Koyana Education Society's

Balasaheb Desai College, Patan

Class: B. Sc. III Semester-IV

Subject: Physics Paper-XI Classical Mechanics

Question bank

Unit I – 1. Lagrangian Formulation

Multiple choice question

1) A constraint is a ……on the freedom of motion of a system of particles.

a) restriction

b) condition

c) further information

d) binding

2) The principal of virtual work deals only the cases of ……

a) static

b) dynamics

c) kinematics

d) kinetics

3) A rigid body moving freely in space has ----------degrees of freedom.

a) 1 b) 6 c) 9 d) 3

4) D' Alembertz principle is.....

a) $\sum_i (F_i^a - p_i)\delta r_i = 0$

b) $\sum_i (F_i^a - \dot{p}_\iota)\delta r_i = 0$

c) $\sum_i (F_i^a + p_i)\delta r_i = 0$

d) $\sum_i (F_i^a + \dot{p}_\iota)\delta r_i = 0$

5) When constraints are introduced into a system , the number of degrees of freedom is.....

a) increased

b) reduced

c) changes

d) remains same

6) The Lagrangian function L is given as

a) L= T+V

b) L = T-V

c) L= V-T

d) L=V/T

7) The constraints involved in the motion of a particle placed on the surface of sphere is .....

a) holonomic

b) non-holonomic

c) rheonomous

d) both a and c

8) If a bead sliding on along uniformly rotating wire in a force free space then at any moment, potential energy of a bead is.....

a) zero

b) nonzero

c)infinity

d) high

9) Generalized co ordinates are .....

a) independent of each other

b) dependent on each other

c) Cartesian coordinates

d) cylindrical coordinates

10) If the constraints are independent of time then they are.....constraints.

a) rheonomous

b) holonomic

c) nonholonomic

d) scleronomous

11) Lagrangian equation is given as.....

a) $\frac{\partial L}{\partial q_i} + \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) = 0$

b) $\frac{\partial L}{\partial q_i} - \left(\frac{\partial L}{\partial \dot{q}_i}\right) = 0$

c)$-\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) - \frac{\partial L}{\partial q_i} = 0$

d)$\frac{\partial f}{\partial y_i} + \left(\frac{\partial L}{\partial \dot{y}_i}\right) = 0$

12) In a formulation the equations of motion are written without any specific reference to the co-ordinate system used.

a) Galilean

b) Newtonian

c) Lagrangian

d) Lorentz

13) For a system of N particles moving independent of each other the number of degrees of freedom is

a) N b) 2N c) 3N d) 6N

14) The generalized coordinates _____.

a) have dimensions of length

b) have dimensions of velocities

c) can be divided into the convenient group of three

d) determine the configuration of the system

15) The principle of virtual work is expressed by the equation

a) $\sum_i \overrightarrow{F_i} \cdot \delta\vec{r_i} = 0$

b) $\sum_i \overrightarrow{F_i^{(a)}} \cdot \delta\vec{r_i} = 0$

c) $\sum_i \overrightarrow{f_i} \cdot \delta\overrightarrow{r_i} = 0$ d) $\sum_i \overrightarrow{F_i} = 0$

16) The Atwood machine may be regarded as an example of a conservative system with.....

a) holonomic, rheonomous constraint c) nonholonomic, rheonomous constraint

b) holonomic, scleronomous constraint d) nonholonomic, scleronomous constraint

17) For a particle moving in free space its .....energy is zero

a) Kinetic c) total

b) potential d) rest mass

18).....constraints are independent of time

a) holonomic c) scheronomous

b) nonholonomic d) rheoenomous

19)The generalized coordinates for motion of a particle moving on the surface of a sphere of radius r are ____.

a) r and θ c) θ and φ

b) r and φ d) zero and φ

20)The Lagrangian equations of motion for a system are equivalent to _____ equations of motion.

a) Newton's c) Poisson

b) Laplace d) Maxwell's

Short answer question

1) What are constraints? Explain holonomic and non-holonomic constraints.
2) Explain scleronomous and rheonomous constraints.
3) Explain the term degrees of freedom.
4) Explain the term 'generalised coordinates'. Why they are needed?
5) Write a note on 'Principle of virtual work'
6) Obtain D'Alembert's principle in generalized coordinates.
7) Write a note on 'Atwood's Machine'.
8) Derive an equation of motion for a bead sliding on a uniformly rotating wire.

Long answer question

1) Obtain Lagrange's equations from D'Alembert's principle.

2) Using Lagrangian formulation, obtain an equation of motion for a particle moving in a free space.
3) Using Lagrange's equation, obtain an experssion for acceleration in the Atwood's machine.
4) Derive an equation of motion for a bead sliding on a uniformly rotating wire.

Unit I – 2. Techniques of calculus of variation

Multiple choice question

1) The shortest distance between two points in a plane is along a…….passing through the two points.

a) curve
c) normal to the plane
b) straight line
d) parallel to the plane

2) Hamilton's principal is ----------principle.

a) an integral
c) an algebraic
b) a differential
d) a linear

3) Analytically Hamilton's principle can be represented as----------

a) $\int_{t_1}^{t_2} L\, dt \neq extremum$
c) $\int_{t_1}^{t_2} L\, dt = 0$
b) $\int_{t_1}^{t_2} L\, dt = extremum$
d) $\int_{t_1}^{t_2} L\, dt = \infty$

4) The Hamiltonian H is given as

a) H = L+V
c) H = T+V
b) H = L-V
d) H =T-V

5) The system is called as monogenic, if all the forces of a system are generated from ---------- function..

a) single
c) triple
b) double
d) fourth

6) If all forces of a system are generated from a single function, the system is called….. system

a) conservative
c) non conservative
b) monogenic
d) polygenic

7) Hamilton's principle is given as. .....

a) $I = \int_{t_1}^{t_2} L\, dt$

c) $I = \int_{t_1}^{t_2} L^2\, dt$

b) $I = \int_{t_1}^{t_2} \frac{1}{L}\, dt$

d) $I = \int_{t_1}^{t_2} L^3\, dt$

8) The Euler-Lagrange's equations are given by.....

a) $\frac{\partial L}{\partial q_i} + \frac{d}{dt}\left(\frac{\partial L}{\dot{q}_i}\right) = 0$

c) $\frac{\partial L}{\partial q_i} - \left(\frac{\partial L}{\dot{q}_i}\right) = 0$

b) $\frac{\partial L}{\partial q_i} - \frac{d}{dt}\left(\frac{\partial L}{\dot{q}_i}\right) = 0$

d) $\frac{\partial L}{\partial q_i} + \left(\frac{\partial L}{\dot{q}_i}\right) = 0$

9) In Brachistochrome problem, the equations of motion of the a particle is.....

a) $x = a(1 - cos\theta), y = a(\theta - sin\theta)$

c) $x = (1 - cos\theta), y = (\theta - sin\theta)$

b) $x = a(\theta - cos\theta), y = a(1 - sin\theta)$

d) $x = a(1 + cos\theta), y = a(\theta + sin\theta)$

10) In Brachistochrome problem, the path of the particle is.....

a) parabola

c) straight line

b) circle

d) cycloid

11) In variational principle, the line integral of some function between two end points is.....

a) zero

c) stationery

b)infinite

d)one

12)The n-dimensional space is called…... space.

a) phase

c) real

b) configuration

d) solar

Short answer question

1) State and explain Hamilton's principle.
2) Show that shortest distance between two points in a plane is along a straight line.
3) Write a note on 'Brachistochrone problem'.
4) Show that the path of a particle moving under constant conservative force field in least time is cycloid.

Long answer question

1) Deduce Hamilton's principle from D'Alembert's principle.
2) Derive Lagrange's equations of motion from Hamilton's principle.

Unit II – 1. Rigid body motion

Multiple choice question

1) A body is said to be rigid if the distance between any two of its constituent particle is _____.

a) Constant b) Large c) changes

2) A rigid body in motion can be completely specified if its _____ are known.

a) Position and centre of mass
b) Position and centre of gravity
c) Position and orientation

3) In case of a rigid body, having N particles, the number of degrees of freedom is _____.

a) 3N b) 3 c) N

4) If a rigid body is rotating with angular velocity ω about an instantaneous axis through a fixed point in the body, the angular momentum vector J about the same point _____

a) Will be always in the direction of ω
b) Will be always perpendicular to ω
c) May be in the direction of ω

5) The body coordinate system is _____ frame of reference.

a) Non-inertial
b) Inertial
c) Inertial and non-inertial

6) A rigid body can have two types of motion, _____.

a) Rotation and vibration
b) Translational and rotational
c) Translation and vibration

7) In a rigid body three equations of constraints are represented as _____.

a) $(r_i - r_j)^2 = a\ constant$
b) $(r_i - r_j)^2 \neq a\ constant$
c) $(r_i^2 - r_j^2)^2 = a\ constant$

8) The quantities like I_{xx}, I_{yy}, I_{zz} are called as _____.

a) Products of inertia
b) moment of inertia
c) measures of inertia

9) In rotational motion of a rigid body the directions of angular velocity and angular momentum are in general_____

a) Different
b) Antiparallel to each other
c) parallel to each other

10) The moment of inertia tensor is symmetric and it has only _____ independent components.

a) Two b) Four c) Six

11) The physical quantity, moment of inertia is a tensor of rank _____.

a) Two b) One c) zero

12) If I_1, I_2, and I_3 represent principal moments of inertia of a rigid body and $\omega=\omega_1\omega_2\omega_3$ is angular velocity with components along three principal axis,____

a) The z-component of the torque acting on the body in general is $N_3 = I_3\omega_3 + (I_2 - I_1)\omega_1\omega_2$

b) For torque free motion of a rigid body, always we have $I_3\omega_3 = constant$

c) The z-component of the torque acting on the body in general is $N_3 = I_3\omega_3$

Short answer question

1) What is rigid body? Write down the equation of constraints for such a body.
2) Derive an expression for kinetic energy of a rigid body in the component form.
3) Write a note on inertia tensor
4) Explain the term moment of inertia and products of inertia.
5) The directions of angular velocity vector and angular momentum vector are in general different. Comment.

Long answer question

1) State and prove Euler's theorem about the motion of a rigid body.
2) Show that directions of vector of angular velocity (ω) and angular momentum (L) are different in angular motion of the rigid body.
3) Derive Euler's equation of motion for a rigid body with fixed point.
4) If a rigid body, with one point fixed, rotating with an angular velocity (ω) and angular momentum (L), show that the kinetic energy is $\frac{1}{2}L\omega$.
5) Derive an expression for the angular momentum of a rigid body in component form.

Unit II – 2. Special theory of relativity

Multiple choice question

1) The velocity of light in free space is _____.

a) Constant c) Infinite

b) Zero d) Relative

2) In Michelson Morley interferometer, a beam of light from a monochromatic source falls upon_____ glass plate

a) semi silvered

b) silvered

c) plane

d)opaque

3) In Galilean relativity the transformation equation for x coordinate from S to S' is....

a) $x' = vt - x$

b) $x' = x - \frac{vt}{c^2}$

c) $x' = \frac{x - vt}{\sqrt{1 - v^2/c^2}}$

d) $x' = x - vt$

4) The wavelength of matter wave is independent of_____

a) mass

b) velocity

c) momentum

d) charge

5) The accelerated frames are _____.

a) inertial

b) non-inertial

c) stationary

d) moving

6) The special theory of relativity was developed by_____

a) Einstein

b) Newton

c) Lorentz

d) Galileo

7) In relativistic velocity addition theorem _____

a) $u = \frac{u' + v}{\frac{u'v}{c^2}}$

b) $u = \frac{u' + v}{1 + \frac{u'v}{c^2}}$

c) $u = u'$+v

d) $u = u'$

8) Einstein's first postulate in special theory of relativity is true in _____ frame of references.

a) inertial

b) accelerated

c) non inertial

d) circular

9) The inertial frame of reference is _____frame of reference

a) an accelerated

b) an unaccelerated

c) a rotating

d) an oscillating

10) Lorentz transformation reduces to Galilian transformations when _____

a) V>>C

c) V= C

b) V<<C

d) V= 1/C

11) For the moving observer, the time interval appears to be…

a) remains constant

c) lengthened

b) increase to infinity

d) shortened

12) The Lorentz transformation equation of time shows that the space and time are not two……. Entities.

a) related

c) independent

b) equivalent

d)dependent

13) For moving observer length appears to be

a) remains constant

c) dialated

b) increase to infinity

d) contracted

14) Who formulated first the classical theory of relativity?

a) Einstein

c) Lorentz

b) Newton

d) Galileo

15) The non- inertial frame of reference is _____frame of reference

a) an accelerated

c) a rotating

b) an unaccelerated

d) an oscillating

16) Mass increases with velocity by the relation

a) $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$

c) $m = \frac{m_0}{1-\frac{v^2}{c^2}}$

b) $m = m_0\sqrt{1-\frac{v^2}{c^2}}$

d) $m = \frac{m_0}{1-\frac{vt}{c^2}}$

17) According to the principle of invariance the equations of motion of a particle would be exactly the same in all.... frames of reference.

a) inertial
c) rotating
b) non-inertial
d) accelerated

18) The purpose of Michelson-Morley experiment was.. ..

a) To measure variable speed of light through ether:

b) To calculate absolute velocity of earth through ether.

c) To verify the length contraction in the direction of motion.

d) To verify the time dilation

19) According to Einstein, velocity of light in free space is...

a) dependent of the direction of propagation
c) a constant
b) variable
d) infinite

20) The body coordinate system is a ----------frame of reference.

a) non inertial
c) both inertial or non inertial
b) inertial
d) either inertial or non inertial

Short answer question

1) State and explain the Einstein's postulates of the special theory of relativity.
2) Deduce the expressions for variation of length with velocity.
3) With usual notations derive the expression, $m = \frac{m_0}{\sqrt{1-v^2/c^2}}$
4) Explain the concept of time dilation.
5) Derive the mass energy relation.
6) Write notes on Inertial frame of reference.
7) Write notes on Non-inertial frame of reference.
8) Write notes on Galilean transformations.
9) Write notes on The ether hypothesis.

Long answer question

1) Describe the Michelson-Morley experiment. How the negative result is interpreted?
2) Write down the Lorentz transformation equations. Derive them on the basis of special theory of relativity.
3) Derive the formula for the relativistic addition of velocities