Instructions to the candidate:
- All questions are compulsory.
- Figures to the right indicate marks.
- Draw diagrams wherever necessary.
- Use of scientific calculator is allowed.
- Ask for graph paper if needed.

Q.1] Choose the correct option (Solve <u>ANY 10</u> out of 12)   **[1 x 10 =10M]**

1. The photoelectric effect could be explained by the ----------
   a. wave nature of light
   b. particle nature of light
   c. dual nature of light
   d. none of these

2. ----------- is the energy required to remove the electrons from the metal surface.
   a. Work function
   b. Kinetic energy
   c. Stopping potential
   d. Potential energy

3. $\nabla \cdot J + \frac{\partial \rho}{\partial t} = 0$ is the mathematical form of ------------
   a. equation of continuity
   b. probability of current density

    c.   Heisenberg's uncertainty principle
    d. Schrödinger's equation

4. Square of magnitude of the wave function $| \varphi |^2$ is called ---------
    a. current density
    b. probability density
    c. volume density
    d. surface density

5. What will be the eigen value for the operator $\frac{d^2}{dx^2}$ for the eigen function e^{4x}
    a. 4
    b. 2
    c. 8
    d. 16

6. The total probability of finding the particle in the entire space must be -----
    a. zero
    b. unity
    c. infinity
    d. double

7. First law of thermodynamics _____
    e. enables to determine change in internal energy of the system
    f. does not help to predict whether the system will or not undergo a change
    g. provides relationship between heat, work and internal energy
    h. all of the above

8. The ground state energy of particle in one dimensional infinite potential well is ---------
    a. $\frac{\pi^2 \hbar^2}{2ma^2}$
    b. $\frac{2\pi^2 \hbar^2}{2ma^2}$
    c. $\frac{3\pi^2 \hbar^2}{2ma^2}$
    d. $\frac{5\pi^2 \hbar^2}{2ma^2}$

9. The first permitted energy level or ground state energy level is also called as ----------
    a. excited energy
    b. zero-point energy
    c. kinetic energy
    d. none of these

10. The wave function φ must be ------------
      a. continuous everywhere
      b. discontinuous everywhere
      c. infinite everywhere
      d. none of these

11. Carnot cycle has maximum efficiency for
      a. reversible engine
      b. irreversible engine
      c. diesel engine
      d. petrol engine

12. The efficiency of a Carnot engine depends on
      a. working substance
      b. design of engine
      c. size of engine
      d. temperatures of source and sink

Q.2] Answer the following in short (<u>ANY 10</u> out of 12)   **[2 x 10 = 20M]**
1. Write Schrödinger's time independent equation and explain physical significance.
2. State Kirchhoff's law of radiation.
3. State two phenomena where classical physics fails to explain the phenomena.
4. What is wave packet?
5. Define eigen function and eigen value.
6. Give the requirement of wave function.
7. What is momentum of gamma radiation having a wavelength $1A^0$
8. Calculate the wavelength associated with a particle moving of momentum
   6.625×10^{-3} kg-m/sec (Given- h = 6.625×10^{-34} j-sec)
9. What is heat engine? Draw schematic diagram for heat engine.
10. Compare Diesel engine and Otto engine.
11. If the compression ratio for Otto engine is 9 and ratio of principal specific heats Cp/Cv is 1.4, find the efficiency of the engine.
12. The efficiency of Otto engine is 50%. If value of γ for the working substance is 1.5, find the compression ratio.

Q.3. Answer in brief (<u>ANY 4</u> out of 6) [4 x 5 = 20M]

1. Define operator. State quantum mechanical operator.
2. Define expectation value. Write mathematical expression for position and momentum.
3. Normalize the wave function of the free particle in the range -∞ to + ∞ is given by

   $$\varphi (X) = A \quad e^{-\alpha x2/2}$$

4. Explain Otto Cycle in brief with Indicator diagram.
5. Carnot's engine, whose low temperature reservoir is at 10^oC, has an efficiency of 50%. It is desired to increase the efficiency to 70%. By how many degrees should the temperature of the high temperature reservoir be increased?
6. Derive relation for efficiency of Carnot's Engine.

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