**Chapter-7**

1. When a 4.00-kg object is hung vertically on a certain light spring that obeys Hooke’s law, the spring stretches 2.50 cm. If the 4.00-kg object is removed, (a) how far will the spring stretch if a 1.50-kg block is hung on it? (b) How much work must an external agent do to stretch the same spring 4.00 cm from its unstretched position?

**Ans:** When the load of mass *M* = 4.00 kg is hanging on the spring in equilibrium, the upward force exerted by the spring on the load is equal in magnitude to the downward force that the Earth exerts on the load, given by *w* = *Mg*. Then we can write Hooke’s law as *Mg* = +*kx*. The spring constant, force constant, stiffness constant, or Hooke’s-law constant of the spring is given by



(a) For the 1.50-kg mass,



(b) Work

1. A 5.75-kg object passes through the origin at time t 5 0 such that its x component of velocity is 5.00 m/s and its y component of velocity is -3.00 m/s. (a) What is the kinetic energy of the object at this time? (b) At a later time, t = 2.00 s, the particle is located at x = 8.50 m and y = 5.00 m. What constant force acted on the object during this time interval? (c) What is the speed of the particle at t = 2.00 s?

**Ans:** (a) K = mv2 = m(v*x*2 + v*y*2)

= (5.75 kg)[(5.00 m/s)2 + (–3.00 m/s)2] = 

(b) We know F*x* = ma*x* and F*y* = ma*y*. At t = 0, x*i* = y*i* = 0, and   
v*xi* = 5.00 m/s, v*yi* = –3.00 m/s; at t = 2.00 s, x*f* = 8.50 m, y*f* = 5.00 m.





F*x* = ma*x* = (5.75 kg)(–0.75 m/s2) = –4.31 N

F*y* = ma*y* = (5.75 kg)(5.50 m/s2) = 31.6 N



(c) We can obtain the particle’s speed at *t* = 2.00 s from the particle under constant acceleration model, or from the nonisolated system model. From the former,







From the nonisolated system model,



The work done by the force is given by



then,



which gives



1. A 100-g bullet is fired from a rifle having a barrel 0.600 m long. Choose the origin to be at the location where the bullet begins to move. Then the force (in newtons) exerted by the expanding gas on the bullet is 15 000 + 10 000*x* - 25 000*x*2, where *x* is in meters. (a) Determine the work done by the gas on the bullet as the bullet travels the length of the barrel. (b) **What If?** If the barrel is 1.00 m long, how much work is done, and (c) how does this value compare with the work calculated in part (a)?

Ans: a) We find the work done by the gas on the bullet by integrating the function given:







(b) Similarly,



(c) 

1. In an electron microscope, there is an electron gun that contains two charged metallic plates 2.80 cm apart. An electric force accelerates each electron in the beam from rest to 9.60% of the speed of light over this distance a) Determine the kinetic energy of the electron as it leaves the electron gun. Electrons carry this energy to a phosphorescent viewing screen where the microscope’s image is formed, making it glow. For an electron passing between the plates in the electron gun, determine (b) the magnitude of the constant electric force acting on the electron, (c) the acceleration of the electron, and (d) the time interval the electron spends between the plates.

Ans: a) 



(b) 





(c) 

(d) 



**Chapter-8**

1. A 20.0-kg cannonball is fired from a cannon with muzzle speed of 1 000 m/s at an angle of 37.0o with the horizontal. A second ball is fired at an angle of 90.0o. Use the isolated system model to find (a) the maximum height reached by each ball and (b) the total mechanical energy of the ball Earth system at the maximum height for each ball. Let y = 0 at the cannon

Ans: (a) 

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We use the Pythagorean theorem to express the original kinetic energy in terms of the velocity components (kinetic energy itself does not have components):

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Because v*xi =* v*xf* , we have



so for the first ball:



and for the second,



(b) The total energy of each ball-Earth system is constant with value



1. An energy-efficient lightbulb, taking in 28.0 W of power, can produce the same level of brightness as a conventional lightbulb operating at power 100 W. The lifetime of the energy-efficient bulb is 10 000 h and its purchase price is $4.50, whereas the conventional bulb has a lifetime of 750 h and costs $0.42. Determine the total savings obtained by using one energy-efficient bulb over its lifetime as opposed to using conventional bulbs over the same time interval.Assume an energy cost of $0.200 per kilowatt-hour

Ans: energy = power × time

For the 28.0-W bulb:

Energy used = (28.0 W)(1.00 × 104 h) = 280 kWh

total cost = $4.50 + (280 kWh)($0.200/kWh) = $60.50

For the 100-W bulb:

Energy used = (100 W)(1.00 × 104 h) = 1.00 × 103 kWh

# of bulbs used 

total cost = 13($0.420) + (1.00 × 103 kWh)($0.200/kWh) = $205.46

Savings with energy-efficient bulb:

$205.46 – $60.50 = $144.96 = 

1. Energy is conventionally measured in Calories as well as in joules. One Calorie in nutrition is one kilocalorie, defined as 1 kcal = 4 186 J. Metabolizing 1 g of fat can release 9.00 kcal. A student decides to try to lose weight by exercising. He plans to run up and down the stairs in a football stadium as fast as he can and as many times as necessary. To evaluate the program, suppose he runs up a flight of 80 steps, each 0.150 m high, in 65.0 s. For simplicity, ignore the energy he uses in coming down (which is small). Assume a typical efficiency for human muscles is 20.0%. This statement means that when your body converts 100 J from metabolizing fat, 20 J goes into doing mechanical work (here, climbing stairs). The remainder goes into extra internal energy. Assume the student’s mass is 75.0 kg. (a) How many times must the student run the flight of stairs to lose 1.00 kg of fat? (b) What is his average power output, in watts and in horsepower, as he runs up the stairs? (c) Is this activity in itself a practical way to lose weight?

Ans: a) Burning 1 kg of fat releases energy



The mechanical energy output is



where *n* is the number of flights of stairs. Then





where the number of times she must climb the stairs is



(b) Her mechanical power output is



(c) 