مراجعة نهائية اختيار من متعدد

موقع المناهج ⇦ المناهج الإماراتية ⇦ الصف الحادي عشر المتقدم ⇦ فيزياء ⇦ الفصل الثاني ⇦ الملف

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Physics Way

Physics 11 Adv

Final revision T2

2024

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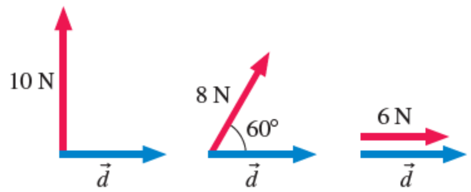
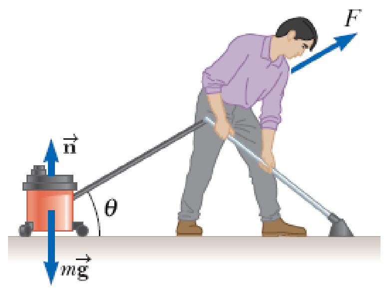
Term 2 G11 – ADV Final revision 2024

STOP TO THINK 10.2 Which force does the most work?

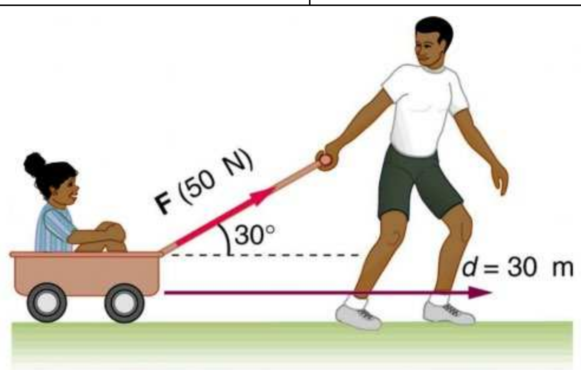
A. The 10 N force
B. The 8 N force
C. The 6 N force
D. They all do the same amount of work.



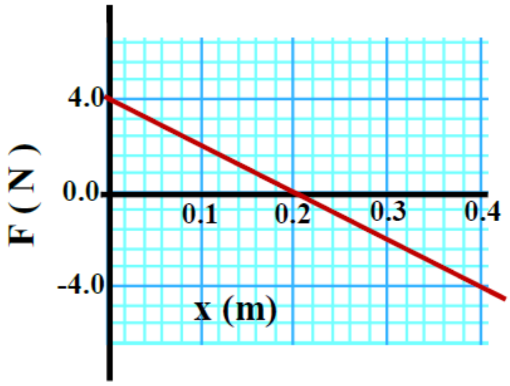
A man cleaning a floor pulls a vacuum cleaner with a force of magnitude F = 34.6 N at an angle of 12.5° with the horizontal. Calculate the work done by the force on the vacuum cleaner as the vacuum cleaner is displaced 4.87 m to the right.



A wagon is pulled with a rope that makes an angle of 30° to the horizontal as shown in the figure. The tension in the rope is 50.0 N. What is the work done by the force on the wagon if it moves 30 m on the horizontal surface?	**يتم سحب عربة بحبل يصنع زاوية قياسها 30° مع الأفقي، كما هو موضح في الشكل. قوة الشد في الحبل 50.0 N ما الشغل الذي تبذله القوة المؤثرة على العربة إذا تحركت مسافة 30 m على السطح الأفقي؟**

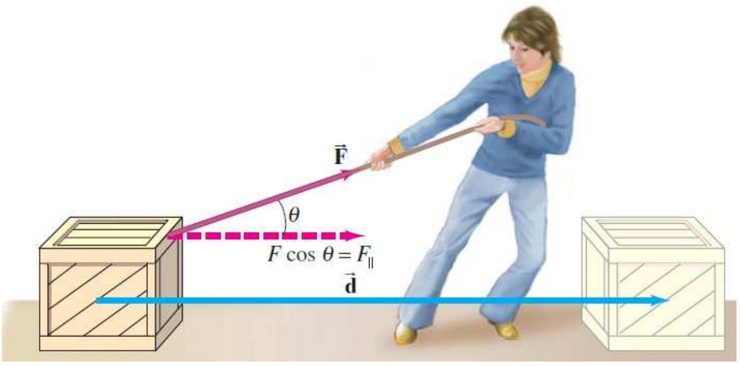


A. 1500 J
B. 3300 J
C. 1300 J
D. 2500 J



The adjacent figure shows a force acting in the positive direction of the x- axis the work done by the force when it moves from x = 0.2 to x = 0.4

A- 0.4 J
B- - 0.4 J
C- 0.8 J
D- 0 J

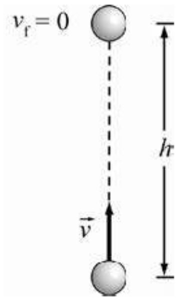


A person pulling a 5 kg crate along the floor. with a force F = 40 N making an angle 65° from the horizontal to move the box a distance d = 4.5m. if the friction force is 15 N. What will be the net work and final crate speed.

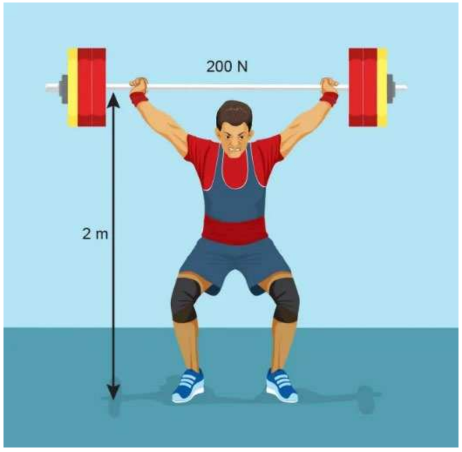
	Net work	Final Speed
A	76 J	5.51 m/s
B	8.6 J	1.85 m/s
C	67.5 J	5.19 m/s
D	55 J	5.51 m/s

At sea level, a nitrogen molecule in the air has an average kinetic energy of 6.2×10^{-21} J. Its mass is 4.7×10^{-26} kg. If the molecule could shoot straight up without colliding with other molecules.

a- How high would it rise?



b- What is the molecule's initial speed?



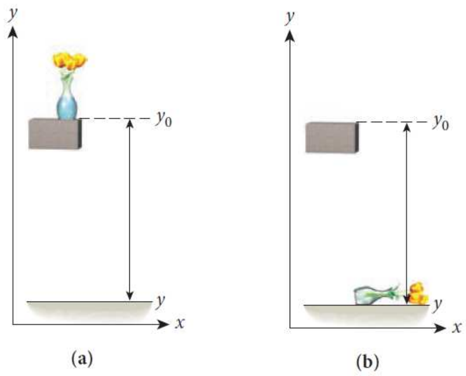
weightlifter lifts a 200 N barbell from the floor to a height of 2 m. How much work is done?

a. 0 J
b. 100 J
c. 200 J
d. 400 J

EXAMPLE 5.1 Falling Vase

PROBLEM

A crystal vase (mass = 2.40 kg) is dropped from a height of 1.30 m and falls to the floor, as shown in Figure 5.7. What is its kinetic energy just before impact? (Neglect air resistance for now.)



SOLUTION

$$v_y^2 = v_{y0}^2 - 2g(y - y_0)$$

$$v^2 = v_x^2 + v_y^2 = 0 + v_y^2 = v_y^2$$

$$v^2 = v_y^2 = 2g(y_0 - y)$$

$$K = \tfrac{1}{2}mv^2 = (2.40\text{ kg})(9.81\text{ m/s}^2)(1.30\text{ m}) = 30.6\text{ J.}$$

A crane lowers a girder into place at constant speed. Consider the work W_G done by gravity and the work W_T done by the tension in the cable. Which is true?

A. $W_G > 0$ and $W_T > 0$

B. $W_G > 0$ and $W_T < 0$

C. $W_G < 0$ and $W_T > 0$

D. $W_G < 0$ and $W_T < 0$

Anas uses a horizontal force of 20N to push a 4 kg box along a horizontal surface for 3 m, then lifts the box up to a shelf 1 m high. What is the total work done on the box?	استخدم أنس قوة أفقية مقدارها 20 N لدفع صندوق كتلته 4 Kg على سطح أفقي مسافة 3 m، ثم رفع الصندوق إلى رف بارتفاع 1 m ما هو الشغل الإجمالي الذي تم إنجازه على الصندوق؟

5.11 Jack is holding a box that has a mass of m kg. He walks a distance of d m at a constant speed of v m/s. How much work, in joules, has Jack done on the box?

a) mgd

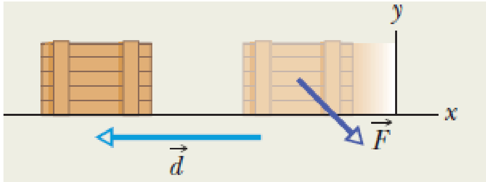
b) $-mgd$

c) $\frac{1}{2}mv^2$

d) $-\frac{1}{2}mv^2$

e) zero

During a storm, a crate of crepe is sliding across a slick, oily parking lot through a displacement $\vec{d} = (-3.0\text{ m})\hat{x}$ while a steady wind pushes against the crate with a force $\vec{F} = (2.0\text{ N})\hat{x} + (-6.0\text{ N})\hat{y}$. The situation and coordinate axes are shown in Fig.



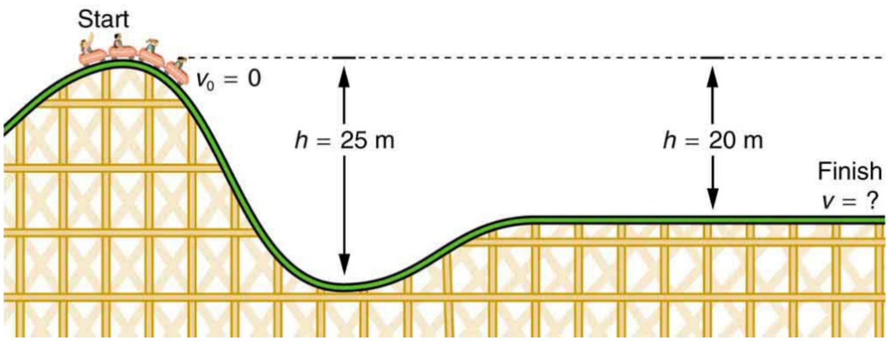
(a) How much work does this force do on the crate during the displacement?

(b) If the crate has a kinetic energy of 10 J at the beginning of displacement $\vec{d}$, what is its kinetic energy at the end of $\vec{d}$?

At $t = 0$, force $\vec{F} = (-5.00\,\hat{x} + 5.00\hat{y} + 4.00\hat{y}\,)$ N begins to act on a 2.00 kg particle with an initial speed of 4.00 m/s. What is the particle's speed when its displacement from the initial point is $\vec{d} = (2.00\hat{x} + 2.00\hat{y} + 7.00\hat{z}\,)$ m?

A particle moves parallel to the *x*-axis. The net force on the particle increases with *x* according to the formula $F_x = (120\ N/m)\ x$, where the force is in newtons when *x* is in meters. How much work does this force do on the particle as it moves from $x = 0$ to $x = 0.50$ m?

a) 7.5 J
b) 15 J
c) 30 J
d) 60 J



A. What is the final speed of the roller coaster shown if it starts from rest at the top of the 20.0 m hill and work done by frictional forces is negligible?

B. What is its final speed (again assuming negligible friction) if its initial speed is 5.00 m/s?

What is the kinetic energy of an ideal projectile of mass 20.1 kg at the apex (highest point) of its trajectory, if it was launched with an initial speed of 27.3 m/s and at an initial angle of 46.9° with respect to the horizontal?

Does the Earth do any work on the Moon as the Moon moves in its orbit?

No. The gravitational force that the Earth exerts on the Moon is perpendicular to the Moon's displacement and so no work is done

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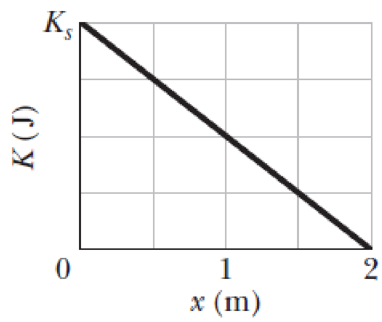
A block is sent up a frictionless ramp along which an *x* axis Extends upward. The kinetic energy of the block as a function of position *x*; the scale of the figure's vertical axis is set by K_s = 40.0 J. If the block's initial speed is 4.00 m/s, what is the normal force on the block?



A constant force delivers an average power of 6 watts to move an object. If the object has an average velocity of 3 m/s and the force acts in the direction of motion of the object, what is the magnitude of the force?	قوة ثابتة تسلم قدرة متوسطة تبلغ 6 watt لتحريك جسم. إذا كان لديك الجسم سرعة متوسطة قدرها 3 m/s والقوة تعمل في اتجاه حركة الجسم، فما هو مقدار القوة؟

A curling stone with a mass of 19.96 kg is given an initial velocity of 2.46 m/s. The stone slides on the ice with a coefficient of kinetic friction of 0.0109. How far does the stone slide before it stops?	حجر تجعيد كتلته 19.96 kg ، كانت سرعته الابتدائية 2.46 m/s ينزلق الحجر على الجليد بمعامل احتكاك حركي قدره 0.0109. إلى أي مدى ينزلق الحجر قبل أن يتوقف؟

a) 18.7 m

b) 28.3 m

c) 34.1 m

d) 39.2 m

In which of the following cases is the work done is zero?

A. Work done by the porter on a suitcase in lifting it from the platform on to his head.
B. Work done by the force of gravity on suitcase as the suitcase falls from porter's head.
C. Work done by the porter standing on platform with suitcase on his head.
D. Work done by force of gravity on a ball thrown up vertically up into the sky.

A car, of mass *m*, traveling at a speed v_1 can brake to a stop within a distance *d*. If the car speeds up by a factor of 2, so that $v_2 = 2v_1$, by what factor is its stopping distance increased, assuming that the braking force *F* is approximately independent of the car's speed?

A- 2d
B- 4d
C- d/2
D- d/4

A 1000 W electric motor lifts a 100 kg safe at constant velocity. The vertical distance through which the motor can raise the safe in 10 s is most nearly	**محرك كهربائي قدرته 1000 W يرفع خزنة وزنها 100 Kg بسرعة ثابتة. المسافة الرأسية التي يمكن للمحرك من خلالها رفع الخزنة خلال 10 s تقريبًا**

A. 1 m
B. 3 m
C. 10 m
D. 100 m

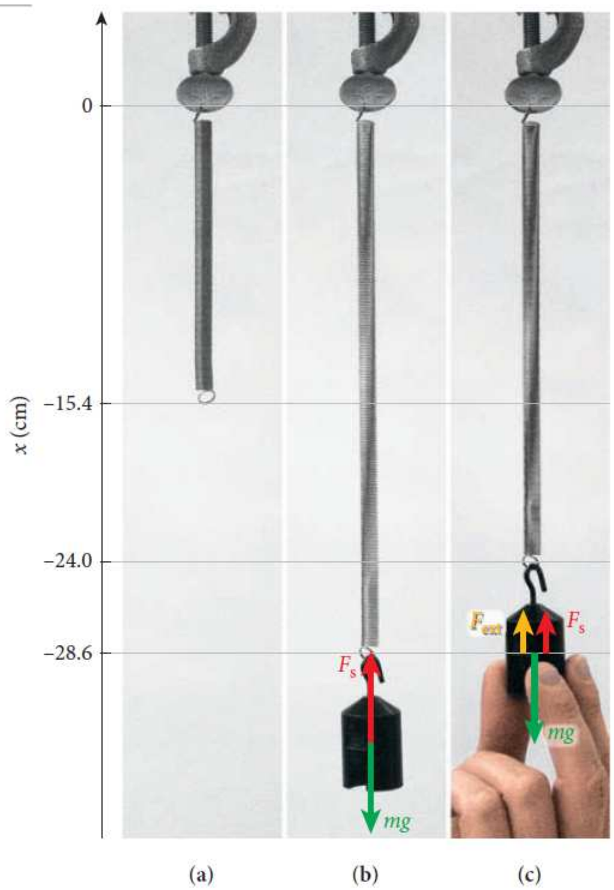
You push your couch a distance of 4.00 m across the living room floor with a horizontal force of 200.0 N. The force of friction is 150.0 N. What is the work done by you, by the friction force, by gravity, and by the net force?

EXAMPLE 5.3 Spring Constant

PROBLEM 1
A spring has a length of 15.4 cm and is hanging vertically from a support point above it (Figure 5.15a). A weight with a mass of 0.200 kg is attached to the spring, causing it to extend to a length of 28.6 cm (Figure 5.15b). What is the value of the spring constant?

SOLUTION 1

$$k = -\frac{F_s}{x - x_0} = -\frac{1.962 \text{ N}}{(-0.286 \text{ m}) - (-0.154 \text{ m})} = 14.9 \text{ N/m}$$



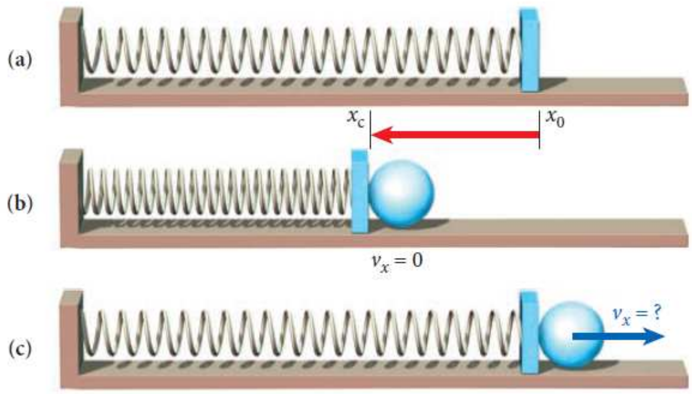
PROBLEM 2
How much force is needed to hold the weight at a position 4.6 cm above −28.6 cm (Figure 5.15c)?

SOLUTION 2

$$F_{ext} + F_s = 0 \Rightarrow F_{ext} = -F_s = kx = (0.046 \text{ m})(14.9 \text{ N/m}) = 0.68 \text{ N.}$$

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

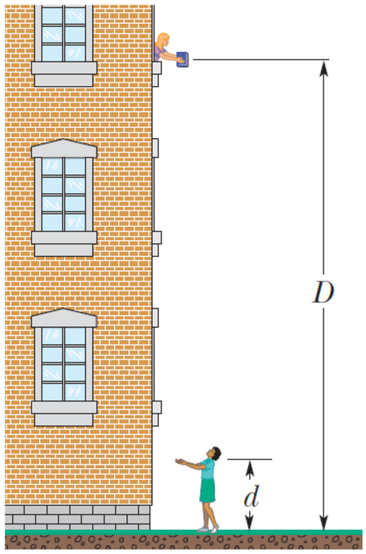
$$v_x = \sqrt{\frac{2K}{m}} = \sqrt{\frac{2(\frac{1}{2}kx_c^2)}{m}} = \sqrt{\frac{kx_c^2}{m}} = \sqrt{\frac{F_{ext}x_c}{m}}$$

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

You drop a 2.00 kg book to a friend who stands on the ground at distance D = 10.0 m below. If your friend's outstretched hands are at distance d = 1.50 m from ground.

(a) how much work W_g does the gravitational force do on the book as it drops to her hands?

(b) What is the change ΔU in the gravitational potential energy of the book

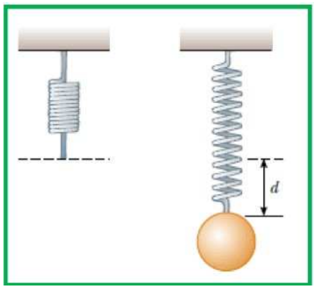


	ΔU_g	W_g
A	-196.0 J	+196.0 J
B	-166.6 J	+166.6 J
C	+166.6 J	-166.6 J
D	-29.4 J	+166.6 J

A spring is being stretched 0.07 m from its equilibrium position. If this stretching requires of 35.0 J work, what is the spring constant?	تم مد زنبرك مسافة 0.07 m من موضع اتزانه. إذا كان هذا التمدد يتطلب شغلًا مقداره 35.0 J ، فما ثابت الزنبرك؟

As in the figure next door, a mass of 16 kg spring is suspended from it and it lengthens by 55.0 cm

The magnitude of the spring constant and the work done by the spring to lengthen it are equal



	spring constant	work done
A	27 N/m	- 540 J
B	270 N/m	- 540 J
C	270 N/m	- 0.054 J
D	27 N/m	- 0.054 J

Ball A has half the mass and eight times the kinetic energy of ball B.

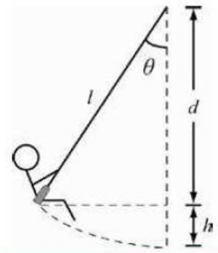
What is the speed ratio v_A/v_B?

A. 16
B. 4
C. 1/16
D. 1/4

A 4.0-kg object is moving with speed 2.0 m/s. A 1.0-kg object is moving with speed 4.0 m/s. Both objects encounter the same constant braking force, and are brought to rest.
Which object travels the greater distance before stopping?

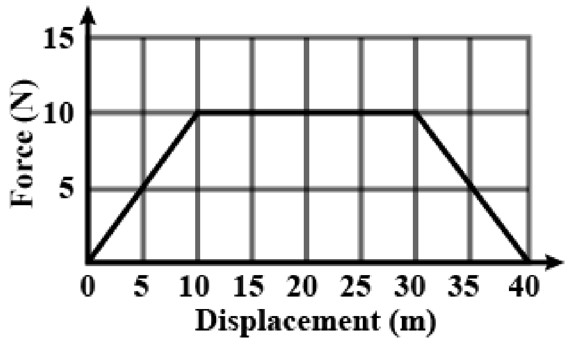
A) the 4.0-kg object
B) the 1.0-kg object
C) Both objects travel the same distance.
D) It is impossible to know without knowing how long each force acts.

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?



$h = l - d = l(1 - \cos\theta)$

The following curve shows the a variable force acting on a box that moves from x = 0 to x = 40 m



a- Find the work done in displacing box from x = 0 to x = 30 m

b- If the box has an initial speed of 25 m/s what will be its speed at x = 30 m

A road worker moves a 32 kg road marking machine by pushing it with a force of magnitude F, making an angle of 25 ° below the horizontal. The marking machine rolls at a constant speed of 0.5 m/s on a horizontal asphalt road surface. The coefficient of rolling friction between the marking machine and the asphalt is 0.18. Find the power delivered by the worker.

A. 14 W
B. 31 W
C. 123 W
D. 150 W

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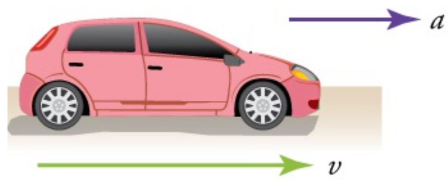
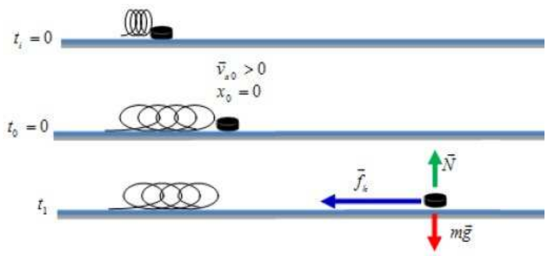
car of mass 942.4 kg accelerates from rest with a constant power output of 140.5 hp. Neglecting air resistance, what is the speed of the car after 4.55 s?

(1 hp = 735.5 watt)

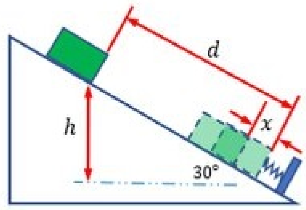


An ideal spring has the spring constant $k = 440.$ N/m. Calculate the distance this spring must be stretched from its equilibrium position for 25.0 J of work to be done.

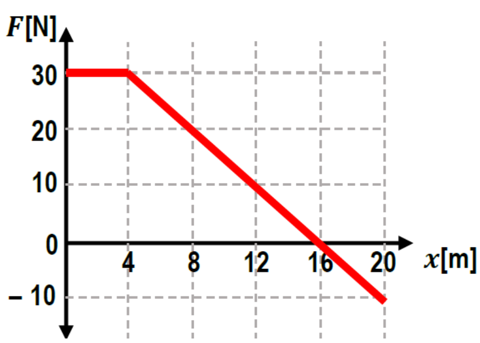
A horizontal spring with spring constant k = 15.19 N/m is compressed 23.11 cm from its equilibrium position. A hockey puck with mass m = 170.0 g is placed against the end of the springe. spring is released, and the puck slides on horizontal ice, with a coefficient of kinetic friction of 0.02221 between the puck and the ice. How far does the hockey puck travel on the ice after it leaves the spring?



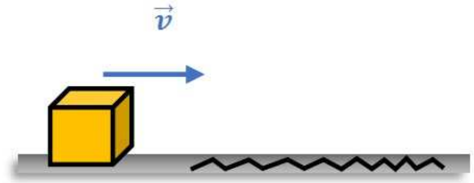
A 4.0 Kg box was pushing the spring 20 cm when it is released and the spring constant is 0.55 N/m. What is the maximum height does the box reach from the ground?



You push a box along a flat, smooth surface for 20 m according to the graph shown below. How much work have you done on the box?



A block of unknown mass is sliding along a flat surface with 30 m/s when it enters a long, rough patch. If the coefficient of friction between the block and the floor is 0.6, calculate the distance the block travels before stopping.



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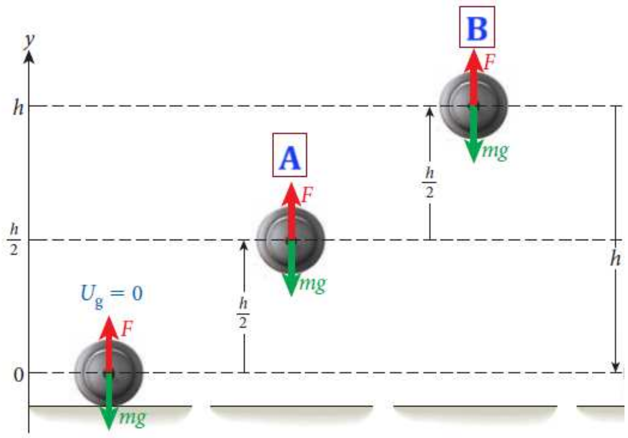
1. The mechanical energy of an object is always equal to

a. the work done on the object.

b. the change in the object's kinetic energy.

c. the sum of the object's kinetic and potential energies.

d. All are correct



For the following object to move from A to B

	gravitational potential energy U_g	work done by gravity W_g
A	mgh	$\frac{1}{2}$ mgh
B	$\frac{1}{2}$ mgh	- mgh
C	mgh	$-\frac{1}{2}$ mgh
D	$\frac{1}{2}$ mgh	- mgh

Based on the law of conservation of mechanical energy, which of the following is not correct?

اعتماداً على قانون حفظ الطاقة الميكانيكية، أي مما يلي ليس صحيحاً؟

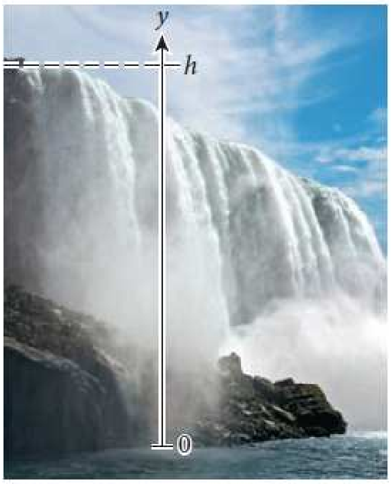
A	E = K + U
B	K + U = 0
C	ΔE = 0
D	ΔE = - ΔU

SOLVED PROBLEM 6.1 Power Produced by Niagara Falls

PROBLEM

The Niagara River delivers an average of 5520 m^3 of water per second to the top of Niagara Falls, where it drops 49.0 m. If all the potential energy of that water could be converted to electrical energy, how much electrical power could Niagara Falls generate?

SOLUTION

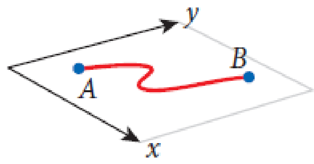


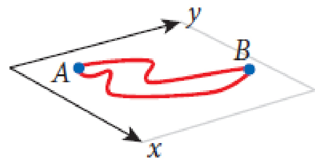
$$\bar{P} = \frac{W}{t} = \frac{mgh}{t} = \left(\frac{m}{t}\right)gh$$

$$\frac{m}{t} = \left(5520\ \frac{m^3}{s}\right)\left(\frac{1000\ kg}{1\ m^3}\right) = 5.52\cdot10^6\ kg/s$$

$$\bar{P} = \left(5.52\cdot10^6\ kg/s\right)\left(9.81\ m/s^2\right)\left(49.0\ m\right) = 2653.4088\ MW$$

(for conservative forces)





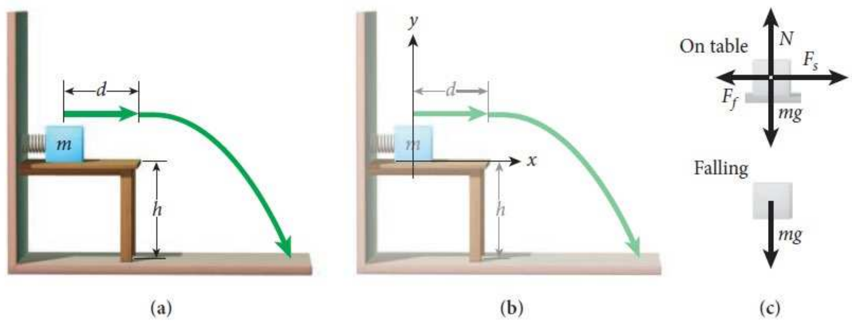
$$W_{B\to A} = -W_{A\to B}$$

$$W_{A\to B,\text{path 2}} = W_{A\to B,\text{path 1}}$$

$$W_{(A\to B)} + W_{(B\to A)} = 0.$$

$$W_{A\to B,\text{path 2}} + W_{B\to A,\text{path 1}} = 0$$

A block of mass 1.40 kg is attached to a spring and sits on a frictionless table which is a height *h* = 4.0 m above the floor. The spring is compressed by *d* = 0.11 m initially. If the spring constant is *k* = 600 N/m, what is the speed of the block when it leaves the spring?



a. 1.2 m/s

b. 2.3 m/s

c. 3.4 m/s

d. 4.7 m/s

SOLVED PROBLEM 6.4 Human Cannonball

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.

Problem 1

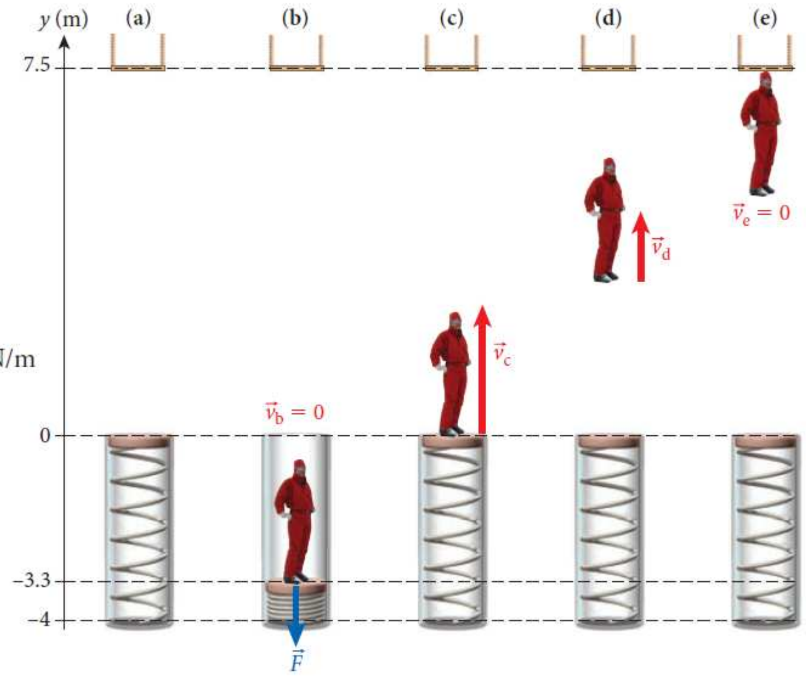
What is the value of the spring constant needed to accomplish this stunt?

SOLUTION 1

$$\tfrac{1}{2}ky_b^2 + mgy_b = mgy_e$$

$$\boxed{k = 2mg\frac{y_e - y_b}{y_b^2}}$$

$$k = 2(68.4\text{ kg})(9.81\text{ m/s}^2)\frac{5.75\text{ m} - (-3.30\text{ m})}{(3.30\text{ m})^2} = 1115.26\text{ N/m}$$



Problem 2

What is the speed that the human cannonball reaches as he passes the equilibrium position of the spring?

SOLUTION 2

$$\tfrac{1}{2}mv_c^2 = mgy_e \Rightarrow$$

$$v_c = \sqrt{2gy_e} = \sqrt{2(9.81\text{ m/s}^2)(5.75\text{ m})} = 10.6\text{ m/s}.$$

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?

$$\text{(a)}\quad W_a = (10.0\ \text{N/cm})\left((5.00\ \text{cm})^2 - (1.00\ \text{cm})^2\right)/2 = 120.\ \text{N cm} = 1.20\ \text{J}$$

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

$$\text{(b)}\quad W_a = (10.0\ \text{N/cm})\left((5.00\ \text{cm})^2 - (-5.00\ \text{cm})^2\right)/2 = 0\text{J}$$

A ball with mass m is thrown vertically into the air with an initial speed v Which of the following equations correctly describes the maximum height h of the ball?	قذفت كرة كتلتها m رأسيًا في الهواء بسرعة ابتدائية vأي من المعادلات التالية تصف بشكل صحيح أقصى ارتفاع h للكرة؟

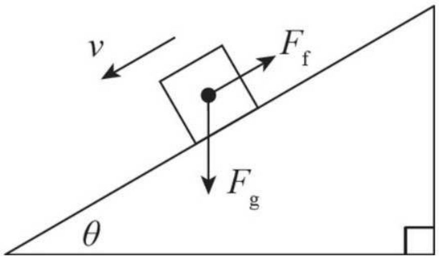
A) $h = \sqrt{\dfrac{v}{2g}}$

B) $h = 2mv/g$

C) $h = \dfrac{mv^2}{g}$

D) $h = \dfrac{v^2}{2g}$

Which of the following is true regarding conservative forces?



A. The work done by conservative forces is path dependent.
B. The work done by conservative forces is path independent.
C. Gravity is a non-conservative force.
D. Friction is a conservative force.

Which of the following statements are true about conservative and non-conservative forces?

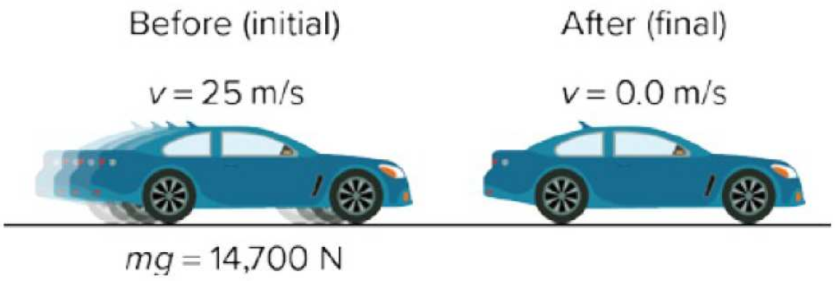
A. For conservative forces energy is dissipated as heat energy.
B. The forces due to air resistance and friction are conservative forces.
C. Work done by nonconservative forces is independent of the path.
D. Work done by conservative forces in a closed path equal zero.

---

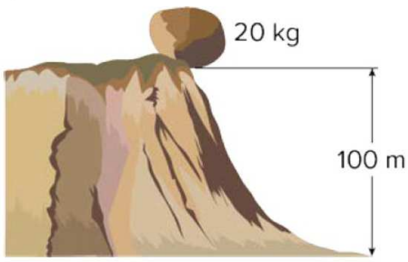
for a one-dimensional case, the work-kinetic energy theorem is equivalent to newton's second law

$$\left([(\frac{1}{2}mv_x^2) - (\frac{1}{2}mv_o^2)] = ma_x\,(x - x_o) = F_x\,\Delta x = W\right)$$

The driver of the car in the image suddenly applies the brakes and the car slides to a stop. The average force between the tires and the road is 7100 N. How far will the car slide after the brakes are applied?



A rock sits on the edge of a cliff, as shown



	Maximum potential energy (J)	the rock's speed as it hits the ground? (m/s)
A	3.4×10^4	80.22
B	2.0×10^4	44.72
C	4.0×10^4	44.72
D	2.0×10^4	80.22

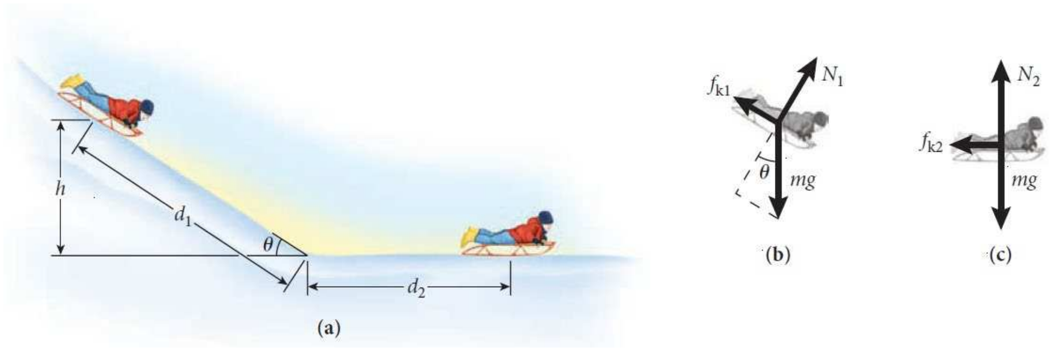
WORK DONE ON A SYSTEM BY AN EXTERNAL FORCE

Positive work W done on an arbitrary system means a **transfer of energy to the system**.

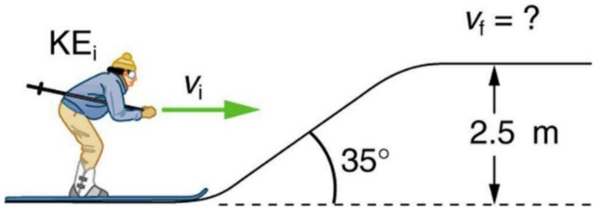
Negative work *W* means a **transfer of energy from the system.**

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 θ **= 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 60.0-kg skier with an initial speed of 12.0 m/s coasts up a 2.50-m-high rise given that the coefficient of friction between her skis and the snow is 0.0800.



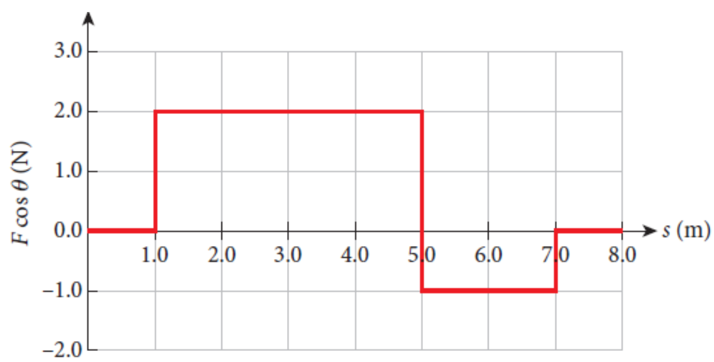
a. How much work does friction do on the skier?

b. Find her final speed at the top.

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. Find

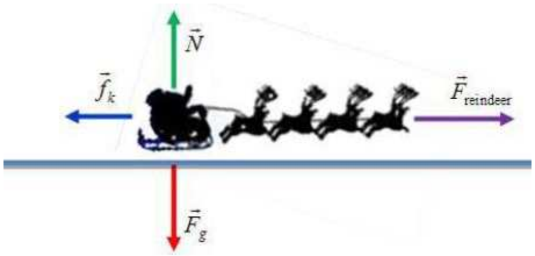
a) the net work done on the block;

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



Santa's reindeer pull his sleigh through the snow at a speed of 3.333 m/s. The mass of the sleigh, including Santa and the presents, is 537.3 kg.

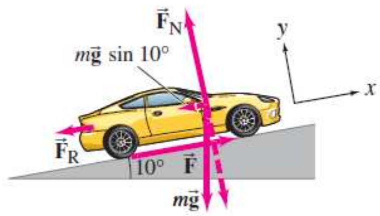
Assuming that the coefficient of kinetic friction between the runners of the sleigh and the snow is 0.1337, what is the total power that the reindeer are providing?



Calculate the power required of a 1400-kg car under the following circumstances:

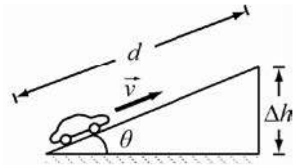
(*a*) the car climbs a 10° hill (a fairly steep hill) at a steady 80 km/h and

(*b*) the car accelerates along a level road from 90 to 100 km/h in 6.0 s to pass another car.



Assume the average retarding force $F_r = 600$ N on the car is throughout

A 103-kg car travels 2.50 km up an incline at constant velocity. The incline has an angle of 3.00° with respect to the horizontal.



A- What is the change in the car's potential energy?

B- What is the net work done on the car?

A person pushes a box of mass *m* a distance *d* across a floor. The coefficient of kinetic friction between the box and the floor is μ_k. The person then picks up the box, raises it to a height *h*, carries it back to the starting point, and puts it back down on the floor. How much work has the person done on the box?

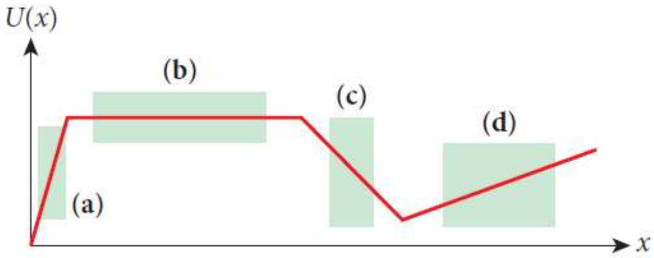
a) zero

b) $\mu_k mgd$

c) $\mu_k mgd + 2mgh$

d) $\mu_k mgd - 2mgh$

The potential energy, $U(x)$, is shown as a function of position, x, in the figure. In which region is the magnitude of the force the highest?



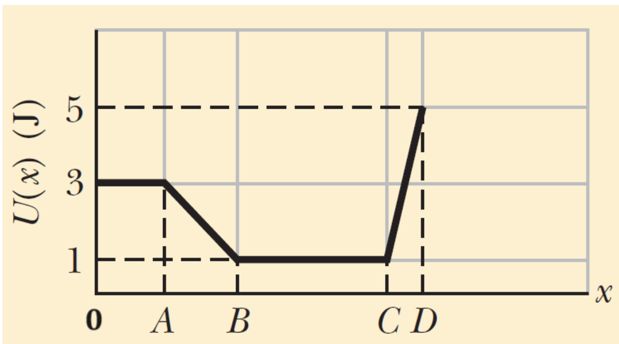
the potential energy of a body in as a function of its displacement is given by the relationship:

$$U(x) = (-2x^2 + 8x + 3)\ J$$

What is the magnitude of its displacement when it is a force is 8 N?

A- 1 m
B- 0 m
C- 1.5 m
D- 4 m

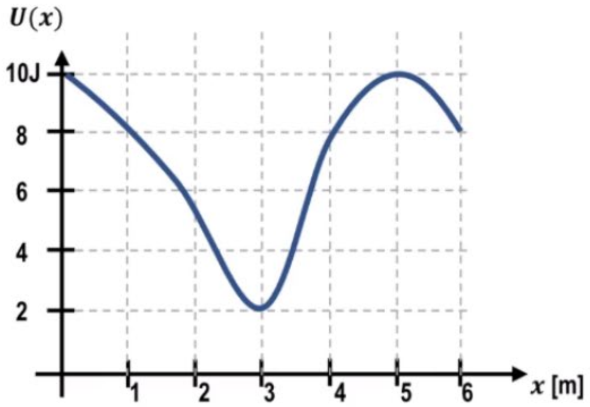
The adjacent graph shows the relationship between the potential energy of a particle moving in one dimension. Identify the stages in which there is **no force**, and the stages in which the force is **positive** and **negative force**.



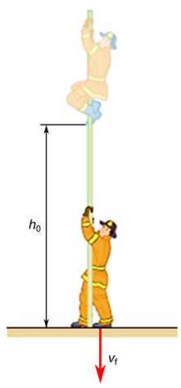
OA	AB	BC	CD

(b) What is the direction of the force when the particle is in region *AB*

EXAMPLE: A 0.5 kg marble moves according to the potential energy graph shown. If you release the marble from rest at x_0 = 1m, **a)** What is the total Mechanical Energy of the marble? **b)** What is the marble's kinetic energy at x = 3m? **c)** Calculate the speed of the marble at x = 4m. **d)** Without touching the marble again, can it ever reach x = 5m?

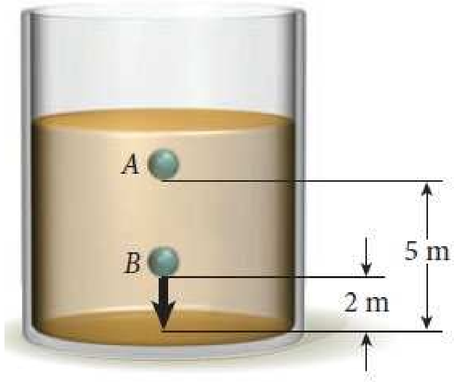


A block of mass 0.773 kg on a spring with spring constant 239.5 N/m oscillates vertically with amplitude 0.551 m. What is the speed of this block at a distance of 0.331 m from the equilibrium position?



A 80.0-kg fireman slides down a 3.00-m pole by applying a frictional force of 400. N against the pole with his hands. If he slides from rest, how fast is he moving once he reaches the ground?

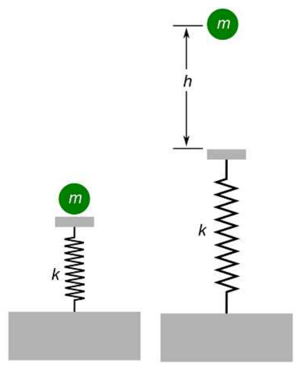
A ball of mass 0.50 kg is released from rest at point *A*, which is 5.0 m above the bottom of a tank of oil, as shown in the figure. At point *B*, which is 2.0 m above the bottom of the tank, the ball has a speed of 6.0 m/s. The work done on the ball by the force of fluid friction is......



a) +15 J.
b) +9 J.
c) -15 J.
d) -5.7 J.

A spring with spring constant *k* is oriented vertically and compressed downward a distance *x* from its equilibrium position. An object of mass *m* is placed on the upper end of the spring, and the spring is released.
The object rises a distance *h* above the equilibrium position of the spring. If the spring is then compressed downward by the same distance *x* and an object of mass 3 *m* is placed on it, how high will the object rise when the spring is released?

a) *h*
b) 3*h*
c) *h*/3
d) h^3

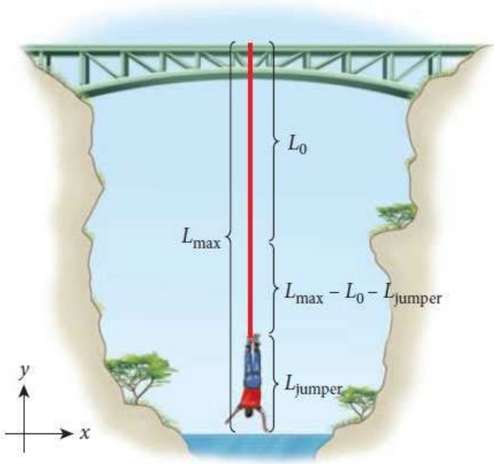


What is the safe length of the jumping wire a jumper of mass 80 kg can use

L_{jumper} = 1.85 m.

L_{max} = 75.0 m

Spring constant k = 50.0 N/m



a) 24.8 m.
b) 42.6 m.
c) 24.6 m.
d) 16.6 m.

How fast would you have to throw a 150-g rock for it to have the same momentum as a 10-g sniper rifle bullet travelling at 900 m/s?

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?

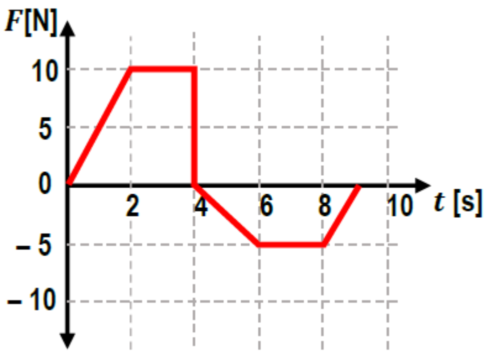
b) What is the ratio of the kinetic energy of the SUV to that of the car?

A 150-g rubber ball is moving at 40m/s to the right, when it hits a wall and bounces back. After the bounce, the ball is moving at 45m/s to the *left*.

a) Calculate the impulse delivered to the ball during the bounce**.**

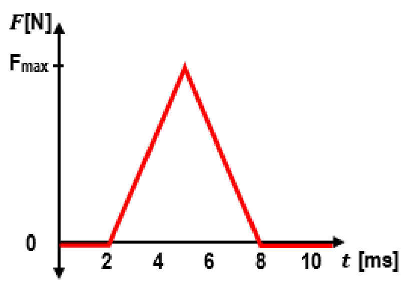
b) If the wall exerts an average force of 410N during the bounce, calculate the amount of time the ball is in contact with the wall**.**

EXAMPLE: A remote-controlled toy car moves forwards and backwards along the x-axis, and the electric motor supplies a changing force as shown by the graph below. **a)** Calculate the impulse delivered to the toy car. **b)** If the car has a mass of 2kg and starts from rest, calculate the final speed of the toy car.

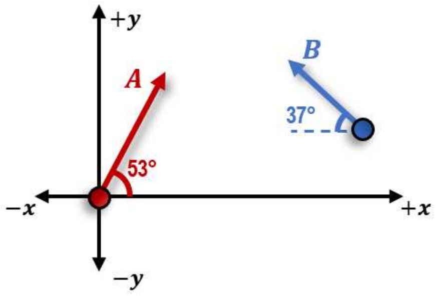


MOMENTUM
$p = mv$
$J = F\Delta t = \Delta p = mv_f - mv_0$

An object experiences a force given by the graph below.
What value of F_{max} would give an impulse of 6 N·s?



Object A moves at 10 m/s at 53° and Object B moves at 5 m/s at –37° as shown below. Calculate the magnitude of the system's total momentum if both objects have a mass of 2 kg.



A. 21.6 kg·*m/s*
B. 22.4 kg·*m/s*
C. 29.7 kg·*m/s*
D. 9.17 kg·*m/s*

On a frictionless air hockey table, puck A of mass 0.250 kg moves to the right and collides with puck B of mass 0.38 kg, which is initially at rest. After the collision, puck A is moving the left at 0.12 m/s and puck B moves to the right at 0.65 m/s.

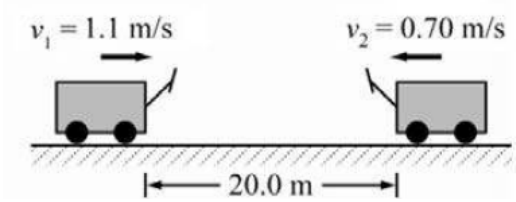
What was the initial velocity of puck A before the collision?

A. 0.73 m/s
B. 0.57 m/s
C. 0.87 m/s
D. 1.1 m/s

An 80-kg astronaut is stranded floating in space is 30 m away from his spaceship. He wants to return to his spaceship in 20 s. How fast must he throw his 2-kg space hammer, directly away from the spaceship, to accomplish this?

A. 40 m/s
B. 120 m/s
C. 240 m/s
D. 60 m/s

You notice that a shopping cart 20.0 m away is moving with a velocity of 0.700 m/s toward you. You launch an identical cart with a velocity of 1.10 m/s directly at the other cart in order to intercept it. When the two carts collide elastically, they remain in contact for 0.200 s.



$$t = \frac{20.0\text{ m}}{0.700\text{ m/s} + 1.10\text{ m/s}} = 11.11\text{ s}$$

$$x = (0.700\text{ m/s})(11.11\text{ s}) = 7.78\text{ m.}$$

$$p_{f1,x} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)p_{i1,x} + \left(\frac{2m_1}{m_1 + m_2}\right)p_{i2,x}$$

$$p_{f2,x} = \left(\frac{2m_2}{m_1 + m_2}\right)p_{i1,x} + \left(\frac{m_2 - m_1}{m_1 + m_2}\right)p_{i2,x}$$

$$v_{f1,x} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_{i1,x} + \left(\frac{2m_2}{m_1 + m_2}\right)v_{i2,x}$$

$$v_{f2,x} = \left(\frac{2m_1}{m_1 + m_2}\right)v_{i1,x} + \left(\frac{m_2 - m_1}{m_1 + m_2}\right)v_{i2,x}$$

Special Case 1: Equal Masses

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

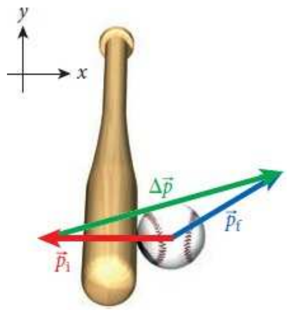
$$v_{f1,x} = v_{i2,x}$$
$$v_{f2,x} = v_{i1,x}.$$

Special Case 2: One Object Initially at Rest

$$p_{f1,x} = \left(\frac{2m_1}{m_1 + m_2}\right)p_{i2,x}$$
$$p_{f2,x} = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)p_{i2,x}$$

$$v_{f1,x} = \left(\frac{2m_2}{m_1 + m_2}\right)v_{i2,x}$$
$$v_{f2,x} = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)v_{i2,x}$$

A Major League pitcher throws a fastball that crosses home plate with a speed of 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 49.17 m/s at an angle of 35.0° above the horizontal.
The mass of a baseball is 0.145 kg.



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

If the contact between the ball and the bat lasted 1.20 ms. What was the magnitude of the average force exerted on the ball by the bat during that time?

One of the events in the Scottish Highland Games is the sheaf toss, in which a 9.09-kg bag of hay is tossed straight up into the air using a pitchfork. During one throw, the sheaf is launched straight up with an initial speed of 2.70 m/s.

a) What is the impulse exerted on the sheaf by gravity during the upward motion of the sheaf (from launch to maximum height)?

b) Neglecting air resistance, what is the impulse exerted by gravity on the sheaf during its downward motion (from maximum height until it hits the ground)?

c) Using the total impulse produced by gravity, determine how long the sheaf is airborne.

EXAMPLE 5.4 Accelerating a Car

PROBLEM

Returning to the example of an accelerating car, let's assume that the car, of mass 1550 kg, can reach a speed of 60 mph (26.8 m/s) in 7.1 s. What is the average power needed to accomplish this?

SOLUTION

We already found that the car's kinetic energy at 60 mph is

$$K = \tfrac{1}{2}mv^2 = \tfrac{1}{2}(1550\text{ kg})(26.8\text{ m/s})^2 = 557\text{ kJ}.$$

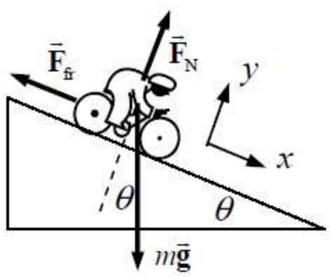
The work to get the car to the speed of 60 mph is then

$$W = \Delta K = K - K_0 = 557\text{ kJ}.$$

The average power needed to get to 60 mph in 7.1 s is therefore

$$\overline{P} = \frac{W}{\Delta t} = \frac{5.57\cdot 10^5\text{ J}}{7.1\text{ s}} = 78.4\text{ kW} = 105\text{ hp}.$$

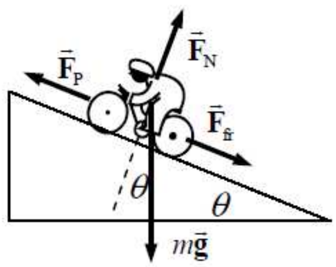
A bicyclist coasts down a 6.0° hill at a steady speed of 4.0 m/s Assuming a total mass of 75 kg (bicycle plus rider), what must be the cyclist's power output to climb the same hill at the same speed



First, consider a free-body diagram for the cyclist going downhill. Write Newton's second law for the x direction, with an acceleration of 0 since the cyclist has a constant speed.

$$\sum F_x = mg\sin\theta - F_{fr} = 0 \quad \rightarrow \quad F_{fr} = mg\sin\theta$$

Now consider the diagram for the cyclist going up the hill. Again, write Newton's second law for the x direction, with an acceleration of 0. The coordinate axes are the same, but not shown in the second diagram.



$$\sum F_x = F_{fr} - F_P + mg\sin\theta = 0 \quad \rightarrow \quad F_P = F_{fr} + mg\sin\theta$$

Assume that the friction force is the same when the speed is the same, so the friction force when going uphill is the same magnitude as when going downhill.

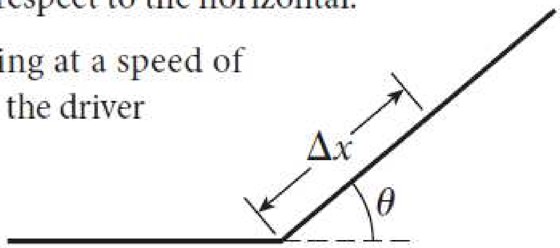
$$F_P = F_{fr} + mg\sin\theta = 2mg\sin\theta$$

The power output due to this force is given by Eq. 6–18.

$$P = F_P v = 2mgv\sin\theta = 2(75\text{ kg})(9.80\text{ m/s}^2)(4.0\text{ m/s})\sin 6.0° = \boxed{610\text{ W}} \approx 0.82\text{ hp}$$

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 61.2 mph has lost its brakes. Fortunately, the driver finds a runaway lane, a gravel-covered incline that uses friction to stop



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.