Class 11 physics most important numerical

[Source: NCERT, SL Arora's new simplified Physics and Pradeep's fundamental Physics**]**

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Units and measurements

1. Convert 1 N into dyne.

   [1 N = 10^5 dyne]

2. Check the dimensional consistency of the following equations:

   a. $\lambda = \frac{h}{mv}$ where h is Planck's constant, λ is wavelength, m is mass, and v is velocity

   b. $v = \sqrt{\frac{2GM}{R}}$, where v is velocity, G is universal gravitational constant, M is mass and R is radius.

   [both are correct]

3. Suppose time period of a simple pendulum depends upon (i) mass m of the bob (ii) length ℓ of the pendulum (iii) acceleration due to gravity g at the place. Derive an expression of time period using method of dimensions.

   $\left[T = 2\pi\sqrt{\frac{\ell}{g}}\right]$

4. Each side of cube is measured to be 7.203 m. What are the total surface area and the volume of the cube to appropriate significant figures?

   $\left[311.3\,m^2, 373.7\,m^3\right]$

5. 5.74 g of a substance occupies 1.2 cm^3. Express its density keeping significant figures in view.

   $\left[4.8\,g\,cm^{-3}\right]$

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6. Find the dimensions of $(a \times b)$ in the equation: $E = \frac{b - x^2}{at}$; where E is energy, x is distance and t is time.

$[M^{-1}L^2T]$

Motion in a straight line

7. A body travels from A to B at 40 m/s and from B to A at 60 m/s. Calculate the average speed and average velocity.

   [Ans. 48 m/s, 0]

8. On a 60 km/h track, a train travels the first 30 km with a uniform speed of 30 km/h. How fast must the train travel the next 30 km so as to average 40 km/h for the entire trip?

   [60 km/h]

9. The displacement of a particle moving along x-axis is given by $x = 18t + 5t^2$. Calculate:
   a. Instantaneous velocity at t = 2 s.
   b. Average velocity between t = 2 s and t = 3 s.
   c. Instantaneous acceleration.

   [38 m/s, 43 m/s , $10 ms^{-2}$]

10. The distance x of a particle moving in one dimension, under the action of a constant force is related to time t by the equation $t = \sqrt{x} + 3$, where x is in meters and t in seconds. Find the displacement of particle when its velocity is zero.

    [0]

11. The acceleration of a particle in m/s^2 is given by $a = 3t^2 + 2t + 2$ where t is in second. If the particle starts with velocity v = 2 m/s at t = 0, then find the velocity at end of 2s.

    [18 m/s]

12. A hundred-meter sprinter increases her speed from rest uniformly at the rate of 1 m/s^2 up to three quarters of the total run and covers the last quarter with uniform speed. How much time does she take to cover the first half and second half of the run?

    [10 s, 4.24 s]

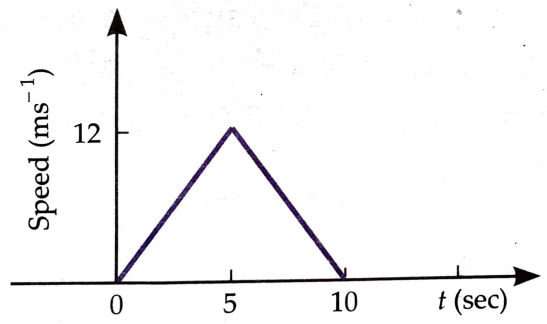
13. A motor car starts from rest and accelerates uniformly for 20 s to velocity of 20 m/s. It then runs at a constant speed and is finally brought to rest in 40 m with a constant acceleration. Total distance covered is 640 m. Find the value of acceleration, retardation and total time taken.

$[2\,ms^{-2}, -5\,ms^{-2}, 39\,s]$

14. A car accelerates from rest at a constant rate α for some time, after which it decelerates at constant rate β to come to rest. If the total time elapsed is t seconds, then calculate:
    a. Maximum velocity attained by the car.
    b. Total distance covered by the car.

$$[v_{max} = \frac{\alpha\beta t}{\alpha+\beta}, \text{ total distance} = \frac{\alpha\beta t^2}{2(\alpha+\beta)}]$$

15. A body covers 12 m in 2nd second and 20 m in 4th second. How much distance will it cover in 4 seconds after the fifth second? [Ans. 136 m]
16. A ball thrown vertically upwards with a speed of 19.6 m/s from the top of a tower returns to earth in 6s. Find the height of the tower.
    [58.8 m]
17. Two balls are thrown simultaneously, A vertically upwards with a speed of 20 m/s from the ground, and B vertically downwards from a height of 40 m with the same speed and along the same straight line of motion. At what points do the two balls collide?
    [after 1 s at height of 15.1 m]
18. A stone falls from a cliff and it travels 24.5 m in last second before it reaches the ground at the foot of the cliff. Find the height of the cliff.
    [44.1 m]
19. The speed time graph of a particle moving along a fixed direction is shown, find:



    (i) Distance travelled by the particle between 0 s to 10 s
    (ii) Average speed between this interval
    (iii) The time when the speed was minimum
    (iv) The time when speed was maximum.
    [60 m, 6 m/s, 10 s, 5 s]

20. A jet airplane traveling at a speed of 450 kilometers per hour ejects the burnt gases at the speed of 1200 kilometers per hour relative to the jet airplane. Find the speed of the burnt gases with respect to a stationary observer on earth. [750 km/h]
21. A car is moving with a speed of 60 kilometers per hour and car B is moving with a speed of 75 kilometers per hour, along parallel straight paths, starting from the same point. What is the position of car a with respect to B after 20 minutes? [5 km behind]
22. Two buses start simultaneously towards each other from towns A&B which are 480 kilometers apart the first bus takes 8 hours to travel from A to B while the second bus takes 12 hours to travel from B to a determine when and where the buses will meet? [4.8 hours, 288 km from A]
23. Two trains A & B each of length 100 meter are running on parallel tracks one overtakes the other in 2 seconds and one crosses the other in 10 seconds. Calculate the velocities of each train.
    [15 m/s and 5 m/s]
24. A motor boat covers the distance between two spots on the river in eight hours and 12 hours downstream and upstream respectively. Find the time required by the boat to cover this distance in Stillwater.
    [9.6 h]

Motion in a plane

25. A particle has a displacement of 12 meters towards east and 5 m towards north and then 6 m vertically upward. Find the magnitude of the sum of these displacements.
    [14.32 m]

26. Two forces of 5 N and 7 N act on a particle with an angle of 60° between them. Find the resultant force.
[10.44 N]

27. Two vectors, both equal in magnitude, have their resultant equal in magnitude of the either. Find the angle between the two vectors.
[120°]

28. 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.
[15 N and 25 N]

29. A boatman can row with a speed of 10 kilometres per hour in still water. If the river flows steadily at 5 kilometers per hour, in which direction should the boatman row in order to reach a point on the other bank directly opposite to the point from where he started? The width of the river is 2 kilometers.
[120°]

30. A motor boat is racing towards North at 25 kilometers per hour and the water current in that region is 10 kilometers per hour in the direction of 60° east of South. Find the resultant velocity of the boat.
[21.8 km/h 23.4° east of north]

31. On a certain day, rain was falling vertically with speed of 35 meter per second. A wind started blowing after some time with a speed of 12 meter per second in east to West direction. In which direction should a boy waiting at a bus stop hold his umbrella?

32. A river 800 m wide river flows at the rate of five km/h. A swimmer who can swim at 10 km/h in still water wishes to cross the river straight.
    a. Along what direction must he strike? [30° upstream perpendicular to river flow]
    b. What should be his resultant velocity? [2.4 m/s]
    c. How much time he would take? [333.3 s]

33. Find a unit vector parallel to the resultant of the vectors $\vec{A} = \hat{i} + 4\hat{j} - 2\hat{k}$ and $\vec{B} = 3\hat{i} - 5\hat{j} + \hat{k}$.
$\left[\frac{1}{3\sqrt{2}}\left(4\hat{i} - \hat{j} - \hat{k}\right)\right]$

34. A vector $\vec{X}$, when added to the resultant of the vectors $\vec{A} = 3\hat{i} - 5\hat{j} + 7\hat{k}$ and $\vec{B} = 2\hat{i} + 4\hat{j} - 3\hat{k}$ gives a unit vector along Y –axis. Find the vector $\vec{X}$.[$-5\hat{i} + 2\hat{j} - 4\hat{k}$]

35. Find the value of λ in the unit vector $0.4\hat{i}+0.8\hat{j}+\lambda\hat{k}$.

[$\sqrt{0.2}$]

36. A force is inclined at 30° to the horizontal. If its rectangular component in the horizontal direction is 50 N, find the magnitude of the force and its vertical component.

[57.74 N, 28.87 N]

37. An airplane takes off at an angle of 30° to the horizontal. If the component of its velocity along the horizontal is 200 km/h, what is its actual velocity? Also find the vertical component of its velocity.

[230 km/h, 115.47 km/h]

38. Find the angle between the vectors $\vec{A}=\hat{i}+2\hat{j}-\hat{k}$ $\vec{B}=-\hat{i}+\hat{j}-2\hat{k}$.

[60°]

39. Find the work done by force $\vec{F}=-\hat{i}+2\hat{j}+3\hat{k}$ in displacing a body through a distance of 4 m along the z-axis.

[12 joules]

40. If $|\vec{A}+\hat{B}|=|\vec{A}-\vec{B}|$, find the angle between $\vec{A}$ and $\vec{B}$.

[90°]

41. If vectors $\vec{P},\vec{Q}$ and $\vec{R}$ have magnitudes 5, 12 and 13 units and $\vec{P}+\vec{Q}=\vec{R}$, find the angle between $\vec{P}$ and $\vec{Q}$.

$\left[\cos^{-1}\left(\frac{12}{13}\right)\right]$

42. If unit vectors $\hat{a}$ and $\hat{b}$ are inclined at angle θ, then prove that $|\hat{a}-\hat{b}|=2\sin\frac{\theta}{2}$.

43. For what value of a are the vectors $\vec{A}=a\hat{i}-2\hat{j}+\hat{k}$ and $\vec{B}=2a\hat{i}+a\hat{j}-4\hat{k}$ perpendicular to each other?

[–2,1]

44. Calculate the area of the parallelogram whose two adjacent sides are formed by the vectors $\vec{A}=3\hat{i}+4\hat{j}$ and $\vec{B}=-3\hat{i}+7\hat{k}$.

[33 sq. units]

45. Determine a unit vector perpendicular to both $\vec{A}=2\hat{i}+\hat{j}+\hat{k}$ and $\vec{B}=\hat{i}-\hat{j}+2\hat{k}$.

$\left[\frac{1}{\sqrt{3}}\left(\hat{i}-\hat{j}-\hat{k}\right)\right]$

46. Two parallel rail tracks run N-S full train a moves North with a speed of 54 kilometers per hour and train B moves South with a speed of 90 kilometers per hour. What is the
    a. relative velocity of B with respect to A?
    b. relative velocity of ground with respect to B?
    c. Velocity of a monkey running on the roof of the train A against its its motion (with a velocity of 18 kilometers per hour with respect to train A) as observed by a man standing on the ground?

    $[-40 ms^{-1}, 25 ms^{-1}, 10 ms^{-1}]$

47. Find the value of a for which the vectors $\vec{A} = 3\hat{i} + 3\hat{j} + 9\hat{k}$ and $\vec{B} = \hat{i} + a\hat{j} + 3\hat{k}$ are parallel.

    [a = 1]

48. The position of a particle is given by $\vec{r} = 30t\hat{\imath} + 2.0t^2\hat{\jmath} + 5.0\hat{k}$ where t is in seconds and the coefficients have the proper units for r to be in meters. (a) Find $v(t)\ and\ a(t)$ of the particle. (b) find the magnitude and direction of $v(t)$ at t = 3.0 s.

    [Ans. $\vec{v}\ (t) = 3.0\hat{\imath} + 4.0t\ \hat{\jmath}, \vec{a}\ (t) = 4.0\hat{\jmath}, 76^o$]

49. A particle starts from origin at t = 0 with a velocity $5\hat{i}\, ms^{-1}$ and moves in x-y plane under action of a force which produces a constant acceleration of $\left(3.0\hat{i} + 2.0\hat{j}\right) ms^{-2}$ (a) what is the y coordinate of the particle at the instant its x coordinate is 84 m? What is the speed of the particle at this time?

    [36.0 m, 25.9 m/s]

50. To a driver going east in a car with a velocity of 40 km/h, a bus appears to move towards north with a velocity of $40\sqrt{3}$ km / h. What is the actual velocity and direction of motion of bus?

    [80 km/h 30° east of north]

51. Rain is falling vertically with a speed of 35 m/s. A woman rides a bicycle with a speed of 12 m/s in east to west direction. What is the direction in which she should hold her umbrella?

    [at an angle of 19° with the vertical towards the west]

Projectile motion

52. A hiker stands on the edge of the cliff 490 m above the ground and throws a stone horizontally with an initial speed of 15 m/s. Neglecting air resistance, find the time taken by the stone to reach the ground, and the speed with which it hits the ground.
[10 s, 99.1 m/s]

53. Two tall buildings face each other and are at a distance of 180 m from each other. With what velocity must a ball be thrown horizontally from a window 55 m above the ground in one building, so that it enters a window 10.9 m above the ground in the second building?
[60 m/s]

54. A stone is dropped from the window of a bus moving at 60 km/h. If the window is 1.96 m high, find the distance along the track, which the stone moves before striking the ground.
[10.54 m]

55. A body is projected with a velocity of 30 m/s at an angle of 30^{o} with the vertical. Find the maximum height, time of flight and horizontal range.
[34.44 m/s, 5.3 s, 79.53 m]

56. A boy stands at 39.2 m from a building and throws a ball just passes through a window 19.6 m above the ground. Calculate the velocity of projection of the ball.
[27.72 m/s]

57. Prove that the maximum horizontal range is four times the maximum height attained by the projectile when fired at an inclination so as to have maximum horizontal range.

58. Show that there are two angles of projection for which the horizontal range is same. Also show that the sum of the maximum heights for these two angles is independent of the angle of projection.

59. Show that there are two values of time for which a projectile is at same height. Also show that the sum of these two times is equal to the time of flight.
60. A cricketer can throw a ball to maximum horizontal distance of 160 m. calculate the maximum vertical height to which he can throw the ball. ($g = 10\ m/s^2$)
    [80 m]
61. An insect trapped in a circular groove of radius 12 cm moves along the groove steadily and completes 7 revolutions in 100 s
    a. What is the angular speed and the linear speed of the motion?
    b. Is the acceleration vector a constant vector? What is the magnitude?
    c. What is its linear displacement?

    [0.44 rad/s, 5.28 cm/s, 2.32 cm/s^2]

Laws of motion

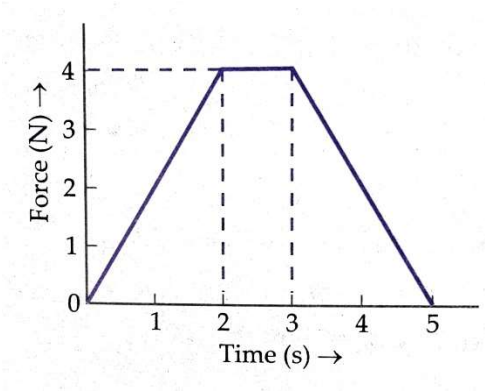
62. A bullet of mass 0.04 kg moving with a speed of 90 m/s enters a heavy wooden block and is stopped after a distance of 60 cm. What is the average resistive force exerted by the block on the bullet?
    [270 N]
63. A force of 5 N gives a mass m_1 an acceleration of 8 m/s^2 and a mass m_2 an acceleration of 24 m/s^2. What acceleration would it give if both masses are tied together?
    [6 m/s^2]
64. A stone of mass 5 kg falls from top of a cliff 50 m high and buries 1 m deep in sand. Find the average resistance offered by the sand and the time it takes to penetrate.
    [2450 N, 0.064 s]
65. A block of metal weighing 2 kg is resting on a friction less plane. It is struck by a jet releasing water at the rate of 1 kg/s and at a speed of 5 m/s. Calculate the initial acceleration of the block.
    [2.5 m/s^2]
66. A batsman hits back a ball straight in the direction of the bowler without changing its initial speed of 12 m/s. If the mass of the ball is 0.15 kg, determine the impulse imparted to the ball.
    [−3.6 Ns]

67. A machine gun fires a bullet of mass 40 g with a speed of 1200 m/s. The person holding the gun can exert a maximum force of 144 N on it. What is the number of bullets that can be fired from the gun per second?
[3 bullets/s]

68. A ball moving with a momentum of 5 kgm/s strikes against wall at an angle of 45o and is reflected at the same angle. Calculate the change in momentum.
[-7.07kgm/s]

69. A ball whose mass is 10 g falls from a height of 10 m. Find the impulse and the average force between the glass ball and the floor if the time during which they are in contact is 0.1 s.
[12 kgm/s, 4.2 N]

70. A force acting on a body of mass 2 kg varies with time as shown. Find the impulse of force and final velocity of the body.



71. Find the apparent weight of a man weighing 49 kg on earth when he is standing in a lift which is (i) rising with an acceleration of 1.2 m/s^2 (ii) going down with the same acceleration (iii) falling freely under the action of gravity and (iv) going up or down with uniform velocity.
[(i) 55 kgf (ii) 43 kgf (iii) 0 (iv) 49 kgf]

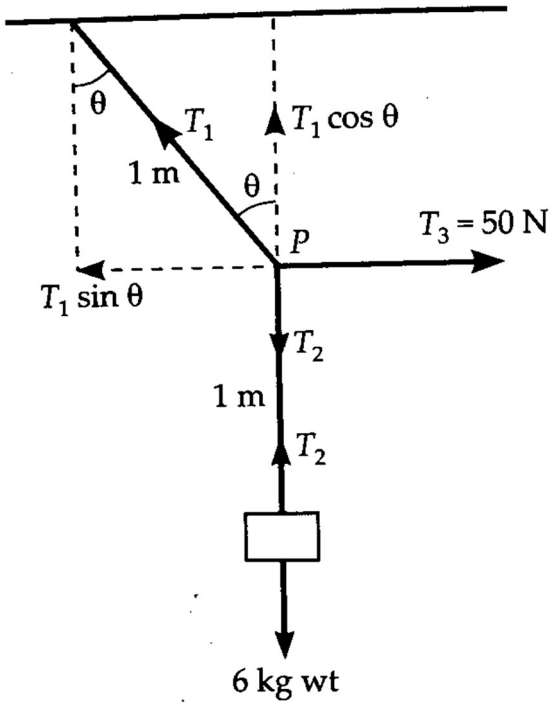
72. An elevator weighs 4000 kg. When upward tension in supporting cable is 48000 N, what is the upwards acceleration? [2.2 m/s^2]

73. A bomb at rest explodes into three fragments of equal masses. Two fragments fly off at right angles to each other with velocities 9 m/s and 12 m/s respectively. Calculate the speed of the third fragment. [15 m/s]

74. A 40 g shell is flying at a speed of 72 km/h. It explodes into two pieces. One of the pieces of mass 15 kg stops. Calculate the speed of the other. [32 m/s]

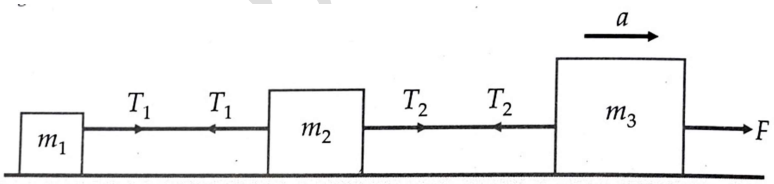
75. A mass of 6 kg is suspended by a rope of length 2 m from a ceiling. A force of 50 N in the horizontal direction is applied at the mid-point of the rope as shown. What is the angle the rope makes with the vertical in equilibrium?

[39.8°]



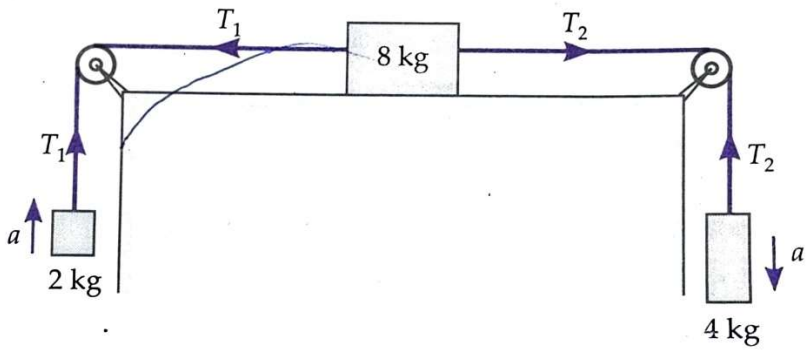
76. Three blocks connected together lie on a horizontal frictionless table and pulled to the right with a force F = 50 N. If m_1 = 5 kg, m_2 = 10 kg and m_3 = 15 kg, find the tensions T_1 and T_2.

[8.33 N, 25 N]



77. Find the acceleration a of the system and tensions T_1 and T_2 in the strings. Assume that the tables and pulleys are frictionless and strings are massless.

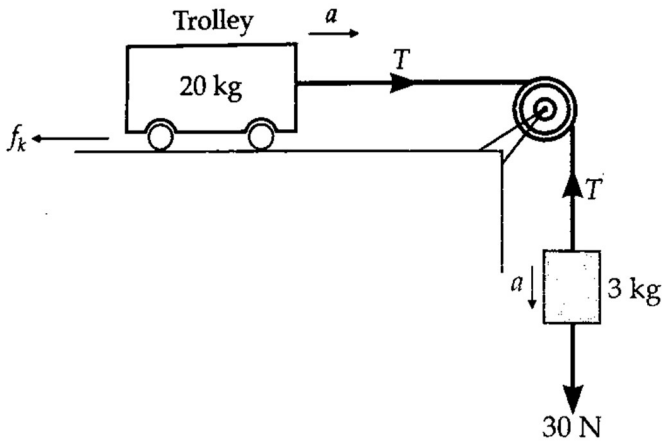
[1.4 m/s^2, 22.4 N, 33.6 N]



Friction

78. 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 train's floor is 0.15. Take g = 10 m/s^2.
[1.5 m/s^2]

79. What is the acceleration of the block and trolley system shown, if the coefficient of kinetic friction between the trolley and the surface is 0.04 N? What is the tension in the string? Take g = 10 m/s^2. Neglect the mass of the string.
[27.12 N, 0.96 m/s^2]



80. A bullet of mass 10 g is fired horizontally into a 5 kg wooden block, at rest on a horizontal surface. The coefficient of kinetic friction between the block and the surface is 0.1. Calculate speed of the bullet striking the block, if the combination moves 20 m before coming to rest.
[3136.26 m/s]

81. A mass of 200 kg is resting on a rough inclined plane of 30^o. If the coefficient of friction is, find the least and greatest forces acting parallel to plane to keep the mass in equilibrium.
[0 and 1960 N]

82. When an automobile moving with a speed of 36 km/h reaches an upward inclined road of angle 30°, its engine is switched off. If the coefficient of friction involved is 0.1, how much distance with the automobile move before coming to rest? Take g = 10 m/s^2
[8.52 m]

83. Find the force required to move a train of 2000 quintals up an incline of 1 in 50, with an acceleration of 2m/s^2, the force of friction being 0.5 newton per quintal.
[440200 N]

Banking of roads

84. A bend in a level road has a radius of 100 m. Find the maximum speed which a car turning this bend may have without skidding, if the coefficient of friction between the tyres and the road is 0.8.
[28 m/s]

85. A train has to negotiate a curve of 400 m. By how much should the outer rail be raised with respect to inner rail for a speed of 48 km/h. The distance between the rails is 1 m.
[0.0454 m]

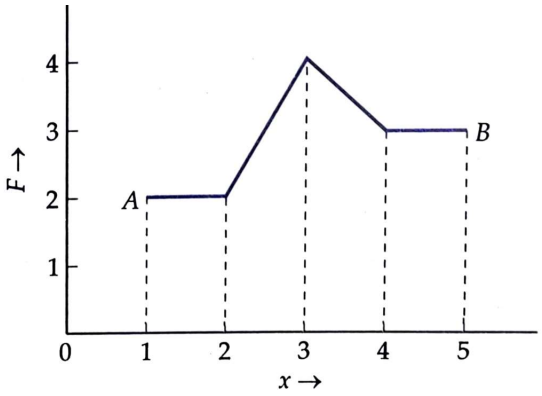
86. A cyclist speeding at 18 km/h on a level road takes a sharp circular turn of radius 3 m without reducing the speed and without bending towards the centre of the circular path. The coefficient of the static friction between the tyres and the road is 0.1. Will the cyclist slip while taking the turn? [yes]

87. A circular race track of radius 300 m is banking at an angle of 15°. If the coefficient of friction between the wheels of the car and the road is 0.2, what is the
    a. Optimum speed of the car to avoid wear and tear on its tyres, and
    b. Maximum permissible speed to avoid slipping?
[28.1 m/s, 38.1 m/s]

Work energy power

88. A force $F = (15 + 0.50x)$ acts on a particle in X direction, where F is in newton and x in metre. Find the work done by this force during a displacement from x = 0 to x = 2.0 m.
[31 J]

89. A body moves a point from A to B under the action of a force as shown. Force is in N and distance is in m. Find the work done.



90. The relation between the displacement x and the time t for a body of mass 2 kg moving under the action of force is given by $x = \frac{t^3}{3}$, where x is in meters and t is in second, calculate the work done by the body in first 2 seconds.
[16 J]

91. A bullet 10 g is fired with a velocity of 800 m/s. After passing through a mud wall 1 m thick, its velocity decreases to 100 m/s. Find the average resistance offered by mud wall.
[3150 N]

92. If the linear momentum of a body increases by 20 %, what is the percentage increase in KE of the body?
[44%]

93. A girl of mass 40 kg sits in a swing formed by a rope of length 6 m. A person pulls the swing to a slide so that the rope makes an angle of 60^o with the vertical. What is the gain in potential energy pf the girl?
[1176 J]

94. Two springs have force constants k_1 and k_2 ($k_1 > k_2$). On which spring is more work done, if (i) they are stretched by the same force (ii) they are stretched by the same amount?
[$W_2 > W_1$, $W_1 > W_2$]

95. A solid of mass 2 kg moving with a velocity of 10 m/s strikes an ideal weightless spring and produces a compression of 25 cm in it. Calculate the force constant of the spring.
[3200 N/m]

96. A car of mass 200 kg is lifted up a distance of 30 m by a crane in 1 min. A second crane does the same job in 2 min. Do the cranes consume same or different amount of fuel? What is the power supplied by each crane? Neglect power dissipation against friction.
[9800 W, 4900 W]

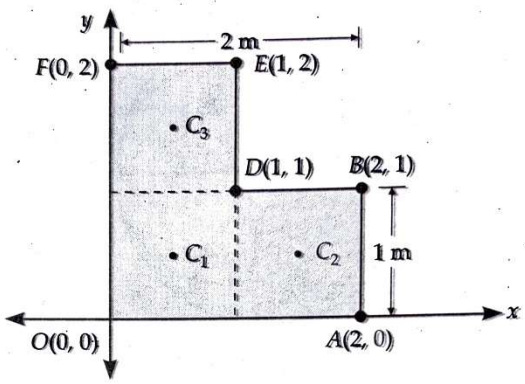
97. An elevator which carries a maximum load of 1800 kg is moving up with a constant speed of 2 m/s. The frictional force opposing the motion is 4000 N. Determine the minimum power delivered by the motor to the elevator.
[44000 W]

98. Water is pumped out of a well 10 m deep by means of a pump rated at 10 kW. Find the efficiency of the motor if 4200 kg of water is pumped out every minute. ($g = 10\ m/s^2$)
[70%]

System of particles and rotational motion

99. Three masses 3, 4 and 5 kg are located at the three corners of an equilateral triangle of side 1 m. Locate the centre of mass of the system.
[0.54 m, 0.36 m]

100. Find the centre of mass of a uniform L shaped lamina (a thin flat plate) with dimensions as shown in figure. The mass of lamina is 3 kg.
[5/6 m, 5/6 m]



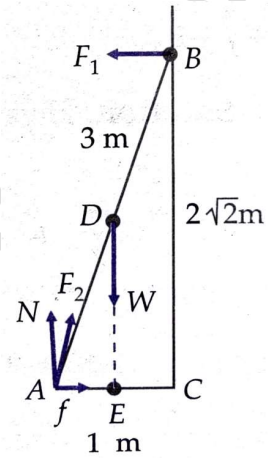
101. A circular plate of uniform thickness has diameter of 56 cm. A circular portion of diameter 42 cm is removed from one edge of the plate. Find CM of the remaining portion.
[9 cm]

102. The angular speed of a motor wheel is increased from 1200 rpm to 3120 rpm in 16 seconds.
   a. What is the angular acceleration, assuming the acceleration to be uniform?
   b. How many revolutions does the wheel make during this time?

[$4\pi, \frac{4\pi n}{t^2}$]

103. A metal bar 70 cm long and 4.00 kg in mass is supported on two knife edges placed 10 cm from each end. Find reaction at knife edges placed 10 cm from each end. A 6 kg weight is suspended at 30 cm form one end. Find reaction an knife edges.
[54.88 N, 43.12 N]

104. A 3 m long ladder weighing 20 kg leans on a frictionless wall. Its feet rest on the floor 1 m form the wall as shown. Find the reaction forces of the wall and the floor.
[34.6 N, 199.0 N]



105. Three balls of masses 1, 2 and 3 kg respectively are arranged at the corners of an equilateral triangle of side 1 m. What will be the moment of inertia of the system about an axis through centroid and perpendicular to the plane of the triangle.
[2 kgm^2]

106. Four particles of masses 4 kg, 2 kg, 3 kg, and 5 kg are respectively located at the four conrers A, B, C and D of a square of side 1 m, as shown. Calculate the moment of inertia of the system about
   a. An axis passing through point of intersection of the diagonals and perpendicular to the plane of the square,
   b. The side AB, and
   c. Diagonal BD

[7 kgm^2, 8 kgm^2, 3.5 kgm^2]

107. The moment of inertia of a uniform circular disc about its diameter is 100 gcm^2. What is its moment of inertia (i) about its tangent (ii) about an axis perpendicular to its plane?
[(i) 500 gcm^2, (ii) 200 gcm^2]

108. Tw pint masses f 2 kg and 10 kg are connected by a weightless rod of length 1.2 m. Calculate the MI of the system about an axis passing through the centre of mass and perpendicular to the system.
[2.4 kgm^2]

109. Calculate the kinetic energy of rotation of a circular disc of mass 1 kg and radius 0.2 m rotating about an axis passing through its centre and perpendicular to its plane. The disc making $\frac{30}{\pi}$ rotations per minute.
[0.01 J]

110. Energy of 484 J is spent in increasing the speed of a flywheel form 60 rpm to 360 rpm. Find the moment of Inertia of the wheel.
[0.7 kgm^2]

111. A solid cylinder rolls down an inclined plane. Its mass is 2 kg and radius 0.1 m. If the height of the inclined plane is 4 m, what is its rotational KE when it reaches the foot of the plane?
[26.13 J]

112. A flywheel of mass 25 kg has a radius of 0.2 m. It is making 240 rpm. What is the torque necessary to bring it to rest in 20 s? If the torque is due to a force applied tangentially on the rim of the flywheel, what is the magnitude of the force?

$[-\frac{\pi}{5}\text{Nm},\ \pi\text{N}]$

113. A chord is wound around the circumference of a wheel of diameter 0.3 m. The axis of wheel is horizontal. A mass of 0.5 kg is attached at the end of the cord and it is allowed to fall from rest. If the weight falls 1.5 m in 4 s, what is the angular acceleration of the wheel? Also find out the moment of inertia of the wheel.

$\left[125\,\text{rads}^{-2}, 0.588\,\text{kgm}^2\right]$

114. A chord of negligible mass is wound round the rim of a flywheel of mass 20 kg and radius 20 cm. A steady pull of 25 N is applied on the chord as shown. The flywheel is mounted on a horizontal axle with frictionless bearings.
    a. Compute the angular acceleration of the wheel.
    b. Find the work done by the pull, when 2 m of the chord in unwound.
    c. Find also the kinetic energy of the wheel at this point. Assume that the wheel starts from rest.

    $\left[12.5\,\text{rads}^{-2}, 50\,\text{J}, 50\,\text{J}\right]$

115. A cylinder of mass 5 kg and radius 30 cm, and free to rotate abut its axis, receives an angular impulse of 3 $\text{kgm}^2\text{s}^{-1}$ initially followed by a similar impulse after every 4 s. What is the angular speed of the cylinder 30 second after the initial impulse? The cylinder is at rest initially.

    $[106.67\,\text{rads}^{-1}]$

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

    [1.5 h]

117. Three bodies, a ring, a solid cylinder and a solid sphere roll down the same inclined plane without slipping. They start from rest. The radii of the bodies are identical. Which of the bodies reaches the ground with maximum velocity?

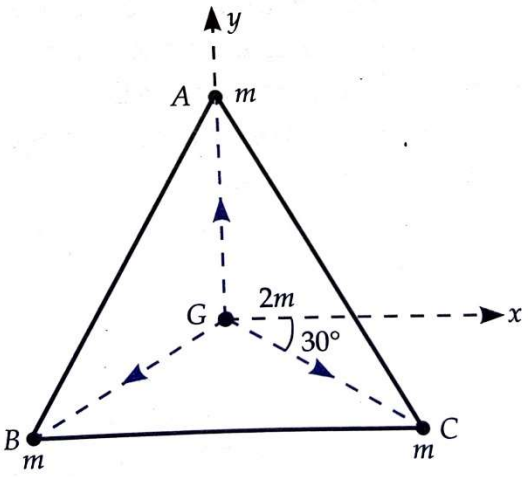
    [Sphere]

Gravitation

118. A mass M is broken into two parts of masses m_1 and m_2 How are m_1 and m_2 related so that force of gravitational attraction between the two parts is maximum?

    [M/2, M/2]

119. Three equal masses of m kg each are fixed at the vertices of an equilateral triangle ABC, as shown



a. What is the force acting on a mass 2 m placed at the centroid G of the triangle?

b. What is the force if the mass at the vertex A is doubled?

Take AG = BG = CG = 1 m

[0, $2Gm^2\hat{j}$]

120. If the radius of the earth shrinks by 2%, mass remaining constant, then how would the value of acceleration due to gravity change?

[increases by 4%]

121. A body weighs 90 kgf on the surface of the earth. How much will it weigh on the surface of mars whose mass is 1/9 and radius is ½ of that of earth?

[40 kgf]

122. At what height above the earth's surface, the value of g is half of its value on earth's surface? Given the radius of earth is 6400 km.

[2649.6 km]

123. Find the percentage decrease in weight of a body when taken to a height of 32 km above the surface of the earth. Radius of earth is 6400 km.

[1%]

124. At what height above the earth's surface, the value of g is same as in a mine 80 km deep?

[40 km]

125. Two bodies of masses 10 kg and 1000 kg are at a distance 1 mm apart. At which point on the line joining them will the gravitational field intensity be zero?

[1/11 m]

126. Find the potential energy of a system of four particles, each of mass m placed at the vertices of a square of side L. Also obtain the potential at the centre of the square.

[NCERT] $\left[-5.41\frac{Gm^2}{L^2}, -4\sqrt{2}\frac{Gm}{L}\right]$

127. The radius of a planet is double that of the earth but their average densities are same If the escape velocities at the planet and the earth are v_p and v_E, then prove that $v_p = 2v_E$.

128. The escape velocity of a projectile on the surface of earth is 11.2 km/s. A body is projected out with twice this speed. What is the speed of the body far away from earth i.e. at infinity? Ignore the presence of the sun and other planets.

[19.4 km/s]

129. The distance of two planets from the sun are 10^{13} and 10^{12} m respectively. Find the ratio of time periods and speeds of the two planets.

$[10\sqrt{10}, 1/\sqrt{10}]$