B.Sc. PHYSICS
FOURTH SEMESTER
ELEMENTS OF MODERN PHYSICS
BSP – 402 OLD COURSE [REPEAT]
[USE OMR FOR OBJECTIVE PART]

SET A

Duration: 3 hrs.

Full Marks: 70

[**Objective**]

Time: 30 min.

Marks: 20

Choose the correct answer from the following:

1X20=20

1. The probability of finding a particle within a distance dx along the x axis is given by?
   - a. 1
   - b. ψ^*
   - c. $\psi^*\psi$
   - d. $\psi^*\psi dx$

2. Which amongst the following is one of the products of the nuclear fission of U_{235}
   - a. Fe_{56}
   - b. Ba_{141}
   - c. Pb_{204}
   - d. None of the options

3. Which of the following represents the Einstein photoelectric equation (symbols have their usual meaning).
   - a. $h\nu = h\nu_0 + E_k$
   - b. $h\nu = h\nu_0 + \Phi$
   - c. $h\nu = \Phi - E_k$
   - d. $h\nu = h\nu_0 - \Phi$

4. Somerfield's Modification yields which kind of orbit?
   - a. Ellipse
   - b. Hyperbolic
   - c. Circular
   - d. None of the Options

5. Compton effect reveals the .... nature of electromagnetic radiation
   - a. Wave
   - b. Particle
   - c. Both
   - d. None

6. Length Contraction happens for whom?
   - a. Traveller
   - b. Observer
   - c. Both
   - d. None

7. When the scattering angle $\varphi=0°$, Compton shift $\Delta\lambda$ will be equal to
   - a. 0.024 A
   - b. 0.048 A
   - c. 0.072 A
   - d. 0

8. The Balmer lines usually falls in which range?
   - a. IR
   - b. Visible
   - c. UV
   - d. None of the Options

9. When a particle is inside a box, the potential inside the box is
   - a. infinite
   - b. Finite but not zero
   - c. 0
   - d. Equal to total energy

10. Which of the forces can only be found in the nucleus?
    a. Gravitational
    b. Strong
    c. Electromagnetic
    d. None of the Above

11. In 'Ultraviolet catastrophe', Rayleigh-Jeans law fails in the region of
    a. Low frequency
    b. High Frequency
    c. Intermediate frequency
    d. None

12. Which of the following can be considered as a magic number with respect to the nuclear shell model
    a. 15
    b. 32
    c. 28
    d. 33

13. The De-Broglie wavelength associated with a material particle is (symbols have usual meaning)
    a. $\dfrac{p}{h}$
    b. $\dfrac{h}{p}$
    c. $\dfrac{1}{hp}$
    d. $\dfrac{p}{h^2}$

14. What is the mass of a person of 65 kg. travelling at 1700km/s
    a. 80 kg
    b. 120 kg.
    c. 90 kg.
    d. ~ 65 kg.

15. Which of the following is not a characteristic of a wavefunction?
    a. continuous
    b. single valued
    c. differentiable
    d. physically significant

16. Zeeman effect occurs due to which field?
    a. Electric
    b. Magnetic
    c. Both Electric and Magnetic
    d. None of the Options

17. What is the diameter of an atomic nucleus?
    a. ~10^{-9}m
    b. ~10^{-10}m
    c. ~ 10^{-15}m
    d. None of the Options

18. Which particle is created in the annihilation of matter and antimatter
    a. Alpha
    b. Beta
    c. Gamma
    d. All of the options

19. Which element has the highest nuclear stability?
    a. Cu
    b. Al
    c. Si
    d. Fe

20. Which pair amongst the following will require the minimum energy input for initiating fusion
    a. H-H
    b. D-T
    c. H-He
    d. None of the Options

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(Descriptive)

Time : 2 hrs. 30 min.   Marks : 50

[Answer question no.1 & any four (4) from the rest]

1. Obtain the expression for the energy eigenvalue of a particle confined in an infinite potential well.   10

2. a. Broadly describe the three different types of radiation.   3+7=10

   b. Explain how a solar neutrino can be detected in earth (8.5 light minutes away from the sun), when the lifetime of the neutrino is ~µs.

3. a. Explain photoelectric effect with an appropriate figure.   5+5=10

   b. How did Einstein explain the observations of photoelectric effect experiment?

4. a. Determine the time dilation and length contraction in %age of a traveler moving at 0.85c.   5+5=10

   b. Explain why you can never reach the speed of light, let alone exceed it (Mathematical Proof required).

5. a. Explain probability density and normalization of a wave function.   5+5=10

   b. Explain the concept of wave-particle duality. Also calculate the wavelength of a material particle based on this hypothesis.

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6.   **a.** Describe the Somerfield's modification on the Bohr's model of an atom, and how does it attempt to explain the hydrogen lines.   6+4=10

      b. Prove that it is impossible for an electron to reside within a nucleus

7.   **a.** What is the percentage of atoms which remains radioactive after a period of 4 years for a material with a half-life of 2.5 years?   5+5=10

      b. Differentiate between Nuclear Fusion and Nuclear Fission and explain what kind of fusion takes place in a star after it has spent all its hydrogen fuel.

8.   Describe how the shell model attempts to explain the stability of the nucleus   10

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