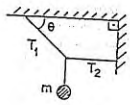
1) In the system shown, a mass m is hanging from two cords. Find the tension T_2. Give proof. Hint: First find T_1.

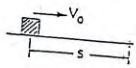


(a) mg; (b) mg Cot θ; (c) mg Cos θ;
(d) mg tan θ; (e) 0; (f) None of the above

2) A block on a smooth incline starts from rest and slides a distance s to the bottom in time t. Take s = 10 m and t = 2s. Find the angle θ of the incline.

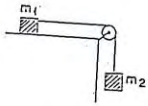
(a) θ = 30°; (b) 17.2°; (c) 60°;
(d) 35.5°; (e) 50°; (f) None of the above

3) A block, sliding on a rough, horizontal surface, has an initial velocity v_o and moves a distance s before coming to rest. Take v_o = 12 m/s and s = 18.0 m. Find the coefficient of friction μ_k.



(a) 0.5; (b) 0.25; (c) 0.33;
(d) 0.4; (e) 0.12; (f) None of the above

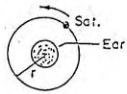
4) For the system shown, the horizontal plane is smooth and $m_2 = 2m_1$. The acceleration a of the masses is given by (Give proof)



(a) 2 g; (b) g/2; (c) $\frac{2}{3}$g;

(d) g; (e) g/3; (f) None of the above

5) A satellite of certain mass rotates around the earth in a circle of radius r. Its centripetal acceleration is a_r. Take $r = 15\times10^3$ km, and $a_r = 2.5$ m/s². Find the satellite's period T; Answer to be in hours. 1 hr = 3600 s.

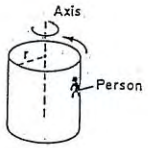


(a) 4.3 hr; (b) 1.5 hr; (c) 0.9 hr;
(d) 5.2 hr; (e) 2 hr; (f) None of the above

6) A car of mass m rounds a circular, horizontal curve of radius r, where the friction coefficient is μ_s If r = 40 m, μ_s = 0.5, and m = 1500 kg, find the maximum allowed speed v, i.e., before slipping; Answer to be in km/hr. 1 m/s = 3.6 km/hr.

(a) 42.3 km/h; (b) 14.1 km/h; (c) 25 km/h;
(d) 50.9 km/h; (e) 200 km/h; (f) None of the above

7) A person is standing against the vertical wall of a rotating, circular cylinder of radius r. The friction coefficient with the wall is μ_s. Find the minimum speed of rotation v of the wall, so that the person does not fall. Take r = 2 m and μ_s = 0.5.



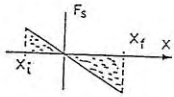
(a) 5.5 m/s; (b) 40 m/s; (c) 25 m/s;
(d) 4 m/s; (e) 6.32 m/s; (f) None of the above

8) A force P at an angle θ acts on a block of mass m that moves along a smooth, horizontal surface. Take m = 2 kg, θ = 60°, and P = 12N. Find the total work done on the block during the first 2 seconds of its motion, assuming the block to start from rest.

(a) 36 J; (b) 40 J; (c) 56 J;
(d) 45 J; (e) 72 J; (f) None of the above

2

9. A spring of force constant k is allowed to move from a state of compression, of x_i to a state of extension x_f. Take $k = 2 \times 10^3$ N/m, $x_i = -0.1$m, and $x_f = 0.2$ m. Find the work Ws done by the spring.

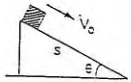


(a) -100 J; (b) 100 J; (c) -30 J;
(d) -70J; (e) -50 J; (f) None of the above

10. Two vectors are A = 2i-3j and B = 3i+2j. Find the angle θ between them.

(a) 45°; (b) 0°; (c) 37°
(d) 60°; (e) 90°; (f) None of the above

11. A block of mass m slides down a smooth incline of length s. It started with an initial velocity v_o. Take m = 2 kg, s = 3m, and v_o = 5 m/s. θ = 37°. Find the kinetic energy of the block at the bottom of the incline. Use work-energy method.



(a) 36 J; (b) 61 J; (c) 75.6 J;
(d) 25 J; (e) 41 J; (f) None of the above

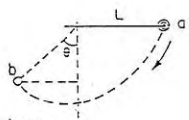
12. A car is travelling at a constant speed v on a horizontal road. The air resistance and friction combined force is F_f. Take v = 40 m/s (144 km/hr) and F_f = 900 N, and find the power delivered by the engine. Answer in hp. 1 hp = 0.75 kW.

(a) 36 hp; (b) 25 hp; (c) 75 hp;
(d) 48 hp; (e) 0; (f) None of the above

13. A particle moves along the x-axis under the action of a force given by $F_x = +2x - 3x^2$, where x in (m) and F in (N). Find the potential energy U at the point x = 2m. Assume that U = 5J at x = 0.

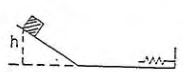
(a) 9 J; (b) 1 J; (c) 10 J;
(d) 20 J; (e) 0; (f) None of the above

14. A pendulum of length L = 2 m, starts from rest at a horizontal level (point a) and swings down. The speed of its sphere at the point b, where θ = 60°, is given by (Give proof)



(a) 20 m/s; (b) 6.3 m/s; (c) 7.5 m/s;
(d) 3.3 m/s; (e) 4.47 m/s; (f) None of the above

15. A block of mass starts at a height h on an incline and slides down, and then horizontally, hitting, at the end, a spring of force constant k. Take m = 5kg, h = 4m, k = 5×10^2 m. Assume the work done by friction to be -50J. Find the maximum compression of the spring as it is hit by the block.



(a) 0.2 m; (b) 1 m; (c) 0.36 m;
(d) 0.25 m (e) 0.5 m; (f) None of the above

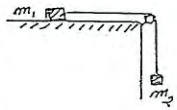
16. Find the angle (in degrees) between the vectors $\underline{A} = 3\hat{i} + 4\hat{j}$ and $\underline{B} = 2\hat{i} + \hat{j} + 2\hat{k}$.

(a) 20 (b) 27 (c) 40 (d) 48 (e) Other

17. A force $F = 2\hat{i} + 3\hat{j}$, acting alone on an object gives it an acceleration of magnitude 2 m/s². What is the mass (in kg) of this object

(a) 1.0 (b) 1.5 (c) 1.8 (d) 6.5 (e) Other

18) In the system shown $m_1 = 10$ kg and $m_2 = 4$ kg. The pulley and cord are massless and frictionless. Find the coefficient of sliding friction betweem m_1 and the horizontal table if the blocks move at a constant speed.



19) (a) 0.1 (b) 0.2 (c) 0.3 (d) 0.4 (e) Other

A 5 kg block is pulled along a horizontal frictionless floor by a force F = 20 N at an angle of 30 degrees above the horizontal. If the force F is slowly increased, what is its value just before the block is lifted off the floor? [Hint: When N = 0]

20) (a) 100 N (b) 20 N (c) 0 (d) 50 N (e) Other

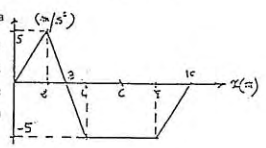
A small object is placed 10 cm from the center of a turntable. It is observed to be about to slide off when the turntable rotates at 45 rev/min. What is the coefficient of static friction between the object and the surface of the table?

(a) 0.22 (b) 0.44 (c) 0.11 (d) 0.47 (e) Other

21) A 0.5 kg object is swung in a vertical circular path on a string 0.4 m long. If a constant speed of 2 m/s is maintained, what is the tension in the string when the object is at the bottom of the circle?

(a) 0 (b) 5 N (c) 10 N (d) 15 N (e) Other

22) A 5 kg mass moves along the x–axis. Its acceleration as a function of its position is shown in the figure. What is the net work performed on the mass by the force as the mass moves from x = 0 to x = 10 m?



(a) –100 J (b) –20 J (c) 25 J (d) –50 J (e) Other

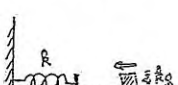
23) A 1.6 kg block slides down a plane (inclined at 25 degrees with the horizontal) at a constant speed of 2 m/s. Calculate the power dissipated by the frictional force on the block?

(a) –20 W (b) –6.8 W (c) –13.5 W (d) –23.5 W (e) Other

24) A 2 kg object accelerates uniformly from rest to a speed of 10 m/s in 3 s. How much work is done on the object during this time interval?

(a) 0 (b) 10 J (c) 100 J (d) –10 J (e) Other

25) A 2 kg block, moving on a frictionless surface collides with a horizontal spring compressing it by 10 cm before coming to rest. If the spring constant k = 1800 N/m find the speed with which the block was moving when it made contact with the spring?

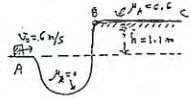


(a) 10 m/s (b) 3 m/s (c) 9 m/s (d) –1 m/s (e) Other

26) A 0.5 kg ball falls past a window,that is 1.50 m in vertical length. How much did the kinetic energy of the ball increase as it fell past the window?

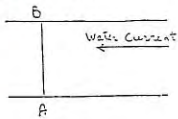
(a) 5.0 J (b) 7.5 J (c) 15.0 J (d) 22.5 J (e) Other

27) A block slides along a track from A to C as shown. The track is frictionless until it reaches the higher level BC. The blocks initial speed is 6 m/s, the height difference is h = 1.1 m, and the coefficient of kinetic friction μ_k between the block and the surface BC is 0.6. Find how far the particle moves along BC before it stops.?



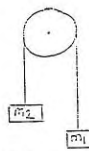
(a) 1.2 m (b) 2.4 m (c) 0.6 m (d) 1.1 m (e) Other

28) The driver of a boat that can move at 10 m/s relative to water, wishes to travel directly across a river from point A to point B. The water flows at 5.0 m/s to the West. Due to the water current, the boat should move relative to water in a direction making an angle θ with the line AB. Find θ.



a) 27° b) 30° c)60° d) 63° e) Other

29) In the Atwood machine shown, if $m_1 = 0.60$ kg and $m_2 = 0.40$ kg, what is the magnitude of the acceleration of the system? (Ignore friction and the mass of the pulley).



a) 5.34 m/s² b) 4.52 m/s² c)2 m/s² d) 1.2 m/s² e) Other

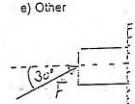
30) A curved road is banked at a 45° angle. When a car rounds this curve at the curve's safe speed (no friction needed to stay on the run), what is its centripetal acceleration?

a) 1.0 g b) 2.0 g c) 0.5 g d) 1.5 g e) Other

31) A person of weight 480 N stands on a scale in an elevator. What will the scale be reading when the elevator is decelerating upward at 4.00 m/s²?

a) 480 N b) 672 N c) 288 N d) 192 N e) Other

32) A block of mass 1.4 kg is pressed against a rough wall by a force F as shown in figure. The coefficient of static friction between the block and the wall is 0.50. What is the minimum value of F that prevents the block from falling down?



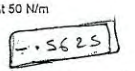
a) 15 N b) 2 N c) 11 N c) 12.5 N e) Other

33) A 100 N force has a horizontal component of 80 N and a vertical component of 60 N. The force is applied to a box which rests on a level frictionless floor. The box starts from rest, and moves 2.0 m horizontally along the floor. What is the final kinetic energy of the box?

a) 200 J b) 160 J c) 120 J d) zero e) Other

34) What is the work required to stretch a spring of spring constant 50 N/m from x = 0.20 m to 0.25 m?

a) 0.45 J b) 0.80 J c) 1.3 J d) 0.050 J e) Other



35) A block of mass 2-kg is projected with a speed v_i along a frictionless surface inclined at 30° (see figure). The block hits the spring (force constant 1200 N/m) and compresses it a distance 10 cm. If d = 90 cm, find the value of v_i.

a) 6 m/s b) 4 m/s c) 5 m/s d) 7 m/s e) Other

36) A 30.0-N stone is dropped from a height of 10.0 m, and strikes the ground with a velocity of 7.00 m/s. What average force of air friction acts on it as it falls?

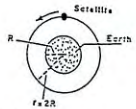
a) 22.7 N b) 76.0 N c) 225 N d) 293 N e) Other

PART I

37) A driver of a car rounds a flat circular curve of radius of 50m. He finds that the car begins to slip when the speed reaches 15m/s. Calculate the friction coefficient μ.

(a) 0.15; (b) 0.03; (c) 0.3; (d) 0.45; (e) 0.1.

38) A satellite orbits the earth uniformly at an altitude equal to the earth's radius (figure). Find the speed of the satellite.
Earth's radius = 6.4×10^3 km.
Hint: Since the gravitational acceleration $g(r) \sim 1/r^2$, it follows that at the satellite orbit $g = 10/4 = 2.5 m/s^2$.



(a) 5.7×10^3 m/s; (b) 11×10^3 m/s; (c) 8×10^3 m/s; (d) 2×10^3 m/s; (e) 4×10^3 m/s.

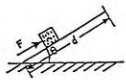
39) A 50-kg child sits on a swing attached to a cord of length 2m tied to a fixed support. What maximum speed can the swing have at the bottom point A before the cord breaks? The maximum tension tolerated by the cord is 4 times the child's weight.

(a) 60 m/s; (b) 300 m/s; (c) 8.9 m/s; (d) 7.7 m/s; (e) 15 m/s.

40) Two vectors are $A = 2i+4j$ and $B = -4i+2j$. Find θ, the angle between the vectors.

(a) 180°; (b) 90°; (c) 30°; (d) 0°; (e) 143°.

41) A force F, parallel to an incline, is used to push a box up a smooth incline ramp a distance d. Find the net work done on the box. F=250N, m=20kg, d=5m, and $\theta = 37°$.



(a) -600J; (b) 1250J; (c) 0J; (d) 1000J; (e) 650J.

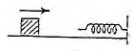
42) It requires an amount of work of 50J to stretch a spring (from equilibrium) by an amount of 0.2m. Find the force constant of the spring.

(a) 1250 N/m; (b) 2500 N/m; (c) 500 N/m; (d) 250 N/m; (e) 1000 N/m.

43) A weightlifter raises 300 kg through 2m in 1.5s. Find his average power.

(a) 6 kW; (b) 4 kW; (c) 5 kW; (d) 2 kW; (e) 2.25 kW.

44) A 4.0-kg block moves on a horizontal, smooth surface at a speed of 5.0 m/s. It touches a horizontal spring of force constant $k=10^4$ N/m and compresses it. The maximum compression in the spring is

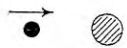


(a) 0.005m; (b) 0.10m; (c) 0.07m; (d) 0.03m; (e) 0.15m.

45) A block of weight 50N is moving with a kinetic energy of 25J on a horizontal surface of coefficient of kinetic friction 0.2. Find the distance covered by the block to come to rest.

(a) 2.5m; (b) 5.0m; (c) 7.5m; (d) 10.0m; (e) 12.5m.

46) A particle of mass 20g is moving to the right at 3m/s towards a particle of mass 40g at rest. Find the speed of the center of mass of the system of two particles.



(a) 0; (b) 2 m/s; (c) 1 m/s; (d) 3 m/s; (e) 4 m/s.

47) A bullet of mass 2g, moving at 150 m/s, strikes and embeds itself in a block of wood of mass 98g, initially at rest. After collision, the energy of the block (in Joules) is:

(a) 22500; (b) 22.5; (c) 450; (d) 45; (e) 0.45.

48) In an elastic, two dimensional collision, a ball A of mass 2-kg, moving at 5m/s, collides with a ball B of mass 8-kg, at rest. After collision, ball A has a speed of 3m/s. What is the speed of B?

(a) 8 m/s; (b) 4 m/s; (c) zero; (d) 1 m/s; (e) 2 m/s.