شكراً لتحميلك هذا الملف من موقع المناهج الإماراتية

تجميعة أسئلة وفق الهيكل الوزاري بريدج

تاريخ نشر الملف على موقع المناهج: 26-02-2024 15:33:16 | اسم المدرس: عبد الله ملكاوي

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Subject الموضوع	Physics(Bridge)
Grade الصف	11
Stream	Advanced/المتقدم

1	Apply the relationship between a particle's kinetic energy, mass, and speed as K= $\frac{1}{2}mv^2$, measured in joules (*j*) or N.m or $\frac{kgm^2}{s^2}$	Example 5.1	131
		Q.[5.11/5.19]	150

Which of the following statements are true regarding kinetic energy?

I. It is a scalar quantity
II. It is either positive or zero
III. It is either positive or negative

. A 200 kg moving tiger has a kinetic energy of 14,400 J. What is the speed of the tiger?

A. 8.5 m/s

B. 12 m/s

C. 72 m/s

D. 144 m/s

The damage done by a projectile on impact is correlated with its kinetic energy. Calculate and compare the kinetic energies of these three projectiles:

a. a 10.0 kg stone at 30.0 m/s

b. a 100.0 g baseball at 60.0 m/s

c. a 20.0 g bullet at 300 m/s

2	Identify that electron-volt (eV), is the kinetic energy that an electron gains when accelerated by an electric potential of 1volt	Student Book	131

Which of the following is **not** a unit of energy?

$$1\ eV = 1.602\times10^{-19}\ J$$

$$1\ Cal = 4186\ J$$

$$1\ Mt = 4.18\times10^{15}\ J.$$

A. Electron volt (eV)

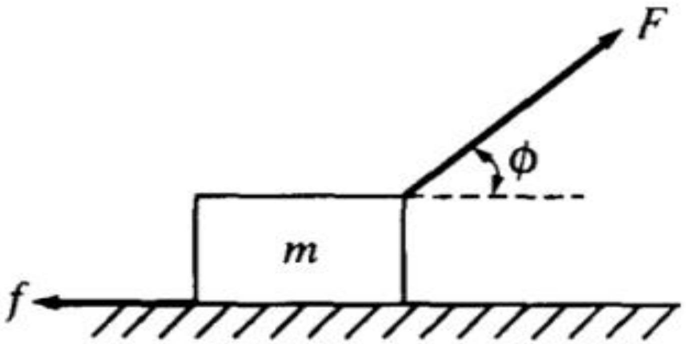
B. Calorie

C. Kg m^2/s^2

D. None. All the above are units of energy

3	Show that the work done on a particle by a force ***F*** when the particle undergoes a displacement $\boldsymbol{\Delta r}$, is given by the scalar product: $W=F\cdot\Delta r=F\Delta r\ cos\alpha$.	Figure5.9	134
		Concept Check5.1	134
		Q.[5.9/5.15/5.17]	150

. A box of mass m is pulled by a force F, which makes an angle ϕ with the horizontal. A frictional force f is applied on the box as it slides on a horizontal surface, as shown in the figure below. Which of the following represents the net work on the box when it covers a distance d?



A. Fd

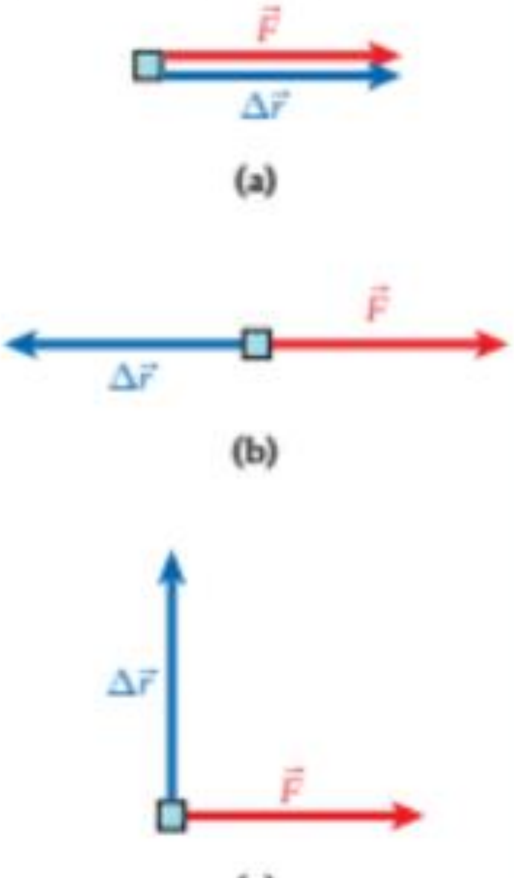
B. $F\cos\phi\, d$

C. $(F\cos\phi - f)d$

D. $(F\sin\phi - f)d$

Concept Check 5.1

Consider an object undergoing a displacement $\Delta\vec{r}$ and experiencing a force $\vec{F}$. In which of the three cases shown below is the work done by the force on the object zero?



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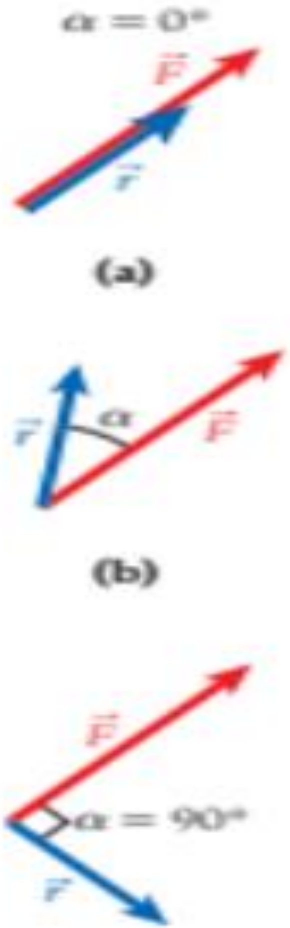
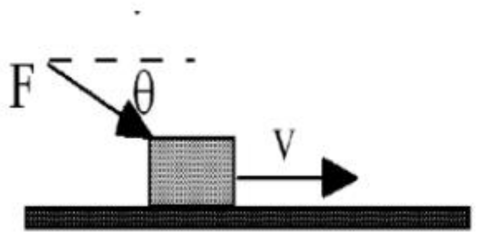


(c)

FIGURE 5.9 (a) $\vec{F}$ is parallel to $\vec{r}$ and $W = |\vec{F}||\vec{r}|$. (b) The angle between $\vec{F}$ and $\vec{r}$ is α and $W = |\vec{F}||\vec{r}|\cos\alpha$. (c) $\vec{F}$ is perpendicular to $\vec{r}$ and $W = 0$.

. A student pushes an object along a horizontal surface a distance d with a force F at an angle θ . If the velocity is constant at a value v, then ___.



A. there is no net work done

B. the net work done is $Fd\cos\theta$

C. the net work done is $Fd\sin\theta$

D. the net work done is Fv

. How much work do movers do horizontally in pushing a 150 kg crate 12.3 m across a floor at constant speed if the coefficient of friction is 0.70?

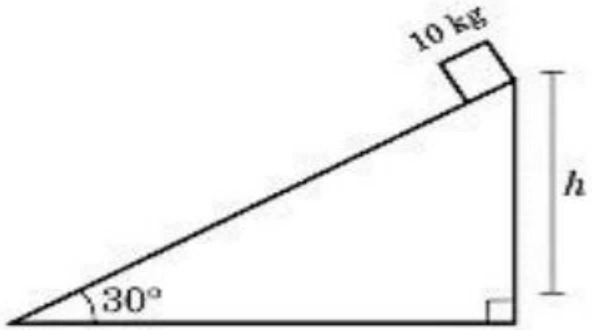
A. $1.3 \times 10^3\ J$

B. $1.8 \times 10^3\ J$

C. $1.3 \times 10^4\ J$

D. $1.8 \times 10^4\ J$

kg block is released from rest at the top of an inclined plane of height $h = 2\text{m}$, as shown in the figure below. The coefficient of kinetic friction between the block and the surface of the incline is 0.2.



19. The work done by gravity is ___________.

B. $-200\ J$

C. $0\ J$

D. $200\ J$

E. $350\ J$

The work done by friction is ___________.

A. $-85\ J$

B. $-68\ J$

C. $0\ J$

D. $68\ J$

4	Define power as the rate at which work is done or energy is transferred.	Student Book	144

Power is the rate at which work is done. Mathematically, this means that the power, P, is the time derivative of the work, W:

$$P = \frac{dW}{dt}. \tag{5.18}$$

It is also useful to define the average power, $\bar{P}$ as

$$\bar{P} = \frac{W}{\Delta t}.$$

. A man of mass 60 kg runs up a flight of 60 steps in 40 seconds. If each step is 20 cm high, his power is __.

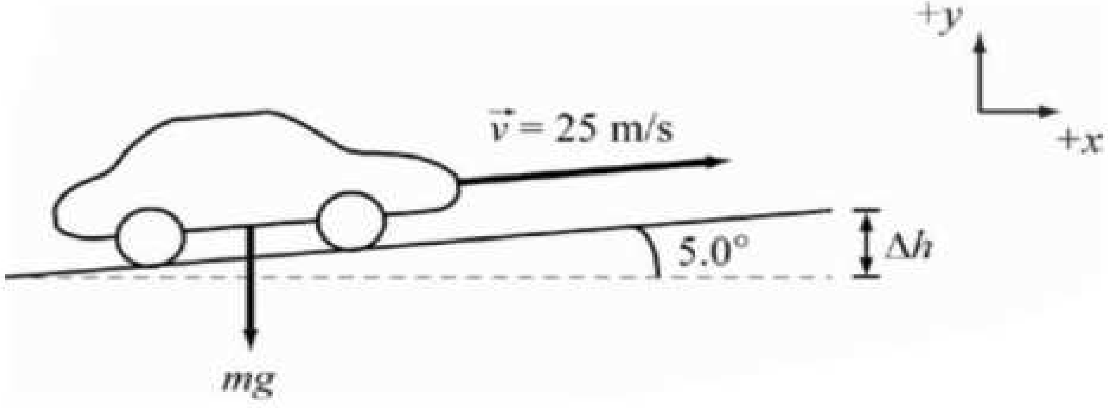
A. 18 W

B. 134 W

C. 177 W

D. 240 W

١٧. Calculate the power required to propel a 1000.0 kg car at 25.0 m/s up a straight slope inclined 5.00° above the horizontal. Neglect friction and air resistance.



A 5.0 kg crate is lifted straight up from the ground at a constant speed of 1.5 m/s to the back of a moving truck which is at a height of 5.0 m above the ground. What power is needed to accomplish this task?

A. 25 W

B. 53 W

C. 74 W

D. 87 W

A 1000 kg car starts from rest and accelerates to 27 m/s in 6.0 s. What is the power required for this to occur?

A. $4.5 \times 10^3\ W$

B. $3.0 \times 10^4\ W$

C. $6.1 \times 10^4\ W$

D. $1.2 \times 10^5\ W$

5	Relate the work done by the gravitational force and the gravitational potential energy for an object lifted from rest to a height h as: $\Delta U_g = -W_g$	Student Book	135

Work Done by the Gravitational Force

With the work-kinetic energy theorem at our disposal, we can now take another look at the problem of an object falling under the influence of the gravitational force, as in Example 5.1. On the way down, the work done by the gravitational force on the object is

$$W_g = +mgh, \tag{5.9}$$

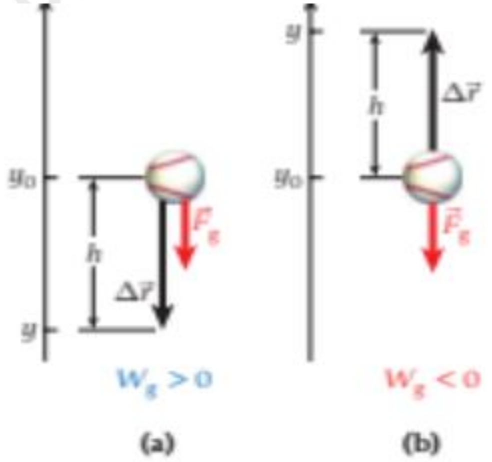


FIGURE 5.10 Work done by the gravitational force. (a) The object during free fall. (b) Tossing an object upward.

We can reverse this situation and toss the object vertically upward, making it a projectile and giving it an initial kinetic energy. This kinetic energy will decrease until the projectile reaches the top of its trajectory. During this time, the displacement vector $\Delta\vec{r}$ points up, in the opposite direction to the force of gravity (Figure 5.10b). Thus, the work done by the gravitational force during the object's upward motion is

$$W_g = -mgh. \tag{5.10}$$

PROBLEM 1

The German lifter Ronny Weller won the silver medal at the Olympic Games in Sydney, Australia, in 2000. He lifted 257.5 kg in the "clean and jerk" competition. Assuming he lifted the mass to a height of 1.83 m and held it there, what was the work he did in this process?

SOLUTION 1

This problem is an application of equation 5.11 for the work done against the gravitational force. The work Weller did was

$$W = mgh = (257.5 \text{ kg})(9.81 \text{ m/s}^2)(1.83 \text{ m}) = 4.62 \text{ kJ}.$$

How much work is done against gravity in lifting a 6.00 kg weight through a distance of 20.0 cm?

A. 1.20 J

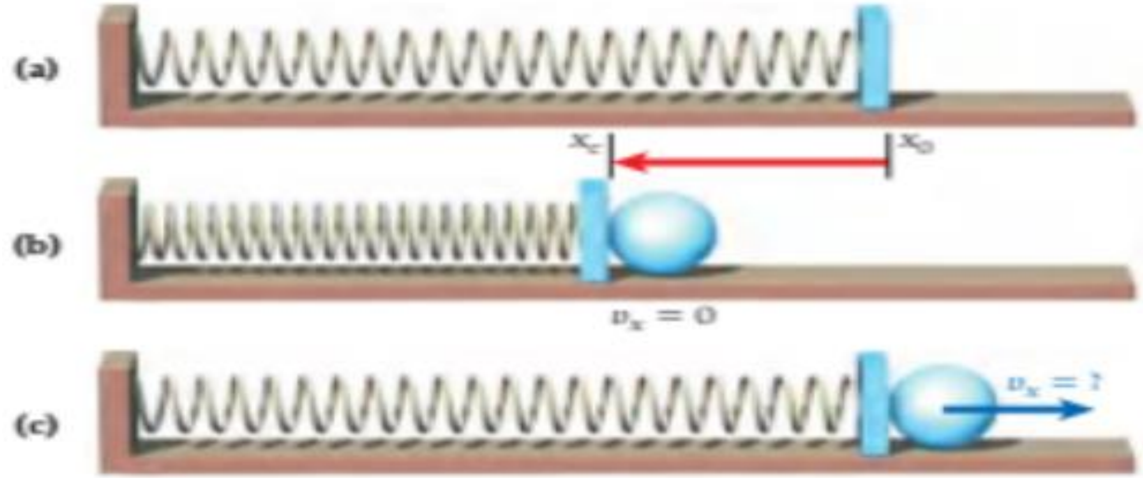
B. 3.33 J

C. 11.8 J

D. 120 J

6	Apply Hook's Law to calculate the spring force, the spring constant, or the displacement of the end of the spring knowing the other two quantities.	Example 5.3	141
		Solved Problem 5.2	142
		Q.[5.42/5.43/5.44]	151

SOLVED PROBLEM 5.2 Compressing a Spring



A massless spring located on a smooth horizontal surface is compressed by a force of 63.5 N, which results in a displacement of 4.35 cm from the initial equilibrium position. As shown in Figure 5.16, a steel ball of mass 0.075 kg is then placed in front of the spring and the spring is released.

PROBLEM

What is the speed of the steel ball when it is shot off by the spring, that is, right after it loses contact with the spring? (Assume there is no friction between the surface and the steel ball; the steel ball will then simply slide across the surface and will not roll.)

SOLUTION

5.44 A spring with spring constant k is initially compressed a distance x_0 from its equilibrium length. After returning to its equilibrium position, the spring is then stretched a distance x_0 from that position. What is the ratio of the work that needs to be done on the spring in the stretching to the work done in the compressing?

5.42 An ideal spring has the spring constant $k = 440$ N/m. Calculate the distance this spring must be stretched from its equilibrium position for 25.0 J of work to be done.

5.43 A spring is stretched 5.00 cm from its equilibrium position. If this stretching requires 30.0 J of work, what is the spring constant?

7	(1) Calculate the gravitational potential energy of a particle -Earth system ($U_g = mgy$).	Example 6.1	155
	(2) Relate the work done by the gravitational force and the gravitational potential energy for an object lifted from rest to a height h as: $\Delta U_g = -W_g$.	Solved Problem 6.1	156-157

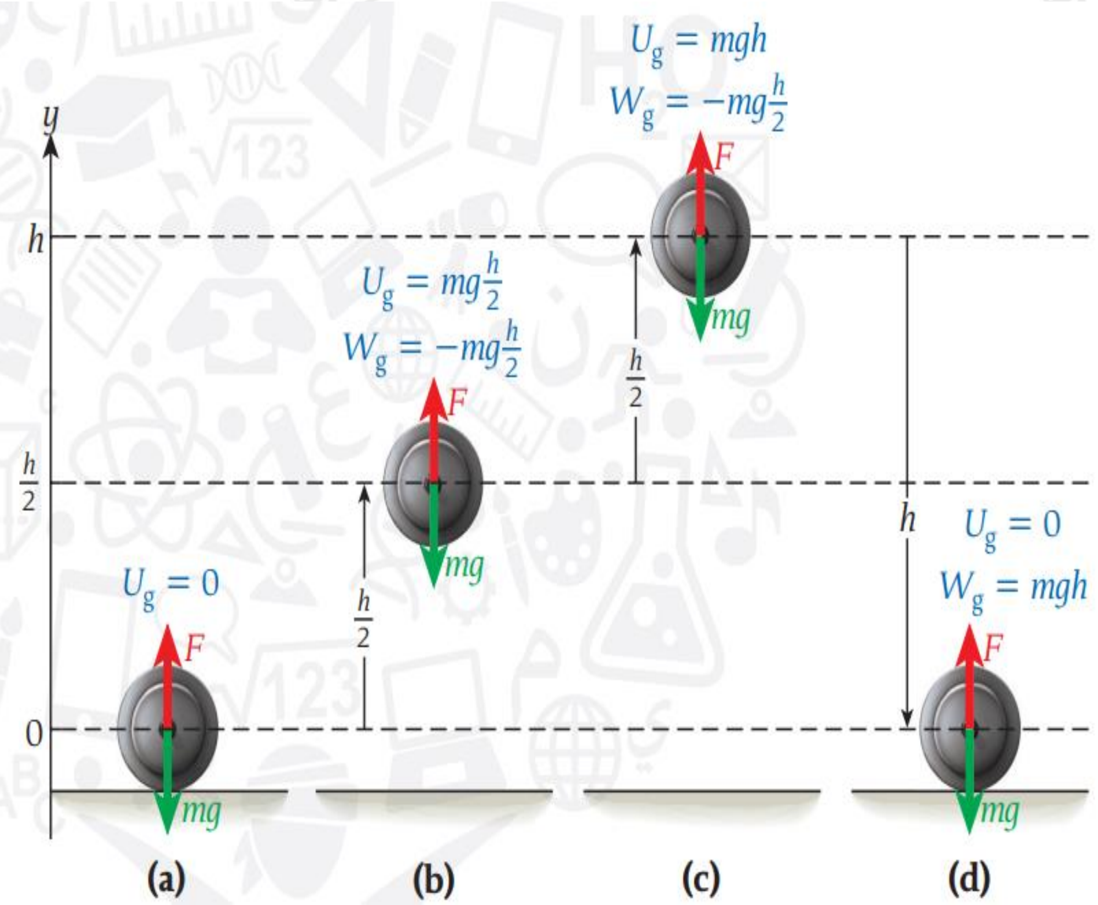
The change in the gravitational potential energy of the mass is then

$$\Delta U_g = -W_g. \qquad \Delta U_g \equiv U_g(y) - U_g(y_0) = mg(y - y_0) = mgh.$$

EXAMPLE 6.1 Weightlifting

PROBLEM

Let's consider the gravitational potential energy in a specific situation: a weightlifter lifting a barbell of mass m. What is the gravitational potential energy and the work done during the different phases of lifting the barbell?



What is the gravitational potential energy of a 2.00 kg book 1.50 m above the floor?

A. 2.25 J

B. 3.00 J

C. 13.1 J

D. 29.4 J

A stone is thrown up in the air and it reaches a maximum height of 10.0 m. What is the initial speed of the stone?

A. 10.0 m/s

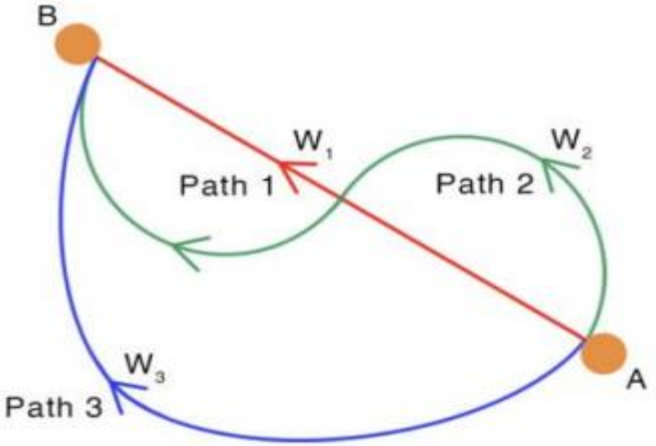
B. 12.0 m/s

C. 14.0 m/s

D. 19.0 m/s

8	(1) Identify that the work done by a conservative force along a closed path is zero: $W_{(A\rightarrow B)} + W_{(B\rightarrow A)} = 0$. (2) Identify that for a particle moving between two points, the work done by a conservative force does not depend on the path taken by the particle : $W_{(A\rightarrow B),path①} = W_{(A\rightarrow B),path②}$	Student Book	157-159

Three students move an object through different paths in a conservative force.



How does the work done by the three students compare?

A. $W_3 > W_2 > W_1$

B. $W_1 > W_2 > W_3$

C. $W_2 = W_3 = W_1$

D. $W_1 = W_2 = W_3$

Any force for which the work done over any closed path is zero is _____ force.

A. a conservative

B. a nonconservative

C. either conservative or nonconservative

D. neither conservative nor nonconservative

	Conservative Force	Non-conservative Force
Work done is	Independent on the path	Dependent on the path
Work done around a closed path is	Zero	Non zero
Law of conservation of energy	Obeys	Does not obey
Loss of mechanical energy	No	Yes
Reversible or irreversible	Reversible	Irreversible
Types	Gravitational force Spring force Electric force Magnetic force	Friction Air resistance Fluid friction Damping force
Example	The force that holds the electrons in an atom	The resistance to a ship sailing on the water

. Which of the following is/are the consequences of the definition of a conservative force?

I. $W_{A\to B} = -W_{B\to A}$
II. The work done by a conservative force is independent of the path taken by the object
III. The gravitational force is an example of a conservative force

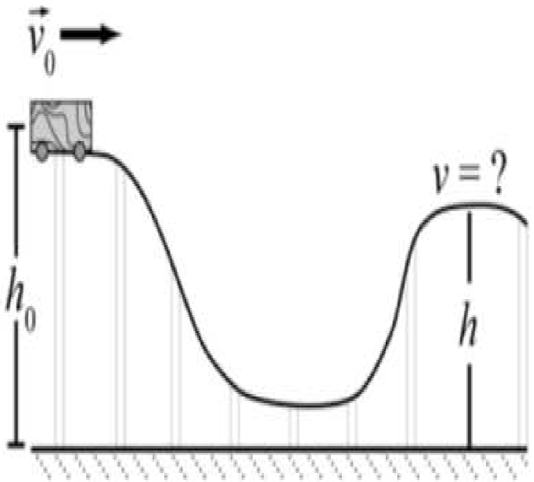
A. I only
B. II only
C. I and III
D. I, II and III

. True or False?

a. A force can be defined as a conservative force if the work done on an object by the force depends only on the initial and final position of the object. (True)
b. The work done by a conservative force will be zero if the object undergoes a displacement that completes a complete closed path.(True)
c. Friction is an example of conservative force (False)
d. The work done by a non-conservative force does not depend on the path taken. (False)
e. The work done by a non-conservative force appear in the system as internal energy rather than kinetic or potential energy (True)

9	State the law of conservation of mechanical energy: "For a mechanical process that occurs inside an isolated system and involves only conservative forces, the total mechanical energy is conserved; $\Delta E_{mech} = \Delta K + \Delta U = 0$ or $K + U = K_o + U_o$.	Student Book	157-159

. A roller coaster is moving at 2.00 m/s at the top of the first hill ($h_0 = 40.0\ m$). Ignoring friction and air resistance, how fast will the roller coaster be moving at the top of a subsequent hill, which is 15.0 m high?



Mechanical energy is equal to the____.

A. kinetic energy only

B. potential energy only

C. sum of kinetic and potential energies

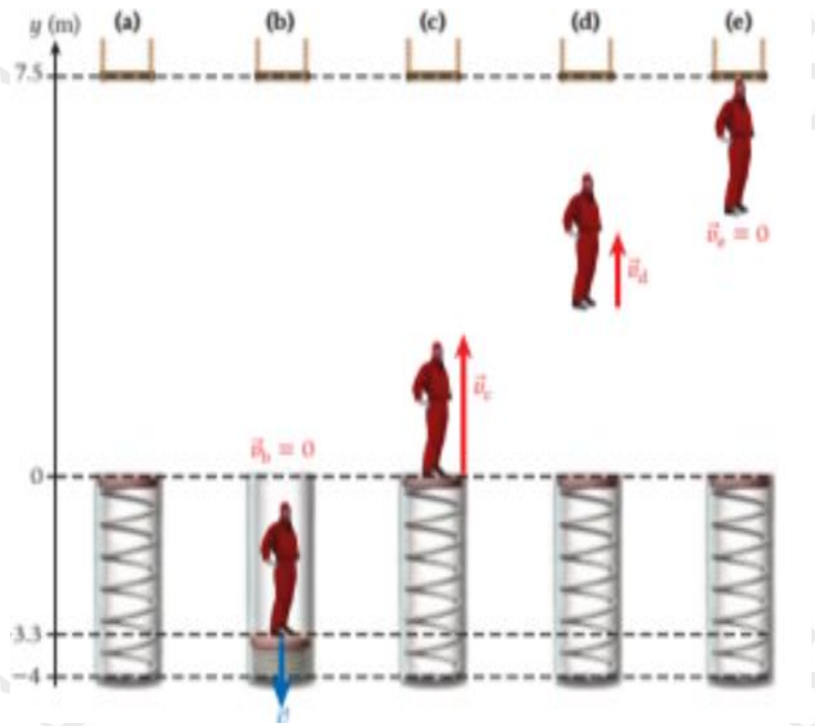
D. difference of kinetic and potential energies

10	Solve problems related to work and energy for the spring force	$E = K + U_s = \frac{1}{2}mv^2 + \frac{1}{2}kx^2.$	Student Book	168
			Solved Problem 6.4	169
			Q.[6.48/6.49]	184

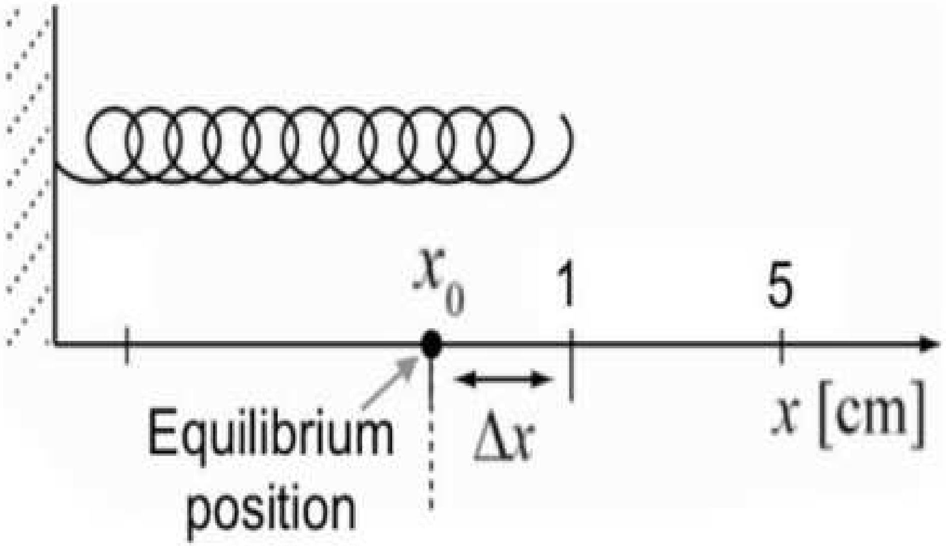
SOLVED PROBLEM 6.4 Human Cannonball

In a favorite circus act, called the "human cannonball," a person is shot from a long barrel, usually with a lot of smoke and a loud bang added for theatrical effect. Before the Italian Zacchini brothers invented the compressed air cannon for shooting human cannonballs in the 1920s, the Englishman George Farini used a spring-loaded cannon for this purpose in the 1870s.

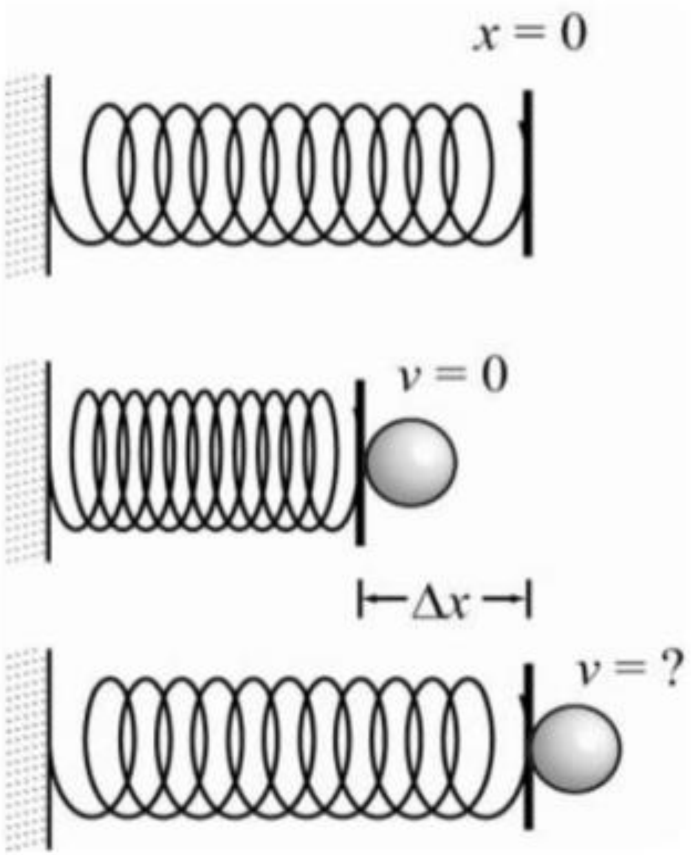
Suppose someone wants to recreate Farini's spring-loaded human cannonball act with a spring inside a barrel. Assume the barrel is 4.00 m long, with a spring that extends the entire length of the barrel. Further, the barrel is upright, so it points vertically toward the ceiling of the circus tent. The human cannonball is lowered into the barrel and compresses the spring to some degree. An external force is added to compress the spring even further, to a length of only 0.70 m. At a height of 7.50 m above the top of the barrel is a spot on the tent that the human cannonball, of height 1.75 m and mass 68.4 kg, is supposed to touch at the top of his trajectory. Removing the external force releases the spring and fires the human cannonball vertically upward.



A spring with a spring constant $k = 1000\ N/m$ is initially stretched by 1.00 cm from its equilibrium position. How much more energy is needed to further stretch the spring to 5.00 cm beyond its equilibrium position?



. A spring with a spring constant of 238.5 N/m is compressed by 0.231 m. Then a steel ball bearing of mass 0.0413 kg is put against the end of the spring, and the spring is released. What is the speed of the ball bearing right after it loses contact with the spring? (The ball bearing will come off the spring exactly as the spring returns to its equilibrium position. Assume that the mass of the spring can be neglected.)



11	Apply the law of conservation of mechanical energy for an isolated system (no external forces) with no dissipative forces involved, to calculate different physics quantities.	Student Book	167
		Figure 6.11	167

SOLVED PROBLEM 6.3 Trapeze Artist

PROBLEM

A trapeze artist starts his motion with the trapeze at rest at an angle of 45.0° relative to the vertical. The trapeze ropes have a length of 5.00 m. What is his speed at the lowest point in his trajectory?

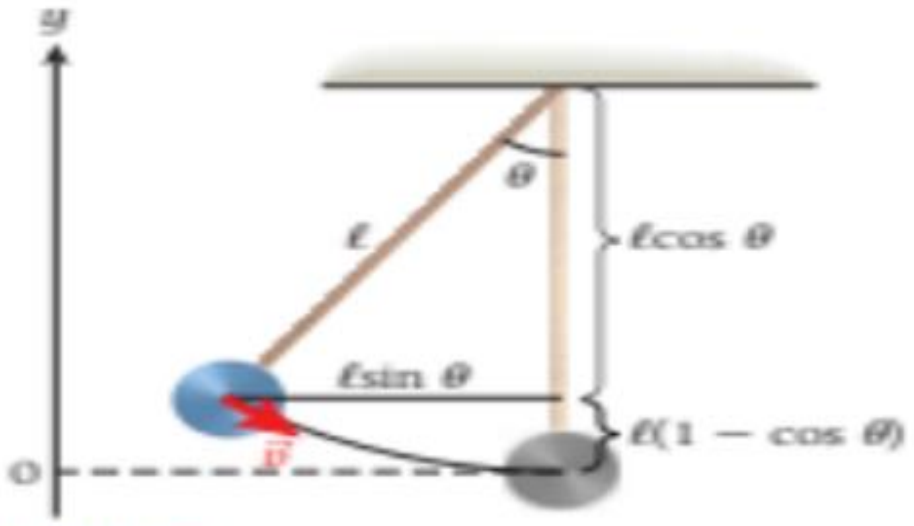
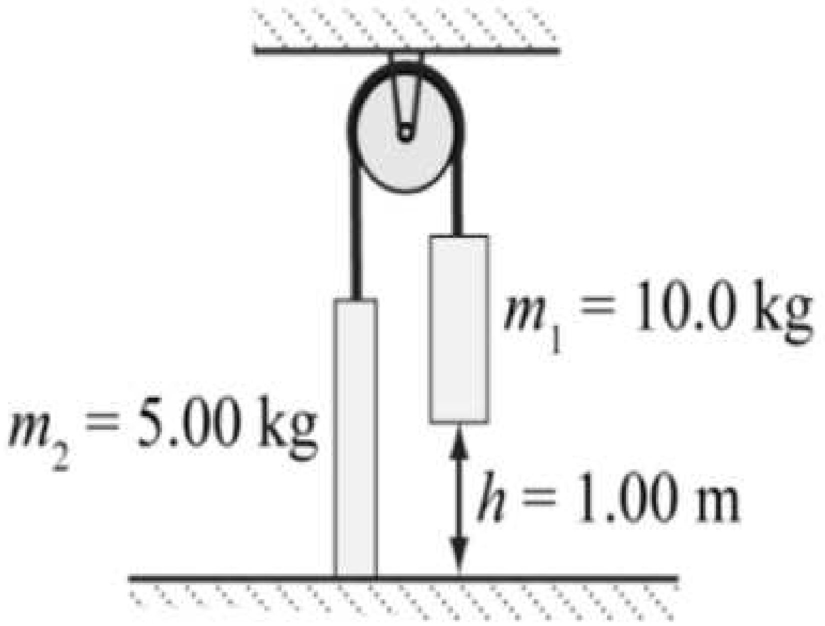


FIGURE 6.12 Geometry of a trapeze artist's swing or trajectory.

. Two masses are connected by a light string that goes over a light, frictionless pulley, as shown in the figure. The 10.0 kg mass is released and falls through a vertical distance of 1.00 m before hitting the ground. Determine how fast the 5.00 kg mass is moving just before the 10.0 kg mass hits the ground.



12	Show that for a one-dimensional case, the work-kinetic energy theorem is equivalent to newton's second law $\left([(\frac{1}{2}\, m v_x^2) - (\frac{1}{2}\, m v_o^2)] = m a_x\, (x - x_o) = F_x\, \Delta x = W\right)$.	Student Book	135

. How much net-work is required to accelerate a 1000 kg car from 20 m/s to 30 m/s?

A. 100 000 J

B. 150 000 J

C. 200 000 J

D. 250000 J

. Initially an object of mass 1.00 kg is moving to the left at 10.0 m/s. If 150 J of work is done on the object, then how fast will it be moving?

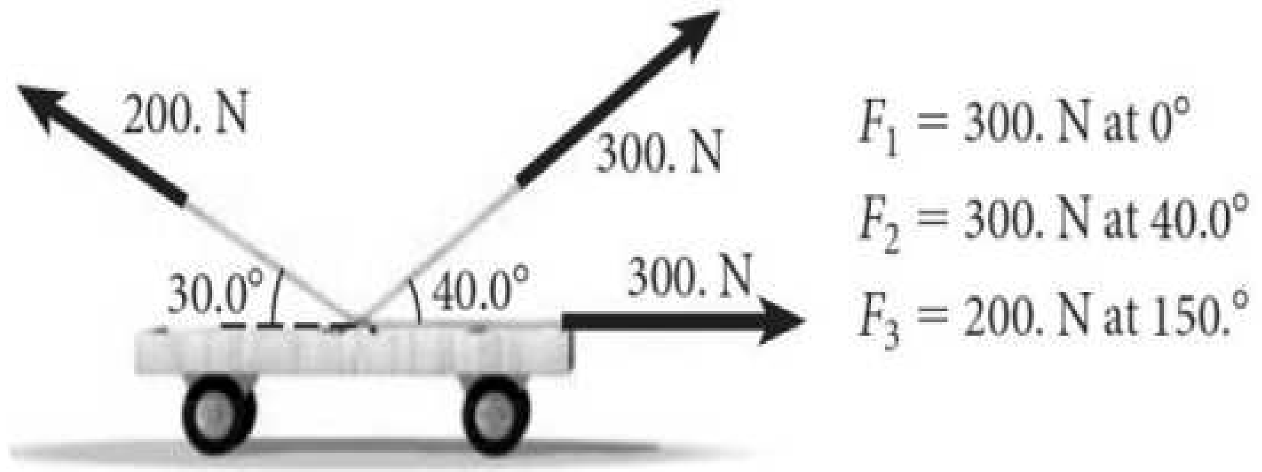
A. 17.3 m/s

B. 20.0 m/s

C. 25.0 m/s

D. 27.3 m/s

. The 125 kg cart in the figure starts from rest and rolls with negligible friction. It is pulled by three ropes as shown. It moves 100. m horizontally. Find the final velocity of the cart.



13	Relate momentum to kinetic energy $K=\frac{p^2}{2m}$	Student Book	190
		Q.(7.25]	217

Momentum and Kinetic Energy

In Chapter 5, we established the relationship, $K = \frac{1}{2}mv^2$ (equation 5.1), between the kinetic energy K, the speed v, and the mass m. We can use $p = mv$ to obtain

$$K = \frac{mv^2}{2} = \frac{m^2v^2}{2m} = \frac{p^2}{2m}.$$

This equation gives us an important relationship between kinetic energy, mass, and momentum:

$$K = \frac{p^2}{2m}. \quad (7.3)$$

7.25 A car of mass 1200 kg, moving with a speed of 72.0 mph on a highway, passes a small SUV with a mass $1\frac{1}{2}$ times bigger, moving at 2/3 the speed of the car.

a) What is the ratio of the momentum of the SUV to that of the car?

b) What is the ratio of the kinetic energy of the SUV to that of the car?

An object with mass m and speed v has a momentum p. What is the momentum of the object if its mass is quadrupled and the speed decreased by half?

A. $p/4$

B. $p/2$

C. $2p$

D. $4p$

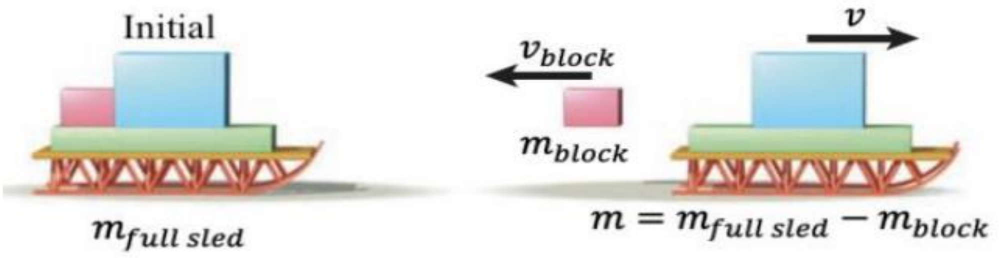
14	Apply the conservation of linear momenta for an isolated system of particles to relate the initial momenta of the particles to their final momenta at any later instant.	Student Book	194-195

the two momenta before the collision (index i1 indicates the initial value for object 1, just before the collision, and index f1 indicates the final value for the same object):

$$\vec{p}_{f1} + \vec{p}_{f2} = \vec{p}_{i1} + \vec{p}_{i2}. \quad (7.8)$$

This equation is the basic expression of the law of **conservation of total momentum,**

. A sled initially at rest has a mass of 52.0 kg, including all of its contents. A block with a mass of 13.5 kg is ejected to the left at a speed of 13.6 m/s. What is the speed of the sled and the remaining contents?



A. 2.80 m/s

B. 3.53 m/s

√ C. 4.77 m/s

A 3.0 kg gun fires a 50 g bullet with a velocity of +500 m/s. What is the recoil velocity v of the gun?

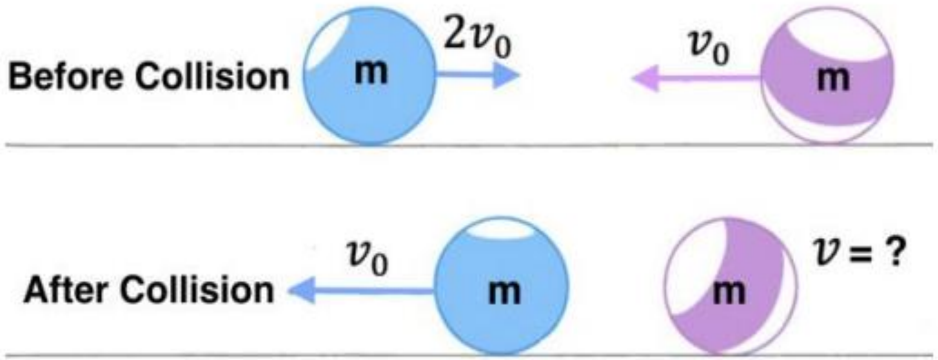
√ A. –8.3 m/s

B. –300 m/s

C. 8.3 m/s

D. 300 m/s

The diagram below represents two identical billiard balls before and after collision.
The blue ball moving with a speed of $2v_0$ to the right collides head-on with the pink ball moving with a speed v_0 towards it. After collision, the blue ball moves to the left with a speed of v_0. What is the velocity of the pink ball after collision?



A. v_0 to the left

B. v_0 to the right

C. $2v_0$ to the left

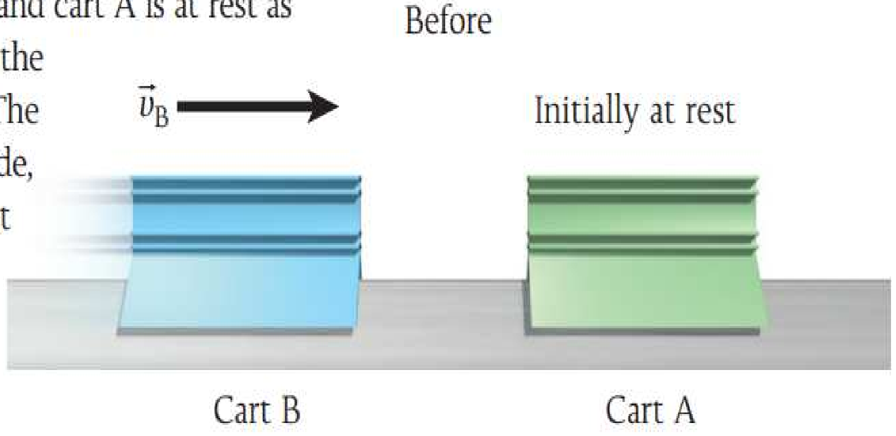
√ D. $2v_0$ to the right

15	Apply the conservation laws of momentum and total kinetic energy for elastic collisions in one dimension to relate the initial kinetic energies and momenta of the two colliding bodies before collision to their final kinetic energies and momenta after collision.	Student Book	196
		Q.(7.51]	219

$$\frac{p_{f1,x}^2}{2m_1} + \frac{p_{f2,x}^2}{2m_2} = \frac{p_{i1,x}^2}{2m_1} + \frac{p_{i2,x}^2}{2m_2}. \quad (7.10)$$

$$p_{f1,x} + p_{f2,x} = p_{i1,x} + p_{i2,x}.$$

7.19 Two carts are riding on an air track as shown in the figure. At time $t = 0$, cart B is at the origin traveling in the positive x-direction with speed v_B, and cart A is at rest as shown in the diagram. The carts collide, but do not stick.



a) the forces *exerted by* the carts
b) the positions of the carts
c) the velocities of the carts
d) the accelerations of the carts
e) the momenta of the carts

16	**(1)** Apply the equation ($W=F \cdot \Delta r=F\Delta r cos\alpha$) to calculate the work done on an object by a constant force by taking the dot product of the force vector F and the displacement vector Δr. **(2)** Apply the relationship between average power, the work done by a force or the associated energy transfer, and the time interval in which that work is done, or energy is transferred ($Pavg = \frac{W}{\Delta t}$).	Q.(5.26/5.30/5.32/5.33]	151

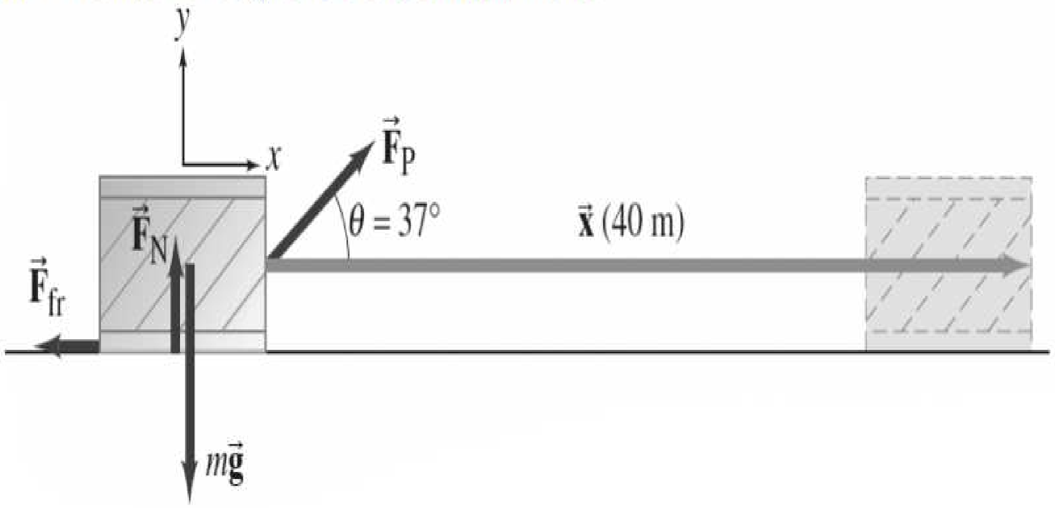
5.26 A force of 5.00 N acts over a distance of 12.0 m in the direction of the force. Find the work done.

5.30 You push your couch a distance of 4.00 m across the living room floor with a horizontal force of 200.0 N. The force of friction is 150.0 N. What is the work done by you, by the friction force, by gravity, and by the net force?

•**5.32** A father pulls his son, whose mass is 25.0 kg and who is sitting on a swing with ropes of length 3.00 m, backward until the ropes make an angle of 33.6° with respect to the vertical. He then releases his son from rest. What is the speed of the son at the bottom of the swinging motion?

5.33 A constant force, $\vec{F} = (4.79, -3.79, 2.09)$ N, acts on an object of mass 18.0 kg, causing a displacement of that object by $\vec{r} = (4.25, 3.69, -2.45)$ m. What is the total work done by this force?

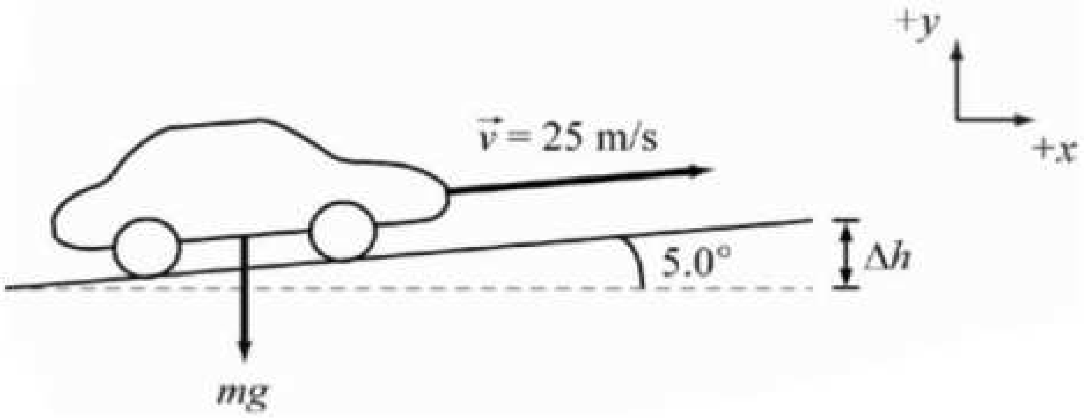
.. A person pulls a 50 kg crate 40 m along a horizontal floor by a constant force which acts at a 37° angle as shown in the figure below. The floor is rough and exerts a friction force.



a. Determine the work done by each force acting on the crate.

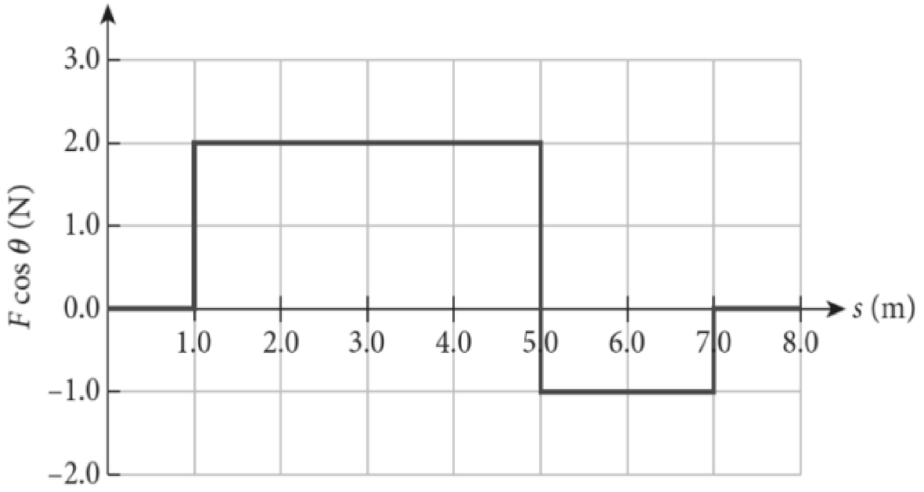
b. Determine the net work done on the crate.

'. Calculate the power required to propel a 1000.0 kg car at 25.0 m/s up a straight slope inclined 5.00° above the horizontal. Neglect friction and air resistance.



17	(1) Calculate graphically the work done on an object from an initial to a final position using a force versus position graph. (2) Solve problems related to work done by a general variable force. (3) Apply the work-kinetic energy theorem to situations where an object is moved by a variable force.	Figure 5.13	139
		Q.[6.78]	186

The graph shows the component ($F \cos \theta$) of the net force that acts on a 2.00 kg block as it moves along a flat horizontal surface.



a. Find the net work done on the block.

b. Find the final speed of the block if it starts from rest at s = 0

When a certain rubber band is stretched a distance x, it exerts a restoring force $F = ax + bx^2$, where a and b are constants. What is the work done in stretching this rubber band from $x = 0$ to $x = L$?

$$W = \int_{x_0}^{x} F_x(x')\,dx'$$

. A force given by $F(x) = 5x^3$ $(in\ N/m^3)$ acts on a 1.00 kg mass moving on a frictionless surface. The mass moves from x = 2.00 m to x = 6.00 m.

a. How much work is done by the force?

$$W = \int_{x_0}^{x} F_x(x')\,dx'$$

A particle of mass m is subjected to a force acting in the x-direction, $F_x = (3.00 + 0.500x)\ N$. Find the work done by the force as the particle moves from x = 0.00 to x = 4.00 m.

$$W = \int_{x_0}^{x} F_x(x')\,dx'$$

18	(1) Determine the instantaneous power by taking the dot product of the force vector and an object's velocity vector. (2) Relate the total energy to the mechanical energy plus the other forms of energy in the presence of nonconservative forces: $E_{total} = E_{mechanical} + E_{other} = K + U + E_{other}$. (3) Generalize the work-energy theorem, in the presence of nonconservative forces: $W_f = \Delta K + \Delta U$	Solved Problem (5.4) Solved Problem (6.6) Q.[6.55/6.56]	147 176 184

Power, Force, and Velocity

For a constant force, the work is given by $W = \vec{F} \bullet \Delta\vec{r}$ and the differential work as $dW = \vec{F} \bullet d\vec{r}$. In this case, the time derivative is

$$P = \frac{dW}{dt} = \frac{\vec{F} \bullet d\vec{r}}{dt} = \vec{F} \bullet \vec{v} = Fv\cos\alpha, \qquad (5.22)$$

SOLVED PROBLEM 5.4 Riding a Bicycle

PROBLEM

A bicyclist coasts down a 4.2° slope at a steady speed of 5.1 m/s. Assuming a total mass of 82.2 kg (bicycle plus rider), what power output must the cyclist expend to pedal up the same slope at the same speed?

$$P = 2Fv = 2(mg\sin\theta)v.$$

$$P = 2(82.2\text{ kg})(9.81\text{ m/s}^2)\sin(4.2°)(5.1\text{ m/s}) = 602.391\text{ W}.$$

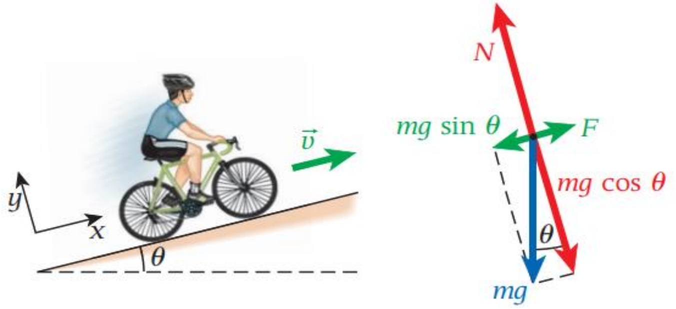
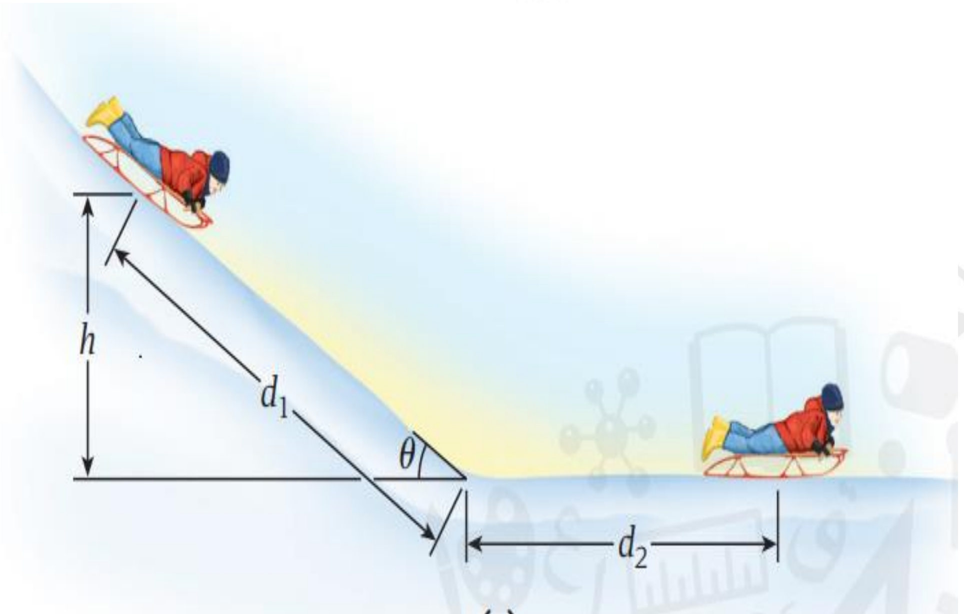


FIGURE 5.24 Sketch of the bicycle moving up the slope (left) and the free-body diagram (right).

SOLVED PROBLEM 6.6 Sledding down a Hill

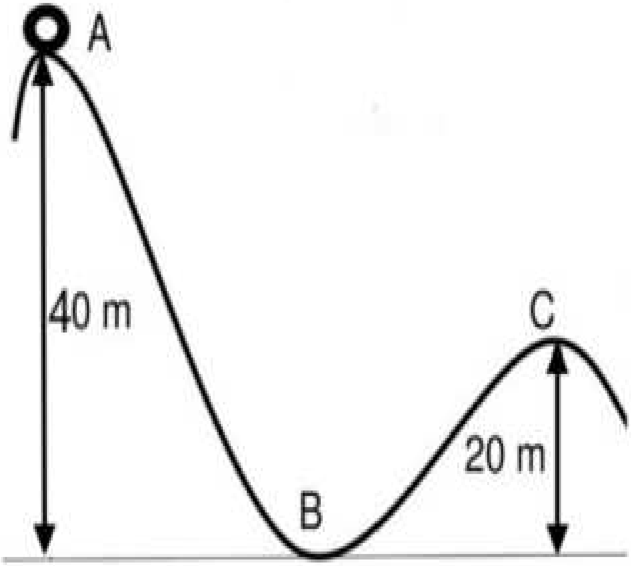
PROBLEM

A boy on a sled starts from rest and slides down a snow-covered hill. Together the boy and sled have a mass of 23.0 kg. The hill's slope makes an angle $\theta = 35.0°$ with the horizontal. The surface of the hill is 25.0 m long. When the boy and the sled reach the bottom of the hill, they continue sliding on a horizontal snow-covered field. The coefficient of kinetic friction between the sled and the snow is 0.100. How far do the boy and sled move on the horizontal field before stopping?



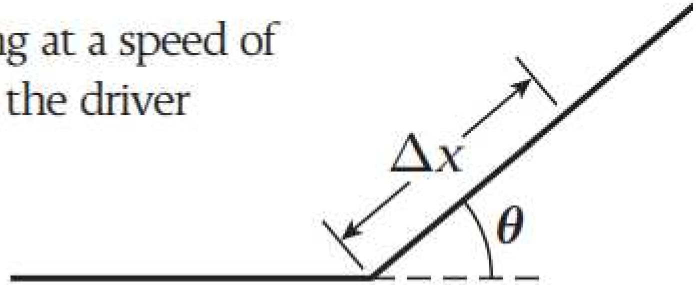
(a)

12. A roller coaster cart of mass 100 kg is at rest at point A and slides down the track until it reaches point C with a speed of 10 m/s. What is the work done by friction?



6.55 How much mechanical energy is lost to friction if a 55.0 kg skier slides down a ski slope at constant speed of 14.4 m/s? The slope is 123.5 m long and makes an angle of 14.7° with respect to the horizontal.

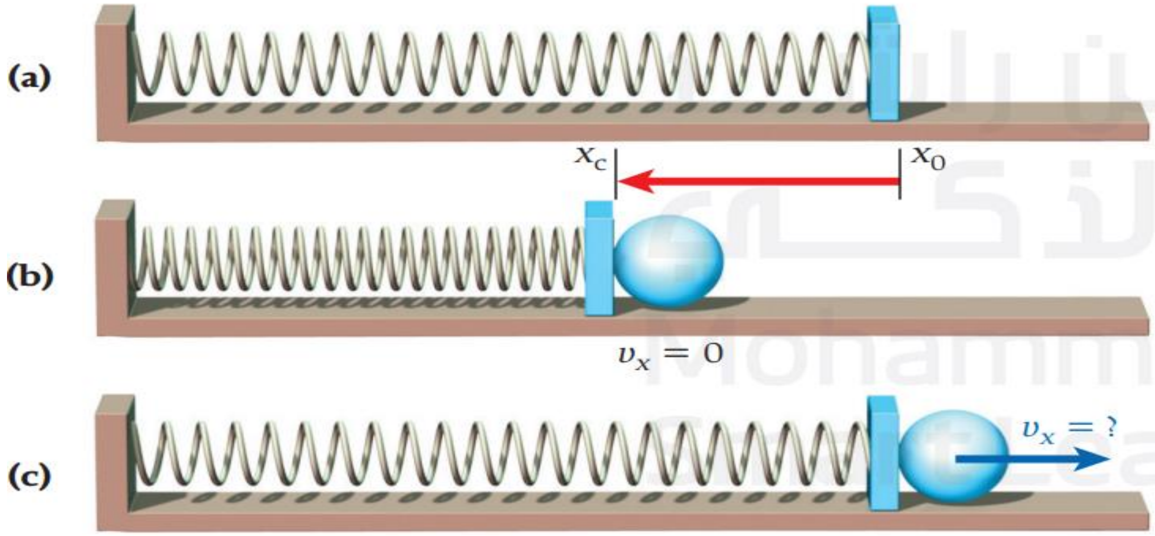
•**6.56** A truck of mass 10,212 kg moving at a speed of 27.4 m/s has lost its brakes. Fortunately, the driver finds a runaway lane, a gravel-covered incline that uses friction to stop



a truck in such a situation; see the figure. In this case, the incline makes an angle of $\theta = 40.15°$ with the horizontal, and the gravel has a coefficient of friction of 0.634 with the tires of the truck. How far along the incline (Δx) does the truck travel before it stops?

19	**(1)** Calculate the elastic potential energy of a mass–spring system: $U=\frac{1}{2}kx^2$ **(2)** Apply the law of conservation of mechanical energy to a mass-spring system to calculate different physical quantities (spring constant, displacement from equilibrium position or velocity at any time, or other).	Solved Problem (5.2)	174
		Q.[6.48/6.49/6.50(a)]	184

SOLVED PROBLEM 5.2 Compressing a Spring



A massless spring located on a smooth horizontal surface is compressed by a force of 63.5 N, which results in a displacement of 4.35 cm from the initial equilibrium position. As shown in Figure 5.16, a steel ball of mass 0.075 kg is then placed in front of the spring and the spring is released.

PROBLEM

What is the speed of the steel ball when it is shot off by the spring, that is, right after it loses contact with the spring? (Assume there is no friction between the surface and the steel ball; the steel ball will then simply slide across the surface and will not roll.)

SOLUTION

$$v_x = \sqrt{\frac{(-63.5 \text{ N})(-0.0435 \text{ m})}{0.075 \text{ kg}}} = 6.06877 \text{ m/s}.$$

6.48 A block of mass 0.773 kg on a spring with spring constant 239.5 N/m oscillates vertically with amplitude 0.551 m. What is the speed of this block at a distance of 0.331 m from the equilibrium position?

6.49 A spring with $k = 10.0$ N/cm is initially stretched 1.00 cm from its equilibrium length.

a) How much more energy is needed to further stretch the spring to 5.00 cm beyond its equilibrium length?

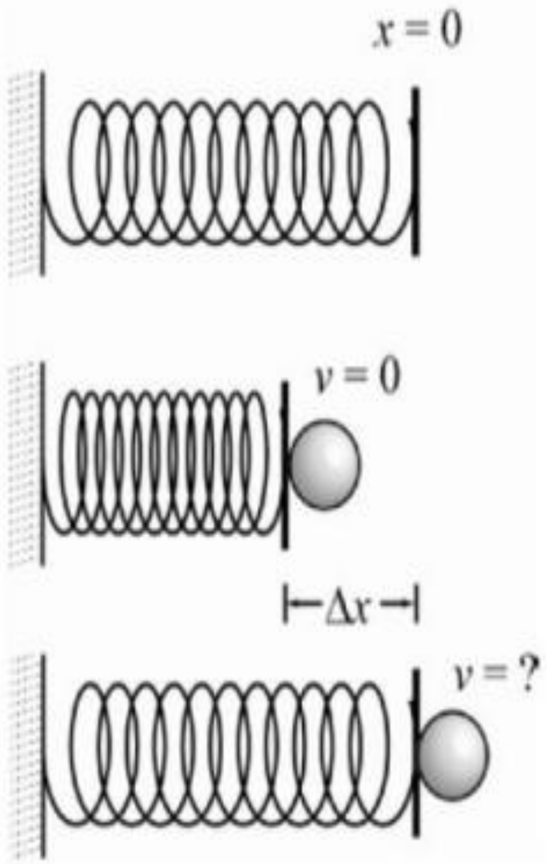
b) From this new position, how much energy is needed to compress the spring to 5.00 cm shorter than its equilibrium position?

6.50 A 5.00-kg ball of clay is thrown downward from a height of 3.00 m with a speed of 5.00 m/s onto a spring with $k = 1600$ N/m. The clay compresses the spring a certain maximum amount before momentarily stopping.

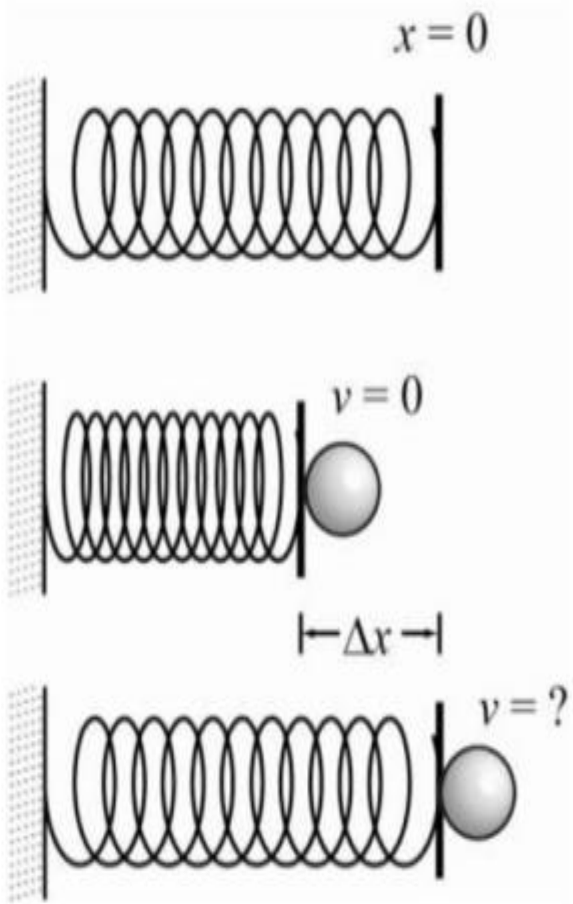
a) Find the maximum compression of the spring.

b) Find the total work done on the clay during the spring's compression.

13. A spring with a spring constant of 238.5 N/m is compressed by 0.231 m. Then a steel ball bearing of mass 0.0413 kg is put against the end of the spring, and the spring is released. What is the speed of the ball bearing right after it loses contact with the spring? (The ball bearing will come off the spring exactly as the spring returns to its equilibrium position. Assume that the mass of the spring can be neglected.)



8. A spring with a spring constant of 238.5 N/m is compressed by 0.231 m. Then a steel ball bearing of mass 0.0413 kg is put against the end of the spring, and the spring is released. What is the speed of the ball bearing right after it loses contact with the spring? (The ball bearing will come off the spring exactly as the spring returns to its equilibrium position. Assume that the mass of the spring can be neglected.)



20	Apply the relationship between impulse, change in momentum, average force, and the time interval over which the impulse acts on the object to calculate unknown physical quantities.	Figure7.3	191
		Example7.1	192
		Q.[7.30]	217/218

EXAMPLE 7.1 Baseball Home Run

A Major League pitcher throws a fastball that crosses home plate with a speed of 90.0 mph (40.23 m/s) and an angle of 5.0° below the horizontal. A batter slugs it for a home run, launching it with a speed of 110.0 mph (49.17 m/s) at an angle of 35.0° above the horizontal (Figure 7.4). The mass of a baseball is required to be between 5 and 5.25 oz; let's say that the mass of the ball hit here is 5.10 oz (0.145 kg).

– Continued

PROBLEM 1

What is the magnitude of the impulse the baseball receives from the bat?

$$\Delta v_x = (49.17\text{ m/s})(\cos 35.0°) - (40.23\text{ m/s})(\cos 185.0°) = 80.35\text{ m/s}$$

$$\Delta v_y = (49.17\text{ m/s})(\sin 35.0°) - (40.23\text{ m/s})(\sin 185.0°) = 31.71\text{ m/s}$$

$$\Delta v = \sqrt{\Delta v_x^2 + \Delta v_y^2} = \sqrt{(80.35)^2 + (31.71)^2}\text{ m/s} = 86.38\text{ m/s}$$

$$\Delta p = m\Delta v = (0.145\text{ kg})(86.38\text{ m/s}) = 12.5\text{ kg m/s.}$$

PROBLEM 2

High-speed video shows that the ball-bat contact lasts only about 1 ms (0.001 s). Suppose, for the home run we're considering, that the contact lasted 1.20 ms. What was the magnitude of the average force exerted on the ball by the bat during that time?

$$\Delta\vec{p} = \vec{J} = \vec{F}_{\text{ave}}\Delta t$$

$$\Rightarrow F_{\text{ave}} = \frac{\Delta p}{\Delta t} = \frac{12.5 \text{ kg m/s}}{0.00120 \text{ s}} = 10.4 \text{ kN}.$$

SOLVED PROBLEM 7.1 Egg Drop

PROBLEM

An egg in a special container is dropped from a height of 3.70 m. The container and egg together have a mass of 0.144 kg. A net force of 4.42 N will break the egg. What is the minimum time over which the egg/container can come to a stop without breaking the egg?

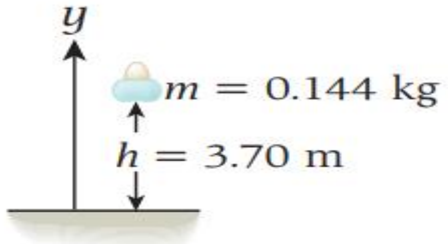


FIGURE 7.6 An egg in a special container is dropped from a height of 3.70 m.

$$\Delta t = \frac{(0.144\ \text{kg})\sqrt{2(9.81\ \text{m/s}^2)(3.70\ \text{m})}}{4.42\ \text{N}} = 0.277581543\ \text{s.}$$

7.30 An 83.0 kg running back leaps straight ahead toward the end zone with a speed of 6.50 m/s. A 115 kg linebacker, keeping his feet on the ground, catches the running back and applies a force of 900 N in the opposite direction for 0.750 s before the running back's feet touch the ground.

a) What is the impulse that the linebacker imparts to the running back?

b) What change in the running back's momentum does the impulse produce?

c) What is the running back's momentum when his feet touch the ground?

d) If the linebacker keeps applying the same force after the running back's feet have touched the ground, is this still the only force acting to change the running back's momentum?

The end