**SAVITRIBAI PHULE PUNE UNIVERSITY**
**Progressive Education Society's**
**Modern College of Arts, Science and Commerce, Ganeshkhind, Pune-411016**
# B.Sc. Blended Program
**(A degree of Savitribai Phule Pune University equivalent to the degree of University of Melbourne)**

**End Semester Examination: 2023-24**

**Program:** B.Sc. Blended **Program (Specific):** B.Sc. Blended (Chemistry) **Set: A**

**Class: S.Y.B.Sc. Blended** **Semester: III**
**Course code: PHY302**
**Course name: Quantum mechanics and Thermodynamics**

**Credits: 3** **Time: 2½ hours** **Maximum marks: 50**

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 frequency below which photoelectric emission is not possible is called ---------
   a. transition frequency
   b. threshold frequency
   c. critical frequency
   d. resonating frequency

2. The momentum operator along X-axis is given as ----------
   a. $\hat{p}_x = -i\hbar \frac{\partial}{\partial x}$
   b. $\hat{p}_x = i\hbar \frac{\partial}{\partial x}$
   c. $\hat{p}_x = -i/\hbar \frac{\partial}{\partial x}$
   d. $\hat{p}_x = i/\hbar \frac{\partial}{\partial x}$

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

4. What will be the eigen value for the operator $\frac{d^2}{dx^2}$ for the eigen function $e^{5x}$
   a. 4
   b. 25
   c. 8
   d. 16

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

6. The first excited state energy of particle in one dimensional infinite potential well is ------
   a. $\frac{\pi^2\hbar^2}{2ma^2}$
   b. $\frac{4\pi^2\hbar^2}{2ma^2}$
   c. $\frac{3\pi^2\hbar^2}{2ma^2}$
   d. $\frac{5\pi^2\hbar^2}{2ma^2}$

7. 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

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

9. First law of thermodynamics _____
   a. enables to determine change in internal energy of the system
   b. does not help to predict whether the system will or not undergo a change
   c. provides relationship between heat, work and internal energy
   d. all of the above

10. The mean free path of gas molecules is inversely proportional to_____
   a. Square of molecular diameter

b. Diameter of molecule
c. Square root of molecular diameter
d. None of these

11. The ordinary differential equation involves _____ independent variables
    a. 1
    b. 2
    c. 3
    d. 4

12. The distance travelled by a gas molecule between two successive collisions is called____
    a. mean path
    b. free path
    c. mean free path
    d. displacement

**Q.2] Answer the following in short (<u>ANY 10</u> out of 12 ) [2 x 10 = 20M]**

1. Write Schrödinger's time dependent equation in 1 and 3 dimensions.
2. State Kirchhoff's law of radiation.
3. State equation of continuity.
4. What is momentum of gamma radiation having a wavelength $2A^0$
   (Given- h = 6.625 $X10^{-34}$ j-sec)
5. Calculate the wavelength associated with a particle moving of momentum
   6.625X $10^{-3}$ kg-m/sec (Given- h = 6.625 $X10^{-34}$ j-sec)
6. Define eigen value and eigen function
7. Explain the term Homogeneity of differential equation with an example.
8. What do you understand by mean free path of molecules of gas?
9. State order and degree of following differential equation $\frac{d4y}{dx4} - \sqrt{y^2 - 5} = 0$.
10. What is heat engine? Draw schematic diagram for heat 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 $\gamma$ 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. Explain the difference between classical physics and quantum physics
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 $\boldsymbol{e^{-x2/2a2}}$
4. What is transport phenomenon? Explain in brief viscosity, conductivity and self-diffusion on the basis of kinetic theory of gases.
5. Explain Otto Cycle in brief with Indicator diagram.
6. Carnot's engine, whose low temperature reservoir is at 10°C, 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?

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