Shri Swami Vivekanand Shikshan Sanstha's

Dattajirao Kadam Arts, Science & Commerce

College, Ichalkaranji

DEPARTMENT OF PHYSICS

QUESTION BANK

B. Sc. – III, PHYSICS (Paper-XI), DSE-E3 Classical Mechanics and Classical Electrodynamics

Multiple choice questions.

1. What is the number of independent coordinates required to specify a system completely called?
   a) Constraints
   b) Degrees of freedom
   c) Generalized coordinates
   d) Virtual displacements
   Answer: b) Degrees of freedom

2. Which of the following is an example of a holonomic constraint?
   a) A rolling disk without slipping
   b) A pendulum in motion
   c) A car moving on a road
   d) A particle under a magnetic field
   Answer: b) A pendulum in motion

3. Which principle states that the virtual work done by constraint forces is zero?
   a) Hamilton's principle
   b) D'Alembert's principle
   c) Principle of least action
   d) Principle of virtual work
   Answer: d) Principle of virtual work

4. D'Alembert's principle is used to derive which of the following?
   a) Newton's laws
   b) Hamiltonian mechanics
   c) Lagrange's equation

d) Work-energy theorem
Answer: c) Lagrange's equation

5. In Lagrangian mechanics, the Lagrangian LLL is defined as:
   a) $L = T + V$
   b) $L = T - V$
   c) $L = V - T$
   d) $L = 2T + V$
   Answer: b) $L = T-$

6. Which of the following is an example of a system with constraints?
   a) Free particle in space
   b) A bead sliding on a rotating wire
   c) A stationary ball
   d) A uniform electric field
   Answer: b) A bead sliding on a rotating wire

7. Atwood's machine is an example of a system described by:
   a) Newton's equations
   b) Lagrange's equations
   c) Hamiltonian mechanics
   d) Quantum mechanics
   Answer: b) Lagrange's equations

8. What kind of motion does a bead experience on a uniformly rotating wire in a force-free condition?
   a) Accelerated motion
   b) Circular motion
   c) Uniform motion
   d) Oscillatory motion
   Answer: c) Uniform motion

9. Lagrange's equations are derived using which principle?
   a) D'Alembert's principle
   b) Principle of least action
   c) Principle of virtual work
   d) Both a and b
   Answer: d) Both a and b

10. Which term describes a constraint that depends explicitly on time?
    a) Holonomic
    b) Non-holonomic
    c) Scleronomic

d) Rheonomic
Answer: d) Rheonomic

11. Hamilton's principle states that:
    a) The total energy is conserved
    b) The action integral is stationary
    c) The kinetic energy is maximized
    d) The work done is zero
    Answer: b) The action integral is stationary

12. What is the shortest path between two points in a plane?
    a) A straight line
    b) A parabola
    c) A circular arc
    d) A hyperbola
    Answer: a) A straight line

13. The brachistochrone problem deals with finding:
    a) The shortest distance
    b) The fastest path under gravity
    c) The least energy path
    d) The highest potential energy configuration
    Answer: b) The fastest path under gravity

14. Hamilton's principle can be used to derive
    a) Newton's laws
    b) Lagrange's equations
    c) Work-energy theorem
    d) Both a and b
    Answer: d) Both a and b

15. Which experiment disproved the existence of the ether?
    a) Michelson-Morley experiment
    b) Young's double-slit experiment
    c) Rutherford's gold foil experiment
    d) Franck-Hertz experiment
    Answer: a) Michelson-Morley experiment

16. Which transformation replaces Galilean transformations in special relativity?
    a) Newtonian transformation
    b) Lorentz transformation
    c) Fourier transformation
    d) Schrodinger transformation
    Answer: b) Lorentz transformation

17. The postulates of special relativity include:
    a) The laws of physics are the same in all inertial frames
    b) The speed of light is constant in all inertial frames
    c) Time is absolute
    d) Both a and b
    Answer: d) Both a and b

18. What happens to the length of an object moving at relativistic speeds?
    a) Expands
    b) Contracts
    c) Remains constant
    d) Becomes infinite
    Answer: b) Contracts

19. Time dilation means that a moving clock runs
    a) Faster
    b) Slower
    c) At the same rate
    d) Unpredictably
    Answer: b) Slower

20. The relativistic addition of velocities states that:
    a) Velocities add linearly
    b) No object can exceed the speed of light
    c) Light slows down in motion
    d) Mass increases with velocity
    Answer: b) No object can exceed the speed of light

21. Einstein's mass-energy relation is given by:
    a) $E=mc^2$
    b) $E=mv^2$
    c) $E=mgh$
    d) $E=1/2mv^2$
    Answer: a) $E=mc^2$

Charged Particle Dynamics (6 hours)

22. Poisson's equation is given by:
    a) $\nabla.V=0$
    b) $\nabla.V=-\rho/\epsilon_0$
    c) $\nabla\cdot E=\rho/\epsilon_0$

d) $\nabla \times E = -\partial B/\partial t$

Answer: b) $\nabla 2V = -\rho/\epsilon 0$

23. The motion of a charged particle in a uniform electric field is:
    a) Parabolic
    b) Circular
    c) Straight line
    d) Random
    Answer: a) Parabolic

24. A charged particle moving perpendicular to a uniform magnetic field follows a:
    a) Straight path
    b) Circular path
    c) Parabolic path
    d) Hyperbolic path
    Answer: b) Circular path

26. Which type of system does Lagrange's equation best describe?
    a) Conservative systems
    b) Non-conservative systems
    c) Static systems
    d) Open systems
    Answer: a) Conservative systems

27. The generalized coordinates in Lagrangian mechanics are chosen based on:
    a) Newton's second law
    b) The constraint conditions
    c) Hamiltonian formalism
    d) Energy conservation
    Answer: b) The constraint conditions

28. Which of the following does not affect the Lagrange's equation formulation?
    a) External forces
    b) Time dependency
    c) Virtual displacements
    d) Path taken by the particle
    Answer: d) Path taken by the particle

29. Which of the following is true for D'Alembert's principle?
    a) It applies only to non-inertial frames
    b) It is an alternative to Newton's laws
    c) It is based on conservation of energy

d) It applies only to quantum mechanics
Answer: b) It is an alternative to Newton's laws

30. Lagrange's equations provide an advantage over Newtonian mechanics because:
    a) They eliminate force calculations
    b) They use Cartesian coordinates
    c) They apply only to static systems
    d) They ignore energy conservation
    Answer: a) They eliminate force calculations

31. What does Hamilton's principle state about the action integral SSS?
    a) SSS is always increasing
    b) SSS remains constant
    c) SSS is stationary for actual motion
    d) SSS is minimized for non-conservative systems
    Answer: c) SSS is stationary for actual motion

32. Which mathematical method is primarily used in the calculus of variations?
    a) Partial differentiation
    b) Functional differentiation
    c) Tensor analysis
    d) Complex analysis
    Answer: b) Functional differentiation

33. In the Brachistochrone problem, the path taken is in the shape of a:
    a) Straight line
    b) Parabola
    c) Cycloid
    d) Hyperbola
    Answer: c) Cycloid

34. Hamilton's principle can be derived from:
    a) Work-energy theorem
    b) Principle of virtual work
    c) D'Alembert's principle
    d) Newton's laws
    Answer: c) D'Alembert's principle

35. Which of the following is not an application of the calculus of variations?
    a) Geodesics
    b) Principle of least time
    c) Kinetic theory of gases
    d) Brachistochrone problem
    Answer: c) Kinetic theory of gases

36. The Michelson-Morley experiment demonstrated that the speed of light is:
    a) Different in all directions
    b) Dependent on ether
    c) Independent of the motion of the observer
    d) Slower in vacuum
    Answer: c) Independent of the motion of the observer

37. According to special relativity, when an object approaches the speed of light, its mass:
    a) Decreases
    b) Increases
    c) Remains constant
    d) Becomes negative
    Answer: b) Increases

38. A moving object contracts along the direction of motion due to:
    a) Length contraction
    b) Time dilation
    c) Relativistic mass increase
    d) Doppler effect
    Answer: a) Length contraction

39. Which of the following is a consequence of time dilation?
    a) Moving clocks run slower
    b) Moving objects appear larger
    c) The speed of light changes
    d) Mass decreases at high velocity
    Answer: a) Moving clocks run slower

40. The relativistic velocity addition formula ensures that:
    a) Speeds always add linearly
    b) No object exceeds the speed of light
    c) Light speed changes in different frames
    d) Newton's laws hold at all speeds
    Answer: b) No object exceeds the speed of light

41. Relativity replaces which concept from classical physics?
    a) Absolute space and time
    b) Conservation of energy
    c) Newton's second law
    d) Wave-particle duality
    Answer: a) Absolute space and time

42. Which of the following is NOT a prediction of special relativity?
    a) Time dilation

b) Length contraction

c) Variable speed of light

d) Mass-energy equivalence

Answer: c) Variable speed of light

45. Laplace's equation applies to:
    a) Regions with no charge
    b) Conducting surfaces only
    c) Dynamic fields
    d) Systems with a net charge
    Answer: a) Regions with no charge

46. The motion of a charged particle in a uniform magnetic field is:
    a) Helical
    b) Straight-line
    c) Parabolic
    d) Chaotic
    Answer: a) Helical

47. When a charged particle moves in crossed EEE and BBB fields, it follows a:
    a) Circular path
    b) Straight-line path
    c) Parabolic path
    d) Cycloidal path
    Answer: d) Cycloidal path

48. Which of the following is true for motion in a uniform electric field?
    a) Acceleration remains constant
    b) Velocity remains constant
    c) Force is zero
    d) Motion is helical
    Answer: a) Acceleration remains constant