

UG (Sem-I) Examination- 2023
(Session- 2023-27)
PHYSICS
MJC-1
MODEL QUESTION PAPER

TIME: 3 Hrs.

FULL MARKS: 70

Candidates are required to give their answers in their own words as far as practicable.

The figure in the margin indicates full marks.

Answer from all the Groups as directed. Group - A is compulsory.

Group-A

1. Choose the correct answer of the following questions : (10×2 = 20)
- A. Find grad(f) if $f(x,y,z) = xy + y^2z$ at the point (0, 1, -1) :
- i) $2i + j + k$
 - ii) $i - 2j + k$
 - iii) $i + 2j + k$
 - iv) $i - j - k$
- B. A field 'F' is said to be conservative if :
- i) $\nabla \cdot \mathbf{F} = 0$
 - ii) $\nabla \cdot \nabla \mathbf{F} = 0$
 - iii) $\nabla \times \mathbf{F} = 0$
 - iv) None of the above
- C. The order and degree of the differential equation $\left[1 + \left(\frac{dy}{dx}\right)^2\right]^2 = \frac{d^2y}{d^2x}$ is :
- i) 1,2
 - ii) 2,2
 - iii) 2,1
 - iv) 4,2
- D. The solution of differential equation $dy = (1 + y^2)dx$ is :
- i) $y = \tan x + c$
 - ii) $y = \tan(x + c)$
 - iii) $x = \tan^{-1}(y + c)$
 - iv) $2x = \tan^{-1}(y + c)$
- E. The addition of two vectors cannot be done by :
- i) Parallelogram
 - ii) Triangle law
 - iii) Polygon law
 - iv) None of the above
- F. Which of the following is true for Centrifugal force :
- i) Centrifugal force is a fictional force.
 - ii) Centrifugal force is a real force.
 - iii) Centrifugal force pulls in a circular motion
 - iv) Centrifugal force causes objects moving in a circular path to move in.

- G.** Rutherford's differential scattering cross – section :
- Has the dimensions of area.
 - Has the dimensions of solid angle.
 - Is proportional to the square of the kinetic energy of the incident particle.
 - Is inversely proportional to $\text{cosec}^4\theta/2$, where θ is scattering angle.
- H.** The maximum and minimum velocities of a satellite are v_1 & v_2 respectively. The eccentricity of the orbit of the satellite is given by :
- $e = v_1 / v_2$
 - $e = v_2 / v_1$
 - $e = (v_1 - v_2) / (v_1 + v_2)$
 - $e = (v_1 + v_2) / (v_1 - v_2)$
- I.** divergence of the curl of a twice differentiable continuous vector function is :
- Unity
 - Infinity
 - Zero
 - A unit vector
- J.** The divergence of the vector $V = y^2i + z^2j + x^2k$:
- $2x$
 - $2y$
 - $2z$
 - 0

Group-B

(4×5 = 20)

- Solve: $x^2dy + y(x + y)dx = 0$.
- Discuss about divergence, gradient, and curl of a physical quantity and its physical significance.
- Solve the given second-order differential equation:

$$\frac{d^2y}{dx^2} + 4y = 2\cos x \cos 3x$$
- Explain the inertial and non-inertial frame of references.
- In Rutherford scattering experiment 10^5 α - particles are scattered at an angle of 2° . calculate the number of α -particles at an angle of 20° .
- Show that $a \times (b \times c) + b \times (c \times a) + c \times (a \times b) = 0$, where a ,b, and c are vectors.

Group-C

(3×10 = 30)

- Prove that : $\nabla^2 f(r) = f''(r) + \frac{2}{r} f'(r)$.
- Solve :

$$\left\{x \cos \frac{y}{x} + y \sin \frac{y}{x}\right\}y - \left\{y \sin \frac{y}{x} - x \cos \frac{y}{x}\right\}x \frac{dy}{dx} = 0.$$
- What is Foucault pendulum? How does it enable us to demonstrate the rotation of the earth about its own axis?
- What are Kepler's law of planetary motion? Give the proof of Kepler's law of planetary motion and hence deduce that the areal velocity is constant.
- Derive the equation for orbit of a particle moving under the influence of an inverse square central force field. Also calculate the time period of motion in elliptical orbit.