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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 $0 \le x \le L$. 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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