M.Sc. PHYSICS
THIRD SEMESTER
ELEMENTS OF MODERN PHYSICS
MSP – 306 MDC
[USE OMR SHEET FOR OBJECTIVE PART]

SET
B

Duration : 3 hrs.   Full Marks : 70

[**Objective**]

Time: 30 min.   Marks: 20

Choose the correct answer from the following: ***1X20=20***

1. X-rays have wavelength of ………… approximately
    a. 1 mm
    b. 1 cm
    c. 1 um
    d. 1 A

2. The number of atoms per unit cell of a simple cubic lattice is
    a. 1
    b. 2
    c. 3
    d. 4

3. Ionic bonding is a result of
    a. Sharing of electron pairs
    b. Transfer of electrons
    c. Both (a) and (b)
    d. Weak interactions between ions

4. Energy bandgaps are not available in which of the following type of materials?
    a. Metals
    b. semiconductors
    c. insulators
    d. dielectrics

5. Holes are the charge carriers in
    a. n-type semiconductors
    b. p-type semiconductors
    c. superconductors
    d. ionic solids

6. The superconducting transition temperature of mercury is
    a. 3.6 K
    b. 4.0 K
    c. 5.7 K
    d. 4.2 K

7. Which of the following phenomena can only be explained by quantum mechanics?
    a. Black body radiation
    b. diffraction of light
    c. polarization of light
    d. the motion of a rocket

8. How many Schrodinger's equations are there?
    a. 1
    b. 2
    c. 3
    d. 4

9. The energy of a microscopic particle confined in infinite potential well is
    a. Continuous
    b. Quantized
    c. Zero
    d. Both a and b

[1]

10. According to Einstein's Special Theory of Relativity, laws of physics can be formulated based on _____
    a. Inertial Frame of Reference
    b. Non-Inertial Frame of Reference
    c. Both Inertial and Non-Inertial Frame of Reference
    d. Quantum State

11. Length contraction happens only
    a. Perpendicular to direction of motion
    b. Along the direction of motion
    c. Parallel to the direction of motion
    d. Both (a) and (b)

3. A Unique idea which was considered in special theory of relativity was
    a. The time period of any event in every frame of reference will be the same
    b. Speed of light will be constant for all frame of reference
    c. For observers, all laws related to physical phenomena are different in different inertial frame reference
    d. A particle or an entity of certain mass can travel at a speed that is greater than the speed of light in vacuum.

13. The material in which the population inversion is achieved is called as
    a. Active medium
    b. Meta-stable state
    c. Passive medium
    d. Stable state

14. The method of achieving population inversion in He-Ne Laser is
    a. Optical pumping
    b. Forward biasing
    c. Chemical reaction
    d. Electrical discharge

4. What does the acronym LASER stands for?
    a. Light Amplification by Spontaneous Emission of Radiation
    b. Light Amplification by Stimulated Emission of Radiation.
    c. Light Absorption by Stimulated Emission of Radiation
    d. Light Absorption by Spontaneous Emission of Radiation

16. What is a magic number
    a. The number of shells in the nucleus
    b. The number of energy levels
    c. The number of paired nucleons
    d. The number of nucleons that represent completed nuclear energy shells

17. The ground state of any even-even nucleus has spin and parity
    a. 0^+
    b. 0^-
    c. 2^+
    d. 2^-

18. The reaction $^2_1H + ^3_1H \rightarrow ^4_2He + n$ is called the
    a. Alpha decay
    b. Fission
    c. Fusion
    d. Beta decay

19. Fission of a nucleus is achieved by bombarding it with
    a. Electron
    b. Proton
    c. Neutron
    d. X-rays

20. Basis means a group of
    a. Atoms
    b. Molecules
    c. Ions
    d. All of these

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(__Descriptive__)

Time : 2 hrs. 30mins.   Marks : 50

[_Answer question no.1 & any four (4) from the rest_]

1. a. Write the postulates of the special theory of relativity.   2+8=10

    b. Deduce the Lorentz transformation equations.

2. a. Draw the energy level diagram and explain the four level   3+7=10
       Pumping scheme in a Laser system.

    b. With the help of neat and labeled diagram, explain the
       construction, process of pumping and population inversion in a
       He-Ne Laser system.

3. a. What is Nuclear Fusion reaction? Explain the following type of   7+3=10
       nuclear fusion reaction that take place within the sun
       (i) proton-proton cycle
       (ii) carbon-nitrogen-oxygen cycle

    b. Draw the diagram and explain briefly the different parts of a
       Nuclear Reactor.

4. a. What do you mean by magic numbers? Explain the spin-orbit   8+2=10
       coupling of nucleon, draw the energy level diagram and show that
       the magic numbers are predicted.

    b. Predict the ground state spin parity of the following
       (i) $^{17}_{8}O$ (ii) $^{19}_{10}Ne$

5. a. Write some postulates of quantum mechanics.   4+6=10

    b. Explain type-I and type-II superconductors with magnetisation
       curves.

6. a. What are chemical bonds?   2+8=10

    b. Explain how ionic and covalent solids are formed with examples
       and figures.

[3]

7. a. Explain wave functions and operators in quantum mechanics.   4+6=10

    b. How will you find an expression for angular momentum in quantum mechanics?

8. Obtain the expressions for energy and wave function for a particle   10
    confined in a one-dimensional box.

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[4]