Brain International School
Vikas Puri, New Delhi

REVISION SHEET

SUBJECT: PHYSICS **CLASS-XI** **TERM-1(26-27)**

1MARKS

1. If $|\vec{A} + \vec{B}| = |\vec{A}| + |\vec{B}|$, then find the angle between $\vec{A}$ and $\vec{B}$.

2. At the highest point on the trajectory of a projectile, its:

a) acceleration is maximum

b) velocity is maximum

c) velocity is minimum

d) acceleration is minimum

3. A particle moves with constant speed v along a circular path of radius r and completes the circle in time T. The acceleration of the particle is

a) $\frac{2\pi v}{T}$

b) $\frac{2\pi r^2}{T}$

c) $\frac{2\pi v^2}{T}$

d) $\frac{2\pi r}{T}$

4. Two equal vectors have a resultant equal to either. The angle between them is

a) 90°

b) 60°

c) 120°

d) 100°

5. Two billiard balls each of mass **0.05 kg** moving in opposite directions with speed **6 m/s** collide and rebound with the same speed. What is the impulse imparted to each ball due to the other?

6. A batsman hits back a ball of mass **0.15 kg** straight in the direction of the bowler without changing its initial speed of **12 m/s**. If the ball moves linearly, determine the impulse imparted to the ball.

7. A 1 kg stationary bomb is exploded into three parts having mass ratio 1 : 1 : 3.The two equal-mass parts move in mutually perpendicular directions with speed 30 m/s each. Find the velocity of the heavier part.

(a) $10\sqrt{2}$

(b) $10/\sqrt{2}$

(c) $15\sqrt{2}$

(d) $15/\sqrt{2}$

8. A block of mass 0.1 kg is pressed against a wall with a horizontal force of 5 N as shown in the figure. If the coefficient of friction between the wall and the block is 0.5, then the frictional force acting on the block will be ($g = 9.8\ m/s^2$):

(a) 9.8 N
(b) 2.5 N
(c) 0.98 N
(d) 0.49 N

9. The coefficient of static friction between two surfaces depends on:
(a) The nature of the surfaces
(b) The shape of the surfaces in contact
(c) The area of contact
(d) All of the above

10. A block of mass 2 kg is placed on the floor. The coefficient of static friction is 0.4. A force of 2.8 N is applied on the block. The force of friction between the block and the floor is:
(a) 2.8 N
(b) 8.0 N
(c) 2.0 N
(d) Zero

11. A man of mass 90 kg is standing in an elevator whose cable broke suddenly. If the elevator falls, the apparent weight of the man is:
(a) 90 N
(b) 90g N
(c) 0 N
(d) Any negative value

12. In which of the following cases is the work done positively?

a) Work is done by the resistive force of air on a vibrating pendulum in bringing it to rest.
b) Work is done by gravitational force while a man lifts a bucket out of a well by means of a rope tied to the bucket.
c) Work is done by an applied force on a body moving on a rough horizontal plane with uniform velocity.
d) Work is done by friction on a body sliding down an inclined plane.

13. In which case is the work done zero?
a) Force and displacement are perpendicular to each other.
b) Force and displacement are at an angle of 45°.
c) Force and displacement are at an angle of 75°.
d) Force and displacement are in the same direction.

14. If the force and displacement of a particle in the direction of force are doubled, then the work done would be:
a) Half
b) 4 times
c) Double
d) 1/4 times

15. A particle moves from the point $(-2\hat{i} + 5\hat{j})$ to $(4\hat{j} + 3\hat{k})$ when a force $(4\hat{i} + 3\hat{j})$ N is applied. How much work has been done by the force?
a) 11 J
b) 2 J

c) 8 J
d) 5 J

16. . If the kinetic energy of a body becomes four times its initial value, the new momentum will be:
a) Become twice its initial value
b) Remain constant
c) Become thrice its initial value
d) Become four times its initial value

17. Two bodies with kinetic energies in the ratio 4 : 1 are moving with equal linear momentum. The ratio of their masses is:
a) 1 : 4
b) 1 : 2
c) 4 : 1
d) 1 : 1

18. The kinetic energy of a body of mass 2 kg and momentum 2 Ns is:
a) 4 J
b) 3 J
c) 1 J
d) 2 J

19. The change in kinetic energy of a particle is equal to:
a) Work done on it by some force.
b) Work done on it by the net force.
c) Work done on it by the aerodynamic force.
d) Loss in ambient kinetic energy.

20. For a ball dropped from a tower of height h, the total mechanical energy is:
a) The sum of potential and kinetic energies.
b) The kinetic energy.
c) The difference of potential and kinetic energies.
d) The potential energy.

21. Physically, the notion of potential energy is applicable only to:
a) The class of forces where work done against the force gets converted to kinetic energy.
b) The class of forces where work done against the force gets stored up as energy.
c) The class of forces where work done against the force gets converted to thermal energy.
d) The class of forces where work done against the force gets dissipated.

22. What is the ratio of kinetic energy of a particle at the bottom to that at the top when it just completes a vertical loop of radius r?
(a) 5 : 2
(b) 5 : 1
(c) 2 : 3
(d) 7 : 2

23. A body is moving under constant acceleration. The power delivered at time t is proportional to:
(a) $t^{1/2}$
(b) t
(c) $t^{3/2}$
(d) t^2

24. Power can be expressed as:
(a) F × v
(b) F · t

(c) $F \cdot v$
(d) $\frac{1}{2} F \cdot v^2$

25. A body is moving unidirectionally under the influence of a source of constant power. Its displacement in time t is proportional to:

(a) $t^{1/2}$
(b) t
(c) $t^{3/2}$
(d) t^2

26. A car of mass 1000 kg accelerates uniformly from rest to a velocity of 54 km/h in 5 s. The average power of the engine during this period (neglect friction) is:
(a) 2250 W
(b) 2000 W
(c) 22500 W
(d) 5000 W

27. A body of mass m_1 collides elastically with another body of mass m_2 at rest. If the velocity of m_1 after collision becomes 2/3 of its initial velocity, the ratio of their masses is:
(a) 2 : 5
(b) 1 : 5
(c) 5 : 2
(d) 5 : 1

28. Two particles collide and stick together after collision. During such a collision, for the total system:
(a) Mechanical energy is conserved, but not linear momentum.
(b) Neither mechanical energy nor linear momentum is conserved.
(c) Linear momentum is conserved, but not mechanical energy.
(d) Both mechanical energy and linear momentum are conserved.

29. In an inelastic collision, what is conserved?
(a) Neither kinetic energy nor momentum
(b) Momentum
(c) Kinetic energy
(d) Kinetic energy and momentum

30. The total momentum of a system of particles is equal to:

a) the product of the total mass of the system and the velocity of its centre of mass

b) the product of the total mass of the system and the average velocity of its centre of mass

c) the product of half the total mass of the system and the velocity of its centre of mass

d) the product of the total mass of the system and the speed of its centre of mass

31. **Assertion (A):** If momentum of a body increases by 50%, its kinetic energy will increase by 125%.
Reason (R): Kinetic energy is proportional to the square of velocity.

32. **Assertion (A):** As we go up the surface of the earth, we feel light weighed than on the surface of the earth.
Reason (R): The acceleration due to gravity decreases on going up above the surface of the earth.

33. **Assertion (A):** When a body is dropped or thrown horizontally from the same height, it would reach the ground at the same time.
Reason (R): Horizontal velocity has no effect on the vertical direction.

2MARKS

34. Two vectors, both equal in magnitude, have their resultant equal in magnitude of the either. Find the angle between the two vectors.

35. Two forces whose magnitudes are in the ratio of 3:5 give a resultant of 35 N. If the angle of inclination be 60°, calculate the magnitude of each force.

36. The sum of the magnitudes of two forces acting at a point is 18 N and the magnitude of their resultant is 12 N. If the resultant makes an angle of 90° with the force of smaller magnitude, what are the magnitudes of the two forces?

37. The position of a particle is given by $\vec{r} = 3.0\, t\, \hat{\imath} - 2.0\, t^2 \hat{\jmath} + 4.0\, \hat{k}$ m

Where t is in seconds and the coefficients have the proper units for $\vec{r}$ to be in meters.

(i) Find the $\vec{v}$ and $\vec{a}$ of the particle. (ii) What is the magnitude and direction of velocity of the particle at t= 2 sec?

38. A particle starts from origin at t = 0 with a velocity 10.0 $\hat{j}$ m/s and moves in x-y plane under action of a force which produces a constant acceleration of $(8\hat{\imath} + 2\hat{\jmath})$ m/s^2 (a) At what time is the x- coordinate of the particle 16 m? What is the y-coordinate of the particle at that time? (b) What is the speed of the particle at the time?

39. A motorboat is racing towards north at 25 km/h and the water current in that region is 10 km/h in the direction of 60° east of south. Find the resultant velocity of the boat.

40. Find unit vector parallel to the resultant of the vector $\vec{A} = \hat{\imath} + 4\hat{\jmath} - 2\hat{k}$ and $\vec{B} = 3\,\hat{\imath} - 5\hat{\jmath} + \hat{k}$.

41. Find the components of $\vec{a} = 2\hat{\imath} + 3\hat{\jmath}$ along the directions of vectors $\hat{\imath} + \hat{\jmath}$ and $\hat{\imath} - \hat{\jmath}$.

42. Show that the vectors $\vec{A} = 3\hat{\imath} - 2\hat{\jmath} + \hat{k}$, $\vec{B} = \hat{\imath} - 3\hat{\jmath} + 5\hat{k}$ and $\vec{C} = 2\hat{\imath} + \hat{\jmath} - 4\hat{k}$ form a right-angle triangle.

43. If the resultant of the vectors $3\hat{\imath} + 4\hat{\jmath} + 5\hat{k}$ and $5\hat{\imath} + 3\hat{\jmath} + 4\hat{k}$ makes an angle θ with x - axis, then find $\cos\theta$.

44. Two forces equal to P and 2 P newton act on a particle. If the first be doubled and the second be increased by 20 N, the direction of the resultant is unaltered. Find the value of P.

45. Derive an expression for the centripetal acceleration of a body moving in a circular path of radius r with uniform speed v.

46. A motorboat is racing towards north at 25 km/h and the water current in that region is 10 km/h in the direction of 60° east of south. Find the resultant velocity of the boat.

47. A bullet travelling with a velocity of 16 m/s penetrates a tree trunk and comes to rest in 0.4 m. Find the time taken during the retardation.

48. The acceleration of a particle in $ms{-2}$ is given by a = $3t^2 + 2t + 2$, where time t is in second. If the particle starts with a velocity v = 2 ms^{-1} at t = 0, then find the velocity at the ends of 2 s.

49. The position of an object moving along x-axis is given by x = a + bt^2, where a = 8.5 m, b = 2.5 ms^{-2} and t is measured in seconds. What is its velocity at t = 0 s and t = 2 s? What is the average velocity between t = 2 s and t = 4 s?

50. A machine gun fires a bullet of mass 40 g with a velocity of 1200 m/s. The man holding it can exert a maximum force of 144 N on the gun. How many bullets can be fired per second at the most?

51. A ball moving with a momentum of 5 kg m/s strikes a wall at an angle of 45° and is deflected at the same angle. Calculate the change in momentum.

52. A body of mass 0.25 kg moving with velocity 12 m/s is stopped by applying a force of 0.6 N.
(i) Time taken to stop the body.
(ii) Impulse of the force.

53. Find a vector whose length is 4 and which is perpendicular to each of the vectors:

$$\vec{A} = \hat{\imath} - 3\hat{\jmath} + 2\hat{k} \text{ and } \vec{B} = \hat{\imath} + 2\hat{\jmath} - \hat{k}.$$

54. A shell of mass 0.020 kg is fired by a gun of mass 100 kg. If the muzzle speed of the shell is 80 m/s, what is the recoil speed of the gun?

55. A hunter has a machine gun that can fire 50 g bullets with a velocity of 150 m/s. A 60 kg tiger springs at him with a velocity of 10 m/s. How many bullets must the hunter fire per second into the tiger to stop it?

56. A body of mass 1 kg, initially at rest, explodes into three fragments of masses in the ratio 1 : 1 : 3. The two equal fragments fly off perpendicular to each other with a speed of 30 m/s each. Find the velocity of the heavier fragment.

57. A bomb at rest explodes into three fragments of equal masses. Two fragments fly off at right angles with velocities 9 m/s and 12 m/s. Calculate the speed of the third fragment.

58. Draw the variation of the force of friction with the applied force.

59. Define the angle of friction. Deduce its relation with the coefficient of friction.

60. Define the angle of repose. Deduce its relation with the coefficient of static friction.

61. Derive an expression for the acceleration of a body sliding down a rough inclined plane.

62. Why is it easier to pull a lawn roller than to push it? Explain.

63. Determine the maximum acceleration of the train in which a box lying on its floor will remain stationary, given that the coefficient of static friction between the box and the train's floor is 0.15.

64. A particle is acted upon by constant forces $F_1 = (2\hat{\imath} - 3\hat{\jmath} + 4\hat{k})$ and $F_2 = (-\hat{\imath} + 2\hat{\jmath} - 3\hat{k})$, and is displaced from A (2,1,0) to B (−3, −4, 2). Find the total work done by these forces.

65. . Calculate the work done to displace the particle from (1, 2) to (4, 5), if $F = 4\hat{\imath} + 3\hat{\jmath}$.

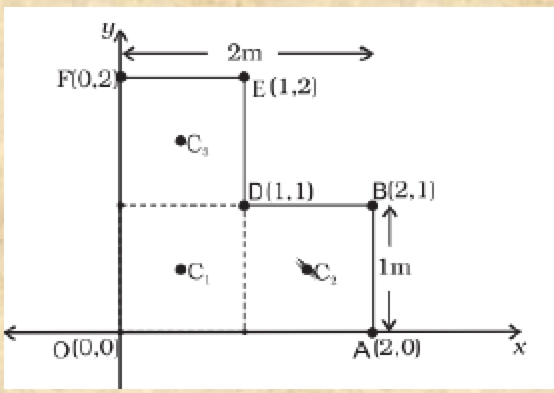
66. If the kinetic energy is increased by 19%, what will be the percentage increase in the linear momentum of the body?

67. Two particles of masses 1 kg and 2 kg are located at x = 0 and x = 3 m. Find the position of their centre of mass.

68. Three-point masses of 1 kg, 2 kg and 3 kg lie at (1, 2), (0, –1) and (2, –3) respectively. Calculate the coordinates of the centre of mass of the system.

69. . Find the centre of mass of three particles at the vertices of an equilateral triangle. The masses are 100 g, 150 g and 200 g respectively. Each side is 0.5 m.

70. Find the centre of mass of a uniform L-shaped lamina (thin flat plate) with dimensions as shown. The mass of the lamina is 3 kg.



71. From a uniform disc of radius R, a circular hole of radius R/2 is cut out. The centre of the hole is at a distance R/2 from the centre of the original disc. Locate the centre of gravity of the remaining body.

3 MARKS

72. A bullet fired at an angle of 30° with the horizontal hits the ground 3.0 km away. By adjusting its angle of projection, can one hope to hit a target 5.0 km away? Assume the muzzle speed to the fixed, and neglect air resistance.

73. Two projectiles are thrown with different velocities and at different angles so as to cover the same maximum height. Show that the sum of the times taken by each to reach the highest point is equal to the total time taken by either of the projectiles.

74. A target is fixed on the top of a pole 13 metre high. A person standing at a distance of 50 metre from the pole is capable of projecting a stone with a velocity$10\sqrt{g}ms^{-1}$. If he wants to strike the target in shortest possible time, at what angle should he project the stone?

75. A machine gun is mounted on the top of a tower 100 m high. At what angle should the gun be inclined to cover a maximum range of firing on the ground below? The muzzle speed of the bullet is 150 ms^{-1} , take g = 10 ms^{-2}

76. A ball is thrown at an angleθ and another ball is thrown at an angle (90° - θ) with the horizontal direction from the same point with velocity 39.2 ms^{-1} . The second ball reaches 50 m higher than the first ball. Find their individual heights. Take g = 9.8 ms^{-1}.

77. A projectile is fired with velocity u making an angle θ with the horizontal. Derive the expression for

(i) time of flight

(ii) horizontal range

78. A particle starts from origin at t = 0 with a velocity 5.0 i m/s and moves in x-y plane under action of a force which produces a constant acceleration of ($3\hat{\imath} + 2\hat{\jmath}$) m/s^2(a) What is the y-coordinate of the particle at the instant its x-coordinate is 84 m? (b) What is the speed of the particle at this time?

79. A body is projected with a velocity of 30 ms^{-1} at an angle of 30° with the vertical. Find the maximum height, time of flight and the horizontal range.

80. ball thrown up is caught by the thrower after 4 s. How high did it go and with what velocity was it thrown? How far was it below the highest point 3 s after it was thrown?

81. A body falling freely under gravity passes two points 30 m apart in 1s. Find from what point above the upper point it began to fall? Take g = 9.8 ms^{-2}.

82. From the top of a tower 100 m in height a ball is dropped and at the same time another ball is projected vertically upwards from the ground with velocity of 25 $ms-1$. Find when and where the two balls will meet. Take g = 9.8 $ms-2$

83. A rocket with a lift-off mass of 20,000 kg is blasted upwards with an initial acceleration of 5.0 m/s². Calculate the initial thrust (force) of the blast.

84. A constant force acting on a body of mass 3.0 kg changes its speed from 2.0 m/s to 3.5 m/s in 25 s. The direction of motion remains unchanged. Find the magnitude and direction of the force.

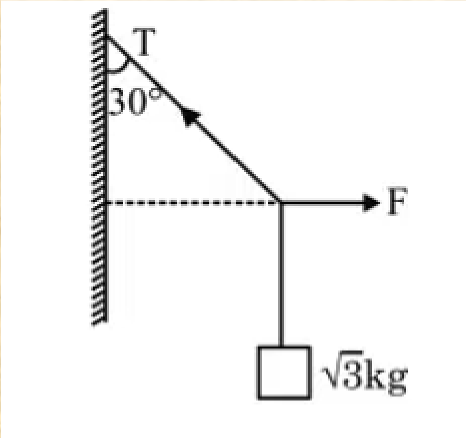
85. A bullet of mass 0.04 kg moving with a speed of 90 m/s enters a heavy wooden block and is stopped after travelling a distance of 60 cm. What is the average force exerted by the block on the bullet?

86. The driver of a three-wheeler moving with a speed of 36 km/h sees a child standing in the middle of the road and brings the vehicle to rest in 4.0 s. Find the average retarding force. Mass of three-wheeler = 400 kg, mass of driver = 65 kg.

87. Show that Newton's second law of motion is the real law of motion.

88. A mass of 6 kg is suspended by a rope of length 2 m from the ceiling. A horizontal force of 50 N is applied at the midpoint of the rope. What angle does the rope make with the vertical in equilibrium? (g = 10 m/s²)

89. A block of 3 kg is attached to a string whose other end is fixed to a wall. An unknown force F is applied so that the string makes an angle of 30° with the wall. Find the tension T.



90. Two bodies of masses 10 kg and 20 kg respectively kept on a smooth, horizontal surface are tied to the ends of a light string. a horizontal force F = 600 N is applied to (i) A, (ii) B along the direction of string. What is the tension in the string in each case?

91. A stone of mass 0.25 kg tied to the end of a string is whirled round in a circle of radius 1.5 m with a speed of 40 rev./min in a horizontal plane. What is the tension in the string? What is the maximum speed with which the stone can be whirled around if the string can withstand a maximum tension of 200 N?

92. A circular racetrack of radius 300 m is banked at an angle of 15°. If the coefficient of friction between the wheels of a race-car and the road is 0.2, what is:

(a) the optimum speed of the race-car to avoid wear and tear on its tyres, and
(b) the maximum permissible speed to avoid slipping?

93. A 70 kg man stands in contact against the wall of a cylindrical drum of radius 3 m rotating about its vertical axis with 200 rev/min. The coefficient of friction between the wall and his clothing is 0.15. What is the minimum rotational speed of the cylinder to enable the man to remain stuck to the wall (without falling) when the floor is suddenly removed?

94. A mass of 4 kg rests on a horizontal plane. The plane is gradually inclined until at an angle $\theta = 15°$ with the horizontal, the mass just begins to slide. What is the coefficient of static friction between the block and the surface?

95. What is the acceleration of the block and trolley system shown in the figure if the coefficient of kinetic friction between the trolley and the surface is 0.04? What is the tension in the string? Take $g = 10\ m/s^2$. Neglect the mass of the spring.

96. A woman weighing 50 kg stands on a weighing machine placed in a lift. What will be the reading of the machine when the lift is:
(i) Moving upwards with a uniform velocity of 5 m/s
(ii) Moving downwards with a uniform acceleration of 1 m/s^2

97. A particle moves along the x-axis from $x = 0$ to $x = 5$ m under the influence of a force $F = 7 - 2x + 3x^2$. Find the work done.

98. Force $F = 0.5x + 10$ acts on a particle, where F is in newton and x is in metre. Calculate the work done during displacement from $x = 0$ to $x = 2$ m.

99. A woman pushes a trunk on a rough railway platform. She applies a force of 100 N over 10 m, then the applied force decreases linearly to 50 N over the next 10 m. Frictional force is 50 N. Plot the applied and frictional forces versus distance and calculate the work done by both forces over 20 m.

100. If the linear momentum is increased by 50%, what will be the percentage increase in the kinetic energy of the body?

101. If the linear momentum is increased by 20%, what will be the percentage increase in the kinetic energy of the body?

102. . If the kinetic energy is increased by 300%, what will be the percentage increase in the linear momentum of the body?

103. If the linear momentum is increased by 10%, what will be the percentage increase in the kinetic energy of the body?

104. In a ballistics demonstration, a police officer fires a bullet of mass 50.0 g with speed 200 m s^{-1} into soft plywood of thickness 2.00 cm. The bullet emerges with only 10% of its initial kinetic energy. What is the emergent speed of the bullet?

105. A block of mass 1 kg moving with speed 2 m s^{-1} enters a rough patch from $x = 0.10$ m to $x = 2.01$ m. The retarding force is $F = -k/x$, where $k = 0.5$ J. Find the final kinetic energy and speed after crossing the patch. [Given ln (20.1) =3]

106. A body of mass 0.5 kg travels in a straight line with velocity $v = ax^{(3/2)}$, where $a = 5\ m^{-1/2}\ s^{-1}$. Find the work done by the net force during displacement from $x = 0$ to $x = 2$ m.

107. The bob of a pendulum is released from the horizontal position. If the length is 1.5 m and 5% of its initial energy is lost due to air resistance, find the speed at the lowest point.

108. The length of a steel wire increases by 0.5 cm when loaded with a weight of 5 kg. Calculate the force constant of the wire and the work done in stretching it.

109. What percentage of the kinetic energy of a moving particle is transferred to a stationary particle when it strikes a stationary particle of nine times its mass?

110. Torques of equal magnitude are applied to a hollow cylinder and a solid sphere, both having the same mass and radius. The cylinder is free to rotate about its standard axis of symmetry, and the sphere is free to rotate about an axis passing through its centre. Which of the two will acquire a greater angular speed after a given time.

111. To maintain a rotor at a uniform angular speed of 200 rad s-1, an engine needs to transmit a torque of 180 N m. What is the power required by the engine?

112. Derive the expression for the variation of 'g' at a depth d from the surface of the earth.

113. Draw a graph showing the variation of acceleration due to gravity g with distance r from the centre of the earth.

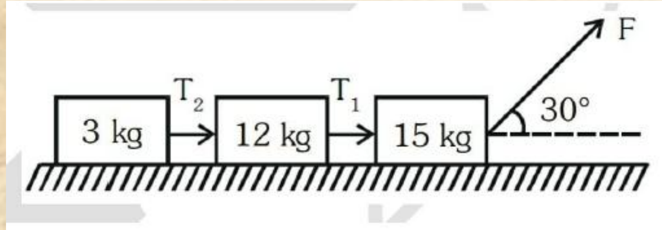
114. What is the relation between height h and depth d for the same change in g, near the earth surface?

115. Derive the expression for the variation of 'g' on the surface of the earth due to axial rotation of the earth.

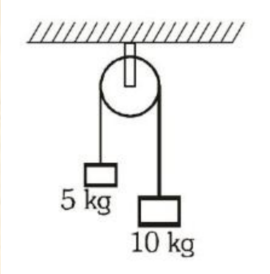
116. Derive an expression for the gravitational potential energy of a body of m located at distance r from the centre of the earth.

<u>5MARKS</u>

117. The surface is frictionless, the ratio of T_1 and T_2 is



118. Two blocks of masses 5 kg and 10 kg are connected to a pulley as shown. What will be their acceleration if the pulley is set free? (g = 10 ms^{-2})



119. Explain why:
(a) A horse cannot pull a cart and run in empty space.
(b) Passengers are thrown forward from their seats when a speeding bus stops suddenly.
(c) It is easier to pull a lawn mower than to push it.
(d) A cricketer moves his hands backwards while holding a catch.

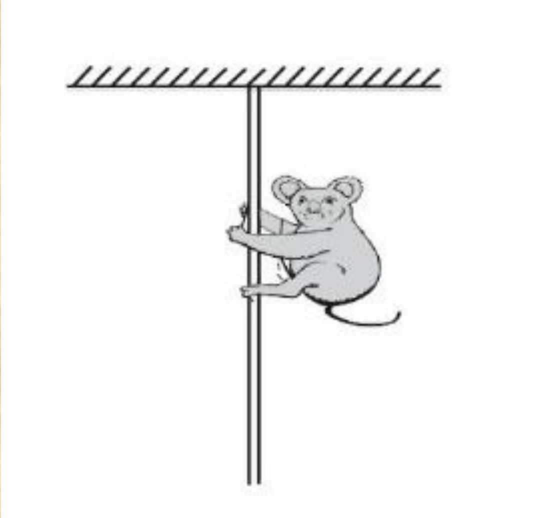
120. A wooden block of mass 2 kg rests on a soft horizontal floor. When an iron cylinder of mass 25 kg is placed on top of the block, the floor yields steadily and the block and cylinder together go down with an acceleration of 0.1 m/s². What is the action of the block on the floor:
(a) before the floor yields, and
(b) after the floor yields?
Take g = 10 m/s². Identify the action–reaction pairs in the problem.

121. Derive an expression for the velocity of a car on a banked circular road having coefficient of friction μ. Hence, write the expression for the optimum velocity.

122. Obtain an expression for the angle which a cyclist must make with the vertical while taking a circular turn (for successful negotiation).

123. A man of mass 70 kg stands on a weighing scale in a lift which is moving:
(a) Upwards with a uniform speed of 10 m/s
(b) Downwards with a uniform acceleration of 5 m/s^2
(c) Upwards with a uniform acceleration of 5 m/s^2
What would be the reading on the scale in each case? What would be the reading if the lift mechanism failed and it hurtled down freely under gravity?

124. A monkey of mass 40 kg climbs on a rope which can withstand a maximum tension of 600 N. In which of the following cases will the rope break? Ignore the mass of the rope.



(a) Climbs up with an acceleration of 6 m/s^2
(b) Climbs down with an acceleration of 4 m/s^2
(c) Climbs up with a uniform speed of 5 m/s
(d) Falls down the rope nearly freely under gravity.

125. A pump on the ground floor fills a tank of volume 30 m^3 in 15 min. The tank is 40 m above the ground and the pump efficiency is 30%. Calculate the electric power consumed.

126. Two bodies of masses 5 kg and 3 kg move in the same direction with velocities 5 m/s and 3 m/s respectively and undergo a one-dimensional elastic collision. Find their velocities after collision.

127. what will be the duration of the day, if earth suddenly shrinks to 1/27 of its original volume, mass remaining the same?

128. What will be the duration of the day, if the earth suddenly, shrinks to 1/64th of its original volume, mass remaining unchanged?

129. Derive the expression for the variation of 'g' with height from the surface of the earth.

130. Define escape velocity. Obtain an expression for the escape velocity of a body from the surface of the earth.

131. State and explain the Kepler's laws of planetary motion.

132. Derive an expression for the total energy of a satellite orbiting the earth. What is the significance of negative total energy?

CBQ

133. While treating the topic of projectile motion, it is assumed that the air resistance has no effect on the motion of the projectile. Friction, force due to viscosity, air resistance are all dissipative forces. In the presence of any of such force opposing motion, any object will lose some part of its initial energy and consequently, momentum too. Thus, a projectile that traverses a parabolic path will certainly show deviation from its idealized trajectory in the presence of air resistance. It will not hit the ground with the same speed with which was projected from it. In the absence of air resistance, the x - component of the velocity remains constant and it is only the y - component that undergoes a continuous change. However, in the presence of air resistance, both of these will get affected. That means that the range will be less than the value calculated from equation

$$R = \frac{u^2 \sin 2\theta_0}{g}$$

Maximum height attained will also be less than the value predicted by the equation

$$H_{max} = \frac{(u \sin\theta_0)^2}{2g}$$

In order to avoid air resistance, we will have to perform the experiment in vacuum or under low pressure.

1. In the absence of air resistance, what happens to the X and Y component of velocity of the projectile?
2. In presence of air resistance, what happens to the range and vertical height of projectile as compared to the same projectile moving without air resistance?
3. Following chart shows the acceleration due to gravity of different planets.

Planet	Acceleration due to gravity, g
Mercury	3.59
Venus	8.87
Earth	9.81
Mars	3.77
Jupiter	25.95
Saturn	11.08

If a body is projected with same speed at same angle, then at which planet range and height are maximum?

4. Show with the help of diagram, the path of a projectile in presence and absence of air resistance?

134. Suppose a scooter or a cycle is moving on a straight horizontal road with a constant speed v.

When the road takes a turn, the vehicle has to move on a curved path.

Let a small portion of this curved path has a radius of curvature r. While negotiating a turn, the vehicle tends to move in straight line due to inertia and hence tend to slip outward. This tendency of a vehicle to slip from a desired path is called skidding.

In order to oppose skidding, frictional force (f) comes into play. This force of friction between the road and the tyres provides necessary centripetal orce $\frac{mv^2}{r}$, where m is the mass of the vehicle.

$\therefore v = \sqrt{\frac{fr}{m}}$ ...(i)

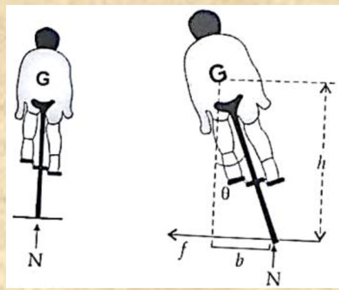
Maximum friction, $f_{max} = \mu N = \mu Mg$

Putting in eqn. (i)

$v_{\max} = \sqrt{\frac{\mu mgr}{m}} = \sqrt{\mu gr}$ ...(ii)

This is the maximum velocity the vehicle can achieve on the curved road.

This frictional force **f** creates another problem. It produces an outward torque h × f about the centre of gravity (G) of the vehicle, where h is the height of centre of gravity. This creates a tendency of over turning. Since the line of action of normal reaction N and weight m g pass through the centre of gravity **G** , they do not produce a counter torque to oppose his tendency of over turning.



To avoid this situation, the rider has to lean towards the centre of curvature of the road. Now, the line of action of normal reaction N does not pass through the centre of gravity. So, N gives rise a counter torque which opposes the torque due to friction i.e., h × f = b × n, where b is the horizontal distance of C.G. and point of ground contact A.

The condition of no over turning is that the rider must lean the vehicle by an angle θ , where

$$\tan\theta = \frac{b}{h} = \frac{f}{N} = \frac{mv^2/r}{mg} = \frac{v^2}{rg}$$

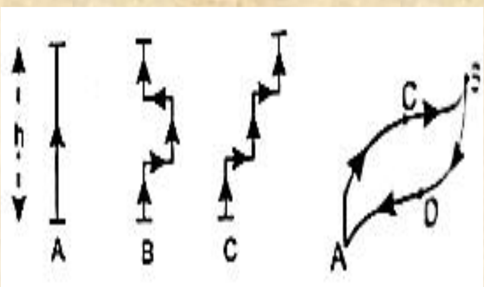
So, as the speed increases, the rider leans towards the ground more and more, so that the frictional force can provide the necessary centripetal force.

For maximum velocity, given by eqn. (i), the maximum angle through which the rider can lean is

$$\tan\theta_{\max} = \frac{f_{\max}}{N} = \frac{v^2\max}{rg} = \frac{\mu rg}{rg} = \mu$$

1. Write the expression for maximum velocity of a two wheeler on a curved road of radius r having coefficient of frictionμ . **(2)**
2. To avoid overturning, the cyclist should turn in which direction, explain. **(1)**
3. To avoid over turning at maximum speed, without skidding, on a road having frictional constant 0.57, how much a cyclist can lean? **(1)**

135. In nature we have various types of forces. A force is said to be a conservative force if work done by (or against) the force for moving an object from one position to another position depends on these two initial and final) points but is independent of other factors like the nature of path followed or velocity of object. It is also found that work done on an object against the conservative force present there gets stored up as the potential energy of the object. When external constraints are removed, the stored potential energy manifests itself as kinetic energy. If above mentioned conditions are not fulfilled then force is called a non - conservative force.



1. Give two examples of conservative forces.
2. Three girls of same mass climb through a certain height h' following different paths shown as A, B and C in the figure. In which case is the work done against gravity maximum and in which case it is minimum?
3. An object is taken from position A to B via a path ACB and then brought back to position A via another path BDA. If the force involved is a conservative force, then show that net work done for entire closed path is zero.
4. What is a non-conservative force? Give two examples

136. Certain collisions are referred to as elastic collisions. Elastic collisions are collisions in which both momentum and kinetic energy are conserved. The total system kinetic energy before the collision equals the total system kinetic energy after the collision. If total kinetic energy is not conserved, then the collision is referred to as an inelastic collision.

The coefficient of restitution, denoted by (e), is the measure of degree elasticity of collision. It is defined as the ratio of the final to initial relative speed between two objects after they collide. It normally ranges from 0 to 1 where 1 would be a perfectly elastic collision. A perfectly inelastic collision has a coefficient of 0. In real life most of the collisions are neither perfectly elastic nor perfectly inelastic and $0 < e < 1$.

(i) Two objects of equal mass collide with each other elastically, what happens to their velocities after the collision? **(1)**

(ii) Define coefficient of restitution, write units. **(2)**

(iii) Give the value of coefficient of restitution for perfectly elastic and perfectly inelastic collision. **(1)**