

- (ii) A muon formed high up in the atmosphere travels with a speed $0.99c$ for a distance of 5.4 km before it decays. What is the life of the muon as measured by us and as measured by the muon? $1+2=3$
- (iii) Define acceleration using four-velocity vector and hence obtain relativistic form of Newton's 2nd law of motion. $2+2=4$

Or

- (i) Obtain the velocity profile for streamline flow of a liquid through a capillary tube. Deduce the fraction of liquid which flows through the section upto distance $\frac{r}{2}$ from the axis, where r is the radius of the capillary tube. $4+3=7$
- (ii) Three capillary tubes of lengths $8l$, $0.2l$ and $2l$ and radii r , $0.2r$ and $0.5r$ respectively are connected in series. If the total pressure across the system in an experiment is P , deduce the pressure across the shortest (middle) capillary tube. 3

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3 (Sem-6/CBCS) PHY HE 5

2025

PHYSICS

(Honours Elective)

Paper : PHY-HE-6056

(Classical Dynamics)

Full Marks : 80

Time : Three hours

The figures in the margin indicate full marks for the questions.

- Answer the following questions : $1 \times 10 = 10$
 - What is called gyroradius? Give its mathematical expression.
 - What do you mean by degree of freedom? Mention a system having two degrees of freedom.
 - State the principle of virtual work.
 - What is called phase space? Mention its dimensions.

- (e) What do you mean by cyclic or ignorable coordinates?

- (f) State the postulates of special theory of relativity.

- (g) Write down the assumptions taken to derive the Lorentz transformation equations of space-time.

- (h) Can a particle move through a medium with a speed greater than that of light in that medium? Justify your answer.

- (i) Define coefficient of viscosity. Mention its unit.

- (j) Why do bubbles of air or gas rise up through water or any other liquid?

2. Answer the following questions: $2 \times 5 = 10$

- (a) Does kinetic energy of a charged particle change when it enters a magnetic field? Justify your answer.

- (b) Distinguish between Lagrangian and Hamiltonian formalisms.

- (c) State time dilation in special theory of relativity.

- (d) Show that $d\tau = \frac{1}{c} ds$, where $d\tau$ is the element of proper time and ds is the length element in four space.

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- (e) Why does Poiseuille's formula fail in the cases of tubes of wider bore and gases?

3. Answer any four from the following questions: $5 \times 4 = 20$

- (a) Show that an electron moving with uniform velocity follows a parabolic path in a transverse uniform electric field.

- (b) Derive Lagrange's equations of motion for a conservative system using D'Alembert's principle.

- (c) What do you mean by Minkowski's space? Four momentum p_μ is given

$$\text{by } p_\mu = m_0 \frac{dx}{dt} \mu = m_0 u_\mu.$$

Use this expression to obtain the following relation :

$$E^2 = p^2 c^2 + m_0^2 c^4,$$

where symbols have their usual meanings. $2+3=5$

- (d) What is called twin paradox in special theory of relativity? Discuss the paradox using space-time diagram. $2+3=5$

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