FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2023
FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT

Roll Number

PHYSICS, PAPER-I

TIME ALLOWED: THREE HOURS	**PART-I (MCQS) MAXIMUM MARKS = 20**
PART-I(MCQS): MAXIMUM 30 MINUTES	**PART-II MAXIMUM MARKS = 80**

NOTE: (i) **Part-II** is to be attempted on the separate **Answer Book.**
(ii) Attempt **ONLY FOUR** questions from **PART-II**. **ALL** questions carry **EQUAL** marks.
(iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.
(iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
(v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.
(vi) Extra attempt of any question or any part of the question will not be considered.
(vii) **Use of Calculator is allowed.**

PART – II

Q. 2. **(a)** What is Gradient of a scalar function? Give its physical significance and show that $\overrightarrow{Grad}\varphi = \vec{\nabla}.\varphi$ (10)

(b) Define the term 'acceleration' and find its Cartesian components. (06)

(c) If $\vec{A} = xz^3\hat{\imath} - 2x^2z\hat{\jmath} + 2yz^4\hat{k}$, then find curl of A at the point (1,-1,1) (04) **(20)**

Q. 3. **(a)** Explain the rotational kinetic energy and determine its formula for a disc, hoop and sphere. (10)

(b) What do you mean by the term 'inertia' in physics? Calculate respectively the rotational inertia of a solid cylinder and a hollow cylinder about an axis of symmetry. (06)

(c) Calculate the angular speed of the second's hand, minutes hand and hour's hand of a watch. (04) **(20)**

Q. 4. **(a)** What was Physics like before relativity and how did Einstein come up with his theory? Mathematically explain how mass and energy is interchangeable? (10)

(b) Discuss in detail the relativity of length using Einstein's special theory of relativity. (06)

(c) Calculate the mass equivalent of energy from an antenna radiating 10KW for 24 hours. (04) **(20)**

Q. 5. **(a)** Define capillarity and derive an expression for the rise of liquid in a capillary tube to show that the height of the liquid column supported is inversely proportional to the radius of the tube. (10)

(b) What are fluids? Write their important characteristics. (06)

(c) A cylindrical swimming pool has radius 2m and depth 1.3m. It is filled completely with salt water. (04) **(20)**
Given, density of salt water = $1.03 \times 10^3 kgm^{-3}$, volume of water = $16.34 m^3$, and the atmospheric pressure = $1.013 \times 10^5 Pa$. Calculate the pressure at the bottom of the pool.

Q. 6. **(a)** For a wave travelling through a medium, demonstrate that the total energy per unit volume is always equal to one half the kinetic and one half the potential energy. (10)

(b) The longitudinal waves can pass through solids. How it is possible and on what parameters the velocity of such waves will depend? (06)

(c) The angular Vibrational frequency of *CO* molecule is $0.6 \times 10^{15} s^{-1}$. Calculate the amount of work required for stretching it by 0.5Å from the equilibrium position. (04) **(20)**

Q. 7. **(a)** An ideal gas is enclosed in a cylinder with movable piston. Calculate the work done on such gas and show that pressure force is non-conservative. (10)

(b) State and briefly explain the intermolecular forces. (06)

(c) Oxygen gas having a volume of $1130 cm^3$ at 42°C and a pressure of 101kPa expanded until its volume is $1530 cm^3$ and its pressure is 106kPa. Find the number of moles of oxygen in the system and its final temperature. (04) **(20)**

Q. 8. Write short notes on any TWO of the following. **(10 each)** **(20)**

a. Kepler's Law of Periods
b. Michelson interferometer
c. Young's double slit experiment

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COMPETITIVE EXAMINATION-2023 FOR RECRUITMENT TO POSTS IN BS-17 UNDER THE FEDERAL GOVERNMENT
PHYSICS, PAPER-II

Roll Number

TIME ALLOWED: THREE HOURS	**PART-I (MCQS) MAXIMUM MARKS = 20**
PART-I(MCQS): MAXIMUM 30 MINUTES	**PART-II MAXIMUM MARKS = 80**

NOTE: (i) **Part-II** is to be attempted on the separate **Answer Book.**
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PART – II

Q. 2. A particle of mass m is in the state

$$\psi(x,t) = A\, e^{-a\left[\left(\frac{mx^2}{h}\right)+it\right]}$$

Where A and a are positive constants.

(a) Find A. (5)
(b) For what potential energy function V(x) does $\psi(x,t)$ satisfy the Schrodinger equation? (5)
(c) Calculate the expectation values of x, x^2, p, and p^2 (5)
(d) Find σ_x and σ_y. Is their product consistent with the uncertainty principle? (5) **(20)**

Q. 3. **(a)** Consider a pair of copper wires 1 mm in diameter and 5 cm apart. In copper the number of conduction electrons per cubic meter is 8.45×10^{28}. Suppose their mean drift velocity v is 0.3 cm / s, calculate current in each wire. (8)
(b) If the wires are 20 cm apart, calculate the magnetic force on the wires. (8)
(c) Define electric current in a wire with respect to number of charges and their drift velocity. (4) **(20)**

Q. 4. Give expressions for the following quantities in terms of e, h, c, k, m_e and m_p.
(a) The energy needed to ionize a hydrogen atom. (5)
(b) The difference in frequency of the Lyman alpha line in hydrogen and deuterium atoms. (5)
(c) The magnetic moment of the electron. (5)
(d) The spread in measurement of the π^0 mass, given that the π^0 lifetime is τ. (5) **(20)**

Q. 5. **(a)** An atom is capable of existing in two states: a ground state of mass M and an excited state of mass M + Δ. If the transition from ground to excited state proceeds by the absorption of a photon, what must be the photon frequency in the laboratory where the atom is initially at rest? (7)
(b) Derive the energy levels of the hydrogen atom, from Coulomb's law and the simple quantization of angular momentum. (7)
(c) In radio astronomy, hydrogen atoms are observed in which, for example, radiative transitions from n = 109 to n = 108 occur. What are the frequency and wavelength of the radiation emitted in this transition? (6) **(20)**

Q. 6. **(a)** Consider the elastic vibrations of a crystal with one atom in the primitive cell and calculate the frequency of an elastic wave in terms of the wavevector that describes the wave and in terms of the elastic constants. (12)
(b) Describe vibrations of crystal. (8) **(20)**

Q. 7. **(a)** Discuss density of states in Three Dimension (8)
(b) Describe Debye Model for Density of States (8)
(c) Define phonon heat capacity. (4) **(20)**

Q. 8. Write Notes on any TWO of the following: **(10 each)** **(20)**
(a) Maxwell's Equations
(b) Magnetic Materials: (Ferro-Dia-Para)
(c) Black Body Radiation

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