T.Y.B.Sc. Physics

PHY 3502: Classical Mechanics

Class: T.Y. B. Sc. Sem: V **Paper II**

Question Bank

➢ Objective Questions

1. The second law of Kepler for planetary motion is a consequence of the law of conservation of—
    a. Isospin
    b. Energy
    c. Linear momentum
    d. Angular momentum

2. At the instant of collision of two balls—
    a. Kinetic energy increases
    b. Potential energy decreases
    c. A part of kinetic energy is changed into heat
    d. The Hamiltonian remains conserved

3. The second law of Kepler for planetary motion is a consequence of the law of conservation of—
    a. Energy
    b. Linear momentum
    c. Angular momentum
    d. Radial angular momentum

4. For central forces find incorrect properties
    a. $f(r) = -V(\bar{r})$
    b. $V(\bar{r}) = V(\bar{r})$
    c. $\mathrm{f}(\bar{\mathrm{r}}) = \frac{\partial|\mathrm{V(r)}|}{\mathrm{dr}}\hat{\mathrm{r}}$
    d. $f(r) = \sum_{n=-\infty}^{\infty} K_n r^n$

5. For two body central force problem, Langrangian is
    a. $L = \frac{1}{2}\mu\left(\dot{r}^2 + r^2 sin^2\theta\dot{\theta}\right) - V(\bar{r})$
    b. $L = \frac{1}{2}m_1\left(\dot{r}_1^2 + \dot{r}^2\dot{\theta}_1^2 + \dot{\theta}_1^2\right) - \frac{1}{2}m_2\left(\dot{r}_2^2 + \dot{r}_2^2\dot{\theta}_1^2 + \dot{\emptyset}_1^2\right) - V(\bar{r})$
    c. $L = \frac{1}{2}(m_1|\dot{r}_1|^2 + m_2|\dot{r}_2|^2) - V(|\bar{r}_1 - \bar{r}_2|)$
    d. $L = \frac{1}{2}\mu(|\dot{r}_1|^2 + |\dot{r}_2|^2) - V(|\bar{r}_1 - \bar{r}_2|)$

6. For rotating frame of reference-
    a. $|v|_{fixed} = [v]_{rot} + \omega \times r$
    b. $|v|_{rot} = [v]_{fixed} + \omega \times r$
    c. $|v|_{fixed} = [v]_{rot} - \omega \times r$
    d. $|v|_{rot} = [v]_{fixed} - \omega \times r$

7. $For\ f(r) = Kr^n, the\ circular\ orbits\ are\ stable\ if\ and\ only\ if$

a. $n < -3$
b. $n > -3$
c. $n > -2$
d. $n < -22$

8. If the work done by a force in moving a particle from point A to point B, does not depend on the path taken by it, then the force is—
    a. Central
    b. Non-conservative
    c. Conservative
    d. Inverse square law of force

9. A central attractive force varies as rm. The velocity of a particle in a circular orbit of radius r is twice the escape velocity from the same radius. Then m—
    a. 1
    b. –1
    c. 2
    d. –2

10. Equation of the orbits of a particle under the action of a central force is given by $r= ae^{b\theta}$, then corresponding force varies as—
    a. $1/r$
    b. $1/r^2$
    c. $1/r^3$
    d. $1/r^4$

11. If orbit is a parabola, then orbit's velocity is—
    a. Less than escape velocity
    b. More than escape velocity
    c. Equal to escape velocity
    d. Velocity should be equal to zero

12. The velocity at any point of central orbit is (1/n) th of what it would be for a circular orbit at the same distance. Then central force F varies as—
    a. $1/r^n$
    b. $1/r^{n2}+ 1$
    c. $1/r^{2n}$
    d. $1/r^{2n2}+ 1$

13. If r_1 and r_2 are the minimum and maximum distances of a planet from the sun, then the eccentricity of the orbit of the planet will be—
    a. $e = r_1/r_2$
    b. $e = r_1+ r_2/r_1– r_2$
    c. $e = r_2– r_1/r_1+ r_2$
    d. $e = r_1– r_2/r_1+ r_2$

14. Inertial frames are those frames of reference in which a free particle moves—

a. Along a straight line with a constant speed
b. With a variable speed along a straight line
c. With variable speed on a curved path
d. With constant speed on a curved path

15. The motion of one projectile as seen from another projectile will always be—
    a. Straight line
    b. Parabola
    c. Ellipse
    d. Circle

16. A particle describe a circular orbit given by $r = 2a \cos \theta$ under the influence of an attractive central force directed towards a point an the circle. Forces varies as—
    a. r^{-2}
    b. r^{-3}
    c. r^{-4}
    d. r^{-5}

17. A particle describes an ellipse under a force to the focus S. When the particle is at one extremity of the minor axis, its kinetic energy is doubled, without any change in the direction of motion. The particle proceeds to describe—
    a. Parabola
    b. Hyperbola
    c. Ellipse
    d. Circle

18. If a planet were suddenly stopped in its orbit, supposed circular, it would fall into the sun in a time—
    a. 1/8 times of its period
    b. 2/8 times of its period
    c. $\sqrt{2}/8$ times of its period
    d. $\sqrt{3}/8$ times of its period

19. In motion under central force—
    a. Only angular momentum is conserved
    b. Only energy is conserved
    c. Both conserved
    d. Kinetic energy is conserved

20. For repulsive inverse square forces, the shape of orbit—
    a. Elliptic
    b. Parabolic
    c. Hyperbolic
    d. All

21. A particle moves in a central force located at $r = 0$ describes the spiral $r = e^{-\theta}$, the magnitude of force is inv. proportional to—
    a. r
    b. r^2
    c. r^3

d. r^4

22. Two particles approach each other with different velocities. After collision, one of them as found to have momentum **P** in their centre of mass frame. In the same reference frame, the other particle must have momentum
    a. Zero
    b. –P/2
    c. −p
    d. -2P

23. At the instant of collision of two balls
    a. kinetic energy increases
    b. potential energy decreases
    c. A part of kinetic energy is changed into heat
    d. The Hamiltonian remains conserved

24. A particle is moving on elliptical path under inverse square law force of the form F(r) = -k/r2. The eccentricity of the orbit is
    a. a function of total energy
    b. Independent of total energy
    c. A function of semi-major axis of the elliptical orbit
    d. Independent of angular momentum

25. A particle describes a circular orbit under the influence of an attractive central force directed towards a point on a circle. The force varies as
    a. The fifth power of the distance
    b. The second power of the distance
    c. The inverse fifth power of the distance
    d. The inverse second power of the distance

26. If $r\ \alpha - r^n$. Then what value of n, the circular orbit described is stable?
    a. n>0
    b. n > -1
    c. n > -2
    d. n > -3

27. An object of mass 2 kg is sliding with a constant velocity of 4 m/s on a friction less horizontal table. The force required to keep the object moving with the same velocity is:
    i. 32 N
    ii. 0 N
    iii. 2 N
    iv. 8 N

28. Newton's third law of motion explains the two forces namely 'action' and 'reaction' coming into action when the two bodies are in contact with each other. These two forces:
    i. Always act on the same body
    ii. Always act on the different bodies in opposite directions
    iii. Have same magnitude and direction
    iv. Acts on either body at normal to each other

29. A water tank filled upto 2/3 of its height is moving with a uniform speed. On sudden application of the brake, the water in the tank would
    i. Move backward
    ii. Move forward
    iii. Come to the rest
    iv. Be unaffected

30. The seat belts are provided in the cars so that if the car stops suddenly due to an emergency braking, the persons sitting on the front seats are not thrown forward violently and saved from getting injured. Can you guess the law due to which a person falls in forward direction on the sudden stopping of the car?
    i. Newton's first law of motion
    ii. Newton's second law of motion
    iii. Newton's third law of motion
    iv. Newton's law of gravitation

31. A passenger in a moving train tosses a coin which falls behind him. Observing this statement what can you say about the motion of the train?
    i. Accelerated
    ii. Retarded
    iii. Along circular tracks
    iv. Uniform

32. Why does a rider on horseback fall when the horse starts running all of a sudden?
    1. The rider is suddenly afraid of falling
    2. The lower body of the rider moves forward with the horse but the inertia of rest keep the upper body at rest
    3. The rider is pushed backwards
    4. None of the above options

33. Which of the following does Newton's first law of motion describe?
    1. Inertia
    2. Work
    3. Energy
    4. Moment of Inertia

34. Projectile reaches a maximum height along vertical direction when sin θ=.....
    1. -1/2
    2. 1/2
    3. 1
    4. 0

35. During projectile motion projectile follows a ..... path.
    1. Circular
    2. Hyperbolic
    3. Elliptical
    4. Parabolic

36. The projectile motion is ..... dimensional motion

1. One
2. Two
3. Three
4. Multidimensional

37. During projectile motion the force of air resistance is .....
    1. directly proportional to the velocity of the projectile
    2. inversely proportional to the velocity of the projectile
    3. directly proportional to square of the velocity of the projectile
    4. inversely proportional to square of the velocity of the projectile

38. Two projectiles are projected with the same velocity. If one is projected at an angle of 30 degree and the other at 60 degree to the horizontal then the ratio of ranges is
    a. 0
    b. ½
    c. 1
    d. 2

39. A body is projected with a velocity of 40 m/s. After 25 m, it crosses a point at a height 20.4 m. Then angle of projection is .....
    1. 90 degree
    2. 60 degree
    3. 30 degree
    4. 0 degree

40. The time of flight of the projectile is.....
    1. T=0
    2. T= t
    3. T= 2t
    4. T= 3t

41. Two projectiles are projected with the same velocity. If one is projected at an angle of 30 degree and the other at 60 degree to the horizontal then the ratio of maximum heights is
    1. 1/3
    2. ½
    3. 1
    4. 2

42. The range of the projectile is maximum if .....
    1. $\sin 2\theta=0$
    2. $\sin 2\theta=1/2$
    3. $\sin 2\theta=2$
    4. $\sin 2\theta=1$

43. In rocket motion mass of the rocket with respective to time .....
    1. initially increases then decreases
    2. remains constant
    3. decreases.
    4. Increases

44. In projectile motion during the motion mass of the projectile .....

1. initially increases then decreases
2. remains constant
3. decreases
4. increases

45. Force on the charged particle in an electric field is .....
    1. inversely proportional to electric field and directly proportional to charge
    2. directly proportional to electric field and inversely proportional to charge
    3. inversely proportional to both charge and electric field
    4. directly proportional to both charge and electric field

46. Range of the projectile is the maximum distance covered by the projectile along ..... direction.
    1. upward
    2. downward
    3. horizontal
    4. vertical

47. The trajectory of the charged particle in electromagnetic field is.....
    1. straight line
    2. circular
    3. cycloid
    4. elliptical

48. If the total external torque acting on the system is zero, then total angular momentum is ..
    1. Increases
    2. Decreases
    3. Zero
    4. is conserved

49. A system in which all the forces acting on it are derivable from potential energy function is called as.....
    1. Open system
    2. closed system
    3. conservative system
    4. Null system

50. For parabolic orbit the values of energy E and eccentricity ϵ are _____
    i. $E=0$ and $\epsilon=1$
    ii. $E>0$ and $\epsilon>1$
    iii. $E>0$ and $\epsilon=1$
    iv. $E>0$ and $\epsilon=0$

51. For hyperbolic orbit the values of energy E and eccentricity ϵ are _____
    i. $E=0$ and $\epsilon>1$
    ii. $E>0$ and $\epsilon>1$
    iii. $E>0$ and $\epsilon=1$
    iv. $E>0$ and $\epsilon=0$

52. At the turning point in an arbitrary potential field the radial velocity is _____
    1. zero
    2. 1
    3. Infinity
    4. ½

53. For elliptical orbit the values of energy E and eccentricity ϵ are _____
    i. $E=0$ and $\epsilon>1$
    ii. $E>0$ and $\epsilon>1$
    iii. $E<0$ and $\epsilon<1$
    iv. $E>0$ and $\epsilon=0$

54. For circular orbit the value of eccentricity _____
    i. $\epsilon>1$
    ii. $\epsilon\geq1$
    iii. $\epsilon<1$
    iv. $\epsilon=0$

55. All the planet moves around the Sun in _____ orbit.
    i. circular
    ii. parabolic
    iii. hyperbolic
    iv. elliptical

56. The areal velocity of the particle in a central force field is _____
    i. Zero
    ii. Conserved
    iii. infinity
    iv. Not conserved

57. The angular momentum is _____ in a central force field.
    i. Zero
    ii. Not conserved
    iii. infinity
    iv. conserved

58. The electrostatic forces are very much _____than the gravitational forces in the interaction of atomic and subatomic particles.
    i. Poor
    ii. Stronger
    iii. Equal
    iv. Lower

59. The flying wheel attached to the shaft of steam engine works on the principle of _____
    a. Centripetal action
    b. Moment of inertia
    c. Newton's third law of motion
    d. Conservation of momentum

60. If any external conservative force also is applied on the distributed loading then?

a. The net force will act at the centroid of the structure only
b. The net load will not be formed as all the forces will be cancelled
c. The net force will act on the base of the loading horizontally
d. The net force will not to be considered, there would be a net force of the distribution, rest will be the external forces

61. A particle is moving under central force about a fixed center of force. Choose the correct
    1. The motion of particle is always on a circular path
    2. Its angular momentum is conserved
    3. Its kinetic energy remains constant
    4. motion of particle takes place in a elliptical orbit

62. The areal velocity of the particle is constant . This is Kepler's ..... law
    1. zeroth
    2. first
    3. second
    4. third

63. Every planet moves around the sun in an elliptical orbit, with the Sun located at the one of the foci of the orbit. This is Kepler's ..... law
    1. zeroth
    2. first
    3. second
    4. third

64. If the total K. E. of all particles before scattering is equal to the total K.E. of particles after scattering, then it is called as
    1. elastic scattering
    2. inelastic scattering
    3. only scattering
    4. none of the above

65. The scattering angle in Lab system is equal to .....
    1. the scattering angle in CM system
    2. half of the scattering angle in CM system
    3. square of the scattering angle in CM system
    4. cube of the scattering angle in CM system

66. The reaction is endoergic if .....
    1. Q=0
    2. Q>0
    3. Q<0
    4. Q=-1

67. The reaction is exoergic if .....
    1. Q=0
    2. Q>0
    3. Q<0
    4. Q=1

68. _____ constraints are independent of time.

1. Holonomic
2. Non-Holonomic
3. Scleronomous
4. Rheonomous

69. The degree of freedom for a free particle in space are _____
    1. Zero
    2. One
    3. Two
    4. Three

70. The Lagrange's equations of motion for a system is equivalent to _____ equations of motion
    1. Newton's
    2. Laplace
    3. Poisson
    4. Maxwell's

71. A particle is constrained to move along the inner surface of a hemisphere number of degrees of freedom of the particle
    1. 1
    2. 2
    3. 3
    4. 4

72. Three particles moving in space so that the distance between any two of them always remain fixed have degree of freedom equal to
    1. 3
    2. 9
    3. 6
    4. 1

73. A cylinder rolling without slipping down a rough inclined plane of an angle θ is an example of
    1. Scleronomic, conservative system only
    2. Scleronomic, holonomic, conservative system.
    3. Only conservative system
    4. Only Scleronomic system

74. The Lagrangian equations of motion are _____ order differential equations.
    1. zero
    2. forth
    3. first
    4. second

75. In Simple pendulum the generalized coordinate is .....
    1. bob of the pendulum
    2. length of pendulum
    3. angle of the pendulum
    4. mass of the bob
    5.

- **Answer in sentence**

76. State centre of mass of the system.
77. State law of conservation of angular momentum.
78. Define range of projectile.
79. Define time of flight of projectile.
80. Define maximum vertical height.
81. What is meant by central force?
82. State Kepler's first law of planetary motion.
83. State Kepler's second law of planetary motion.
84. What is meant by apsidal distance?
85. Give characteristics of central force.
86. What is meant by elastic collision?
87. Define impact parameter.
88. Define total cross section.
89. Define differential cross-section.
90. What is meant by inelastic collision?
91. Define degrees of freedom.
92. State D' Alembert's principle?
93. What are the cyclic coordinates?
94. What is meant by phase space?
95. What are the types of constrains?

- **Shorts Notes**

96. Write note on Projectile motion.
97. Write note on conservation of energy of the system.
98. Write note law of conservation of linear momentum.
99. Write note on rocket motion.
100. Write note on centre of mass.
101. Write note on Orbit of satellite.
102. Write note on eccentricity and give classification of orbits
103. Write note on Kepler's third law.
104. Write note on equation of orbit.
105. Write note on general features of motion.
106. Write note on centre of mass.
107. Write note on laboratory frame.
108. Write note on differential cross-section.
109. Write note on impact parameter.
110. Write note on inelastic scattering.
111. Write note on cyclic or Ignorable coordinates.
112. Write note on non-holonomic constraints.
113. Write note on configuration space.
114. Write note on Atwood's machine.
115. Write note on Phase space.

- **Short Answer Questions**

116. State Newton's laws of motion.
117. What is meant by conservative force?
118. What is meant by drift velocity in crossed electric and magnetic field?
119. Find the angle of projection at which range of the projectile is maximum.
120. Give two assumption of rocket motion.
121. What are the characteristics of central force?
122. State and prove Kepler's second law of planetary motion.
123. What is meant by geostationary orbit of satellite?
124. What is meant by geosynchronous orbit of satellite?
125. Draw the effective potential energy curve for inverse square force.
126. What is meant by 'Laboratory system' in a two-body problem?
127. What is meant by centre of mass system in two body scattering problem?
128. Distinguish between elastic and inelastic scattering.
129. Explain in brief cross-section in scattering process.
130. In what way is the use of CM frame advantageous as compared to that of laboratory frame?
131. State specific examples of force of constraints.
132. What is meant by holonomic constraints?
133. How does the constraint affect the motion of a mechanical system?
134. State the principle of virtual work.
135. What are the generalized co-ordinates?

- **Long Answer Questions**

136. Obtain the path of projectile in resistive medium.
137. Obtain motion of charged particle under constant magnetic field.
138. Show that the path of charged particle moving with uniform velocity in transverse electric field is parabola.
139. Obtain motion of charged particle in crossed electric and magnetic field.
140. Applying Newton's laws to a system of particles in a conservative force field, establish the law of conservation of linear and angular momentum.
141. State and prove Kepler's third law of planetary motion.
142. Derive the differential equation of orbit in central force field.
143. Draw the effective potential energy curve under inverse square law of central force. Discuss various cases for total energy.
144. Show that the product of maximum and minimum linear speeds of a particle in an elliptic orbit is $(2\pi a/\tau^2)$, where τ is the period and a is the semi-major axis.
145. The distance between sun and earth is suddenly reduced to half of the present distance. What will be duration of year?
146. Describe two body elastic collision in laboratory frame.
147. Obtain the relation between position vectors and velocities in lab and

CM Frame.

148. Find relation between the scattering angles in the LAB and CM systems in two body problems.
149. Obtain Q value equation in elastic collision.
150. Show that for identical particle scattering, $\sigma(\theta) = 4 \cos \theta \, \sigma (\theta')$.
151. Explain limitations of Newtonian Mechanism.
152. Explain the idea of phase space in detail.
153. Show that Hamiltonian of a system represent total energy of the system.
154. Explain the principle of virtual work and D' Alembert's principle.
155. Obtain expression for generalised acceleration and generalised force.