1600 years. Find the value of decay constant.

(e) What is nuclear fission?

3. Answer any five from the following questions : 5×5=25

(a) Establish the Einstein's equation for the explanation of photoelectric effect.

(b) Show that, in a dispersive medium, the group velocity is less than the phase velocity.

(c) Obtain the uncertainty relation between energy and time by considering the concept of wave-packet.

(d) Briefly describe about Ruby laser.

(4)

- (e) Deduce the one-dimensional time-dependent Schrödinger's wave equation.
- (f) Establish the radioactive decay law

$$N = N_0 e^{-\lambda t}$$

where the symbols have their usual meanings.

- (g) What is population inversion? Discuss optical pumping to achieve population inversion. Define stimulated emission.

1+3+1=5

4. Answer any two from the following questions :

10×2=20

- (a) What is Compton effect? Derive the relationship between the change in wavelength and the scattering angle of the X-rays in Compton scattering experiment.
- (b) A particle of mass m is confined in a field-free region between rigid and impenetrable walls at $x=0$ and $x=a$. Show that the stationary energy levels of the particle are given by

$$E_n = \frac{n^2 \pi^2 \hbar^2}{2ma^2}$$

Draw the energy-level diagram for the particle.

(5)

- (c) Write short notes on the following :

5×2=10

- (i) Liquid-drop model
- (ii) Magic numbers
