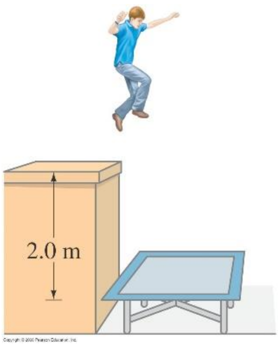
CHAPTER VIII
POTENTIAL ENERGY AND CONSERVATION OF ENERGY
PROBLEM SET

1) A spring with $k = 63\ \text{N/m}$ hangs vertically next to a ruler. The end of the spring is next to the 15-cm mark on the ruler. If a 2.5-kg mass is now attached to the end of the spring, where will the end of the spring line up with the ruler marks? **[Answer: 54 cm]**

2) In the high jump, the kinetic energy of an athlete is transformed into gravitational potential energy without the aid of a pole. With what minimum speed must the athlete leave the ground in order to lift his center of mass 2.10 m and cross the bar with a speed of $0.70\ \text{m/s}$?

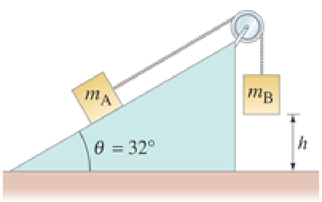
[Answer: 6.5 m/s]

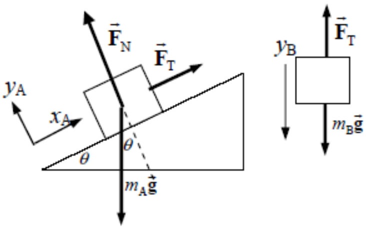
3) A 72-kg trampoline artist jumps vertically upward from the top of a platform with a speed of $4.5\ \text{m/s}$. (*a*) How fast is he going as he lands on the trampoline, 2.0 m below (Fig. 8–31)? (*b*) If the trampoline behaves like a spring of spring constant 5.8×10^4 N/m, how far does he depress it? **[Answer: a) 7.7 m/s, b) -0.28 m]**



4) Two masses are connected by a string as shown in Fig. 8–34. Mass $m_A = 4.0\ \text{kg}$ rests on a frictionless inclined plane, while $m_B = 5.0\ \text{kg}$ is initially held at a height of $h = 0.75\ \text{m}$ above the floor. (*a*) If m_B is allowed to fall, what will be the resulting acceleration of the masses? (*b*) If the masses were initially at rest, use the kinematic equations (Eqs. 2–12) to find their velocity just before m_B hits the floor. (*c*) Use conservation of energy to find the velocity of the masses just before m_B hits the floor. You should get the same answer as in part (*b*).

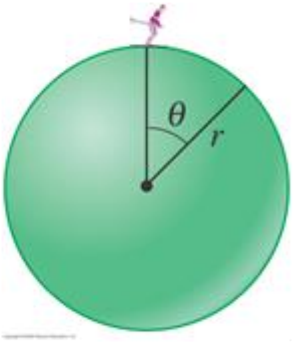
[Answer: a) $3.1\ \text{m/s}^2$, b) 2.2 m/s, c) expression below]

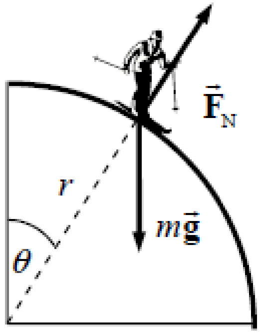




$$v_2 = \sqrt{2gh\left(\frac{m_B - m_A \sin\theta}{m_A + m_B}\right)}$$

5) *** A skier of mass *m* starts from rest at the top of a solid sphere of radius *r* and slides down its frictionless surface. (*a*) At what angle θ (Fig. 8–36) will the skier leave the sphere? (*b*) If friction were present, would the skier fly off at a greater or lesser angle? **[Answer: a) 48^0, b) greater]**





6) Consider the track shown in Fig. 8–37. The section AB is one quadrant of a circle of radius 2.0 m and is frictionless. B to C is a horizontal span 3.0 m long with a coefficient of kinetic friction $\mu_k = 0.25$. The section CD under the spring is frictionless. A block of mass 1.0 kg is released from rest at A. After sliding on the track, it compresses the spring by 0.20 m. Determine: (*a*) the velocity of the block at point B; (*b*) the thermal energy produced as the block slides from B to C; (*c*) the velocity of the block at point C; (*d*) the stiffness constant *k* for the spring.

[Answer: a) 6.3 m/s, b) 7.4 J, c) 4.9 m/s, d) 610 N/m]

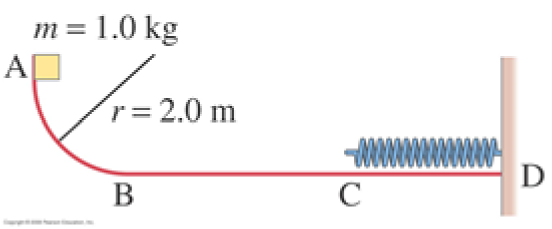


Fig. 8–37

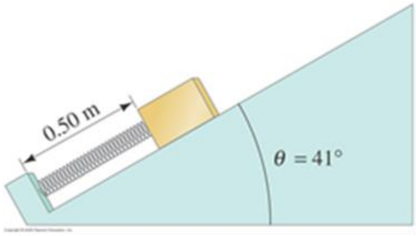
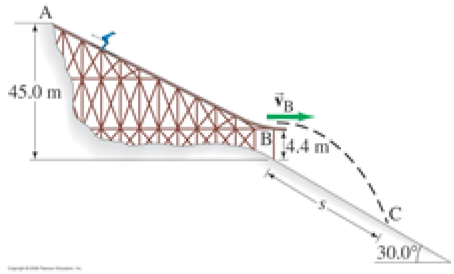


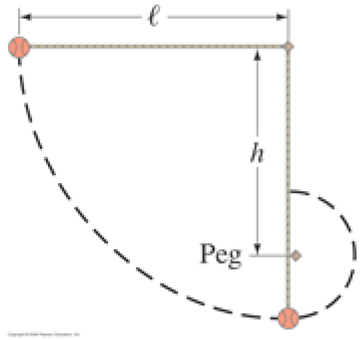
Fig. 8–38

7) *** A spring $(k = 75 \text{ N/m})$ has an equilibrium length of 1.00 m. The spring is compressed to a length of 0.50 m and a mass of 2.0 kg is placed at its free end on a frictionless slope which makes an angle of 41° with respect to the horizontal (Fig. 8–38). The spring is then released. (*a*) If the mass is *not* attached to the spring, how far up the slope will the mass move before coming to rest? (*b*) If the mass *is* attached to the spring, how far up the slope will the mass move before coming to rest? (*c*) Now the incline has a coefficient of kinetic friction μ_k. If the block, attached to the spring, is observed to stop just as it reaches the spring's equilibrium position, what is the coefficient of friction μ_k? **[Answer: a) 0.73 m, b) 0.66 m, c) 0.40]**

8) A 62-kg skier starts from rest at the top of a ski jump, point A in Fig. 8–41, and travels down the ramp. If friction and air resistance can be neglected, (*a*) determine her speed v_B when she reaches the horizontal end of the ramp at B. (*b*) Determine the distance ***s*** to where she strikes the ground at C. **[Answer: a) 28.2 m/s, b) 116 m]**



9) A ball is attached to a horizontal cord of length ***l***, whose other end is fixed, Fig. 8–42. (*a*) If the ball is released, what will be its speed at the lowest point of its path? (*b*) A peg is located a distance ***h*** directly below the point of attachment of the cord. If ***h***=0.80***l*** what will be the speed of the ball when it reaches the top of its circular path about the peg? **[Answer:a)$\sqrt{2gl}$, b) $\sqrt{1.2gl}$]**



10) *** A 56-kg student runs at 5.0 m/s, grabs a hanging rope, and swings out over a lake (Fig. 8–45). He releases the rope when his velocity is zero. (*a*) What is the angle θ when he releases the rope? (*b*) What is the tension in the rope just before he releases it? (*c*) What is the maximum tension in the rope? **[Answer: a) 29^0, b) 480 N, c) 690 N]**