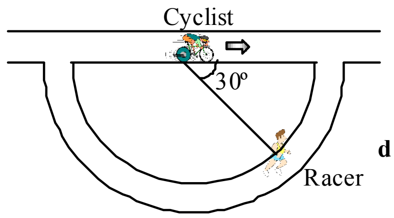
1 Mechanics

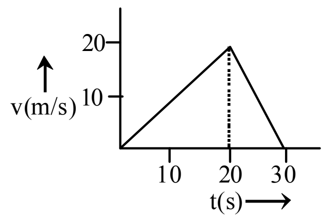
EXERCISE

1. A cyclist is moving with a constant acceleration of 1.2 m/s^2 on a straight track. A racer is moving on a circular path of radius 150 m at constant speed of 15 m/s. Find the magnitude of velocity of racer which is measured by the cyclist has reached a speed of 20 m/s for the position represented in the figure -



(A) 18.03 m/s (B) 25 m/s (C) 20 m/s (D) 15 m/s

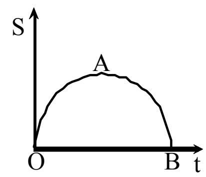
2.* v-t graph of an object of mass 1 kg is shown. Select the wrong statement-



(A) Work done on the object in 30 s is zero
(B) The average acceleration of the object is zero
(C) The average velocity of the object is zero
(D) The average force on the object is zero

3. A train starting from rest travels the first part of its journey with constant acceleration a, second part with constant velocity v and third part with constant retardation a, being brought to rest. The average speed for the whole journey is $\frac{7v}{8}$. The train travels with constant velocity for ...of the total time -
(A) 3/4 (B) 7/8 (C) 5/6 (D) 9/7

4. The graph of displacement-time for a body travelling in a straight line is given. We can conclude that -



(A) the velocity is constant
(B) the velocity increases uniformly
(C) the body is subjected to acceleration from O to A
(D) the velocity of the body at A is zero

5.* A particle is projected vertically upwards and it reaches the maximum height H in time T seconds. The height of the particle at any time t will be-
(A) g (t - T)2 (B) H - g (t - T)2 (C) g (t - T)2 (D) H - g (t - T)

6. A body moves with uniform velocity of u = 7 m/s from t = 0 to t = 1.5 sec. For t > 1.5 s, it starts moving with an acceleration of 10 m/s2. The distance travelled between t = 0 to t = 3 sec will be -
(A) 47.75 m (B) 32.25 m (C) 16.75 m (D) 27.50 m

7. A person is standing on a truck moving with a constant velocity of 14.7 m/s on a horizontal road. The man throws a ball in such a way that it returns to the truck after the truck has moved 58.8 m. What is the speed of the ball as seen from the truck?
(A) 9.8 m/s (B) 19.6 m/s (C) 29.4 m/s (D) 24.5 m/s

8. A stone is thrown from a bridge at an angle of 30º down with the horizontal with a velocity of 25 m/s. If the stone strikes the water after 2.5 sec then calculate the height of the bridge from the water surface-

(A) 61.9 m (B) 35 m (C) 70 m (D) None

9.* A cannon ball has a range R on a horizontal plane. If h and h' are the greatest heights in the two paths for which this is possible, then-

(A) $R = 4\sqrt{(hh')}$ (B) $R = \frac{4h}{h'}$ (C) R = 4 h h' (D) $R = \sqrt{hh'}$

10. If retardation produced by air resistances to projectile is one-tenth of acceleration due to gravity, the time to reach maximum height approximately-

(A) increase by 9% (B) decrease by 9%
(C) increase by 11% (D) decrease by 11%

11.* A particle starts from the origin of coordinates at time t = 0 and moves in the xy plane with a constant acceleration α in the y-direction. Its equation of motion is $y = \beta x^2$. Its velocity component in the x-direction is -

(A) variable (B) $\sqrt{\frac{2\alpha}{\beta}}$ (C) $\frac{\alpha}{2\beta}$ (D) $\sqrt{\frac{\alpha}{2\beta}}$

12.* Two particles are projected from the same point with the same speed, at different angles θ_1 and θ_2 to the horizontal. They have the same horizontal range. Their times of flight are t_1 and t_2 respectively incorrect statement is.

(A) $\theta_1 + \theta_2 = 90º$ (B) $\frac{t_1}{t_2} = \tan\theta_1$ (C) $\frac{t_1}{t_2} = \tan\theta_2$ (D) $\frac{t_1}{\sin\theta_1} = \frac{t_2}{\sin\theta_2}$

13. A particle moves along the positive branch of the curve $y = \frac{x^2}{2}$ where $x = \frac{t^2}{2}$, where x and y are measured in metre and t in second. At t = 2 sec, the velocity of the particle is -

(A) $(2\hat{i} - 4\hat{j})$ m/sec (B) $(2\hat{i} + 4\hat{j})$ m/sec (C) $(2\hat{i} + 2\hat{j})$ m/sec (D) $(4\hat{i} - 2\hat{j})$ m/sec

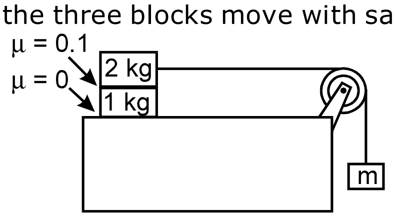
14. A boy standing on a long railroad car throws a ball straight upwards. The car is moving on the horizontal road with an acceleration of $1 m/s^2$ and the projection velcoity in the vertical direction is 9.8 m/s. How far behind the boy will the ball fall on the car -

(A) 1 m (B) 2 m (C) 3 m (D) 4 m

15. A block of mass 4 kg is kept over a rough horizontal surface. The coefficient of friction between the block and the surface is 0.1. At t = 0, 3 m/s $(\hat{i})$ velocity is imparted to the block and simultaneously 2N $(-\hat{i})$ force starts acting on it. Its displacement in first 5 second is ($g = 10 m/s^2$) -

(A) $8\hat{i}$ (B) $-8\hat{i}$ (C) $3\hat{i}$ (D) $-3\hat{i}$

16. Mass of upper block and lower block kept over the table is 2 kg and 1 kg respectively and coefficient of friction between the blocks is 0.1. Table surface is smooth. The maximum mass M for which all the three blocks move with same acceleration is ($g = 10 m/s^2$) -

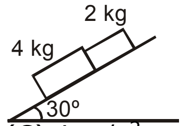


(A) 1 kg (B) 2/3 kg (C) 1/3 kg (D) 3/4 kg

17. A block slides down an inclined surface of inclination 30º with the horizontal. Starting from rest it covers 8m in the first two seconds. Find the coefficient of kinetic friction between the two.
(A) 0.11 (B) 0.5 (C) 0.8 (D) 0.2

18. A body of mass 2 kg is lying on a rough inclined plane of inclination 30º. Find the magnitude of the force parallel to the incline needed to make the block move (a) up the incline (b) down the incline. Coefficient of static friction = 0.2
(A) 13 N, 5 N (B) 13 N, 13 N (C) 13 N, 0 N (D) 5 N, 13 N

19. Figure shows two blocks in contact sliding down an inclined surface of inclination 30º. The friction coefficient between the block of mass 2.0 kg and the incline is μ_1, and that between the block of mass 4.0 kg and the incline is μ_2. Calculate the acceleration of the 2.0 kg block if μ_1 = 0.30 and μ_2 = 0.20, Take g = 10 m/s^2



(A) 2 m/s^2 (B) 2.7 m/s^2 (C) 4 m/s^2 (D) 2.4 m/s^2

20.* A box of mass 8 kg is placed on a rough inclined plane of inclination θ. Its downward motion can be prevented by applying an upward pull F and it can be made to slide upwards by applying a force 2F. The coefficient of friction between the box and the inclined plane is -

(A) $\frac{1}{3}\tan\theta$ (B) $3\tan\theta$ (C) $\frac{1}{2}\tan\theta$ (D) $2\tan\theta$

21. The rear side of a truck is open and box of mass 20 kg is placed on the truck 4 meters away from rest with an acceleration of 2 m/sec^2 on a straight road. The truck starts from rest with an acceleration of 2 m/sec^2 on a straight road. The box will fall off the truck when it is at a distance from the starting point equal to (μ = 0.15) -
(A) 4 m (B) 8 m (C) 16 m (D) 32 m

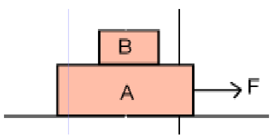
22.* A uniform rope of length ℓ lies on a table if the coefficient of friction is μ, then the maximum length ℓ, of the part of this rope which can over hang from the edge of the table without sliding down is -

(A) $\frac{\ell}{\mu}$ (B) $\frac{\ell}{\mu+1}$ (C) $\frac{\mu\ell}{\mu+1}$ (D) $\frac{\mu\ell}{\mu-1}$

23. A particle is projected along a line of greatest slope on a rough plane inclined at an angle of 45º with the horizontal, if the coefficient of friction is 1/2, then the retardation is-

(A) $\frac{g}{\sqrt{2}}$ (B) $\frac{g}{2\sqrt{2}}$ (C) $\frac{g}{\sqrt{2}}\left(1+\frac{1}{2}\right)$ (D) $\frac{g}{\sqrt{2}}\left(1-\frac{1}{2}\right)$

24. A body A of mass 1 kg rests on a smooth surface. Another body B of mass 0.2 kg is placed over A as shown. The coefficient of static friction between A and B is 0.15. B will begin to slide on A, if A is pulled with a force greater than -



(A) 1.764 N (B) 0.1764 N
(C) 0.3 N (D) it will not slide for any F

25. A heavy uniform chain lies on a horizontal table top. If the coefficient of friction between the chain and the table surface is 0.25, then the maximum fraction of the length of the chain that can hang over one edge of the table is -
(A) 20% (B) 25% (C) 35% (D) 15%

26. A block rests on an inclined plane that makes an angle θ with the horizontal, if the coefficient of sliding friction is 0.50 and that of static friction is 0.75, the time required to slide the block 4 m along the inclined plane is -

(A) 25 s (B) 10 s (C) 5 s (D) 2 s

27.* A force F accelerates a block of mass m on horizontal surface. The coefficient of friction between the contact surface is μ. The acceleration of m will be -

(A) $\frac{F-\mu mg}{M}$ (B) zero (C) may be (A) or (B)(D) none of these

28. A horizontal force F is exerted on a 20 kg block to push it up an inclined plane having an Inclination of 30º. The frictionalforce retarding the motion is 80 N. For the acceleration of the moving block to be zero, the force F must be-

(A) 206 N (B) 602 N (C) 620 N (D) 260 N

29. A person wants to drive on the vertical surface of a large cylindrical wooden 'well' commonly known as 'death well' in a circus. The radius of the well is R and the coefficient of friction between the tyres of the motorcycle and the wall of the well is μ_s. The minimum speed the motor cyclist must have in order to prevent slipping should be -

(A) $\sqrt{\frac{gR}{\mu_s}}$ (B) $\sqrt{\frac{\mu_s}{gR}}$ (C) $\sqrt{\frac{\mu_s g}{R}}$ (D) $\sqrt{\frac{R}{\mu_s g}}$

30. A spherical ball of mass 1/2 kg is held at the top of an inclined rough plane making angle 30º with the horizontal the coefficient of limiting friction is 0.5. If the ball just slides down the plane without rolling its acceleration down the plane is -

(A) $\left[\frac{2-\sqrt{3}}{4}\right]g$ (B) g (C) $\left[\frac{2\sqrt{3}-1}{4}\right]g$ (D) $\left[\frac{\sqrt{3}-1}{2}\right]g$

31. An object is placed on the surface of a smooth inclined plane of inclination θ. It takes time t to reach the bottom of the inclined plane. If the same object is allowed to slide down rough inclined plane of same inclination θ, it takes time nt to reach the bottom where n is a number greater than 1. The coefficient of friction μ is given by -

(A) $\mu = \tan\theta \left(1-\frac{1}{n^2}\right)$ (B) $\mu = \cot\theta \left(1-\frac{1}{n^2}\right)$

(C) $\mu = \tan\theta \left(1-\frac{1}{n^2}\right)^{1/2}$ (D) $\mu = \cot\theta \left(1-\frac{1}{n^2}\right)^{1/2}$

32. A given object takes n times as much time to slide down a 45º rough incline as it takes to slide down a perfectly smooth 45º incline. The coefficient of kinetic friction between the object and the incline is given by -

(A) $1 - \frac{1}{n^2}$ (B) $\frac{1}{1-n^2}$ (C) $\sqrt{1-\frac{1}{n^2}}$ (D) $\sqrt{\frac{1}{1-n^2}}$

33. A 15 kg mass is accelerated from rest with a force of 100 N. As it moves faster, friction and air resistance create an oppositively directed retarding force given by $F_R = A + Bv$, where A = 25 N and B = 0.5 N/m/s. At what velocity does the acceleration equal to one half of the initial acceleration?

(A) 25 ms^{-1} (B) 50 m/s (C) 75 m/s (D) 100 m/s

34. Two blocks of masses M = 3 kg and m = 2 kg, are in contact on a horizontal table. A constant horizontal force F = 5 N is applied to block M as shown. There is a constant frictional force of 2 N between the table and the block m but no frictional force between the table and the first block M, then the acceleration of the two blocks is-

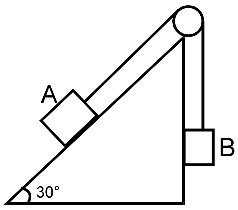
(A) 0.4 ms^{-2} (B) 0.6 ms^{-2} (C) 0.8 ms^{-2} (D) 1 ms^{-2}

35. Block A of mass M in the system shown in the figure slides down the incline at a constant speed. The coefficient of friction between block A and the surface is $\frac{1}{3\sqrt{3}}$.

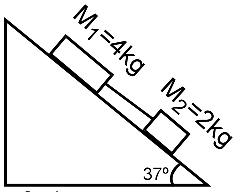
The mass of block B is-

(A) M/2 (B) M/3

(C) 2M/3 (D) M/$\sqrt{3}$



36. Two blocks connected by a massless string slide down an inclined plane having angle of inclination 37º. The masses of the two blocks are M_1 = 4 kg and M_2 = 2 kg respectively and the coefficients of friction 0.75 and 0.25 respectively-



(A) The common acceleration of the two masses is 1.3 ms^{-2}

(b) The tension in the string is 14.7 N

(c) The common acceleration of the two masses is 2.94 ms^{-2}

(d) The tension in the string is 5.29 N

(A) a, d (B) c, d (C) b, d (D) b, c

37. A block of mass m is placed on a rough inclined plane of inclination θ kept on the floor of the lift. The coefficient of friction between the block and the inclined plane is μ. With what acceleration will the block slide down the inclined plane when the lift falls freely ?

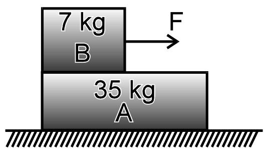
(A) Zero

(B) g sin θ – μg cos θ

(C) g sin θ + μg cos θ

(D) None of these

38 Block A of mass 35 kg is resting on a frictionless floor. Another block B of mass 7 kg is resting on it as shown in the figure. The coefficient of friction between the blocks is 0.5 while kinetic friction is 0.4. If a force of 100 N is applied to block B, the acceleration of the block A will be (g = 10 m s^{-2}) :



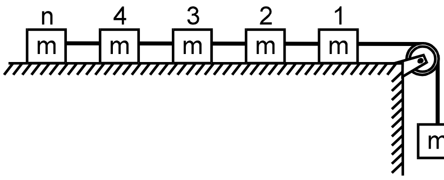
(A) 0.8 m s^{-2} (B) 2.4 m s^{-2} (C) 0.4 m s^{-2} (D) 4.4 m s^{-2}

39. A wooden block of mass M resting on a rough horizontal surface is pulled with a force F at an angle ϕ with the horizontal. If μ is the coefficient of kinetic friction between the block and the surface, then acceleration of the block is -

(A) $\frac{F}{M}$ (cos ϕ + μ sin ϕ) – μg (B) F sin ϕ/M

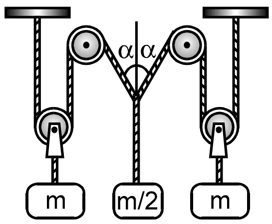
(C) μF cosϕ (D) μF sin ϕ

40. In the given arrangement, n number of equal masses are connected by strings of negligible masses. The tension in the string connected to n^{th} mass is -



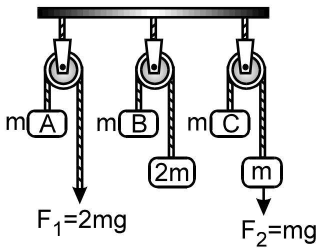
(A) $\frac{mMg}{nm+M}$ (B) $\frac{mMg}{nmM}$ (C) mg (D) mng

41. In the given figure, pulleys and strings are massless. For equilibrium of the system, the value of α is -



(A) 60° (B) 30° (C) 90° (D) 120°

42. In the figure, the blocks A, B and C each of mass m have accelerations a_1, a_2 and a_3 respectively. F_1 and F_2 are external forces of magnitude 2 mg and mg respectively. Then -

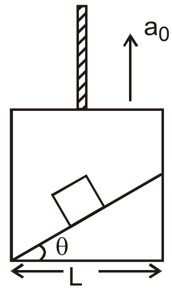


(A) $a_1 = a_2 = a_3$ (B) $a_1 > a_3 > a_2$ (C) $a_1 = a_2$, $a_2 > a_3$ (D) $a_1 > a_2$, $a_2 = a_3$

43. A particle slides down a smooth inclined plane of elevation θ, fixed in an elevator going up with an acceleration a_0 (figure). The base of the incline has a length L. Find the time taken by the particle to reach to the bottom -

(A) $\left[\frac{2L}{g\sin\theta\cos\theta}\right]^{1/2}$ (B) $\left[\frac{2L}{(g-a_0)\sin\theta\cos\theta}\right]^{1/2}$

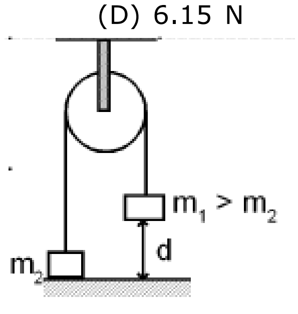
(C) $\left[\frac{2L\sin\theta}{(g+a_0)\cos\theta}\right]^{1/2}$ (D) $\left[\frac{2L}{(g+a_0)\sin\theta\cos\theta}\right]^{1/2}$



44. A chain has five rings. The mass of each ring is 0.1 kg. This chain is pulled upwards by a froce F producing an acceleration of 2.50 m/sec^2 in the chain. Then the force of action (reaction) on the joint of second and third ring from the top is -
(A) 0.25 N (B) 1.23 N (C) 3.69 N (D) 6.15 N

45. If the masses are released from the position shown in figure then the speed of mass m_1 just before it strikes the floor is -

(A) $[2m_1gd/(m_1+m_2)]^{1/2}$
(B) $[2(m_1 - m_2)gd/(m_1+m_2)]^{1/2}$
(C) $[2(m_1 - m_2)gd/m_1]^{1/2}$
(D) None of the above



46. The linear momentum P of a body varies with time and is given by the equation $P=x+yt^2$, where x and y are constants. The net force acting on the body for a one dimensional motion is proportional to-

(A) t^2 (B) a constant (C) 1/t (D) t

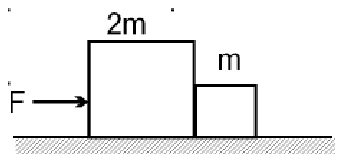
47. A rope of legth L is pulled by a constant force F. What is the tension in the rope at a distance x from the end where the force is applied ?

(A) $\frac{Fx}{L-x}$ (B) $F\frac{L}{L-x}$ (C) FL/x (D) F(L – x)/L

48. The acceleration with which an object of mass 100 kg be lowered from a roof using a cord with a breaking strength of 60 kg weight without breaking the rope is- (assume g = 10 m/sec^2)

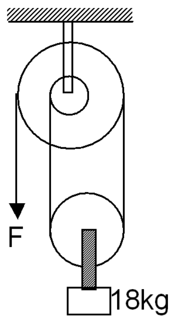
(A) 2 m/sec^2 (B) 4 m/sec^2 (C) 6 m/sec^2 (D) 10 m/sec^2

49. Two blocks are in contact on a frictionless table one has a mass m and the other 2m. A force F is applied on 2m as shown is Figure. Now the same force F is applied on m. In the two cases respectively the ratio of force of contact between the two blocks will be-



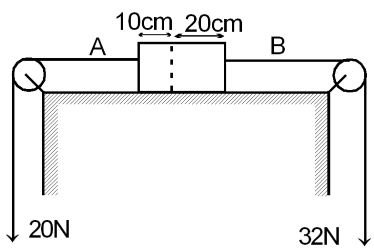
(A) 1 : 1 (B) 1 : 2 (C) 1 : 3 (D) 1 : 4

50. In the figure at the free end a force F is applied to keep the suspended mass of 18 kg at rest. The value of F is-



(A) 180 N (B) 90 N (C) 60 N (D) 30 N

51. Figure shows a uniform rod of mass 3 kg and of length 30 cm. The strings shown in figure are pulled by constant forces of 20 N and 32 N .The acceleration of the rod is-



(A) 2 m/s^2 (B) 3m/s^2 (C) 4 m/s^2 (D) 6 m/s^2

52. In the above question tension in rod at a distance 10 cm from end A is-

(A) 18 N (B) 20 N (C) 24 N (D) 36 N

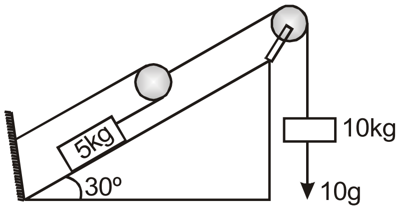
53. A balloon of mass M and a fixed size starts coming down with an acceleration f(f<g). The ballast mass m to be dropped from the ballon to have it go up with an acceleration f. Assuming negligible air resistance is find the value of m

(A) $\left(\frac{M}{g+f}\right)f$ (B) $\frac{Mf}{2(g+f)}$ (C) $\left(\frac{2Mf}{g+f}\right)$ (D) $\frac{M(g+a)}{g}$

54. A conveyor belt is moving horizontally with a uniform velocity of 2 m/sec. Material is dropped at one end at the rate of 5 kg/sec and discharged at the other end. Neglecting the friction, the power required to move the belt is-

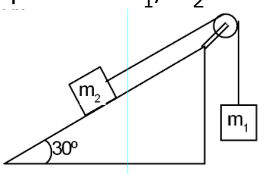
(A) 10 watts (B) 15 watts (C) 20 watts (D) 40 watts

55. In fig, a mass 5 kg slides without friction on an inclined plane making an angle 30º with the horizontal. Then the acceleration of this mass when it is moving upwards, the other mass is 10 kg. The pulleys are massless and frictionless. Take g = 10 m/sec^2.-



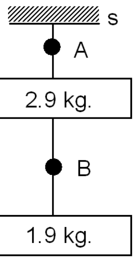
(A) .33 m/sec^2 (B) 3.3 m/sec^2 (C) 33 m/sec^2 (D) None of these

56. Two masses m_1 and m_2 are connected by light string, which passes over the top of a smooth plane inclined at 30º to the horizontal, so that one mass rests on the plane and the other hangs vertically as shown in fig. It is found that m_1, hanging vertically can draw m_2 up the full length of the plane in half the time in which m_2 hanging vertically draws m_1 up. Find m_1/m_2 . Assume pulley to be smooth-



(A) $\frac{2}{3}$ (B) $\frac{3}{2}$ (C) $\frac{4}{7}$ (D) $\frac{7}{4}$

57. Two blocks of masses 2.9 kg and 1.9 kg are suspended from a rigid support S by two inextensible wires each of length 1 m. The upper wire has negligible mass and the lower wire has a uniform mass of 0.2 kg/m. Thewhole system of block, wire and support have an upward acceleration of 0.2 m/s^2. g = 9.8 m/s^2. The tension at the mid-point of lower wire is-



(A) 10 N (B) 20 N (C) 30 N (D) 50 N

58. Body A is placed on frictionless wedge making an angle θ with the horizon. The horizontal acceleration towards left to be imparted to the wedge for the body A to freely fall vertically, is-

(A) g sinθ (B) g cos θ (C) g tanθ (D) g cotθ

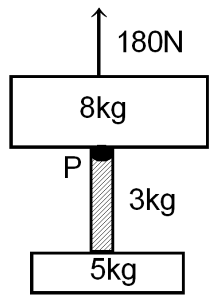
59. A triangular block of mass M with angle 30º, 60º, 90º rests with its 30º– 90º side on a horizontal smooth fixed table. A cubical block of mass m rests on the 60º – 30º sideofthe triangular block. What horizontal acceleration a must M have relative to the stationary table so that m remains stationary with respect to the triangular block [M = 9 kg, m = 1 kg]

(A) 2.8 m/s^2 (B) 5.6 m/s^2 (C) 8.4 m/s^2 (D) Zero

60. A body of mass 8 kg is hanging from another body of mass 12 kg. The combination is being pulled up by a string with an acceleration of 2.2 m/sec^2. The tension T_1 will be -

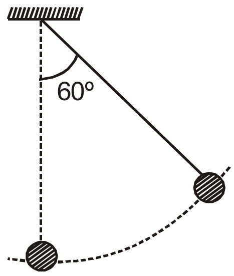
(A) 260 N (B) 240 N (C) 220 N (D) 200 N

61. Two blocks of mass 8 kg and 5 kg are connected by a heavy rope of mass 3 kg. An upward force of 180 N is applied as shown in the figure. The tension in the string at point P will be:



(A) 60 N (B) 90 N
(C) 120 N (D) 150 N

62. A pendulum of length ℓ = 1 m is released from θ_0 = 60º. The rate of change of speed of the bob at θ = 30º is: (g = 10 m/s^2)



(A) $5\sqrt{3}\,m/s^2$ (B) 5 m/s^2 (C) 10 m/s^2 (D) 2.5 m/s^2

63. A particle moves along a circle of radius R = 1 m so that its radius vector $\vec{r}$ relative to a point on its circumference rotates with the constant angular velocity ω = 2 rad/s. The linear speed of the particle is:

(A) 4m/s (B) 2 m/s (C) 1 m/s (D) 0.5 m/s

64. Starting from rest, a particle rotates in a circle of radius $R = \sqrt{2}\,m$ with an angular acceleration α = π/4 rad/s^2.The magnitude of average velocity of the particle over the time it rotates quarter circle is:

(A) 1.5 m/s (B) 2 m/s (C) 1 m/s (D) 1.25 m/s

65. A particle is moving in a circle of radius 1 m with speed varying with time as v = (2t) m/s. In first 2 sec:

(A) distance travelled by the particle is 4 m
(B) displacement of the particle is 4 sin 2
(C) average speed of the particle is 5 m/s
(D) average velocity of the particle is zero

66. A ball suspended by a thread swings in a vertical plane so that its acceleration in the extreme position and lowest position are equal. The angle θ of thread deflection in the extreme position will be -

(A) $\tan^{-1}(2)$ (B) $\tan^{-1}(\sqrt{2})$ (C) $\tan^{-1}\left(\frac{1}{2}\right)$ (D) $2\tan^{-1}\left(\frac{1}{2}\right)$

67. A particle suspended from a fixed point, by a light inextensible thread of length L is projected horizontally from its lowest position with velocity $\frac{\sqrt{7gL}}{2}$. The thread will slack after swinging through an angle θ, such that θ equal

(A) 30º (B) 135º (C) 120º (D) 150º

68. A particle is projected with a speed u at an angle θ with the horizontal. Consider a small part of its path near the highest position and take it approximately to be a circular arc. What is the radius of this circle ? This radius is called the radius of curvature of the curve at the point :

(A) $\frac{u^2 \sin^2\theta}{g}$ (B) $\frac{u^2 \cos^2\theta}{g}$ (C) $\frac{u^2 \tan^2\theta}{g}$ (D) $\frac{u^2}{g}$

69. A stone of mass m tied to the end of a string revolves in a vertical circle of radius R. The net forces at the lowest and highest points of the circle directed vertically downwards are: [Choose the correct alternative]

Lowest point Highest point

(A) $mg - T_1 mg + T_2$

(B) $mg + T_1\ mg - T_2$

(C) $mg + T_1 - (mv_1^2)/R\ mg - T_2 + (mv_1^2)/R$

(D) $mg - T_1 - (mv_1^2)/R\ mg + T_2 + (mv_1^2)/R$

T_1 and v_1 denote the tension and speed at the lowest point. T_2 and v_2 denote the corresponding values at the highest point.

70. A rubber band of length ℓ has a stone of mass m tied to its one end. It is whirled with speed v so that the stone describes a horizontal circular path. The tension T in the rubber band is -

(A) zero (B) mv^2/ℓ (C) $> (mv^2)/\ell$ (D) $< mv^2/\ell$

71. The equation of motion of a particle moving on circular path (radius 200 m) is given by $s = 18t + 3t^2 - 2t^3$ where s is the total distance covered from straight point in metres at the end of t seconds. The maximum speed of the particle will be-

(A) 15 m/sec (B) 23 m/sec

(C) 19.5 m/sec (D) 25 m/sec

72. The kinetic energy of a particle moving along a circle of radius R depends on the distance covered s as $T = KS^2$ where K is a constant. Find the force acting on the particle as a function of S -

(A) $\frac{2K}{S}\sqrt{1+\left(\frac{S}{R}\right)^2}$ (B) $2KS\sqrt{1+\left(\frac{R}{S}\right)^2}$ (C) $2KS\sqrt{1+\left(\frac{S}{R}\right)^2}$ (D) $\frac{2S}{K}\sqrt{1+\left(\frac{R}{S}\right)^2}$

73. A point moves along a circle with velocity v = at where a 0.5 m/sec^2. Then the total acceleration of the point at the moment when it covered (1/10) th of the circle after beginning of motion -

(A) 0.5 m/sec^2 (B) 0.6 m/sec^2 (C) 0.7 m/sec^2 (D) 0.8 m/sec^2

74. A solid body rotates about a stationary axis so that its angular velocity depends on the rotation angle ϕ as $\omega = \omega_0 - k\phi$, where ω_0 and k are positive constants. At the moment t = 0, the angle $\phi = 0$. Find the time dependence of rotation angle -

(A) $K.\ \omega_0 e^{-kt}$ (B) $\frac{\omega_0}{K}[e^{-kt}]$ (C) $\frac{\omega_0}{K}[1-e^{-k.t}]$ (D) $\frac{K}{\omega_0}[e^{-kt} - 1]$

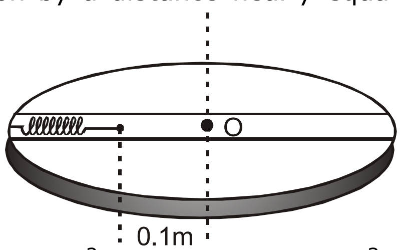
75. A heavy particle hanging from a fixed point by a light inextensible string of length ℓ is projected horizontally with speed $\sqrt{(gl)}$. Then the speed of the particle and the inclination of the string to the vertical at the instant of the motion when the tension in the string equal the weight of the particle-

(A) $\sqrt{\frac{3l}{g}}$, $\cos^{-1}$ (3/2)
(B) $\sqrt{\frac{lg}{3}}$, $\cos^{-1}$ (2/3)
(C) $\sqrt{\frac{3g}{l}}$, $\cos^{-1}$ (2/3)
(D) $\sqrt{\frac{gl}{3}}$, $\sin^{-1}$ (2/3)

76. A body is allowed to slide on a frictionless track from rest position under gravity. The track ends into a circular loop of diameter D. What should be the minimum height of the body in terms of D so that it may complete successfully the loop?

(A) $\frac{4}{5}$D (B) $\frac{5}{4}$D (C) 1 D (D) 2 D

77. A circular turn table of radius 0.5 m has a smooth groove as shown in fig. A ball of mass 90 g is placed inside the groove along with a spring of spring constant 10^2 N/cm. The ball is at a distance of 0.1 m from the centre when the turn table is at rest. On rotating the turn table with a constant angular velocity of 10^2 rad-sec^{-1} the ball moves away from the initial position by a distance nearly equal to-



(A) 10^{-1} m (B) 10^{-2} m (C) 10^{-3} m (D) 2×10^{-1} m

78.* A gramophone record is revolving with an angular velocity ω. A coin is placed at a distance r from the centre of the record. The static coefficient of friction is μ. The coin will revolve with the record if-

(A) $r > \mu g\ \omega^2$
(B) $r = \mu g / \omega^2$ only
(C) $r < \mu g / \omega^2$ only
(D) $r \leq \mu g / \omega^2$

79. A mass of 2.9 kg, is suspended from a string of length 50 cm, and is at rest. Another body of mass 100 gm moving horizontally with a velocity of 150 m/sec, strikes and sticks to it. What is the tension in the string when it makes an angle of 60° with the vertical

(A) 153.3 N (B) 135.3 N (C) 513.3 N (D) 351.3 N

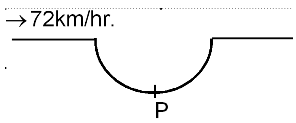
80. The vertical section of a road over a canal bridge in the direction of its length is in the form of circle of radius 8.9 metre. Then the greatest spped at which the car can cross this bridge wihout losing contact with the road at its hgihest point, the centre of gravity of the car being at a height h = 1.1 metre from the ground. Take g = 10 m/sec^2-

(A) 5 m/sec (B) 10 m/sec (C) 15 m/sec (D) 20 m/sec

81.* A car of mass 1000 kg moves on a circular path with constant speed of 16 m/s. It is turned by 90º after travelling 628 m on the road. The centripetal force acting on the car is-

(A) 160 N (B) 320 N (C) 640 N (D) 1280 N

82. A car while travelling at a speed of 72 km/hr. Passes through a curved portion of road in the form of an arc of a radius 10 m. If the mass of the car is 500 kg the reaction on the car at the lowest point P is-



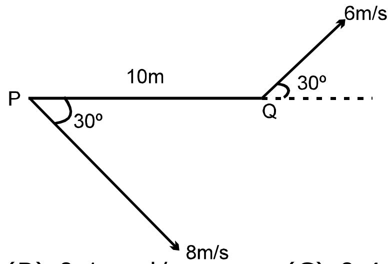
(A) 25 KN (B) 50 KN (C) 75 KN (D) None of these

83. A stone is rotated steadily in a horizontal circle with a time period T by means of a string of length ℓ. If the tension in the string is kept constant and length ℓ increase by 1%, then percentage change in time period T is-
(A) 1 % (B) 0.5 % (C) 2 % (D) 0.25 %

84. A stone of mass 1 kg tied to a light inextensible string of length 10/3 metre is whirling in a vertical circle. If the ratio of maximum tension to minimum tension in the string is 4, then speed of stone st highest point of the circle is- [$g = 10\ m/s^2$]

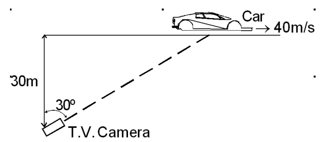
(A) 20 m/s (B) $10\sqrt{3}$ m/s (C) $5\sqrt{2}$ m/s (D) 10 m/s

85. Two moving particles P and Q are 10 m apart at a certain instant. The velocity of P is 8 m/s making 30° with the line joining P and Q and that of Q is 6 m/s making an angle 30° with PQ as shown in the firuge .Then angular velocity of P with respect to Q is-



(A) 0 rad/s (B) 0.1 rad/s (C) 0.4 rad/s (D) 0.7 rad/s

86. A racing car is travelling along a track at a constant speed of 40 m/s. A T.V. camera men is recording the event from a distance of 30 m directly away from the track as shown in figure. In order to keep the car under view in the positio shown, the angular speed with which the camera should be rotated, is-



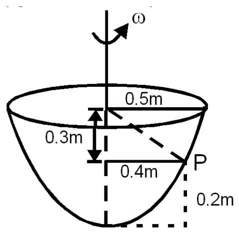
(A) 4/3 rad/sec (B) 3/4 rad/sec (C) $8/3\sqrt{3}$ rad/sec (D) 1 rad/sec

87. A partcile of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time t as $a_c = k^2\ r\ t^2$, where k is a constant, the power delivered to the particle by the forces acting on it is-
(A) $2\ \pi\ m\ k^2\ r^2\ t$ (B) $m\ k^2\ r^2\ t$ (C) $(m\ k^4\ r^2\ t^5)/3$ (D) 0

88. A partcle rests on the top of a hemisphere of radiu R. Find the smallest horizontal velocity that must be imparted to the particle if it is to leave the hemisphere without sliding down it-

(A) $\sqrt{gR}$ (B) $\sqrt{2gR}$ (C) $\sqrt{3gR}$ (D) $\sqrt{5gR}$

89. A particle P will be in equilibrium inside a hemispherical bowl of radius 0.5 m at a height 0.2 m from the bottom when the bowl is rotated at an angular speed ($g = 10\ m/sec^2$)



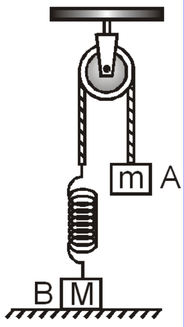
(A) $10 / \sqrt{3}$ rad/sec (B) $10\sqrt{3}$ rad/sec

(C) 10 rad/sec (D $\sqrt{20}$ rad/sec

90. Kinetic energy of a particle moving in a straight line varies with time t as $K = 4t^2$. The force acting on the particle-

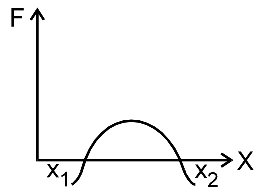
(A) is constant
(B) is increasing
(C) is decreasing
(D) first increase and then decrease

91. In the figure the block A is released from rest when the spring is at its natural length. For the block B of mass M to leave contact with the ground at some stage, the minimum mass of A must be-



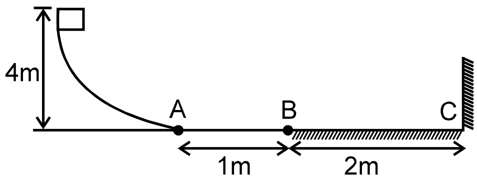
(A) 2 M
(B) M
(C) $\frac{M}{2}$
(D) a function of M and the force constant of the spring

92.* The force acting on a body moving along x-axis varies with the position of the particle as shown in the figure. The body is in stable equilibrium at -



(A) $x = x_1$
(B) $x = x_2$
(C) Both x_1 and x_2
(D) Neither x_1 nor x_2

93. A block of mass m = 0.1 kg is released from a height of 4 m on a curved smooth surface. On the horizontal surface, path AB is smooth and path BC offers coefficient of friction $\mu = 0.1$. If the impact of block with the vertical wall at C be perfectely elastic, the total distance covered by the block on the horizontal surface before coming to rest will be (take $g = 10\ ms^{-2}$) -



(A) 29 m
(B) 49 m
(C) 59 m
(D) 109 m

94. A force $\vec{F} = (2\hat{i} + 5\hat{j} + \hat{k})$ is acting on a particle. The particle is first displaced from (0, 0, 0) to (2m, 2m, 0) along the path x = y and then from (2m, 2m, 0) to (2m, 2m, 2m) along the path x = 2m, y = 2m. The total work done in the complete path is -

(A) 12 J
(B) 8 J
(C) 16 J
(D) 10 J

95. A chain of mass m and length ℓ is placed on a table with one-sixth of it hanging freely from the table edge. The amount of work. done to pull the chain on the table is

(A) $mg\ell/4$
(B) $mg\ell/6$
(C) $mg\ell/72$
(D) $mg\ell/36$

96. The force required to row a boat over the sea is proportional to the speed of the boat. It is found that it takes 24 h.p. to row a certain boat at a speed of 8km/hr, the horse power required when speed is doubled -

(A) 12 h.p.
(B) 6 h.p.
(C) 48 h.p.
(D) 96h.p.

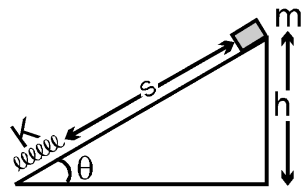
97. A 50 kg girl is swinging on a swing from rest. Then the power delivered when moving with a velocity of 2m/sec upwards in a direction making an angle 60º with the vertical is

(A) 980W
(B) 490W
(C) $490\sqrt{3}$ W
(D) 245W

98. A locomotive of mass m starts moving so that its velocity varies according to thelaw $v = k\sqrt{s}$ where k is constant and s is the distance covered. Find the total work performed by all the forces which are acting on the locomotive during the first t seconds after the beginning of motion.

(A) $W = \frac{1}{8}mk^4t^2$. (B) $W = \frac{1}{4}m^2k^4t^2$ (C) $W = \frac{1}{4}mk^4t^4$ (D) $W = \frac{1}{8}mk^4t^4$

99. A block of mass m slips down an inclined plane as shown in the figure. When it reaches the bottom it presses the spring by a length (spring length <<h and spring constant = K) -



(A) $(2mgh/K)^{1/2}$ (B) $(mgh/K)^{1/2}$
(C) $(2gh/mK)^{1/2}$ (D) $(gh/mK)^{1/2}$

100. Sand drops fall vertically at the rate of 2kg/sec on to a conveyor belt moving horizontally with the velocity of 0.2 m/sec. Then the extra force needed to keep the belt moving is
(A) 0.4 Newton (B) 0.08 Newton (C) 0.04 Newton (D) 0.2 Newton

101. An engine pumps a liquid of density 'd' continuously through a pipe of area of cross section A. If the speed with which the liquid passes through a pipe is v. then the rate at which the Kinetic energy is being imparted to the liquid is
(A) $Adv^3/2$ (B) (1/2)Adv (C) $Adv^2/2$ (D) Adv^2

102. A boy is standing at the centre of a boat which is free to move on water. If the masses of the boy and the boat are m_1 and m_2 respectively and the boy moves a distance of 1 m forward then the movement of the boat is ...... metres

(A) $\frac{m_1}{m_1+m_2}$ (B) $\frac{m_2}{m_1+m_2}$ (C) $\frac{m_1}{m_2}$ (D) $\frac{m_2}{m_1}$

103. A bullet of mass m strikes a pendulum bob of mass M with velocity u. It passes through and emerges out with a velocity u/2 from bob. The length of the pendulum is ℓ. What should be the minimum value of u if the pendulum bob will swing through a complete circle?

(A) $\frac{2M}{m} \times \sqrt{5g\ell}$ (B) $\frac{M}{2m}\sqrt{5g\ell}$ (C) $\frac{2M}{m} \times \frac{1}{\sqrt{5g\ell}}$ (D) $\frac{M}{2m} \times \frac{1}{\sqrt{5g\ell}}$

104. An open water tight railway wagon of mass 5×10^3 kg coasts at an initial velocity of 1.2 m/sec. without friction on a railway track. Rain falls vertically downwards into the wagon. What change then occurred in the velocity of the wagon, when it has collected 10^3kg of water ?
(A) 10 m/s (B) 3m/s (C) 0.2m/s (D) 9m/s

105. Two equal lumps of putty are suspended side by side from two long strings so that they are just touching. One is drawn aside so that its centre of gravity rises a vertical distance h. It is released and then collides inelastically with the other one. The vertical distance risen by the centre of gravity of the combination is -
(A) h. (B) 3h/4 (C) h/2 (D) h/4

106. A billiard ball moving at a speed 2m/s strikes an identical ball initially at rest, at a glancing blow. After the collision one ball is found to be moving at a speed of 1m/s at 60º with the original line of motion. The velocity of the other ball shall be -
(A) $(3)^{1/2}$m/s at 30º to the original direction.
(B) 1m/s at 60º to the original direction.
(C) $(3)^{1/2}$m/s at 60º to the original direction.
(D) 1 m/s at 30º to the original direction.

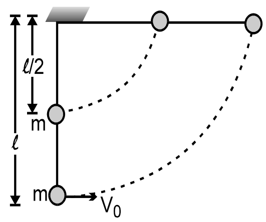
107. Three particles each of mass m are located at the vertices of an equilateral triangle ABC. They start moving with equal speeds υ each along the medians of the triangle and collide at its centroid G. If after collision, A comes to rest and B retraces its path along GB, then C

(A) also comes to rest
(B) moves with a speed υ along CG
(C) moves with a speed υ along BG
(D) moves with a speed along AG

108. An object of mass m slides down a hill of height h and of arbitrary shape and stops at the bottom because of friction. The coefficient of friction may be different for different segments of the path. Work required to return the object to its position along the same path by a tangential force is

(A) mgh
(B) 2 mgh
(C) – mgh
(D) it can not be calculated

109. A light rod of length ℓ is pivoted at the upper end. Two masses (each m), are attached to the rod, one at the middle and the other at the free end. What horizontal velocity must be imparted to the lower end mass, so that the rod may just take up the horizontal position?



(A) $\sqrt{6\ell g}/5$
(B) $\sqrt{\ell g}/5$
(C) $\sqrt{12\ell g/5}$
(D) $\sqrt{2\ell g}/5$

110. A machine, which is 72 percent efficient, uses 36 joules of energy in lifting up 1kg mass through a certain distance. The mass is the allowed to fall through that distance. The velocity at the end of its fall is

(A) 6.6 ms^{-1}
(B) 7.2 ms^{-1}
(C) 8.1 ms^{-1}
(D) 9.2 ms^{-1}

111. A billiard ball moving at a speed of 6.6 ms^{-1} strikes an identical stationary ball a glancing blow. After the collision, one ball is found to be moving at a speed of 3.3, ms^{-1} in a direction making an angle of 60º with the original line of motion. The velocity of the other ball is

(A) 4.4 ms^{-1}
(B) 6.6 ms^{-1}
(C) 3.3 ms^{-1}
(D) 5.7 ms^{-1}

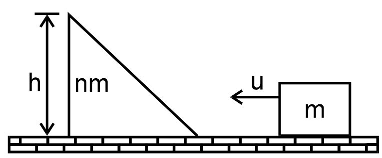
112. A projectile of mass 3m explodes at highest point of its path. It breaks into three equal parts. One part retraces its path, the second one comes to rest. The range of the projectile was 100 m if no explosion would have taken place. The distance of the third part from the point of projection when it finally lands on the ground is -

(A) 100 m
(B) 150 m
(C) 250 m
(D) 300 m

113. A man of mass m moves with a constant speed on a plank of mass 'M' and length 'L' kept initially at rest on a frictionless horizontal surface, from one end to the other in time 't'. The speed of the plank relative to ground while man is moving, is -

(A) $\frac{L}{t}\left(\frac{M}{m}\right)$
(B) $\frac{L}{t}\left(\frac{m}{M+m}\right)$
(C) $\frac{L}{t}\left(\frac{m}{M-m}\right)$
(D) None of these

114. A block of mass m is pushed towards a movable wedge of mass nm and height h, with a velocity u. All surfaces are smooth. The minimum value of u for which the block reach the top of the wedge is -



(A) $\sqrt{2gh}$
(B) 2ngh
(C) $\sqrt{2gh\left(1+\frac{1}{n}\right)}$
(D) $\sqrt{2gh\left(1-\frac{1}{n}\right)}$

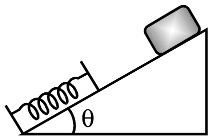
115. A uniform flexible chain of mass m and length 2ℓ hangs in equilibrium over a smooth horizontal pin of negligible diameter. One end of the chain is given a small vertical displacement so that the chain slips over the pin. The speed of chain when it leaves pin is-

(A) $\sqrt{2g\ell}$ (B) $\sqrt{g\ell}$ (C) $\sqrt{4g\ell}$ (D) $\sqrt{3g\ell}$

116. A particle of mass 0.5 kg is displaced from position $\vec{r}_1(2, 3, 1)$ to $\vec{r}_2(4, 3, 2)$ by applying of force of magnitude 30 N which is acting along $(\hat{i} + \hat{j} + \hat{k})$. The work done by the force is -

(A) $10\sqrt{3}$ J (B) $30\sqrt{3}$ J (C) 30 J (D) None of these

117. In the given figure, the inclined surface is smooth. The body releases from the top. Then-

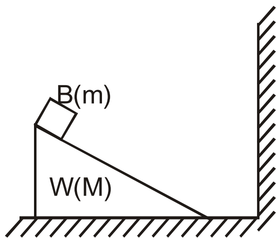


(A) the body has maximum velocity just before striking the spring
(B) The body performs periodic motion
(C) the body has maximum velocity at the compression $\frac{mg\sin\theta}{k}$ where k is spring constant
(D) both (B) and (C) are correct

118. A body of mass 2 kg is moved from a point A to a point B by an external agent in a conservative force field. It the velocity of the body at the points A and B are 5 m/s and 3 m/s respectively and the work done by the external agents is –10 J, then the change in potential energy between points A and B is-

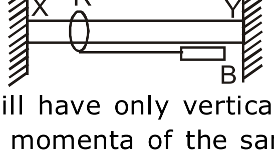
(A) 6 J (B) 36 J (C) 16 J (D) None of these

119. In the figure the block B of mass m starts from rest at the top of a wedge W of mass M. All surfaces are without friction. W can slide on the ground B slides down onto the ground, moves along it with a speed v, has an elastic collision with the wall, and climbs back onto W. then incorrect statement is



(A) B will reach the top of W again
(B) From the beginning, till the collision with the wall, the centre of mass of 'B plus W' does not move horizontally
(C) After the collision, the centre of mass of 'B plus W' moves with the velocity $\frac{2mv}{m+M}$
(D) When B reaches its highest position on W, the speed of W is $\frac{2mv}{m+M}$

120. The ring R in the arrangement shown can slide along a smooth, fixed, horizontal rod XY. It is attached to the block B by a light string. The block is released from rest, with the string horizontal.



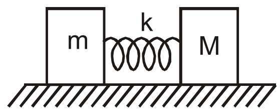
(A) One point in the string will have only vertical motion
(B) R and B will always have momenta of the same magnitude.
(C) When the string becomes vertical, the speed of R and B will be directly proportionaly to their masses
(D) R will lose contact with the rod at some point

121. A block of mass M is hanging over a smooth and light pulley through a light string. The other end of the string is pulled by a constant force F. The kinetic energy of the block increases by 20 J in 1s.
(A) The tension in the string is Mg
(B) The tension in the string is F
(C) The work done by the tension on the block is 20 J in the above 1s
(D) The work done by the force of gravity is –20 J in the above 1s

122. A smooth sphere is moving on a horizontal surface with velocity vector $2\hat{i}+2\hat{j}$ immediately before it hits a vertical wall. The wall is parallel to $\hat{j}$ vector and the coefficient of restitution between the sphere and the wall is e = $\frac{1}{2}$. The velocity vector of the sphere after it hits the wall is:
(A) $\hat{i}-\hat{j}$ (B) $-\hat{i}+2\hat{j}$ (C) $-\hat{i}-\hat{j}$ (D) $2\hat{i}-\hat{j}$

123. Two particles having position vectors $\vec{r}_1=(3\hat{i}+5\hat{j})$ metres and $\vec{r}_2=(-5\hat{i}-3\hat{j})$ metres are moving with velocities $\vec{\upsilon}_1=(4\hat{i}+3\hat{j})$ m/s and $\vec{\upsilon}_2=(a\hat{i}+7\hat{j})$ m/s. If they collide after 2 seconds the value of a is:
(A) 2 (B) 4 (C) 6 (D) 8

124. A light spring of spring constant k is kept compressed between two blocks of masses m and M on a smooth horizontal surface (figure) When released, the blocks acquire velocities in opposite directions. The spring loses contact with the blocks when it acquires natural length. If the spring was initially compressed through a distance x, find the final speed of mass m.

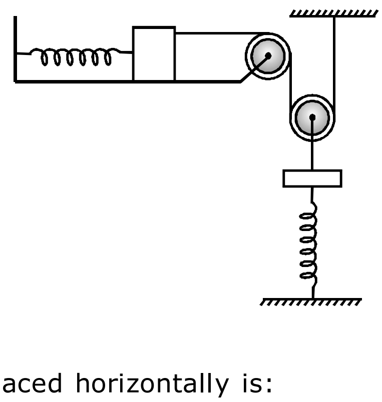


(A) $\sqrt{\frac{KM}{m(M+m)}}\,x$ (B) $\sqrt{\frac{Km}{M(m+M)}}\,x$ (C) $\sqrt{\frac{KM}{m(M-m)}}\,x$ (D) $\sqrt{\frac{Km}{M(M-m)}}\,x$

125. Force acting on a particle is $(2\hat{i}+3\hat{j})$ N. Work done by this force is zero. when a particle is moved on the line 3y + kx = 5. Here value of k is:
(A) 2 (B) 4 (C) 6 (D) 8

126. A pendulum of mass 1 kg and length ℓ = 1m is released from rest at angle θ = 60º. The power delivered by all the forces acting on the bob at angle θ = 30º will be: (g = 10 m/s^2)
(A) 13.4 W (B) 20.4 W (C) 24.6 W (D) zero

127. The system is released from rest with both the springs in unstretched positions. Mass of each block is 1 kg and force constant of each spring is 10 N/m. Extension of horizontal spring in equilibrium is:



(A) 0.2 m (B) 0.4 m
(C) 0.6 m (D) 0.8 m

128. In previous question maximum speed of the block placed horizontally is:
(A) 3.21 m/s (B) 2.21 m/s (C) 1.93 m/s (D) 1.26 m/s

129. A particle undergoes uniform circular motion. About which point on the plane of the circle, will the angular momentum of the particle remain conserved?

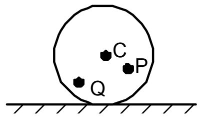
(A) centre of the circle (B) on the circumference of the circle.

(D) inside the circle (D) outside the circle

130. A horizontal circular plate is rotating about a vertical axis passing through its centre with an angular velocity 0. A man sitting at the centre having two blocks in his hands stretches out his hands so that the moment of inertia of the system doubles. If the kinetic energy of the system is K initially, its final kinetic energy will be

(A) 2K (B) K/2 (C) K (D) K/4

131. A disc is rolling without slipping with angular velocity . P and Q are two points equidistant from the centre C. The order of magnitude of velocity is



(A) $v_Q > v_C > v_P$ (B) $v_P > v_C > v_Q$

(C) $v_P = v_C$, $v_Q = v_C/2$ (D) $v_P < v_C > v_Q$

132.. A uniform thin rod of mass M and length L is standing vertically along the Y-axis on a smooth horizontal surface with its lower end at origin (0, 0). A slight disturbance at t 0 causes the lower end to slip on smooth surface along the positive X-axis and the rod starts falling. The path followed by the centre of mass of the rod during its fall is a/an.

(A) Straight line (B) Parabola (C) Ellipse (D) Circle

133. A spinning ballet dancer changes the shape of her body by spreading her arms.

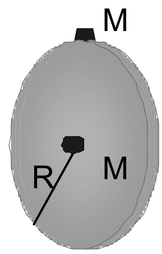
(A) The angular momentum of the system is conserved.

(B) The angular velocity of the system increases.

(C) The rotational kinetic energy of the system increases.

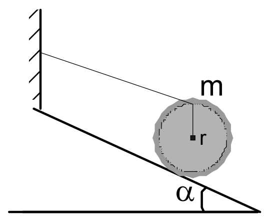
(D) The moment of inertia of the system decreases.

134. A uniform disc of mass M object of mass M is attached to the rim and raised to the highest point above the centre. The unstable system is then released. The angular speed of the system when the attached object passes directly beneath the pivot is.



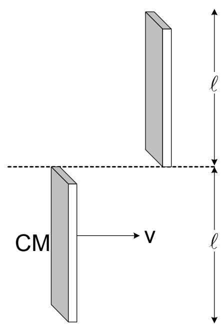
(A) $\sqrt{\frac{3R}{8g}}$ (B) $\sqrt{\frac{3g}{8R}}$ (C) $\sqrt{\frac{8R}{3g}}$ (D) $\sqrt{\frac{8g}{3R}}$

135. A spool with a thread wound on it is placed on a smooth inclined plane set at an angle of 30 to the horizontal. The free end of the thread is attached to the wall as shown. The mass of the spool is m 200g, its moment of inertia relative to its own axis is I 0.45gm2, the radius of the wound thread layer is r 3 cm. The acceleration of the spool axis is:



(A) 0.5ms - 2 (B) 5 ms - 2 (C) 1.4 ms - 2 (D) 14ms - 2

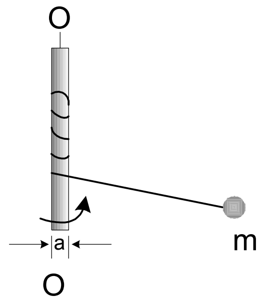
136. A bar of mass m, length is in pure translatory motion with its centre of mass velocity . It collides with and sticks to another identical bar at rest as shown in figure. Assuming that after collision it becomes one composite bar of length 2l, the angular velocity of the composite bar will be.



(A) $\frac{3v}{4\ell}$ anticlockwise (B) $\frac{4v}{3\ell}$ anticlockwise

(C) $\frac{3v}{4\ell}$ clockwise (D) $\frac{4v}{3\ell}$ clockwise

137. A small particle of mass m is given an initial high velocity in the horizontal plane and winds its cord around the fixed vertical shaft of radius a. All motion occurs essentially in horizontal plane. If the angular velocity of the cord is when the distance from the particle to the tangency point is r0, then the angular velocity of the cord after it has turned through an angle is.



(A) $\omega = \omega_0$ (B) $\omega = \frac{a}{r_0}\omega_0$

(C) $\omega = \frac{\omega_0}{1 - \frac{a}{r_0}\theta}$ (D) $\omega = \omega_0\theta$

138. A long horizontal rod has a bead which can slide along its length and is initially placed at a distance L from one end A of the rod. The rod is set in angular motion about A with a constant angular acceleration . If the coefficient of friction between rod and the bead is , and gravity is neglected, then the time after which the bead starts slipping is.

(A) $\sqrt{\frac{\mu}{\alpha}}$ (B) $\frac{\mu}{\sqrt{\alpha}}$ (C) $\frac{1}{\sqrt{\mu\alpha}}$ (D) infinitesimal

Statement Type Questions (139 to 157)
(a) If both Statement- I and Statement- II are true, and Statement - II is the correct explanation of Statement– I.
(b) If both Statement - I and Statement - II are true but Statement - II is not the correct explanation of Statement – I.
(c) If Statement - I is true but Statement - II is false.
(d) If Statement - I is false but Statement - II is true.

139. **Statement I :** Two balls of different masses are thrown vertically up with same speed. They will pass through their point of projection in downward direction with the same speed.
Statement II : The maximum height and downward velocity attained at the point of projection are independent of the mass of the ball.
(A) a (B) b (C) c (D) d

140. **Statement I :** For angle of projection $\tan^{-1}(4)$, the horizontal range and maximum height are equal.
Statement II : The maximum range of projectile is directly proportional to square of velocity and inversely proportional to acceleration of gravity.
(A) a (B) b (C) c (D) d

141. **Assertion :** A coin is placed on phonogram turn table. The motor is started, coin moves along the moving table.
Reason : Rotating table is providing necessary centripetal force to the coin.
(A) a (B) b (C) c (D) d

142. **Assertion :** By pressing a block against a rough wall, one can balance it.
Reason : Smooth walls can not hold the block by pressing the block against the wall, however high the force is exerted.
(A) a (B) b (C) c (D) d

143. **Assertion :** The value of dynamic friction is less than the limiting friction.
Reason : Once the motion has started, the inertia of rest has been overcome.
(A) a (B) b (C) c (D) d

144. **Statement - I :** A cyclist always bends in wards while negotiating a curve.
Statement - II : By bending, he lowers his centre of gravity
(A) a (B) b (C) c (D) d

145. **Statement I :** The maximum speed at which a car can turn on level curve of radius 40 m, is 11 m/s ; $\mu = 0.3$.
Statement II : $v = \sqrt{\mu Rg} \Rightarrow \mu = \frac{v^2}{Rg} = \frac{11\times11}{40\times10} = 0.3$.
(A) a (B) b (C) c (D) d

146. **Statement I :** On banked curved road, vertical component of normal reaction provides the necessary centripetal force.
Statement II : Centripetal force is always required for turning.
(A) a (B) b (C) c (D) d

147. **Statement I :** The tendency to overturn of skidding/overturning is quadrupled, when a cyclist doubles his speed of turning.

Statement II : $\tan\theta = \frac{v^2}{Rg} \Rightarrow$ becomes 4 times as v doubled.
(A) a (B) b (C) c (D) d

148. **Statement - I:** In an elastic collision of two billiards balls, the kinetic energy is not conserved during the short interval of time of collision between the balls.
Statement - II: Energy spent against friction does not follow the law of conservation of energy.
(A) a (B) b (C) c (D) d

149. **Statement - I:** Work done in moving a body in non-uniform circular motion is zero.
Statement - II: The centripetal force always acts along the radius of the circle.
(A) a (B) b (C) c (D) d

150. **Statement-I:** Both stretched and compressed springs possess potential energy.
Statement - II: Work done against restoring force is stored as potential energy.
(A) a (B) b (C) c (D) d

151. **Statement I :** Work done by or against the friction in moving the body through any round trip is zero.
Statement II : This is because friction is a conservative force.
(A) a (B) b (C) c (D) d

152. **Statement I :** Work done in moving a body over a smooth inclined plane does not depend upon slope of inclined plane, provided its height is same.
Statement II : $W = mgh = mgl\sin\theta$
(A) a (B) b (C) c (D) d

153. **Statement I :** For the stable equilibrium force has to be zero and potential energy should be minimum.
Statement II : For the equilibrium it is not necessary that the force is not zero.
(A) a (B) b (C) c (D) d

154. **Statement-I :** Angular velocity is a characteristic of the rigid body as a whole.
Statement-II : Angular velocity may be different for different particles of a rigid body about the axis of rotation.
(A) a (B) b (C) c (D) d

155. **Statement I :** If bodies slide down an inclined plane without rolling, then all the bodies reach the bottom simultaneously.

Statement II : Acceleration of all bodies are equal and independent of shape.
(A) a (B) b (C) c (D) d

156. **Statement I :** A wheel moving down a perfectly frictionless inclined plane shall undergo slipping (not rolling).

Statement II : For rolling torque is required**,** which is provided by tangential frictional force.
(A) a (B) b (C) c (D) d

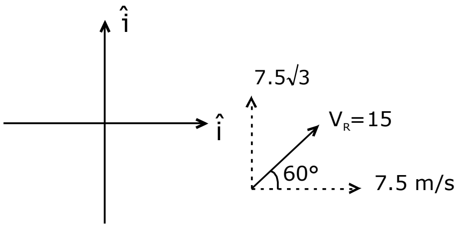
157. **Statement I :** The centre of mass of a circular disc lies always at the centre of the disc.

Statement II : Circular disc is a symmetrical body.
(A) a (B) b (C) c (D) d

HINTS & SOLUTIONS

Mechanics

1. **A**



$\vec{V}_c = 20 m/s\,\hat{i} \quad \vec{V}_R = 7.5\hat{i} + 7.5\sqrt{3}\hat{i}$

$\vec{V}_{RC} = 7.5\hat{i} + 7.5\sqrt{3}\hat{i} - 20\hat{i}$

$|\vec{V}_{RC}| = \sqrt{(12.5)^2 + \left(7.5\sqrt{3}\right)^2}$

= 18.027 m/sec

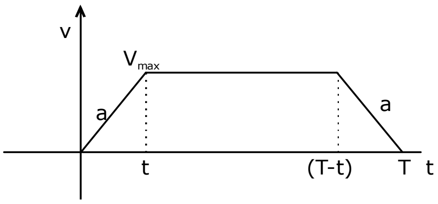
2. **C**

$a_{av} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t} = \frac{0}{\Delta t} = 0$

w = F.ds = o × ds = 0

$v_{av} = \frac{\text{area of (v.t curve)}}{\Delta t}$

3. **A**



$v_{av} = \frac{v_{max}t + v_{vax}(T - 2t)}{T} = \frac{7}{8}v_{max}$

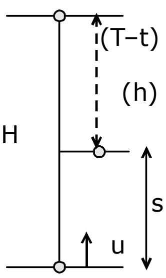
$t + T - 2t = \frac{7}{8}T$

Time when particle move with constant velocity = $T - 2t = \frac{3}{4}T$

4. **D**

$\left(\frac{ds}{dt}\right)_{at(A)} = 0$ means velocity is $v_A = 0$

5. **B**



$u = \sqrt{2gh}$

u = gT

at any time t

$s = ut - \frac{1}{2}gt^2$

$s = H - \frac{1}{2}gT - t$

$s = H - \frac{1}{2}g(T - t)^2$

6. **B**

S = 7 x (1.5)+7 x (1.5)+1/2 x 10 x $(1.5)^2$

7. **B**

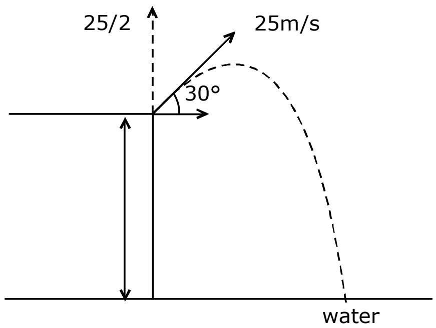
$t = \frac{d}{v} = \frac{58.8}{14.7} = 4s$

$t = \frac{2u}{g}$

$2\mu = 4^2 \times 9.8$

$\mu = 19.6 m/s$

8. **A**



$-H = \frac{25}{2} \times 2.5 - \frac{1}{2} \times 10 \times 2.5 \times 2.5$

$H = \frac{625}{20} + \frac{625}{20} = \frac{625}{10} = 62.5m$

9. **A**

$h = \frac{u^2 \sin^2\theta}{2g}$

$h' = \frac{u^2 \sin^2(90 - \theta)}{2g}$

$hh' = \frac{u^2 \sin^2\theta \cos^2\theta}{2g \times 2g}$

$hh' = \left(\frac{u^2 \times \sin\theta\cos\theta}{2 \times 2g}\right)^2 = \left(\frac{u^2 \sin 2\theta}{g}\right)^2$

$hh' = \frac{R^2}{16} \Rightarrow R = \sqrt{16hh'}$

$R = 4\sqrt{hh'}$

10. **B**

$T = \frac{u\sin\theta}{g}, \quad T' = \frac{u\sin\theta}{\left(\frac{11g}{10}\right)} = \frac{10T}{11}$

$\Delta T \frac{T - T'}{T} = \frac{T - \frac{10T}{11}}{T} = \frac{T}{11} \times 100^{-1} = 9\%$

11. **D**

$y = \frac{1}{2}\alpha t^2$

$x = ut$

$t = \frac{x}{u}$

$y = \frac{1}{2}\alpha\frac{x^2}{u^2}$

$y = \frac{1\alpha}{2-u^2}x^2$

$u = \sqrt{\frac{\alpha}{2B}}$

12. **C**

$\theta_2 = 90 - \theta_1$

$\theta_1 + \theta_2 = 90$

$t_1 = \frac{2u\sin\theta_1}{g}$

$t_2 = \frac{2u\sin\theta_2}{g}$

$\frac{t_1}{t_2} = \frac{\sin\theta_1}{\sin\theta_2}$

13. **B**

$y = \frac{x^2}{2}$ where $x = \frac{t^2}{2}$

$y = \frac{\left(\frac{t^2}{2}\right)^2}{2}$, $y - \frac{t^4}{8}$

$v_y \frac{t^3}{2}$

at t = 2 sec, $v_x = 2\hat{i}$

$v_y = \frac{8}{2}\hat{j} = 4\hat{j}$

$\vec{v} = (2\hat{i} + 4\hat{i})m/s$

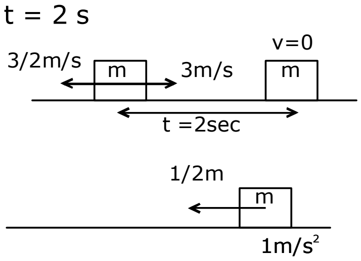
14. **B**

15. **C**

$v = u + at$

$0 = 3 - \frac{3}{2}t$

t = 2 s



$s = ut - \frac{1}{2}at^2$

$= 3\times 2 - \frac{1}{2}\times\frac{3}{2}\times 4$

= 6–3 = 3m

16. **D**

2kg →

1kg → f=2N

$a_{max} = 2m/s^2$

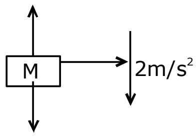
$\rightarrow 2m/sh2$

3kg → T T = 6N

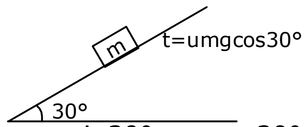
10M–6 = 2m

8 m = 6

M=6/8 = 3/4 kg



17. **A**



a = gsin30° – ugcos30°

$a = \left(\frac{g}{2} - \frac{ug\sqrt{3}}{2}\right)$

$v8 = \frac{1}{2}\times\left(\frac{g}{2} - \frac{ug}{2}\sqrt{3}\right)$

$4 = \frac{g}{2}\left(1 - u\sqrt{3}\right)$

$8 = 1 - u\sqrt{3}$

$u\sqrt{3} = 1 - 0.8 = 0.2$

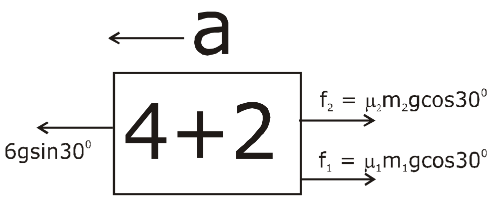
$u = \frac{0.2}{1.73} = 0.11$

18. **C**

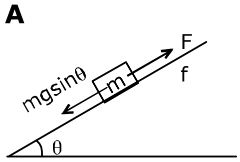
For upward

f = mg sinθ + μmg cosθ

19. **D**



20. **A**



F +f = Mgsingθ

2F = f+Mgsinθ ....(1)

2F = 2Mgsinθ−2f ...(2)

(1) - (2)

$\sin\theta = 3\mu g\cos\theta$

$\frac{1}{3}\tan\theta = \mu$

21. D

f = μmg = 30N

$a_B = 1.5\ m/s^2$

$a_T = 2 m/s^2$

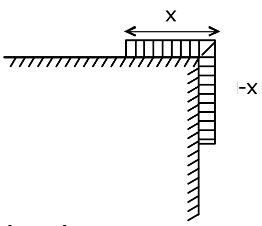
$a_{BT} = -0.5\ m/s^2$

$4 = \frac{1}{2}\times 0.5t^2$

t = 4 s

$s = \frac{1}{2}at^2 = 16m$

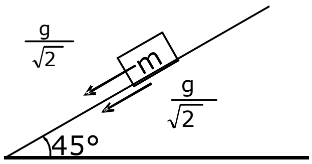
22. B



$(\ell - x)\lambda g = \mu x\lambda g$

$x = \frac{\ell}{1+\mu}$

23. C

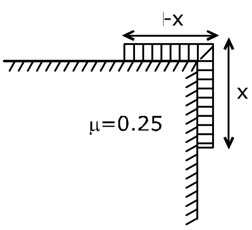


$a = \frac{g}{\sqrt{2}}\left(1+\frac{1}{2}\right)$

24. A

$f_{min} = \mu(m_1 + m_2)g$

25. A



$(\ell - x)\lambda g\frac{1}{4} = x\lambda g$

$x = \frac{\ell}{5}\times 100 = 20\%$

26. D

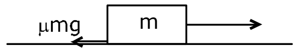
$a = g\sin\theta - \mu g\cos\theta$

$\because mg\sin\theta = \mu\cos\theta$

tan θ = μ = 3/4 ⇒ θ = 37°

$4 = \frac{1}{2}10\left(\frac{3}{5} - \frac{1}{2}\times\frac{4}{5}\right)t^2$, t = 2s

27. A



$a = \frac{F - \mu mg}{m}$

28. A

$F = \frac{F\sqrt{3}}{2} = mg\sin 30 + 80$

F = 206N

29. A

$\frac{mv^2}{R} = N$ f = mg= μN

$v = \sqrt{\frac{Rg}{\mu}}$ N = mg/μ

30. A

$a = \frac{10\times 1}{2} - 0.5\times 10\times\frac{\sqrt{3}}{2} = g\left(\frac{2-\sqrt{3}}{4}\right)$

31. A

$s = \frac{1}{2}g\sin\theta t^2$

$s = \frac{1}{2}(g\sin\theta - mg\cos\theta)n^2t^2$

$\frac{1}{2}g\sin\theta t^2 = \frac{1}{2}g(\sin\theta - \mu\cos\theta)n^2t^2$

$\mu = \tan\theta\left(1 - \frac{1}{n^2}\right)$

32. A

same as Q. no 31 (θ = 45°)

33. C

$a_{in} = \frac{100-25}{15} = \frac{75}{15} = 5m/s^2$

$\frac{5}{2} = \frac{100-(25+\frac{v}{2})}{15}$

$v = 75 m/s^2$

34. B

$a = \frac{F-f}{(m+M)}$

$a = 0.6\ m/s^2$

35. B

$T - mg' = \frac{mg}{2} - \frac{1}{3\sqrt{3}}mg\frac{\sqrt{3}}{2}$

$M' = \frac{M}{2} - \frac{M}{6} = \frac{M}{3}$

36. **A**

$$6a = 6\times 10\times \frac{3}{5} - \left(\frac{3}{4}10\times 4\times \frac{4}{5} + \frac{1}{4}\times 10\times 2\times \frac{4}{5}\right)$$

$a = 1.3\ m/s^2$

37. **A**

Free fall N = 0

$a_m = a_L = g\downarrow$

38. **A**

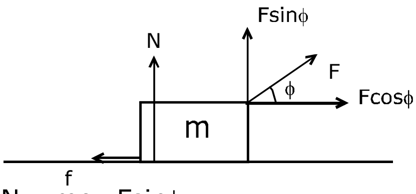
Relative slipping present

$\mu = .4$

$f = \mu mg = 28$

$35a = 28 \Rightarrow a = 0.8\ m/s^2$

39. **A**



$N = mg - F\sin\phi$

$Ma = F\cos\phi - f$

$$a = \frac{F}{m}\left(\cos\phi + \mu\sin\phi\right) - \mu g$$

40. **A**

$$a_{system} = \frac{Mg}{mn + M}$$

$$T = \frac{mMg}{mn + M}$$

41. **A**

$$T = \frac{mg}{2}$$

$$2T\cos\theta = \frac{mg}{2} \Rightarrow \cos\alpha = \frac{1}{2}$$

$\alpha = 60°$

42. **B**

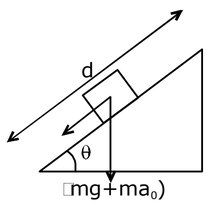
$$a_1 = \frac{2mg - mg}{m} = g$$

$$a_2 = \frac{2mg - mg}{3m} = g/3$$

$a_3 = 2mg - mg/2m$

$= g\ /\ 2$

43. **D**



$$d\cos\theta = L \Rightarrow d = \frac{L}{\cos\theta}$$

$$L = \frac{1}{2}\left(g + a_0\right)\sin\theta\cos\theta t^2$$

44. **C**

$N = mg + ma$

$N = 0.3\ (10 + 2.5) = 3.69$

45. **B**

$$a = \frac{m_2 - m_1}{(m_1 + m_2)}\,x\,g$$

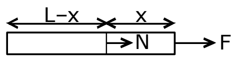
$v = \sqrt{2ad}$

46. **D**

$$F = \frac{dp}{dt} = 2yt$$

$F \propto t$

47. **D**



$$N = \frac{M}{L}(L - x)\frac{F}{M} \qquad \left(a = \frac{F}{m}\right)$$

$$N = \left(\frac{L - x}{L}\right)F$$

48. **B**

$T - mg = ma$

$1000 - 600 = ma$

$a = 4\ m/s^2$

49. **B**

$$a = \frac{F}{3m} \qquad a = \frac{F}{3m}$$

$$N_1 = m\frac{F}{3m} = \frac{F}{3} \qquad N_2 = \frac{2F}{3}$$

$$N_1 : N_2 = \frac{1}{3} : \frac{2}{3} = 1 : 2$$

50. **B**

$2F = 180$

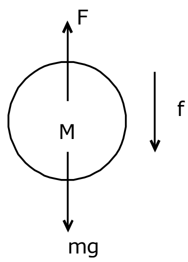
51. **C**

$$\frac{32 - 20}{3} = a$$

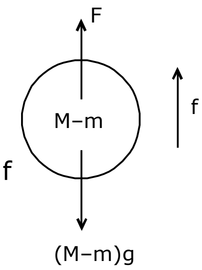
52. **C**

$T - 20 = 4$

53. **C**



$Mg - F = Mf$



$F - (M-m)g = (M-m)f$

$m(g + f) = Mg + mf - Mg + Mf$

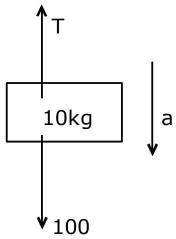
$$m = \frac{2mf}{(g + f)}$$

54. **C**

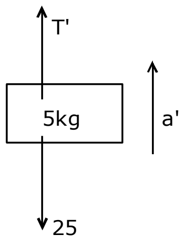
$P = F.V \qquad F = \frac{vdm}{dt} = 10\ N$

$P = 10 \times 2 = 20$ watts

55. **B**



$100 - T = 10a$ ....(1)



$T' - 25 = 5a'$

$T = 2T'$

$a' = 2a$

by eq. (1), (2) & (3)

$a' = \frac{50}{15} = 3.33 m/s^2$

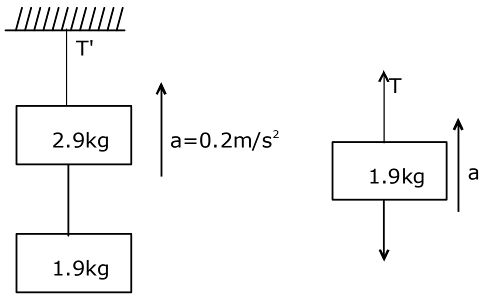
56. **B**

$m_1 g - m_2 g \sin 30^0 = a_1(m_1 + m_2)$

$m_2 g - m_1 g \sin 30^0 = a_2(m_1 + m_2)$

$4a_1 = a_2$

57. **B**



$T - 2\times9.8 = 2\times0.2$

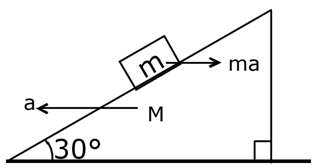
$T = 19.6 + 0.4 = 20N$

58. **D**

$ma\sin\theta = mg\cos\theta$

$a = g \cot\theta$

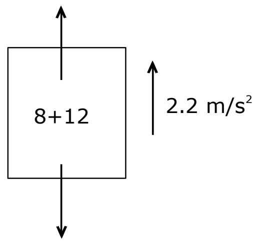
59. **B**



$ma\cos 30 = mg \sin 30$

$a = 5.6 m/s^2$

60. **B**



$T_1 - 200 = 20 \times 2.2$

$T_1 = 240\ N$

61. **B**

62. **B**

$a_T = g\sin 30 = 10 \times 1/2 = 5 m/s^2$

63. **A**

$v = wR$

$= 4 \times 1 = 4\ m/s$

64. **C**

$v_{avg} = \frac{\text{displacement}}{\text{time}} = \frac{\sqrt{2}R}{t}$

$\theta = \frac{1}{2}\alpha t^2$

$t = 2\ s$

$v_{av} = \frac{\sqrt{2}\times\sqrt{2}}{2} = 1 m/s$

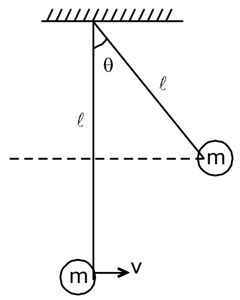
65. **A**

$R = m, \qquad v = 2t$

$a_T = 2$

$s = \frac{1}{2}a_T t^2 = \frac{1}{2}\times 2 \times 4 = 4m$

66. **D**



$mg(\ell - \ell\cos\theta) = \frac{1}{2}mv^2$

$\frac{v^2}{\ell} = 2g(1-\cos\theta)$

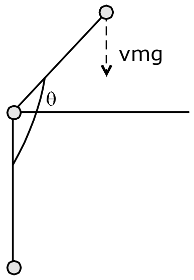
$a_T = g\sin\theta$

$2g(1-\cos\theta) = g\sin\theta$

$\tan\left(\frac{\theta}{2}\right) = \frac{1}{2}$

$\frac{\theta}{2} = \tan^{-1}\frac{1}{2}$

67. **C**



$$Mg\sin\theta = \frac{mv^2}{\ell}$$

$$v^2 = \ell g \sin\theta$$

$$\frac{1}{2}m\frac{7g\ell}{2} = \frac{1}{2}mv^2 + mg(\ell + \ell\sin\theta)$$

$$\sin\theta = \frac{1}{2}, \ \theta = 30^\circ$$

Total angle = 90 + 30 = 120°

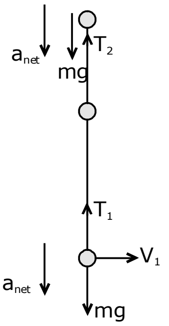
68. **B**

$$mg = \frac{mv^2\cos^2\theta}{R}$$

69. **A**

$F_H = mg + T_2$

$F_L = mg - T_1$



70. **D**

$$T = \frac{mv^2}{(\ell + x)}$$

$$T < \frac{mv^2}{\ell}$$

71. **C**

$s = 18t + 3t^2 - 2t^3$

$v = 18 + 6t - 6t^2$

$$\frac{dv}{dt} = 6 - 12t = 0, \qquad t = \frac{1}{2}s$$

$$v_{max} = 19.5 m/s$$

72. **C**

$KE = Ks^2$

$$\frac{1}{2}mv^2 = ks^2$$

$$F_c = \frac{mv^2}{R} = \frac{2ks^2}{R}$$

$$v^2 = \frac{2ks^2}{m}$$

$$v = \sqrt{\frac{2k}{m}}s$$

$$a_T = \frac{dv}{dt} = \sqrt{\frac{2k}{m}}v$$

$$a_T = \sqrt{\frac{2k}{m}} \times \sqrt{\frac{2k}{m}} \times s$$

$$a_T = 2k \times s$$

$F_T = ma_t = 2ks$

$$F_{net} = \sqrt{(2ks)^2 + \left(\frac{2ks^2}{R}\right)^2}$$

$$= 2ks\sqrt{1 + \left(\frac{s}{R}\right)^2}$$

73. **D**

$v = at \qquad a = 0.5 \ m/s^2$

$v = 0.5t$

$a_T = \alpha R \qquad \theta = \left(\frac{\pi}{5}\right)$

$a_T = 0.5 \ m/s^2$

$$a_c = \frac{0.5 \times 0.5}{R}t^2$$

$$\frac{\pi}{5} = \frac{1}{2} \times \frac{0.5}{R}t^2$$

$$a_r = \sqrt{0.25 + 0.4} = 0.8 m/s^2$$

74. **C**

$\omega = \omega_0 - k\phi \qquad t = 0 \qquad \phi_0 = 0$

$\omega_t = \omega_0$

$$\frac{d\theta}{dt} = \omega_0 = k\phi$$

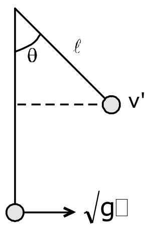
$$\int_0^\phi \frac{1 d\theta}{(\omega_0 - k\phi)} = \int_0^t dt$$

$$\left(\frac{-1}{k}\right)\log\left(\frac{\omega_0 - k\phi}{\omega_0}\right) = t$$

$$\omega_0 - k\phi = \omega_0 e^{-kt}$$

$$\phi = \frac{\omega_0}{k}(1 - e^{-k}t)$$

75. **B**



$T - mg\cos gq = \frac{mv^2}{\ell}$

$mg(1-\cos\theta) = \frac{mv^2}{\ell}$

$v'^2 = 2g\ell(1-\cos\theta)$

$\frac{1}{2}mgl = \frac{1}{2}mv'^2 + mg(l - s\cos\theta)$

$\frac{1}{2}mg\ell = \frac{1}{2}mg\ell(1-\cos\theta) + mg\ell(1-\cos\theta)$

$\frac{1}{2} = \frac{3}{2}\left(1-\cos\theta\right)$ $\qquad$ $\frac{1}{3} = 1-\cos\theta$

$\cos\theta = 1 - \frac{1}{3} = \frac{2}{3}$

$0 = \cos^{-1}\left(\frac{2}{3}\right)$

$v'^2 = gl\left(1-\frac{2}{3}\right)$ $\qquad$ $v'^2 = g\ell\left(\frac{1}{2}\right) = \frac{g\ell}{3}$

$v' = \sqrt{\frac{g\ell}{3}}$

76. **B**

$mgh = \frac{1}{2}m\left(\sqrt{5gD/2}\right)^2$

$mgh = \frac{1}{2}m\frac{5gD}{2}$

$h = \frac{5D}{4}$

77. **B**

$kx = k\omega^2(\ell + x)$

$10^4 x = 90\times10^{-3}\times10^4(0.1+x)$

$x = 0.09(0.1 + x)$

$x = 0.09 \times 0.1 + 0.09x$

$x(1-0.09) = 0.09\times0.1$

$x(0.91) = 0.09\times0.1$

$x = 9.89\times10^{-3}$

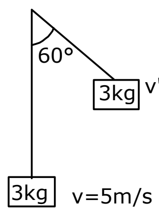
$x = 10^{-2}$ m

78. **D**

$f = 4mg = m\omega^2 r$

$r = \frac{\mu g}{\omega^2}$ $\qquad$ $r \le \frac{\mu g}{\omega^2}$

79. **B**



$0.1\times150 = 3v'$

$v' = 5$m/s

$\frac{1}{2}\times3\times25 = 3\times10\times\frac{1}{2}\left(\frac{1}{2}\right) + \frac{1}{2}\times3v'^2$

$\frac{25}{2} = \frac{5}{2} + \frac{v'^2}{2}$

$v'^2 = 20$

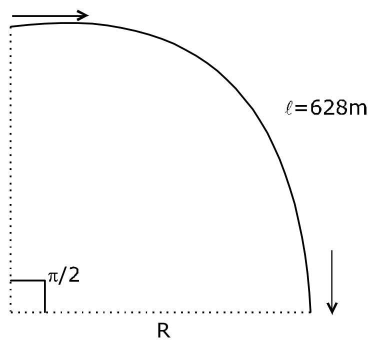
$T = mg\cos60° + mv'^2/\ell = 135$N

80. **B**

$\frac{mv^2}{r} = Mg$

$v = \sqrt{rg} = 10$ m/s

81. **C**



$\theta = \frac{\ell}{R}$

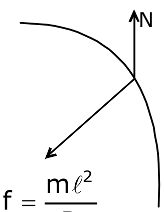
$R = \frac{\ell}{\theta} = \frac{628}{314}\times2\times100$

$F = \frac{mv^2}{R}$

$= \frac{1000\times16\times16}{400}$ =640 N

82. **A**

$v = 72\times\frac{5}{18} = 20$m/s



$f = \frac{m\ell^2}{R}$

$R = \sqrt{N^2 + f^2}$

$= \sqrt{(5000)^2 + (20000)^2}$

= 25 K

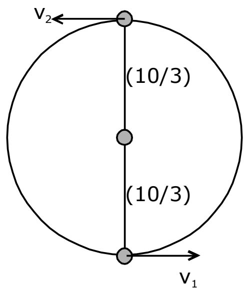
83. **B**

$T = 2\pi\sqrt{\frac{\ell}{g}}$

$\frac{\Delta T}{T} = \frac{1}{2}\frac{\Delta\ell}{\ell}$

=0.5%

84. **D**



$$\frac{T_{max}}{T_{min}} = \frac{\ell mg + mv_1^2}{mv_2^2 - mg\ell}$$

$$\frac{4}{1} = \frac{v_1^2 + g\ell}{v_2^2 - g\ell}, \qquad \frac{1}{2}mv_1^2 = mg2\ell + \frac{1}{2}mv_2^2$$

$$4v_2^2 - v_1^2 = 5g\ell \qquad v_1^2 = 4g\ell + v_2^2$$

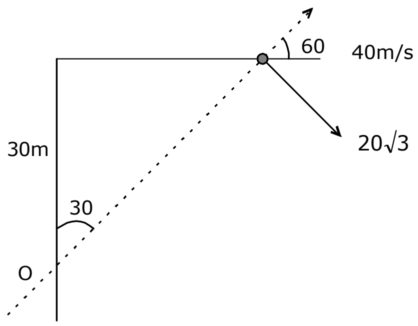
$$4v_2^2 - (4g\ell + v_2^2)5g\ell$$

$$3v_2^2 = 9g\ell \qquad v_2 = \sqrt{3\times10\times10} = 10m/s$$

85. **D**

$$\omega_{PQ} = \frac{V_{\perp Relative}}{R} = \frac{7}{10} = 0.7rad/s$$

86. **D**



$$\cos 30 = \frac{30}{d}$$

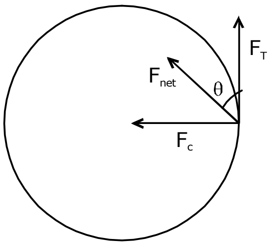
$$\omega = \frac{v}{R} = \frac{20\sqrt{3}\times\sqrt{3}}{60} = 1rad/s$$

87. **B**

$$a_c = k^2rt^2 \qquad P = Fv$$

$$\frac{v^2}{r} = k^2rt^2 \qquad v = krt \qquad Ft = mkr$$

$$F_{net} = \sqrt{(mk^2rt^2)^2 + \left(2mk^2r^2t^2\right)^2}$$



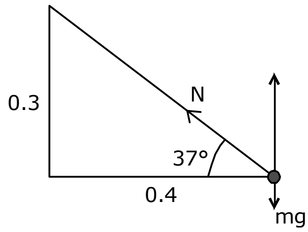
$$P = Fv\cos\theta \quad = mk^2r^2\,t$$

88. **A**

$$Mg - N = \frac{mv^2}{R}, N = 0$$

$$V = \sqrt{Rg}$$

89. **A**



$$\frac{3}{4} = \frac{g}{R\omega^2}$$

$$\omega^2 = \frac{4g}{3R}$$

$$\omega = \frac{10}{\sqrt{3}}rad/s$$

90. **A**

$$\frac{1}{2}mv^2 = 4t^2$$

$$v = \sqrt{\frac{o}{m}}t$$

$$m\frac{dv}{dt} = m\sqrt{\frac{8}{m}}$$

$$F = \sqrt{8m} = costant$$

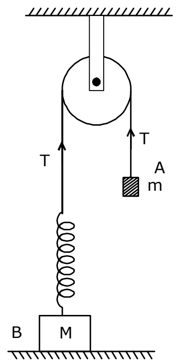
91. **C**

$$kx = mg$$

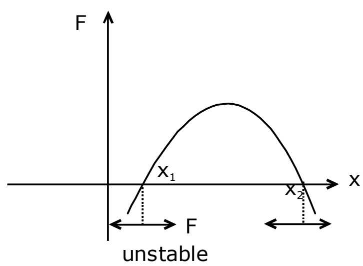
$$x = \frac{mg}{k}$$

$$\frac{1}{2}kx^2 = mgx$$

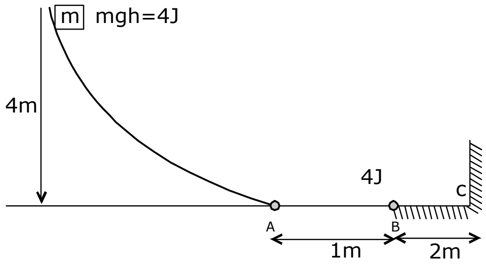
$$m = \frac{M}{2}$$



92. **D**



93. **C**



$$mgh = \frac{1}{2}mv^2$$

$$v = \sqrt{2hg} = \sqrt{2 \times 10 \times 4} = \sqrt{80} m/s$$

$a = \mu g$, $= 0.1 \times 10$, $= 1 \ m/s^2$

$0 = 80 - 2 \times 1 \times s$

s = 40m

Distance covered = 59m

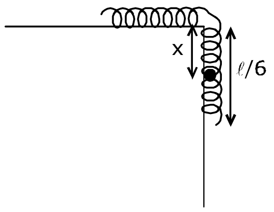
94. **C**

$$\Delta \vec{r} = 2\hat{i} + 2\hat{j} + 2\hat{k}$$

$$\vec{F} = 2\hat{i} + 5\hat{j} + \hat{k}$$

$$\vec{w} = \vec{F}.\Delta\vec{r} = 4 + 10 + 2 = 16J$$

95. **C**



$$w = \int_0^{L/6} \frac{M}{L} \cdot \left(\frac{L}{6} - x\right) g dx = \frac{Mg\ell}{72}$$

96. **D**

$F \propto v$

$$F_1 = \frac{k.d_1}{t_1}, \qquad F_2 = \frac{k.d_2}{t_2}$$

$$\text{Power} = \frac{w}{t} = \frac{F.d}{t} = F.v$$

$P \propto v^2$

$P_2 = kv_2^2$

$$\frac{P_1}{P_2} = \frac{v_1^2}{v_2^2}$$

$$P_2 = \frac{v_2^2}{v_1^2} . P_1$$

P_2 = 96 h.p

97. **B**

$P = \vec{F}.\vec{V}$

$= mg.v \cos\theta$

$= 50 \times 9.8 \times 2 \cos 60° = 490$ w

98. **A**

$v = k\sqrt{s}$

$$\frac{dv}{dt} = \frac{k}{2\sqrt{s}} \cdot \frac{ds}{dt}$$

$$a = \frac{k^2}{2}$$

$$F = ma = \frac{mk^2}{2}$$

(Distanced covered in t seconds)

$$\frac{ds}{dt} = v, \int_0^x \frac{1}{v} .ds = \int_0^t dt \Rightarrow x = \frac{t^2k^2}{4}$$

$$dw = \int_0^x F.ds \quad = \int_0^{t^2k^2/4} \frac{mk^2}{2} .ds = \frac{mk^4t^2}{8}$$

99. **A**

$$mgh = \frac{1}{2}kx^2$$

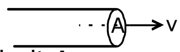
$$x = \left(\frac{2mgh}{k}\right)^{1/2}$$

100. **A**

$$F = v \frac{dm}{dt}$$

$F = 0.2 \times 2 = 0.4$ newton

101. **A**



dm = dvdt A

$$\frac{dm}{dt} = dvA$$

$$K = \frac{1}{2}mv^2$$

$$\frac{dk}{dt} = \frac{1}{2}\frac{dm}{dt}v^2 \quad = \frac{1}{2}DUV^2A$$

$$\frac{dk}{dt} = \frac{1}{2}dAv^3$$

102. **A**

$xm_2 = (1 - x)m_1$

$xm_2 = m_1 - xm_1$

$x(x_1 + mx) = m_1$

$$x = \frac{m_1}{m_1 + m_2}$$

103. **A**

$mu = mv' + mu/2$

$$mv' = \frac{mu}{2}$$

$$v' = \frac{m}{M}\frac{u}{2}$$

$$\sqrt{5g\ell} = \frac{m}{M}\frac{u}{2} \Rightarrow M = \frac{2M\sqrt{5g\ell}}{m}$$

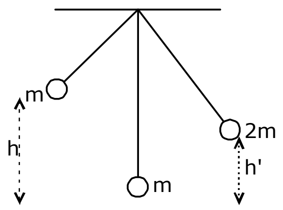
104. C

$5\times10^3\times1.2 = 6\times10^3 v$

v = 1m/s

v_{rel} = 0.2 m/sec.

105. D



$$\frac{1}{2}mv^2 = mgh$$

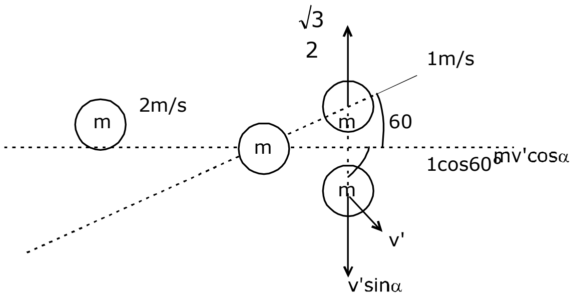
$$v = \sqrt{2gh}$$

$$v' = \sqrt{\frac{gh}{2}}$$

$$\frac{1}{2}2mv'^2 = 2mgh'$$

$$h' = \frac{h}{4}$$

106. A



$$2m = \frac{m}{2} + mv'\cos\alpha$$

$$\Rightarrow \frac{3}{2} = v'\cos\alpha \;....(1)$$

$$\frac{\sqrt{3}}{2} = v'\sin\alpha \quad ....(2)$$

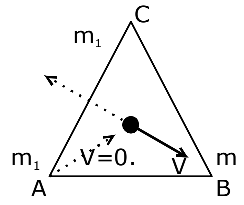
by Eq (2) /(1) $\tan\alpha = \frac{1}{\sqrt{3}}$, $\alpha = 30°$

$(1)^2 + (2)^2$

$$\Rightarrow v'^2\cos^2\alpha + v'^2\sin^2\alpha = \frac{9}{4} + \frac{3}{4}$$

$$v' = \sqrt{3}m/s$$

107. C



$p_i = 0$

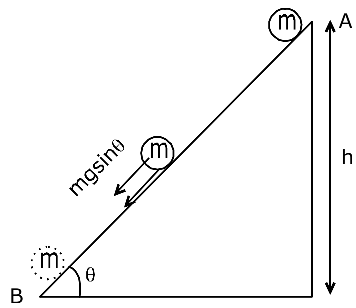
p_f must be zero

$$\vec{P}_A + \vec{P}_B + \vec{P}_C = 0$$

$$\vec{P}_A = 0$$

$$\vec{P}_B = -\vec{P}_C$$

108. B



$f_{AB} = mgh$

$F = f_{BA} + mgh \qquad = 2mgh$

109. C

$$\frac{1}{2}M\frac{v_0^2}{4} + \frac{1}{2}Mv_0^2 = Mgl + Mg\frac{\ell}{2}$$

$$v_0 = \sqrt{\frac{12g\ell}{5}}$$

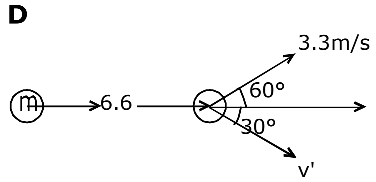
110. B

$$Mgl = 36\times\frac{72}{100}$$

$$h = \frac{324}{125}$$

$$v = \sqrt{2gh} = 7.2m/s$$

111. D



$$v'\sin30 = 3.3\frac{\sqrt{3}}{2}$$

$$v' = 5.7m/s$$

112. C

Linear momentum conservation in x-axis at highest point.

$d = \frac{R}{2} + 2R \qquad (R=100)$

d = 250

113. B

$$\frac{Mx}{t} = \frac{m(L-x)}{t}$$

114. C

$mu = (m + \eta m)v'$

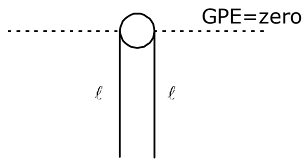
$$v' = \frac{u}{1+\eta}$$

Energy conservation

$$\frac{1}{2}mu^2 = mgh + \frac{1}{2}(m+\eta m)v'^2$$

$$u = \sqrt{2gh\left(1+\frac{1}{\eta}\right)}$$

115. B



$$\frac{-mg\ell}{2} = \frac{1}{2}mv^2 - mg\ell \quad v = \sqrt{g\ell}$$

116. B

$w = \vec{F}.\vec{d}$

$$= \frac{30(\hat{i}+\hat{j}+\hat{k})}{\sqrt{3}}.\left(2\hat{i}+\hat{k}\right) = 30\sqrt{3}\ \text{J}$$

117. D

It will not perform SHM

$kx = mg\sin\theta$, maximum velocity

118. A

$\Delta U = w_F - \Delta k = -10 + 16 = 6\ \text{J}$

119. A

When slide

$$Mgh = \frac{1}{2}Mv_1^2 + \frac{1}{2}mv_2^2 \qquad ....(1)$$

$$MV_1 = mv_2 \qquad (2)$$

when climb

$$\frac{1}{2}mv_2^2 + \frac{1}{2}Mv_1^2 = mgh + \frac{1}{2}(M+m)v'^2$$

From (1), (2) & (3)

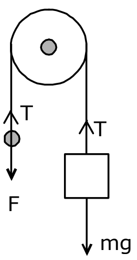
h' < h

120. A

COM will remain constant in x direction

COM will move in y direction

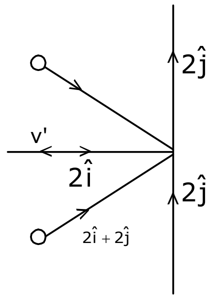
121. B



$w_T + v_{mg} = k = 205$

$w_T = 20 - w_{mg}$

122. B



$$v' = ev = \frac{1}{2}\times 2 = 1$$

$= -1\hat{i}$

So velocity $= -\hat{i} + 2\hat{j}$

123. D

$\vec{r}_{12} = \vec{v}_{12} \times t$

124. A

125. A

$F = \left(2\hat{i}+3\hat{j}\right)N$

$\Rightarrow$ m=3/2

F.x = 0

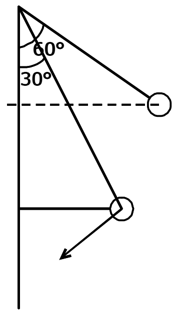
$\theta = 90°$

$3y + kx = 5$

$$m = \frac{-k}{3}\times\frac{3}{2} = -1$$

K=2

126. A



$$(1\cos 30 - 1\cos 60)mg = \frac{1}{2}mv^2$$

$$\left(\frac{\sqrt{3}}{2}-\frac{1}{2}\right)\times 1\times 10 = \frac{1}{2}\times v^2$$

P = mg sin30v

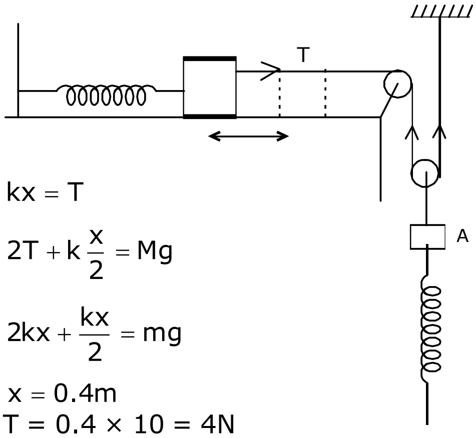
$v^2 = \left(\sqrt{3}-1\right)10$

$v = \sqrt{10(\sqrt{3}-1)}$

$$= 1\times 10\times\frac{1}{2}\times\sqrt{7.32} \qquad v = \sqrt{7.32}$$

$= 5\times\sqrt{7.32} = 13.4$

127. B



$kx = T$

$2T + k\frac{x}{2} = Mg$

$2kx + \frac{kx}{2} = mg$

$x = 0.4m$

$T = 0.4 \times 10 = 4N$

128. D

$w_T + w_{sp} = \Delta k$

$4 \times 0.4 + \left(-\frac{1}{2}k(0.4)^2\right) = \frac{1}{2} \times mv^2$

$1.6 - 5 \times 0.16 = 0.5v^2$

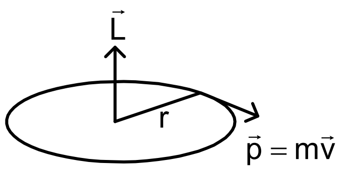
$1.6\left[1 - \frac{1}{2}\right] = 0.5v^2$

$1.6 \times \frac{1}{2} = 0.5v^2$

$\Rightarrow v^2 = \frac{8}{5} = 1.6$

$v = \sqrt{1.6} = 1.26 m/s$

129. A



The direction of $\vec{L}$ (about the center) is perpendicular to the plane containing the circular path. Both magnitude and direction of the angular momentum of the particle moving in a circular path about its center O is constant.

130. B

The linear momentum (L) is conserved, since τ_{ext} is zero.

Let

$\therefore I_o\omega_o = 2I_o\omega \Rightarrow \omega = \frac{\omega_o}{2}$

$K = \frac{1}{2}I\omega_o^2;$

$K_f = \frac{1}{2}(2I_o) x \left(\frac{\omega_o}{2}\right)^2 = \frac{1}{2} x 2I_o x \frac{\omega_0^2}{4}$

$= \left\{\frac{1}{2}\left(\frac{I_o\omega_0^2}{2}\right)\right\} x \frac{1}{2} = \frac{K}{2}$

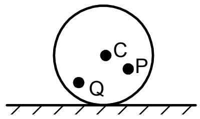
131. C

Here $V_C = V_C$

$V_P = \sqrt{V_C^2 + \omega^2 r^2}$

$V_Q = \sqrt{V_C^2 + \omega^2 r^2 + 2V_C\omega r\cos\theta}$

132. D



$x = \frac{L}{2}\cos\theta ; y = \frac{L}{2}\sin\theta$

$\left(\frac{2x}{L}\right)^2 + \left(\frac{2y}{L}\right)^2 = 1$

$\Rightarrow x^2 + y^2 = \frac{L^2}{4} = \text{circle}$

133. A

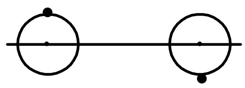
Iw = constant

When ballet dancer then I will increase

$\Rightarrow \omega$ will$\downarrow$

$\frac{1}{2}I\omega^2 = \frac{1}{2}Ix\left(\frac{C}{I}\right) = \frac{C^2}{2I}$

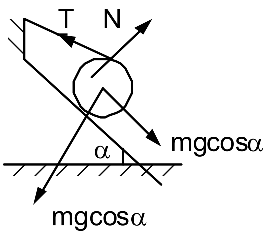
134. D



$mgR = -mgR + \left(\frac{mR^2}{2} + mR^2\right)\frac{1}{2}\omega^2$

$2mR = \frac{3mR^2}{4}\omega^2 \qquad \omega = \sqrt{\frac{8g}{3R}}$

135. C



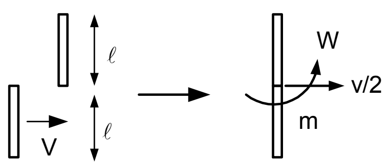
$mg\sin\alpha - T = mA$

$TR = I\alpha , A = R\alpha \qquad T = \frac{I\alpha}{R}$

$mg\sin\alpha - \frac{Ia}{R^2} = ma$

So a = 1.4 m/s²

136. A

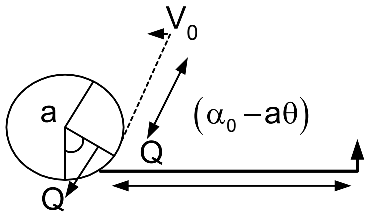


by conservator angular momentum about joint

$$\frac{mvl}{2} = \frac{4 \times 2Ml^2}{12}\omega$$

$\omega = \frac{3V}{4l}$ anti clock wise

137. C



$$V_o = (r_o - a\theta)\omega$$

$$\omega = \frac{v_o}{r_o - a\theta} \;\&\; V_o = r_o\omega_o$$

$$\Rightarrow \omega = \frac{r_o\omega_o}{r_o - a\theta} = \frac{\omega_o}{1 - \frac{a}{r_o}\theta}$$

138. A

$N = mL\alpha$

$f_{max} = \mu N = m\mu L\alpha$

$\omega = \alpha t$

$m\omega^2 L = f_{max}$

$\Rightarrow mx\alpha^2 t^2 L = \mu mL\alpha$

$$\Rightarrow t = \sqrt{\frac{\mu}{\alpha}}$$

SHM, Wave, Gravitation, Fluid, Heat

158. A

$$E = \frac{1}{2}mv_{es}^2$$

159. B

$$v_e = \sqrt{\frac{Gm}{R}}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{m_1}{m_2} \times \frac{R_2}{R_1}}$$

$v_1 = 11.2$

$v_2 = \frac{11.2}{55} = 5.023$ □ 5 km/sec

160. C

$T^2 \propto R^3$

$T \propto R^{3/2}$

$$\frac{dT}{T} \times 100 = \frac{3}{2}\frac{dR}{R} \times 100$$

$dR = 1.01\,R - R = .01R$

$$= \frac{3}{2} \times \frac{.01R}{R} \times 100 = 1.5\%$$

161. C

$$F = \frac{-\partial u}{\partial x}\hat{i} - \frac{\partial v}{\partial y}\hat{j}$$

$$\frac{\partial u}{\partial x} = a, \quad \frac{\partial u}{\partial x} = b,$$

$F = -a\hat{i} - b\hat{j}$

$$\therefore a_{cc} = \sqrt{\frac{a^2 + h^2}{m}}$$

162. A

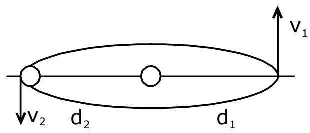
$$E = -\left[\frac{am}{1} + \frac{Gm}{2^2} + \frac{Gm}{4^2} + \frac{Gm}{8^3}\right]$$

$= G\left(\frac{255}{256}\right)$ □ G

163. C

$g = \frac{GMe}{R_e^2}$ no change

164. C

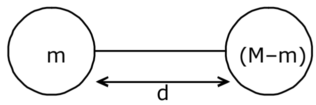


$v_1 d_1 = v_2 d_2$

$$\therefore v_2 = \frac{v_1 d_1}{d_2}$$

165. A

166. D



$$F = \frac{G(M-m)m}{d^2}$$

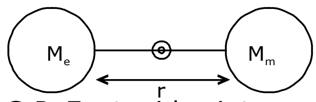
$$\therefore \frac{dF}{dm} = 0, \quad \frac{m}{M} = \frac{1}{2} \quad m = \frac{M}{2}$$

167. D

using D.A

$$\frac{GM_e m}{R_e} + \frac{1}{2}mv^2 = \frac{GM_e m}{R_e}$$

168. A



G.P. E. at mid point

$$= \frac{-GM_e}{r/2} - \frac{GM_m}{r/2}$$

$$= \frac{-2G}{r}(M_e + M_m)$$

G.P.E at mid point