Honors Physics
Problem Set
Unit 4

4.1 A sledge loaded with bricks has a total mass of 18.0 kg and is pulled at constant speed by a rope. The rope is inclined at 20.0° above the horizontal, and the sledge moves a distance of 20.0 m on a horizontal surface. The coefficient of kinetic friction between the sledge and surface is 0.500. (a) What is the tension of the rope? (b) How much work is done by the rope on the sledge? (c) What is the mechanical energy lost due to friction?

4.2 A 2.0-g bullet leaves the barrel of a gun at a speed of 300 m/s. (a) Find its kinetic energy. (b) Find the average force exerted by the expanding gases on the bullet as the bullet moves the length of the 50-cm-long barrel.

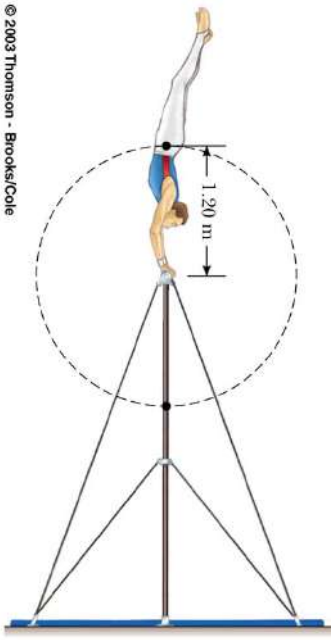
4.3 A 2 000-kg car moves down a level highway under the actions of two forces. One is a 1 000-N forward force exerted on the drive wheels by the road; the other is a 950-N resistive force. Use the work-kinetic energy theorem to find the speed of the car after it has moved a distance of 20 m, assuming it starts from rest.

4.4 On a frozen pond, a 10-kg sled is given a kick that imparts to it an initial speed of v_0 = 2.0 m/s. The coefficient of kinetic friction between sled and ice is μ_k = 0.10. Use the work-kinetic energy theorem to find the distance the sled moves before coming to rest.

4.5 A softball pitcher rotates a 0.250-kg ball around a vertical circular path of radius 0.600 m before releasing it. The pitcher exerts a 30.0-N force directed parallel to the motion of the ball around the complete circular path. The speed of the ball at the top of the circle is 15.0 m/s. If the ball is released at the bottom of the circle, what is its speed upon release?

4.6 A 40-N toy is placed in a light swing that is attached to ropes 2.0 m long. Find the gravitational potential energy associated with the toy relative to its lowest position (a) when the ropes are horizontal, (b) when the ropes make a 30° angle with the vertical, and (c) at the bottom of the circular arc.

4.7 A gymnast swings on the high bar as shown in Figure P5.29. Starting from rest directly over the bar, he swings around the bar while keeping his arms and legs outstretched. Treating the gymnast as though his entire mass were concentrated at a point 1.20 m from the bar, determine his speed as he passes under the bar at position **A**.



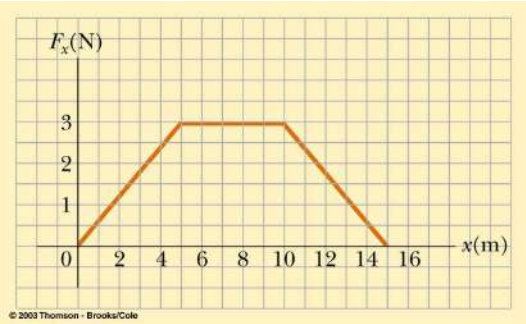
4.8 Tarzan swings on a 30.0-m-long vine initially inclined at an angle of 37.0° with the vertical. What is his speed at the bottom of the swing (a) if he starts from rest? (b) if he pushes off with a speed of 4.00 m/s?

4.9 A 25.0-kg child on a 2.00-m-long swing is released from rest when the ropes of the swing make an angle of 30.0° with the vertical. (a) Neglecting friction, find the child's speed at the lowest position. (b) If the actual speed of the child at the lowest position is 2.00 m/s, what is the mechanical energy lost due to friction?

4.10 Starting from rest, a 10.0-kg block slides 3.00 m down a frictionless ramp (inclined at 30.0° from the floor) to the bottom. The block then slides an additional 5.00 m along the floor before coming to a stop. Determine (a) the speed of the block at the bottom of the ramp, (b) the coefficient of kinetic friction between block and floor, and (c) the mechanical energy lost due to friction.

4.11 While running, a person dissipates about 0.60 J of mechanical energy per step per kilogram of body mass. If a 60-kg person develops a power of 70 W during a race, how fast is the person running? Assume a running step is 1.5 m long.

4.12 An object is subject to a force F_x that varies with position as in Figure P5.56. Find the work done by the force on the object as it moves (a) from $x = 0$ to $x = 5.00$ m, (b) from $x = 5.00$ m to $x = 10.0$ m, and (c) from $x = 10.0$ m to $x = 15.0$ m. (d) What is the total work done by the force over the distance $x = 0$ to $x = 15.0$ m?



4.13 A ski jumper starts from rest 50.0 m above the ground on a frictionless track, and flies off the track at an angle of 45.0° above the horizontal and at a height of 10.0 m above the level ground. Neglect air resistance. (a) What is his speed when he leaves the track? (b) What is the maximum altitude he attains after leaving the track? (c) Where does he land relative to the end of the track?

4.14 A 5.0-kg block is pushed 3.0 m up a vertical wall with constant speed by a constant force of magnitude F applied at an angle of $\theta = 30°$ with the horizontal, as shown in Figure P5.70. If the coefficient of kinetic friction between block and wall is 0.30, determine the work done by (a) **F**, (b) the force of gravity, and (c) the normal force between block and wall. (d) By how much does the gravitational potential energy increase during this motion?