If both the mass and speed of an object are doubled, its momentum

A. remains unchanged.
B. is doubled.
C. is quadrupled.
D. decreases.
If both the mass and speed of an object are doubled, its momentum

A. remains unchanged.
B. is doubled.
C. **is quadrupled.**
D. decreases.
If the mass of an object decreases to half, and its speed doubles, its momentum

A. remains unchanged.
B. is doubled.
C. is quadrupled.
D. decreases.
If the mass of an object decreases to half, and its speed doubles, its momentum

A. remains unchanged.
B. is doubled.
C. is quadrupled.
D. decreases.

Explanation:

\( \frac{m}{2} \times 2v = mv \)
Your friend says that impulse equals momentum. This statement isn’t correct, and the missing word is

A. work.
B. acceleration.
C. speed or velocity.
D. change.
Your friend says that impulse equals momentum. This statement isn’t correct, and the missing word is

A. work.
B. acceleration.
C. speed or velocity.
D. change.

_Explanation:_
Your friend should say that impulse equals the _change_ in momentum.
A car and a heavy truck roll down a hill and reach the bottom at the same speed. Compared with the momentum of the car, the momentum of the truck is

A. less.
B. the same.
C. more.
D. None of the above.
A car and a heavy truck roll down a hill and reach the bottom at the same speed. Compared with the momentum of the car, the momentum of the truck is

A. less.
B. the same.
C. more.
D. None of the above.

Explanation:
Here we have more mass at the same speed for more momentum.
A 1-kg ball has twice as much speed as a 10-kg ball. Compared with the 1-kg ball, the 10-kg ball has

A. the same momentum.
B. 5 times as much momentum.
C. 10 times as much momentum.
D. 100 times as much momentum.
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A. the same momentum.
B. 5 times as much momentum.
C. 10 times as much momentum.
D. 100 times as much momentum.

Explanation:
Momentum of 1-kg ball = \( m(2v) = 2 \, mv \).
Momentum of 10-kg ball = \((10m)v = 10 \, mv\).
When both the force and time of contact are doubled, the impulse on an object is

A. unchanged.
B. doubled.
C. quadrupled.
D. decreased.
When both the force and time of contact are doubled, the impulse on an object is

A. unchanged.
B. doubled.
C. **quadrupled.**
D. decreased.

*Explanation:*

\[ 2F \times 2t = 4Ft \]
If the speed of a racing car doubles, what else doubles?

A. Its momentum.
B. Its kinetic energy.
C. Both of the above.
D. Neither of the above.
If the speed of a racing car doubles, what else doubles?

A. Its momentum.  
B. Its kinetic energy.  
C. Both of the above.  
D. Neither of the above.  

Comment:  
Note that momentum is proportional to speed, but kinetic energy is proportional to speed squared.
The impulse–momentum relationship is a direct result of Newton’s

A. first law.
B. second law.
C. third law.
D. law of gravity.
The impulse–momentum relationship is a direct result of Newton’s

A. first law.
B. **second law.**
C. third law.
D. law of gravity.

**Explanation:**
Equate Newton’s second law \( a = F/m \) to \( \Delta v/\Delta t \) and get \( F/m = \Delta v/\Delta t \). From this, \( F\Delta t = \Delta (mv) \). Calling \( \Delta t \) simply the time interval \( t \), we get \( Ft = \Delta mv \).
When a cannonball is shot from a cannon, the cannon recoils. Compared with the momentum given to the cannonball, the momentum of the recoiling cannon is ideally

A. less.
B. equal and opposite.
C. greater.
D. nonexistent.
When a cannonball is shot from a cannon, the cannon recoils. Compared with the momentum given to the cannonball, the momentum of the recoiling cannon is ideally

A. less.
B. equal and opposite.
C. greater.
D. nonexistent.

Comment:
Note the similarity of this with Newton’s third law.
When you catch a fast-moving baseball with your bare hand, a good idea is to catch it so that your hand stops it

A. quickly.
B. slowly.
C. Both of the above ways.
D. None of the above ways.
When you catch a fast-moving baseball with your bare hand, a good idea is to catch it so that your hand stops it

A. quickly.
B. slowly.
C. Both of the above ways.
D. None of the above ways.

Explanation:
More time in the impulse that stops the ball results in less force and less ouch.
When you jump from an elevated position to the ground below, the force you experience when landing depends on

A. the jumping height.
B. the softness or hardness of the ground.
C. how much you bend your knees.
D. All of the above.
When you jump from an elevated position to the ground below, the force you experience when landing depends on

A. the jumping height.
B. the softness or hardness of the ground.
C. how much you bend your knees.
D. All of the above.
On roller blades, you toss a ball horizontally away from you. The mass of the ball is one-tenth your mass. Compared with the speed you give to the ball, your recoil speed will ideally be

A. one-tenth as much.
B. the same.
C. ten times as much.
D. 100 times as much.
On roller blades, you toss a ball horizontally away from you. The mass of the ball is one-tenth your mass. Compared with the speed you give to the ball, your recoil speed will ideally be

A. one-tenth as much.
B. the same.
C. ten times as much.
D. 100 times as much.

*Explanation:*
Momentum conservation illustrated.
When a blank is fired from a pistol, although no bullet emerges, hot gases due to the firing do emerge. Compared with the momentum of the recoiling pistol, the momentum of these gases is

A. less.
B. the same.
C. more.
D. nonexistent.
When a blank is fired from a pistol, although no bullet emerges, hot gases due to the firing do emerge. Compared with the momentum of the recoiling pistol, the momentum of these gases is

A. less.
B. the same.
C. more.
D. nonexistent.

*Explanation:*

Momentum conservation illustrated. More than one person has been killed by gases from a closely held gun shooting blanks.
Which of the following equations best illustrates the usefulness of automobile air bags?

A. $F = ma.$
B. $Ft = \Delta mv.$
C. $KE = \frac{1}{2}mv^2.$
D. $Fd = \Delta \frac{1}{2}mv^2.$
Which of the following equations best illustrates the usefulness of automobile air bags?

A. \( F = ma \).

B. \( Ft = \Delta mv \).

C. \( KE = \frac{1}{2}mv^2 \).

D. \( Fd = \Delta \frac{1}{2}mv^2 \).

Comment:
Extend the time, decrease the force.
A piece of clay moving with one unit of momentum strikes and sticks to a heavy bowling ball initially at rest. After the clay sticks, both ideally move with a combined momentum of

A. less than one unit.
B. one unit.
C. more than one unit.
D. no momentum at all.
A piece of clay moving with one unit of momentum strikes and sticks to a heavy bowling ball initially at rest. After the clay sticks, both ideally move with a combined momentum of

A. less than one unit.
B. one unit.
C. more than one unit.
D. no momentum at all.

Explanation:
Momentum conservation illustrated.
Whereas impulse involves force and time, work involves force and

A. energy.
B. acceleration.
C. distance.
D. power.
Whereas impulse involves force and time, work involves force and

A. energy.
B. acceleration.
C. **distance**.
D. power.
Raising an auto on a service station rack requires work. Raising it twice as high requires

A. the same work, but twice the power.
B. twice the work.
C. twice the power.
D. All of the above.
Raising an auto on a service station rack requires work. Raising it twice as high requires

A. the same work, but twice the power.
B. twice the work.
C. twice the power.
D. All of the above.

Explanation:
Twice the distance for the same force = twice the work.
Raising an auto on a service station rack requires work. Raising a twice-as-heavy auto the same vertical distance requires

A. the same work, but twice the power.
B. twice the work.
C. twice the power.
D. All of the above.
Raising an auto on a service station rack requires work. Raising a twice-as-heavy auto the same vertical distance requires

A. the same work, but twice the power.
B. **twice the work.**
C. twice the power.
D. All of the above.

*Explanation:*
Twice the force for the same distance = twice the work.
If an object has momentum, it must also have

A. potential energy.
B. kinetic energy.
C. work.
D. All of the above.
If an object has momentum, it must also have

A. potential energy.
B. **kinetic energy**.
C. work.
D. All of the above.

*Explanation:*
Anything with speed has both momentum and kinetic energy.
If an object has kinetic energy, it must also have

A. potential energy.
B. momentum.
C. power.
D. impulse.
If an object has kinetic energy, it must also have

A. potential energy.
B. momentum.
C. power.
D. impulse.
A piece of clay moving with one unit of kinetic energy strikes and sticks to a heavy bowling ball initially at rest. After the clay sticks, both ideally move with a combined kinetic energy of

A. less than one unit.
B. one unit.
C. more than one unit.
D. no momentum at all.
A piece of clay moving with one unit of kinetic energy strikes and sticks to a heavy bowling ball initially at rest. After the clay sticks, both ideally move with a combined kinetic energy of

A. less than one unit.
B. one unit.
C. more than one unit.
D. no momentum at all.

Comment:
Distinguish between momentum and kinetic energy. Kinetic energy is not conserved in less than perfectly elastic collisions.
When you jump from an elevated position to the ground below, the kinetic energy you have when you meet the ground depends on

A. the jumping height.
B. the softness or hardness of the ground.
C. how much you bend your knees.
D. All of the above.
When you jump from an elevated position to the ground below, the kinetic energy you have when you meet the ground depends on

A. the jumping height.
B. the softness or hardness of the ground.
C. how much you bend your knees.
D. All of the above.

*Explanation:*
The only significant distance here, with the work–energy theorem, is that of the elevated position.
A 1-kg iron ball and a 10-kg iron ball are dropped from rest from the top of a one-story building. When hitting the ground below, compared with the 1-kg ball, the 10-kg ball has

A. less momentum and KE.
B. the same momentum and KE.
C. 10 times as much momentum and 10 times as much KE.
D. 10 times as much momentum and 100 times as much KE.
A 1-kg iron ball and a 10-kg iron ball are dropped from rest from the top of a one-story building. When hitting the ground below, compared with the 1-kg ball, the 10-kg ball has

A. less momentum and KE.
B. the same momentum and KE.
C. 10 times as much momentum and 10 times as much KE.
D. 10 times as much momentum and 100 times as much KE.

*Explanation:*
Both have equal speeds. Both momentum and KE are directly proportional to mass.
When a car is braked to a stop, unless it is a hybrid, its kinetic energy is transformed to

A. stopping energy.
B. potential energy.
C. energy of motion.
D. heat.
When a car is braked to a stop, unless it is a hybrid, its kinetic energy is transformed to

A. stopping energy.
B. potential energy.
C. energy of motion.
D. heat.
When a hybrid car brakes to a stop, much of its kinetic energy is transformed to

A. heat.
B. work.
C. electric potential energy.
D. gravitational potential energy.
When a hybrid car brakes to a stop, much of its kinetic energy is transformed to

A. heat.
B. work.
**C. electric potential energy.**
D. gravitational potential energy.

*Explanation:*
This is a major reason for the high efficiencies of hybrid vehicles.
A machine can multiply forces or

A. distances.
B. work.
C. energy.
D. All of the above.
A machine can multiply forces or

A. distances.
B. work.
C. energy.
D. All of the above.

Comment:
Multiplying work and energy is a conservation NO-NO!
A model airplane moves three times as fast as another identical model airplane. Compared with the kinetic energy of the slower airplane, the kinetic energy of the faster airplane is

A. the same for level flight.
B. twice as much.
C. four times as much.
D. more than four times as much.
A model airplane moves three times as fast as another identical model airplane. Compared with the kinetic energy of the slower airplane, the kinetic energy of the faster airplane is

A. the same for level flight.
B. twice as much.
C. four times as much.
D. more than four times as much.

*Explanation:*
The three-times-as-fast airplane has nine times as much kinetic energy.
A heavy object and a light object that are allowed to fall from the same height have equal

A. total energies.
B. momenta.
C. Both of the above.
D. None of the above.
A heavy object and a light object that are allowed to fall from the same height have equal

A. total energies.
B. momenta.
C. Both of the above.
D. None of the above.

Explanation:
They have equal accelerations and equal speeds, but not equal total energies or momenta.
A big fish swims upon and swallows a small fish at rest. After lunch, the momentum of the big fish is

A. the same as before.
B. less than before.
C. more than before.
D. transformed into internal energy.
A big fish swims upon and swallows a small fish at rest. After lunch, the momentum of the big fish is

A. the same as before.
B. less than before.
C. more than before.
D. transformed into internal energy.

Explanation:
Momentum conservation illustrated, as mass increases and speed decreases.
A moving freight car slams into another identical freight car at rest. The two cars stick together and move along the track. The speed of the coupled cars compared with the initial speed of the first car is

A. half.
B. one-quarter.
C. the same.
D. double.
A moving freight car slams into another identical freight car at rest. The two cars stick together and move along the track. The speed of the coupled cars compared with the initial speed of the first car is

A. half.
B. one-quarter.
C. the same.
D. double.

_Explanation:_
Momentum conservation illustrated. Question to ponder: How does the kinetic energy of the two-car system compare before and after collision?