**Chapter-7**

1. In 1990, Walter Arfeuille of Belgium lifted a 281.5-kg object through a distance of 17.1 cm using only his teeth. (a) How much work was done on the object by Arfeuille in this lift, assuming the object was lifted at constant speed? (b) What total force was exerted on Arfeuille’s teeth during the lift?

Ans:

(a) The work done by a constant force is given by

 

 where  is the angle between the force and the displacement of the object. In this case, *F* = –*mg* and  giving

 W = (281.5 kg)(9.80 m/s2)[(17.1 cm)(1 m/102 cm)] = 

 (b) If the object moved upward at constant speed, the net force acting on it was zero. Therefore, the magnitude of the upward force applied by the lifter must have been equal to the weight of the object:

 F = mg = (281.5 kg)(9.80 m/s2) = 2.76 × 103 N = 

1. A 7.80-g bullet moving at 575 m/s strikes the hand of a superhero, causing the hand to move 5.50 cm in the direction of the bullet’s velocity before stopping. (a) Use work and energy considerations to find the average force that stops the bullet. (b) Assuming the force is constant, determine how much time elapses between the moment the bullet strikes the hand and the moment it stops moving.

Ans:

(a) As the bullet moves the hero’s hand, work is done on the bullet to decrease its kinetic energy. The average force is opposite to the displacement of the bullet:

 

 

 

 (b) If the average force is constant, the bullet will have a constant acceleration and its average velocity while stopping is . The time required to stop is then

 

1. A 0.20-kg stone is held 1.3 m above the top edge of a water well and then dropped into it. The well has a depth of 5.0 m. Relative to the configuration with the stone at the top edge of the well, what is the gravitational potential energy of the stone–Earth system (a) before the stone is released and (b) when it reaches the bottom of the well? (c) What is the change in gravitational potential energy of the system from release to reaching the bottom of the well?

Ans:

Use U = mgy, where y is measured relative to a reference level. Here, we measure y to be relative to the top edge of the well, where we take y = 0.

 (a) *y* = 1.3 m: U = mgy = (0.20 kg)(9.80 m/s2)(1.3 m) = 

 (b) *y* = –5.0 m: U = mgy = (0.20 kg)(9.80 m/s2)(–5.0 m) = 

 (c) 

1. *Why is the following situation impossible?* A librarian lifts a book from the ground to a high shelf, doing 20.0 J of work in the lifting process. As he turns his back, the book falls off the shelf back to the ground. The gravitational force from the Earth on the book does 20.0 J of work on the book while it falls. Because the work done was 20.0 J 1 20.0 J 5 40.0 J, the book hits the ground with 40.0 J of kinetic energy.

Ans: We need to be very careful in identifying internal and external work on the book-Earth system. The first 20.0 J, done by the librarian on the system, is external work, so the system now contains an additional
20.0 J compared to the initial configuration. When the book falls and the system returns to the initial configuration, the 20.0 J of work done by the gravitational force from the Earth is internal work. This work only transforms the gravitational potential energy of the system to kinetic energy. It does not add more energy to the system. Therefore, the book hits the ground with 20.0 J of kinetic energy. The book-Earth system now has zero gravitational potential energy, for a total energy of 20.0 J, which is the energy put into the system by the librarian.

**Chapter-8**

1. For saving energy, bicycling and walking are far more efficient means of transportation than is travel by automobile. For example, when riding at 10.0 mi/h, a cyclist uses food energy at a rate of about 400 kcal/h above what he would use if merely sitting still. (In exercise physiology, power is often measured in kcal/h rather than in watts. Here 1 kcal = 1nutritionist’s Calorie = 4 186 J.) Walking at 3.00 mi/h requires about 220 kcal/h. It is interesting to compare these values with the energy consumption required for travel by car. Gasoline yields about 1.30X108 J/gal. Find the fuel economy in equivalent miles per gallon for a person (a) walking and (b) bicycling.

Ans:

*Answer:* Your grandmother can accompany you.

(a) The fuel economy for walking is



 (b) For bicycling:

 

1. A block of mass *m* = 200 g is released from rest at point Ⓐ along the horizontal diameter on the inside of hemispherical bowl of radius *R* = 30.0 cm, and the surface of the bowl is rough. The block’s speed at point Ⓑ is 1.50 m/s. (a) What is its kinetic energy at point Ⓑ? (b) How much mechanical energy is transformed into internal energy as the block moves from point Ⓐ to point Ⓑ? (c) Is it possible to determine the coefficient of friction from these results in any simple manner? (d) Explain your answer to part (c)

(a) Let us take *U* = 0 for the particle-bowl-Earth system when the particle is at . Since *vB =* 1.50 m/s and *m =* 200 g,

 

 (b) At , *vi =* 0, *KA =* 0, and the whole energy at  is *UA =* *mgR*:

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At ,

 *Ef* = *KB + UB* = 0.225 J + 0

The decrease in mechanical energy is equal to the increase in internal energy.

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The energy transformed is

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 (c) 

 (d) 

3. As the driver steps on the gas pedal, a car of mass 1 160 kg accelerates from rest. During the first few seconds of motion, the car’s acceleration increases with time according to the expression
 *a* = 1.16*t-* 0.210*t*2- 1 0.240*t*3

 where *t* is in seconds and *a* is in m/s2. (a) What is the change in kinetic energy of the car during the interval from *t* = 0 to *t* = 2.50 s? (b) What is the minimum average power output of the engine over this time interval? (c) Why is the value in part (b) described as the *minimum* value?

Ans:

(a) To calculate the change in kinetic energy, we integrate the expression for *a* as a function of time to obtain the car’s velocity:

 

 At *t* = 0, *vi* = 0. At *t* = 2.5 s,

 

 The change in kinetic energy during this interval is then

 

 (b) The road does work on the car when the engine turns the wheels and the car moves. The engine and the road together transform chemical potential energy in the gasoline into kinetic energy of the car.

 

 

 (c) 