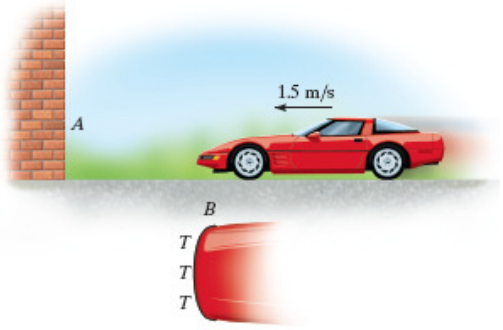
Exercise 3

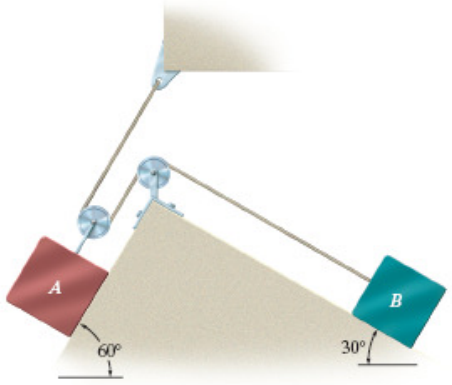
1. (Prob. 14-5) A car is equipped with a bumper *B* designed to absorb collisions. The bumper is mounted to the car using pieces of flexible tubing *T*. Upon collision with a rigid barrier at *A*, a constant horizontal force **F** is developed which causes a car deceleration of *3g* ($29.43 m/s^2$), which is the highest safe deceleration for a passenger without a seatbelt. If the car and passenger have a total mass of *1.5Mg* and the car is initially coasting with a speed of *1.5m/s*, determine the magnitude of **F** needed to stop the car and the deformation of the bumper tubing.

2. (Prob. 14-9) When a driver applies the brakes of a light truck traveling at 40km/h, it skids 3m before coming to a complete stop. How far will the truck skid if it is traveling at double the original speed when the brakes are applied?

3. (Prob. 14-14) Determine the velocity of the *300N* (approx. *30kg*) block *A* if the two blocks are released from rest and the *200N* (approx. *20kg*) block *B* moves *1 m* up the incline. The coefficient of kinetic friction between both blocks and the inclined planes is $\mu_k = 0.10$.

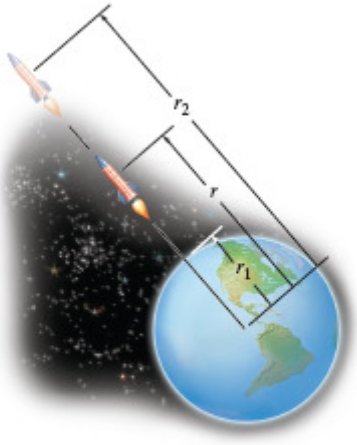


Prob. 14–5



Prob. 14–14

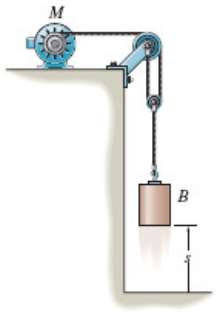
4. (Prob. 14-37) A rocket of mass *m* is fired vertically from the surface of the earth, i.e. at $r = r_1$. Assuming no mass is lost as it travels upward, determine the work it must do against gravity to reach a distance r_2. The force of gravity is $F = \frac{GM_e m}{r^2}$, where M_e is the mass of the earth and *r* is the distance between the rocket and the centre of the earth. The constant *G* is universal constant of gravitation and is determined from experiment to be $G = 66.73(10^{-12})\ m^3/(kg \cdot s^2)$.



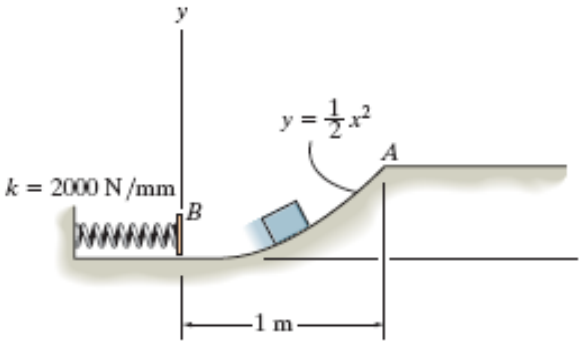
Prob. 14–37

5. (Prob. 14-51) To dramatise the loss of energy in an automobile, consider a car having a weight of 25kN (approx. 25 tons) that is traveling at 50km/h. If the car is brought to a complete stop, determine how long a 100-watt light bulb must burn to expend the same amount of energy.

6. (Prob. 14-58) The *250 N* (approx. 25kg) load is hoisted by the pulley system and motor *M*. If the crate starts from rest and by constant acceleration attains a speed of *4.5m/s* after rising *s=1.8m*, determine the power that must be supplied to the motor at this instant. The motor has an efficiency of $\varepsilon = 0.76$. Neglect the mass of the pulleys and cable.



Prob. 14–58

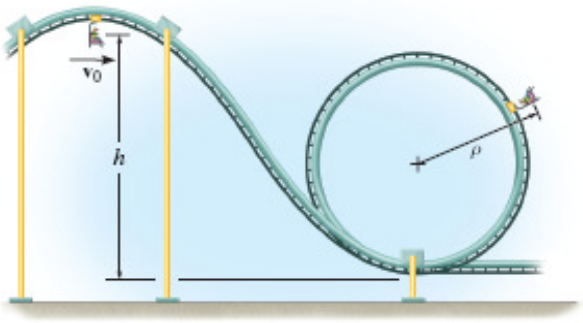


Probs. 14–70/71

7. (Prob. 14-70) Determine the smallest amount the spring at *B* must be compressed against the *0.5 kg* block so that when it is released from *B* it slides along the smooth surface and reaches point *A*.

8. (Prob. 14-71) If the spring is compressed *75 mm* against the *0.5 kg* block and it is released from rest, determine the normal force of the smooth surface on the block when it reaches point *s=150 mm*.

9. (Prob. 14-88) The Raptor is an outside loop roller coaster in which riders are belted into seats resembling ski-lift chairs. If the cars travel at v_0*=4m/s* when they are at the top of the hill, determine the speed when they are at the top of the loop and the reaction of the *70-kg* passenger on his seat at this instant. The car has a mass of *50 kg*. Take *h=12m*, $\rho = 5m$. Neglect friction and the size of the car and passenger.



Prob. 14–88