A particle is acted on by only two forces, one is conservative \((F_c)\) and one is nonconservative \((F_{nonc})\), as it moves from point A to point B. The kinetic energies of the particle at points A and B are equal if

a) \(W_{F_c} = 0\)

b) \(W_{F_{nonc}} = 0\).

c) \(W_{F_c} + W_{F_{nonc}} = 0\)

d) \(F_{nonc} \gg F_c\)

e) \(F_c \gg F_{nonc}\)
The reference level for gravitational potential energy

a) Must be at ground level.
b) Can be chosen arbitrary.
c) Must be at the initial position of the object.
d) Must be at the lowest position reached by the object.
e) Must be at the highest position reached by the object.
A 25 Kg object initially at the origin is acted upon by a variable force as shown in the figure. If the object starts from origin with initial speed of 3 m/s, what is the speed (in m/s) of the object at $x = 12$ m?
A 5 Kg box moving at 8 m/s on a horizontal, frictionless surface slides into a spring of force constant \( k = 2000 \text{ N/m} \) that is attached to a wall. Find the maximum compression distance (in m) of the spring.
A stockroom worker pushes a box with mass 12 kg on a horizontal rough surface with a constant speed of 4 m/s. The coefficient of kinetic friction between the box and the surface is \( \mu_k = 0.2 \).

a) What horizontal force (in N) must the worker apply to maintain the motion?

b) If the force calculated in part (a) is removed, how far (in m) does the box slide before coming to rest?
A single conservative force acts on a 5.0 Kg particle. The force is described by the equation:
\[ F_x = 2x + 4x^3, \] where \( x \) is in meters. As the particle moves along the \( x \)-axis from \( x = 2 \) m to \( x = 4 \) m. Calculate the change in the potential energy (in J) of the system.
Two blocks are connected by a very light string passing over a massless and frictionless pulley as shown in the figure. Travelling at constant speed, the 20 Kg block moves 2 m to the right on a rough surface and the 8 Kg block moves 2 m downward. During this process,

a) How much work (in J) is done on the 8 Kg block by the force of gravity?

b) How much work is done (in J) on the 20 Kg block by the tension in the string?

c) How much work (in J) is done on the 20 Kg block by the force of friction?

d) Calculate the coefficient of kinetic friction of the rough surface.
A 4 Kg object is moving on a rough circular track \((r = 0.8 \text{ m})\) as shown. The speed of the object at point \(A\) is 12 m/s and at point \(B\) is 6 m/s. How much work (in J) is done on the object between \(A\) and \(B\) by the force of friction?
For the cases shown in the figure, the three objects are released from rest at the top and feel no friction or air resistance during their motion down to the ground. When they reach the ground one of the following statements is correct:

a) The object in case III will have the highest speed.
b) Object in case III will have the smallest speed.
c) The work done by gravity on the object III during the trip is the highest.
d) The work done by gravity during the trip is the same for the three objects.
e) None of the above.
A 3.5 kg block is placed against a horizontal spring ($k = 3000 \text{ N/m}$) that is compressed a distance $x = 4.0 \text{ cm}$. When the spring is released the block moves on a horizontal frictionless surface. Calculate the kinetic energy of the block when $x = 2.0 \text{ cm}$. 
A force $\vec{F}$ is applied to a 2 kg box as it moves along a straight track along the $x$-axis. The $x$-component of the force varies with $x$ as shown in the figure. Calculate the work done by the force between $x = 0$ and $x = 6 \, m$. 
A block of mass $m$ slides with speed $v$ on a frictionless horizontal surface and then rises up a hill of height $h = 1 \text{ m}$ and stops. Calculate the minimum value of $v$ for the block to attain the top of the hill.
A ball is released from the top of a building of height $H$ and falls freely to the floor. If air resistance is ignored, which graph represents correctly the total mechanical energy ($E$) as a function of vertical height $y$ of the ball?

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الخبير هو من ارتكب كل الأخطاء التي يمكن ارتكابها في مجال محدد.
The figures show a conservative and variable force $F_x$ acting on a particle of mass $m$ moving along the positive $x$-axis. Rank the change of the potential energy from the least (or most negative) to the greatest (or most positive).

a) 1, 2, 3
b) 1, 3, 2
c) 2, 3, 1
d) 3, 2, 1
e) 2, 1, 3
Find the work (in J) done by a force $F_x$ as the object moves from $x = 4 \, m$ to $x = 7 \, m$. 
A block of mass $5 \text{ kg}$ is pulled by a force $F$ and moves on a smooth horizontal surface as shown in the figure. At point $A$ its speed is $4 \text{ m/s}$, after it travels a distance of $3 \text{ m}$ beyond this point (to point $B$) its speed become $8 \text{ m/s}$. By using work-energy theorem, find the magnitude of the force acting on the block (in N).
A block of mass $2 \text{ kg}$ is compressing a spring $(k = 250 \text{ N/m})$ from unstretched position (point A) to point B by a distance of $4 \text{ cm}$ on a smooth and horizontal surface as shown. Find the work (in J) done by the spring during the motion from A to B.
A cart moves from rest with a constant acceleration of $2 \text{ m/s}^2$ due to several forces acting on it. One of these forces is the force of the worker who assists the cart by pushing on it with a horizontal force $F(t) = 3t$, where $F$ in N and $t$ in s. Find the instantaneous power (in watt) delivered by this force at $t = 6s$. 
A block of mass $2 \text{ kg}$ is moving in $xy$ plane. The net force is described by potential energy function $U(x, y) = x^2 + 2y^2$ ($U$ is in J, $x$ and $y$ are in m). What is the acceleration vector, in unit vector notations, (in m/s$^2$) of the block when it is at point $x = 3m$ and $y = 1.5m$?
A 800 N student stands on a bathroom scale in an elevator. As the elevator starts moving, the scale reads 600 N. Find the acceleration (in m/s²) of the elevator (magnitude and direction).
A 2 kg block situated on a rough inclined surface is connected to 160 \( N/m \) spring. The block is released from rest, when the spring is unstretched. The block moves a maximum distance of 15 cm down the incline.

a) What is the change in the gravitational potential energy (in J)?

b) What is the coefficient of kinetic friction between the block and the incline?
A ball is thrown vertically upward. At the maximum height the potential (U) and kinetic (K) energies are respectively.

a) max, max  
b) max, min  
c) min, max  
d) min, min  
e) constant, constant
In the spring-mass system shown in the figure the mass is attached to the spring. The mass moves back and forth between points a and c. The minimum magnitude of the block’s acceleration is reached at

a) a only
b) b only
c) c only
d) a and c
e) a, b and c
A 60 kg boy runs up the stairs of a 80 m tall building. If the boy reaches the top in 2 minutes. (Consider only the work done by the boy against gravity). Find his average power output (in watt).
A particle is under the influence of a conservative force whose potential energy is \( U = 5x^2 - 20x \) where \( U \) is in (J) and \( x \) is in (m). Find the position (in m) on the x-axis where the force on the particle is zero.
A ball of mass $4 \text{ kg}$ is thrown with a speed of $20 \text{ m/s}$ at an angle $\theta$ from the roof of a building which is $25 \text{ m}$ tall. Find the speed (in m/s) of the ball just before it hits the ground.
A block of mass \( m = 2 \, kg \) is attached to a spring of force constant \( k = 800 \, N/m \) as shown in the figure. The block is pulled to a position \( x_i = 30 \, cm \) to the right of the equilibrium position and released from rest. Find the speed (in m/s) the block has as it passes through the equilibrium position. (Horizontal surface is frictionless)
A force \( \vec{F} = 6\hat{i} + 8\hat{j} \, N \) acts on a particle that undergoes a displacement \( \Delta\vec{r} = -5\hat{i} + 10\hat{j} \, m \).

a) Find the work (in J) done by this force on the particle.

b) Find the angle between the force \( \vec{F} \) and the displacement \( \Delta\vec{r} \).

 algunos de los materiales en el canal (HS Engineers)
A small block of mass $0.4 \, kg$ slides in a vertical circle of radius $R = 5 \, m$ on the inside of a circular rough track. When the block is at the bottom of the track (point A), it experiences a normal force of $36 \, N$. When the block reaches the top of its path (point B), the magnitude of the normal force is $0.8 \, N$. Find the work done by friction (in J) during this motion from A to B.
The shown pendulum starts moving at position $A$ with an initial speed of $V_A > 0$. If the pendulum stops momentarily at the other end, then the angle $\theta_B$ with the vertical at this end will be

- $\theta_B = \theta_A$
- $\theta_B < \theta_A$
- $\theta_B > \theta_A$
- $\theta_B = 0$
- $\theta_B$ cannot be determined
A ball of mass $m$ is thrown vertically upward and returns back to its initial position. The work done by gravity on the ball during its entire trip is:

- Zero
- $mgh$
- $-mgh$
- $mg(2h)$
- $mg(-2h)$
A projectile which is fired from the ground, follows a parabolic path as shown in figure 1. The graph that best describes the projectile’s kinetic energy with time is

![Graphs showing kinetic energy over time](image)
A block is attached to two light springs as shown. When the block is moved to the right by 0.3 m, the total force exerted on the block by both springs is 900 N. If the force constant of one spring is 1000 N/m. Find the force constant (in N/m) of the other spring.
Starting from rest at point A, a small block of mass $5 \, kg$ slides down a frictionless, semi-circular slide of radius $R = 2 \, m$. Find the normal force acting on the block when it is moving at point B.
A horizontal force $F$ acting on a particle of mass $m$ varies with position as shown in the graph. Find the work done on the particle by the force $F$ from $x = 0$ to $x = 15 \text{ m}$. 

![Graph showing a horizontal force $F$ acting on a particle, varying with position from $x = 0$ to $x = 15 \text{ m}$]
Find the angle in degrees between the two vectors:

\[ \vec{A} = \hat{i} + \hat{j} + \hat{k} \]
\[ \vec{B} = \hat{i} - \hat{j} + \hat{k} \]
A ball of mass m is thrown from point A off a cliff of height h with an initial speed \( v_A \) and strikes the ground with speed \( v_B \) at point B. Neglecting air resistance, the change in total mechanical energy of the ball from point A to point B is:

- Zero
- \( mgh \)
- \( -mgh \)
- \( \frac{1}{2} mv_B^2 - \frac{1}{2} mv_A^2 \)
Three masses $A$, $B$, and $C$ are connected by a system of massless pulleys and light strings and move as shown in the figure. The work done by the force of gravity on masses $A$, $B$, and $C$ respectively is

- positive, positive, negative
- zero, positive, positive
- zero, positive, negative
- zero, negative, negative
- zero, negative, positive
A pendulum moves along the trajectory as shown in the figure. At point B in the figure, the tension in the string and the kinetic energy, respectively are:

- maximum, minimum.
- minimum, maximum.
- maximum, maximum.
- Tension and kinetic energy are constant throughout the motion.
A horizontal force $F_x$ acting on a particle varies with the position as shown in the graph below. Find the work (in J) done on the particle as it moves from $x = 0 \text{ m}$ to $x = 6 \text{ m}$. 
A constant force $\vec{F} = (4\hat{i} - 3\hat{j})N$ acts on a particle, if the displacement of the particle is $\Delta \vec{r} = -8\hat{i} + 6\hat{k} \text{m}$ calculate:

a) the work (in J) done by the force.

b) the angle between the force and the displacement.
A particle of mass $0.8 \, kg$ is under the influence of a conservative force whose potential energy is $U(x) = 6x^2 - 20x$, where $x$ is measured in m and $U$ is measured in J. Find the acceleration (in m/s$^2$) of the particle at $x = 2.0 \, m$. 
A 4 kg block is projected from the top of a frictionless incline toward a spring with speed $v = 2.0 \, m/s$ as shown in the figure. If the spring is compressed a distance of $x = 0.2 \, m$ when the block momentarily stops, find the spring constant $k$ (in N/m).
One observer drops a ball from the top of a building while another observer at the bottom of the building observes its motion. On which of the following will the two observers disagree? (Neglect air resistance)

a) the change in the ball’s potential energy.

b) the ball’s kinetic energy at some point during its motion.

c) the change in the ball’s total mechanical energy.

d) the magnitude of the ball’s acceleration.

e) the ball’s potential energy as measured relative to each observer’s position.
The kinetic energy of an object depends upon

a) the relative distance between the object and another object.

b) the frame of reference in which the motion is measured.

c) the mass and the acceleration.

d) only on the speed.

e) the mass and the velocity.

Second, April 2016
A normal force

a) can only do positive work
b) can only do negative work
c) can do either positive, negative, or zero work.
d) can do work only in the opposite direction of friction
e) can never do work
A 2.4 kg object is initially at rest. Find the net work (in J) done on the object if its velocity changes to $8.00 \hat{i} + 4.00 \hat{j} \text{ m/s}$. 
A block of mass \( m = 2 \text{ kg} \) is placed on a frictionless horizontal surface and is attached to a spring with force constant \( k = 800 \text{ N/m} \). The block is pulled 6 cm to the right of equilibrium and is released from rest. Find the speed (in m/s) of the block as it passes through the equilibrium position.
A 3730 kg elevator loaded with passengers is moving up at a constant speed of 2 m/s. What is the power output (in hp) of the motor?
A bead of mass 2 kg slides without friction around a loop-the-loop. The bead is released from rest at a height \( h = 4R \), where \( R = 8 \text{ m} \) is the radius of the loop-the-loop. Find the normal force (in N) exerted on the bead from the surface at point A.
A 2 kg object moving at 6 m/s on a rough horizontal surface comes to a complete stop after traveling a distance of 4 m. Assume the frictional force is constant.

a) Use the work-energy theorem to calculate the magnitude of the frictional force (in N) stopping the object.

b) What is the magnitude of the acceleration (in m/s\(^2\)) of the object?

c) Find the coefficient of the kinetic friction between the block and the surface.

Second, April 2016
Which one of the five graphs correctly shows the potential energy of a spring as a function of its elongation $x$?

(a) \[ U(x) \]

(b) \[ U(x) \]

(c) \[ U(x) \]

(d) \[ U(x) \]

Which one of the five graphs correctly shows the potential energy of a spring as a function of its elongation $x$?
The power developed by a certain engine is a function of time according to $P = 2 + 2t + 3t^2$ where $P$ is in (W) and $t$ is in (s). Find the work (in J) done by the engine in the interval from $t = 0$ to $t = 2$ s.
A 0.5 kg block is pushed against spring 1 ($K_1 = 500 \, N/m$), compressing it 0.2 m. When it is released from rest, the block leaves spring 1 and travels along the track and then hits spring 2 ($K_2 = 400 \, N/m$). The track is frictionless except for the portion between A and B. What is the maximum compression distance of the spring 2?
An object, tied to a string, moves halfway around a circle of radius $R$ (from point A to point B). The work done by the tension is

- $FR$
- $2FR$
- $\pi FR$
- $2\pi R$
- zero
In raising an object to a given height by means of an inclined plane, as compared with raising the object vertically, there is a reduction in:

- Applied force required
- Work required
- Weight
- Change in the potential energy
- Value of $g$
A 0.6 kg object is subject to a force $F_x$ that varies with position as shown in the following figure. If the object starts from rest at $x = 0 \text{ m}$. Find the position $(x)$ at which the object changes its direction.
A 10 Kg object undergoes a displacement \( \Delta \vec{r} = 5\hat{i} + 3\hat{j} + 3\hat{k} \). During the displacement, a constant force \( \vec{F} = -3\hat{i} + \hat{j} + 4\hat{k} \) acts on the object. The displacement is in (m) and the force is in (N). Calculate the work (in J) done by the force \( \vec{F} \) on this object.
A spring of force constant $k$ (compressed a distance $x$ from its equilibrium position at point B) is released, and a block of mass $m$ moves vertically upward a distance $h$ from point B to point C. Ignoring air resistance, the total work done on the block as it moves from point A to point C is

- $0$
- $\frac{1}{2} kx^2$
- $mgh$
- $\frac{1}{2} m v_{\text{max}}^2$
- $mg (h + x)$
If the kinetic energy of a particle of mass \( m \) is doubled, then its speed will increase by a factor of

- 2
- \( 2\sqrt{2} \)
- 4
- 8
- \( \sqrt{2} \)
A box moves from the origin under the influence of a variable force whose graph is shown. **Find the work done** (in J) by the force on the box as it moves from $x = 0$ m to $x = 8$ m.
In problem SP6, find the work done (in J) by gravity on the car as it moves from point A (bottom of the track) to point B (the top of the track).
A 2.0 kg block is moving at 6.0 m/s on a frictionless horizontal surface toward a spring with force constant $k = 800 \text{ N/m}$ that is attached to a wall, as shown in the figure. Find the maximum distance (in m) the spring will be compressed.
Several forces act upon the shown box causing it to move according to the given position – time graph. If the magnitude of one of these forces $F$ at $t = 7 \text{ s}$ is $30 \text{ N}$, find the instantaneous power (in watts) by this force $F$ at this instant.
A block moves a distance of 5.0 m from point A on a rough horizontal surface and then is projected horizontally off a table of height \( h = 1.25 \) m at point B. The block then lands at point C, a horizontal distance \( d \) from the base of the cliff, as shown in the figure. Air resistance is negligible. Its speed at point A is 6.0 m/s and its speed at point B is 2.0 m/s.

a) **Find the horizontal distance, \( d \) (in m).**

b) **Use the work-energy theorem to find the coefficient of kinetic friction, \( \mu_K \), of the rough surface between points A and B.**
Two masses $m_1$ and $m_2$ with $m_2 > m_1$ are connected via a light rope over a massless pulley, as shown in the figure. They are then released from rest. The work done by gravity on $m_1$ and $m_2$, respectively, is

- positive, positive
- negative, negative
- positive, negative
- negative, positive
- zero, zero
A block attached to a spring is pulled from its equilibrium position at point O a distance x to point A, then released from rest. The block slides on a frictionless surface. Which of the following is true as the block passes point O?

- \( v = 0, a = 0 \)
- \( v = 0, a \) is at a maximum
- \( v \) and \( a \) are both at a maximum
- \( v \) is at a maximum, \( a = 0 \)
- \( v \) and \( a \) are both at constant throughout the motion
A constant force \( \vec{F} = (30\hat{i} - 40\hat{j})N \) acts on a particle that undergoes a displacement of \( \Delta\vec{r} = (-8\hat{i} + 10\hat{j})m \). Find the average power delivered by \( \vec{F} \) during the first 5 seconds.
A variable force acting along the x-axis is shown in the figure. It acts upon an object of mass $m = 4.0 \text{ kg}$. If the speed of the object at the origin is $2 \text{ m/s}$ in the $+x$ direction, find the speed of the object when it is at the position $x = 4 \text{ m}$. 

![Graph showing force vs. position with a variable force acting along the x-axis.](image)
A car of mass \( m \) in an amusement park ride rolls without friction around a track, as shown in the figure. The car starts from rest at a point A at a height \( h \) above the bottom of the circular loop of radius \( R \). It completes a loop then compresses a spring at point C a distance of \( x = 1.2 \text{ m} \) before stopping momentarily.

a) (2 points) Find the minimum height (\( h_{\text{min}} \)) in terms of \( R \) such that the car completes the vertical loop without falling off the top of the loop (point B).

b) (1 point) Suppose now \( h = 3R \), \( R = 15 \text{ m} \), and \( m = 100 \text{ kg} \). Find the value of the spring constant \( k \).
Three blocks are connected as shown. The ropes and pulleys are of negligible mass. When released, block C moves downward, block B moves up the ramp, and block A moves to the right. After each block has moved a distance d, the force of gravity has done

a) Positive work on A, B, and C.

b) Zero work on A, positive work on B, negative work on C.

c) Zero work on A, negative work on B, positive work on C.

d) Positive work on A, negative work on B, positive work on C.

e) Negative work on A, B, and C.
Two variable forces $F_1$ and $F_2$ act on a particle causing it to move in a straight line with constant acceleration of $2.5 \text{ m/s}^2$. $F_1 = 5t$ where $F_1$ is in Newtons and $t$ is in seconds. If the particle starts from rest at $t = 0$, what instantaneous power (in watts) does $F_1$ (which is in the direction of motion) deliver to the particle at $t = 6$?
A 0.50 kg block compresses a massless spring \( (k = 1000 \, N/m) \) placed on an incline whose surface is smooth (frictionless) except for a rough portion of length \( d_1 = 2.5 \, m \) as shown in the figure. When the spring is released the block moves up the incline a maximum distance \( d_2 = 6.0 \, m \) measured from the relaxed position \((x = 0)\) of the spring. If the compression distance \( x = 0.20 \, m \) and \( \theta = 30^\circ \).

a) Find the work (in J) done by friction along the rough portion \( d_1 \).

b) Find the coefficient of kinetic friction \( \mu_k \) between the block and the incline in the rough portion \( d_1 \).
A massless rope connects a block of mass \( m = 20 - kg \) to a spring of force constant \( k = 16 \times 10^3 N/m \). The block is released from rest causing the pulley to rotate (without the rope slipping) and the spring to stretch. If the pulley has moment of inertia \( 0.2 \times kg \times m^2 \) and radius 10 cm, find the speed (in m/s) of the block just before it hits the ground.

Final, May 2014
A 10-g bullet moving with a speed $v$ strikes and passes through a ball of mass $M = 2 \text{ kg}$ suspended by a 1.6-m long string. The bullet emerges with a speed of $v/2$. The ball then rotates along the vertical circular path shown in the figure.

a) **Find the speed** (in m/s) of the ball at the top of the circular path (point A) if the string is on verge to be loose at this point. (The ball does not fall down.)

b) **Find the initial speed** $v$ (in m/s) of the bullet that would yield the situation in (a).
A 2 kg rock is released from rest at a height of 20 m above the ground and feels no air resistance. What is its mechanical energy at a height of 8 m if the reference coordinates are taken at the ground level?

a) 320 J  
b) 400 J  
c) 180 J  
d) Zero  
e) 160 J
A 2.0-\textit{kg} block slides down a frictionless incline while a force $F$ is opposing its motion causing it to move with constant speed a distance of 5.0 m. Find the work done by $F$ (in J).
At $t = 0$, a 0.15-$kg$ particle moving horizontally with velocity $-8 \, m/s$ is acted upon by a horizontal force $F$ of magnitude varying with time as shown in the figure. **Find the momentum of the particle at $t = 4 \, m/s$** (in N.s)
A block is attached to a spring \((k = 500 \, N/m)\) on a horizontal frictionless surface. Initially, the spring is at the relaxed position and the block is at rest. A force of magnitude \(100-N\) is then applied to the block leading to a compression of the spring. \textbf{Find the kinetic energy} (in J) of the block when the spring is compressed by \(0.20 \, m\).
A 2.0-\textit{kg} block moving with initial speed of 8.0 m/s on a rough horizontal surface hits a horizontal spring \((k = 500 \text{ N/m})\) and compresses it a maximum distance of 0.40 m. Find the work done by friction (in J).
In the system shown, when the block \((m = 4.0 \, kg)\) falls down it pulls the rope causing the pulley to rotate about a fixed horizontal axis. The block has a speed of \(3.0 \, m/s\) when it has fallen \(6.0 \, m\). Find the moment of inertia of the pulley (in kg \(m^2\)), if the pulley has a radius of \(0.80 \, m\).
During free fall (neglecting air resistance) of a ball of mass $m$ from a height $h$ to the ground, the change in total mechanical energy of the ball equals to

a) 0
b) $mgh$
c) $-mgh$
d) $\Delta K$
e) $\Delta U$
A constant force \( F = 6.0 \hat{i} - 2.0 \hat{j} \, \text{N} \) acts on a particle that undergoes a displacement from point A at the origin to point B located at \((3.0 \, \text{m}, 1.0 \, \text{m})\). Find the work (in J) done by the force on the particle.
A block of mass \(4 \, kg\) compresses a spring of force constant \(k = 1000 \, N/m\) a distance of \(x = 0.2 \, m\). Find the distance, \(d\) (in m) the block goes along the incline after it is released. Ignore friction.
A 5 kg block is released from rest at point A. The track is frictionless except for the horizontal portion between points B and C, which has a length of 6 m. The block travels down the track, hits a spring of force constant 1000 N/m, and compresses it 0.3 m before coming to rest momentarily. Determine the coefficient of kinetic friction ($\mu_k$) between the block and the rough surface.
A 2 kg box is pulled along a rough horizontal surface by a varying force described by the equation \( F_x = (3x^2 + 4)N \), \( x \) is in meters (see the figure). If the force of kinetic friction is constant \( f_k = 6N \), calculate the speed (in m/s) of the box at point B if its speed at point A is...
A ball is tied to one end of a string of length 0.5 m and the other end of the string is held fixed. The ball is set moving around a vertical circle without friction as show in the figure. Calculate the minimum speed of the ball at point A (in m/s) in order to arrive point B and complete the circle.
A man pushes, with a constant speed, a 40 kg box from point A to point B along a rough incline ($\mu_k = 0.4$), see the figure. The distance between A and B is 12 m and it is covered by the box in 8 seconds.

a) Calculate the work done on the box by the fictional force (in J) when the box is moved from A to B.

b) Calculate the work done on the box by the man (in J).

c) Calculate the power (in W) by the man required to push the box from A to B.

d) Choose the correct answer: If the man stops pushing when the box reaches point B, then the box will

a. slide down directly towards A.
b. stop immediately at point B.
c. slide up to reach the maximum position C and then slide down towards A.
d. slide up to reach the maximum position C and then stop immediately at point C.
A man drives a car to another city and then returns back to his initial position. Over the entire trip, the work done by the driving force of the car’s engine (assumed constant) and the work done by friction, respectively, are:

- zero; positive
- zero; negative
- positive; negative
- negative; positive
A 2 kg block rests on a rough horizontal surface ($\mu_k = 0.75$) is attached to a spring of force constant $k = 600 \, N/m$ as shown in the figure. The block is pulled to a position $x_i = 20 \, cm$ to the right of the equilibrium position and then released from rest. **Find the speed** (in m/s) of the block as it passes through equilibrium position.
A 4 kg object has a velocity \((5\hat{i} - 2\hat{j})\) m/s. Find the net work done on the object (in J) if its velocity changes to \((8\hat{i} + 4\hat{j})\) m/s.
A box of mass $3 \text{ kg}$ slide along the track as shown in the figure. The curved portions of the track are frictionless, but the flat part is rough ($\mu_k = 0.2$). The box is released from rest at point A and stopped momentarily at point B. Calculate the value of $h$ (in m).
The blocks $A$ and $B$ move from rest on a smooth surface under the effect of the same force $F$. They cover the same distance $d$. If $m_A = 2m_B$ their kinetic energies at this end point are related as

- $K_A = 2K_B$
- $K_A = \frac{1}{2}K_B$
- $K_A = K_B$
- $K = 4K_B$
- $K_A = \frac{1}{4}K_B$
A ball of mass $0.12 \text{ kg}$ is dropped from a height $45 \text{ m}$ to the ground. It rebounds to a height $20 \text{ m}$. Find the average force (in N) exerted on the ball from the ground if the contact time is $12 \times 10^{-3} \text{ s}$ Neglect air resistance.
A 2 kg carte is pulled up a 36.9° rough incline with an initial speed of 6 m/s. If the pulling force is 90 N parallel to the incline and the coefficient of kinetic friction is 0.325, what is the final speed of the carte after it is pulled 5.0 m up the incline?
A and B are two blocks of equal masses of $2 \text{ kg}$ each. An ideal spring of $k = 900 \text{ N/m}$ is attached to block A which is moving with a speed of $2 \text{ m/s}$ to the left. Block B is released from a height of $5 \text{ m}$ and slides along a smooth surface and then strikes block A on the horizontal track. The two blocks have a head on elastic collision. (Hint: at maximum compression the two blocks are very close and move momentarily with the same speed, $v$) Find

a) The speed $v$ (in m/s) of the combined masses at the maximum compression of the spring.
b) The maximum compression (in m) of the spring.
c) The velocities (in m/s) of each block after block B has lost contact with the spring.
A conservative force acts on a particle which is moving along the x axis. The variation of the potential energy of the system is shown. Rank the labeled regions according to the magnitude of the net force acting on the particle, least to greatest.

- AB, BC, CD
- AB, CD, BC
- BC, CD, AB
- BC, AB, CD
- CD, BC, AB
A 16 kg block is fastened to a light spring ($k = 400 \text{ N/m}$) that passes over a massless frictionless pulley as shown. The block is released from rest when the spring is unstretched. **Calculate the speed of the block after it has dropped 0.4 m.**
A 6 kg block is released from rest at point A and moved down the incline, then on a horizontal surface and then up a semicircular hump of radius 1 m as shown. The track is frictionless except the portion BC \((\mu_k = 0.1)\). If the normal force acting on the block at the top of the hump is 12 N, calculate the height \(h\) (in m).
In the spring-mass system shown in the figure, the mass moves back and forth between points (a) and (b) on a frictionless surface. The acceleration of the block reaches zero at:

- a only
- b only
- O only
- a and b only
- a, b, and O
The potential energy for a system of one particle is \[ U = 5x^2 - 60x \] where \( U \) is in Joules and \( x \) is in meters. Find the position of the particle when it is at equilibrium.
A block of mass 3 kg is pushed to compress a spring, of a force constant $k = 480 \, N/m$, a distance $x = 20 \, cm$. The block is released from point A, then it slides 80 cm along a rough horizontal surface and stops finally at point B. Find the coefficient of kinetic friction $\mu_k$. 
A box of mass 20 kg is pushed horizontally from rest along a rough roof ($\mu_k = 0.2$) a distance 5 m by a force F. The box falls off the roof and hits the ground 3 m from the base of the building. The height of the building is 10 m.

a) With what speed does the box leave the roof?

b) Calculate the magnitude of the horizontal force F that was exerting on the box.
Neglecting air resistance, a swinging pendulum has at the bottom of its path:

- minimum kinetic energy
- minimum mechanical energy
- minimum potential energy
- maximum mechanical energy
- maximum potential energy
A 3 kg block is pushed against a spring \((k = 600 \text{ N/m})\), compressing it 0.2 m. When the block is released it leaves the spring then moves along a frictionless horizontal surface, and then moves up a frictionless incline. How far \((d)\) (in m) does the block travel up the incline before starting to slide back down?
The net conservative force acting on a block \((m = 0.5 \, kg)\) moving in the xy plane is described by the potential energy function 

\[ U(x, y) = 4x^2 - 2y^4, \] (U is measured in J), (x and y are measured in m). What is the acceleration (in m/s\(^2\)) in unit vector notation of the block when it is located at the point \((1, 1)\) m.
Two identical blocks ($m_1 = m_2 = 2 \text{ kg}$), $m_2$ rests on a frictionless horizontal surface and $m_1$ is released from rest at the top of a rough incline ($\mu_k = 0.234$) as shown in the figure. If the two blocks collide elastically on the horizontal surface. Find the speed (in m/s) of their center of mass after this elastic collision.