U.G. 3rd Semester Examination - 2024
PHYSICS
[MINOR]
Course Code : PHY-MI-T-03 & 02
[NEP-2020]

Full Marks : 30   Time : 2 Hours

The figures in the right-hand margin indicate marks.

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

Answer all the questions from Selected Option.
OPTION-A
PHY-MI-T-03
(Mechanics)
GROUP-A

1. Answer any **five** questions :   2×5=10

   a) Establish the equivalence relation between mass and energy?

   b) What is the difference between angle of twist and angle of shear?

   c) An elementary particle with a half-life of $2×10^{-5}(-5)$ *Sec* is moving with a velocity of $c/4$ w.r.t earth. What would be its half-life as measured by an observer on the earth?

d)   What is strain energy? Define Poisson's ratio.

e)   State two postulates of special theory of relativity.

f)   What is the *burnt out velocity* of a rocket?

g)   Explain how a moving rod is contracted along the direction of motion.

h)   What do you mean by *adhesion* and *cohesion*?

GROUP-B

2.   Answer any **two** questions :   5×2=10

a)   Show that in an inertial frame, if an equal amount of force is applied on two bodies of different masses, the ratio of their accelerations is inversely proportional to the ratio of their masses. Define the center of mass of a system of particles and the centre of gravity. Can the centre of gravity coincide with c.m.?   2+2+1

b)   Deduce the equation of motion of a particle executing simple harmonic motion. Find the resultant of two rectangular simple harmonic motions of same frequency, but differing in amplitude and phase.   2+3

c) Write a short note on GPS. 5

d) What do you understood by collision? Does collision necessarily mean physical contact of the colliding particles? Show that the kinetic energies of two colliding particles in the centre of mass frame are inversely proportional to their masses. 1+1+3

GROUP-C

Answer any **one** question: $10 \times 1 = 10$

3. a) Show that the areal velocity of a particle moving under central force is constant. 3

b) Calculate the velocity with which a body is to be projected from the surface of the earth so that it will never return. 3

c) A particle of mass m is projected vertically upwards from the surface of a planet of mass M and radius R with a velocity $\sqrt{\dfrac{GM}{2R}}$. Show that the maximum height attend by the body is $\sqrt{\dfrac{R}{3}}$. 4

4. a) Find the expression of strain energy of a twisted wire. 4

b) Show that shear is equivalent to compression and equal compressional strain at right angles to each other. 4

c) A thick and short wire and another one is thin and long of same material are taken. Which one has greater torsional rigidity? 2

5. a) What is capillary action? Explain why water rises in a narrow glass tube? Deduce an expression for capillary rise h of a liquid of density ρ (θ is the angle of contact). 1+2

b) Explain what do you mean by gravitational potential and intensity at a point. 2

c) State Kepler's law on the motion of planetary bodies. Deduce Kepler's law from Newton's law of gravitation. 2+3

6. a) Write down the postulates of special theory of relativity. 2

b) Write a short note on Time dilation. 3

c) Prove that if $u/c \ll 1$, the kinetic energy K of a moving particle will always be much less than its rest mass energy $m_0 c^2$. 2

d) A 0.50 MeV electron moves at right angles to a magnetic field in a path whose radius of curvature is 2.0 cm. What is the magnetic induction B? By what factor does the effective mass of the electron exceeds its rest mass? 3

(4)

OPTION-B

PHY-MI-T-02

(Electricity and Magnetism)

GROUP-A

1. Answer any **five** questions : $2 \times 5 = 10$

    a)   State and explain Biot-Savart's law.

    b)   State and explain Brewster's law.

    c)   Check whether the vector $\vec{E} = 2x\hat{i} + y\hat{j} - 3z\hat{k}$ represents an electrostatics field or not.

    d)   Explain why to magnetic lines of forces do not intersect each other.

    e)   Derive the expression for the energy stored in a capacitor.

    f)   With the help of suitable example differentiate paramagnetic, diamagnetic, and ferromagnetic materials.

    g)   State and explain Poynting's theorem.

    h)   Define equipotential surface.

GROUP-B

2. Answer any **two** questions : 5×2=10

a) Write down Gauss's theorem of electrostatics. Apply this theorem to calculate the electric field at a distance r from the centre of a spherical conductor of charge density ρ. 2+3=5

b) Derive the expression of the torque experienced by a magnetic dipole kept perpendicular to a magnetic field $\vec{B}$. Write down the physical significance of $\vec{\nabla}.\vec{E} = 0$. 4+1=5

c) State and explain Ampère's circuital law. Using this law derive the expression for the magnetic field due to a long current carrying conductor. 1+4=5

d) What do you mean by source field and sink field? Find out the equivalent resistance value between two end points in the infinite series given below (value of each resistor 1 Ω)
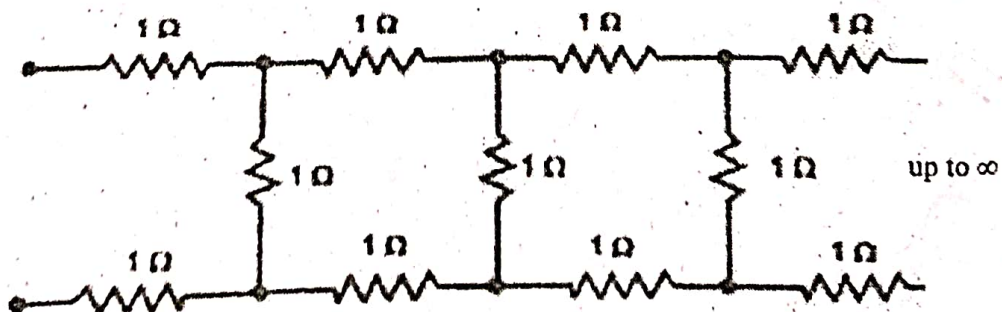
2+3=5

GROUP-C

Answer any **one** question : $\qquad$ $10 \times 1 = 10$

3. a) Write down four Maxwell's equations, explaining each term. Write down the equation of continuity. Write down the expression for the velocity of light in free space (c) in terms of μ_0 and ϵ_0. Then find out the value of c in SI units. Write a short note on Poynting's theorem.

$$3+1+1+1+4=10$$

b) Two charges of $10\,\mu\,C$ and $-10\,\mu\,C$ are placed at two points A and B separated by a distance of 10 cm. Find the electric field at a point P on the perpendicular bisector of AB at a distance 12 cm from its midpoint. Define Bohr magneton. Determine its value. What kind of materials will you suggest for the electromagnet and permanent magnet? $\qquad$ $5+1+3+1=10$

c) Define magnetic susceptibility and permeability. Find the relationship between B and H. Explain Hysteresis and Hysteresis loss. Why transformer cores are laminated?

$$2+2+2+2+2=10$$

d) A magnetized steel needle of length l has magnetic moment M. It is then bent into a semi-circular arc. What is its new magnetic moment? What is motional e.m.f.? Define self-inductance and mutual inductance. 4+2+(2+2)=10

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