GIVE FEEDBACK

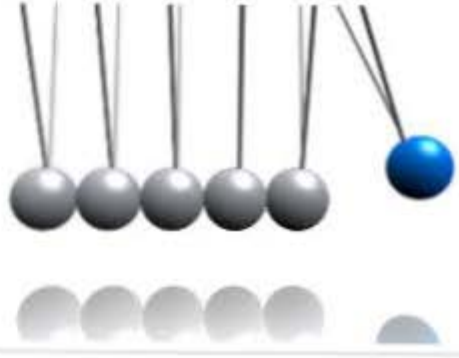
CONTINUE >

In this resource only the linear momentum will be considered. A similar concept, called angular momentum, may also be used in rotational dynamics where it is expressed in rotational terms.

Momentum is a concept used in mechanics for the solution of certain types of problems which are difficult to solve by the force-acceleration method or the work-energy method.

Problems that involve direct relations between force, mass, velocity and time are suitable for analysis using the impulse-momentum method.

The impulse-momentum method is based on the concept of linear momentum and the related physical quantity called impulse.



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In this resource we will limit our treatment of momentum to one dimension. In this way we can define the direction of the velocity as either negative or positive. This will simplify the calculations while you become familiar with the concepts.

Momentum

Momentum is sometimes described as the quantity of motion.

Linear momentum is the product of the mass of a body and its velocity at any given instant.

Since velocity is a vector quantity, momentum is also a vector quantity.

GIVE FEEDBACK

OK

Which of the following is the correct definition of linear momentum?

Click the correct answer.

- The product of the mass of a body and its velocity at any given instant
- The sum of the mass of a body and its velocity at any given instant
- The difference between the mass of a body and its velocity at any given instant
- The quotient of the mass of a body and its velocity at any given instant
- The product of the square of the mass of a body and its velocity at any given instant

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

Linear momentum is the product of the _____ of a body and its _____ at any given instant.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The formula for linear momentum

Momentum is the product of the mass of a body and its velocity at any given instant.

Equation

where:

p is the momentum

m is the mass of the body

v is the velocity of the body

GIVE FEEDBACK

OK

Type your answer in the box.

In the equation $p = m v$, the symbol p refers to the [ ], the symbol m refers to the [ ] of the body and the symbol v refers to the [ ] of the body.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match each of the symbols from the equation $p = m\,v$ with the correct description.

Drag statements on the right to match the left.

p	Momentum of the body
m	Mass of the body
v	Velocity of the body

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Symbols and SI unit used for momentum

Unlike energy, momentum is a vector quantity, i.e. it has a direction that corresponds to the direction of the velocity.

The SI unit of momentum is the kilogram metre per second, kg.m/s.

Credit: Sergey Kohl / Shutterstock.com

GIVE FEEDBACK

OK

Which of the following is the correct SI unit for linear momentum?

Click the correct answer.

- kgm/s
- kgm/s^2
- N
- N/kg
- J
- Jm/s

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

The SI unit of momentum is the _____.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Example

A rocket of mass 2.5 t is fired vertically upwards with a velocity of 250 m/s.

What is its momentum?

GIVE FEEDBACK

CONTINUE >

Solution

$$p = m \times v$$
$$= 2{,}500\,\text{kg} \times 250\,\text{m/s}$$
$$= 625{,}000\,\text{kg.m/s upwards}$$

Therefore the momentum is $625{,}000\,\text{kg m/s}$ upwards.

A 2 kg football is kicked vertically upwards with a velocity of 12 m/s. Calculate the momentum of the football. (Answer in kgm/s.)

+ − · ÷ $\frac{\square}{\square}$ $\square^2$ $\sqrt{\square}$ Clear

$(\square)$ ▼ ≤ ▼ π m ▼ $\overline{\square}$? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

A rocket of mass 1.5 t is fired vertically upwards with a velocity of 300 m/s. What is its momentum? (Answer in kgm/s.)

+ − · ÷ $\frac{\square}{\square}$ $\square^2$ $\sqrt{\square}$ Clear

$(\square)$ ▼ ≤ ▼ π m ▼ $\overline{\square}$? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

A 1,200 kg car is travelling north with a velocity of 108 km/h. Calculate the momentum of the football.

+ − · ÷ $\frac{\square}{\square}$ $\square^2$ $\sqrt{\square}$ Clear

$(\square)$ ▼ ≤ ▼ π m ▼ $\overline{\square}$? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

The principle of the conservation of linear momentum

According to Newton's first law of motion, the velocity of a body does not change unless an external force is applied to change the velocity.

This law implies conservation of momentum in the absence of an external force. That is, the total momentum before an event is equal to the total momentum after the event.

This principle enables us to solve certain types of problems directly, where the use of other methods is not convenient.

GIVE FEEDBACK

OK

The total momentum before an event is equal to the total momentum after the event. This is a statement of which principle?

Click the correct answer.

- Conservation of momentum
- Newton's second law
- Environmental conservation
- Newton's third law
- The law of diminishing returns
- Conservation of energy

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

Conservation of momentum requires that the total momentum _____ an event is equal to the total _____ after the event.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Example

A block of wood of mass 2 kg is freely suspended on a string.

A bullet of mass 75 g is fired horizontally into the block.

If the velocity of the bullet before impact is 415 m/s, calculate the velocity of the block, with the bullet embedded in it, immediately after the impact.

Solution

Momentum before impact:

$$\text{Bullet: } 0.075\ \text{kg} \times 415\ \text{m/s} = 31.13\ \text{kg m/s}$$
$$\text{Block} = 0$$
$$\therefore \text{Total before impact} = 31.13\ \text{kg m/s}$$

Momentum after impact:

Bullet and block: $(2 + 0.075)\,kg \times v = 2.075\,v$

Conservation of momentum requires that the momentum after impact be equal to the momentum before impact:

$$\therefore 2.075\,v = 31.13$$
$$v = 15\ \text{m/s}$$

Hence velocity immediately after impact is 15 m/s.

A block of wood of mass 3 kg is freely suspended on a string.

A bullet of mass 50 g is fired horizontally into the block.

The velocity of the bullet before impact is 400 m/s.

SMALL MEDIUM LARGE

Type your answer in the box.

The momentum of the block of wood before the impact is _____ kg.m/s.

The momentum of the bullet before the impact is _____ kg.m/s.

The total momentum of the system before the impact is _____ kg.m/s.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A block of wood of mass 3 kg is freely suspended on a string.

A bullet of mass 50 g is fired horizontally into the block.

The velocity of the bullet before impact is 400 m/s.

SMALL MEDIUM LARGE

Type your answer in the box.

The momentum of the block of wood and the embedded bullet after the impact is _____ kg times the velocity v m/s.

The total momentum of the system after the impact is _____ kg.m/s.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A block of wood of mass 3 kg is freely suspended on a string.

A bullet of mass 50 g is fired horizontally into the block.

The velocity of the bullet before impact is 400 m/s.

SMALL MEDIUM LARGE

Type your answer in the box.

Consideration of conservation of momentum gives the equation [ ] v = [ ].

Solving this equation gives the value of v = [ ] m/s, which is the velocity of the combined wood block and embedded bullet after the impact (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Impulse

The product of the force and the time during which it acts is called **impulse**.

Impulse is a vector quantity because it contains force which is a vector quantity.

GIVE FEEDBACK

OK

Which of the following is the correct definition of impulse?

Click the correct answer.

- The product of the force and the time during which it acts
- The force divided by the time during which it acts
- The quotient of the force and the square of the time during which it acts
- The product of the force and the square of the time during which it acts
- The sum of the force and the time during which it acts
- The difference between the force and the time during which it acts

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

The product of the force and the time during which it acts is called _____.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

According to Newton's second law of motion, force and acceleration are related by the formula $F = m\,a$. If a constant force F is applied during a time interval t, the acceleration produced by the force is:

$$a = \frac{v - v_0}{t}$$

and substitution yields:

$$F = m\left(\frac{v - v_0}{t}\right)$$

This can be rearranged as follows:

$$F\,t = m\,v - m\,v_0$$

The right-hand side of this equation can be recognised as the change of momentum from $m\,v_0$ to $m\,v$, where v_0 and v are the initial and final velocities respectively of the body on which force F is acting.

The left-hand side of this equation is defined as impulse (the product of the force and the time during which it acts).

Therefore the impulse is equal to the change in momentum.

Which of the following is the correct description of the relationship between impulse and momentum?

Click the correct answer.

- The impulse is equal to the difference between the initial momentum and the final momentum
- The impulse is equal to the final momentum
- The momentum is equal to the change in impulse
- The momentum is equal to the impulse squared
- The impulse is equal to the momentum squared

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following is the correct description of the relationship between impulse and momentum?

Click the correct answer.

- The impulse is equal to the change in momentum
- The impulse is equal to the initial momentum
- The impulse is equal to the final momentum
- The momentum is equal to the change in impulse
- The momentum is equal to the impulse squared

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The formula for impulse

Equation

where:

F is the applied force

t is the time during which the force acts

m is the mass of the body

v is the velocity of the body after application of the force

v_0 is the velocity of the body before application of the force

GIVE FEEDBACK

OK

Which of the following is the correct equation for impulse?

Click the correct answer.

$F t = m v - m v_0$

$F t = m a$

$F = t(m v - m v_0)$

$I = m v - m v_0$

$I = m(v + v_0)$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match each symbol from the equation $F\,t = m\,v - m\,v_0$ with the correct description.

Drag statements on the right to match the left.

F	The applied force
t	The time during which the force is applied
m	The mass of the body
v	The velocity of the body after the application of the force
v_0	The velocity of the body before the application of the force

Do you know the answer?

I KNOW IT | I THINK SO | UNSURE | NO IDEA

Impulse is calculated by multiplying force by time. Therefore the SI unit for impulse is obtained by multiplying the SI unit for force by the SI unit of time.

The SI unit used for impulse

The unit of impulse is the newton second, N.s.

GIVE FEEDBACK

OK

Which of the following is the correct SI unit for impulse?

Click the correct answer.

- N.s
- N/s
- N
- J
- J/s
- N.m

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

The unit of impulse is the [ ] [ ].

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Example

When a golf ball of mass 50 g is struck by a club, the ball and club are in contact for 0.001 s.

Immediately after impact, the ball travels at 45 m/s.

Determine the average force of the collision.

GIVE FEEDBACK

CONTINUE >

Solution

Momentum before impact:

$$m\,v_0 = 0$$

Momentum after impact:

$$\begin{aligned} m\,v &= 0.05\ \text{kg} \times 45\ \text{m/s} \\ &= 2.25\ \text{kg m/s} \end{aligned}$$

Substitute into $F\,t = m\,v - m\,v_0$:

$$\begin{aligned} F \times 0.001 &= 2.25 - 0 \\ \therefore F &= 2{,}250\ \text{N} \\ &= 2.25\ \text{kN} \end{aligned}$$

Therefore the average force of the collision is 2.25 kN.

When a stationary ball of mass 600 g is struck by a bat, the bat and ball are in contact for 0.001 s.

Immediately after impact, the ball travels at 38 m/s.

SMALL MEDIUM LARGE

Type your answer in the box.

The momentum of the ball before impact is _____ kg.m/s.

The momentum of the ball after impact is _____ kg.m/s.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

When a stationary ball of mass 600 g is struck by a bat, the bat and ball are in contact for 0.001 s.

Immediately after impact, the ball travels at 38 m/s.

SMALL MEDIUM LARGE

Type your answer in the box.

The force that acted on the ball was _____ kN.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

When a stationary golf ball of mass 45 g is struck by a club, the ball and club are in contact for 0.002 s.

Immediately after impact, the ball travels at 50 m/s.

SMALL | MEDIUM | LARGE

Type your answer in the box.

The momentum of the ball before impact is _____ kg.m/s.

The momentum of the ball after impact is _____ kg.m/s.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

When a stationary golf ball of mass 45 g is struck by a club, the ball and club are in contact for 0.002 s.

Immediately after impact, the ball travels at 50 m/s.

SMALL MEDIUM LARGE

Type your answer in the box.

The force that acted on the golf ball was _____ N.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Example

The exhaust gases from a rocket have a velocity of 1,200 m/s and flow at the rate of 5 kg/s.

Determine the thrust produced by the gases.

GIVE FEEDBACK

CONTINUE >

Solution

The exhaust jets accelerate the gases from rest to 1,200 m/s.

Initial momentum:

$$m\,v_0 = 0$$

Final momentum:

$$\begin{aligned} m\,v &= 5\,\text{kg} \times 1{,}200\,\text{m/s} \\ &= 6{,}000\,\text{kg m/s} \end{aligned}$$

Substitute into $F\,t = m\,v - m\,v_0$:

$$\begin{aligned} F \times 1\,s &= 6{,}000\ \text{kg m/s} - 0 \\ \therefore F &= 6{,}000\ \text{N} \\ &= 6\ \text{kN} \end{aligned}$$

Hence the thrust is 6 kN.

The exhaust gases from a rocket have a velocity of 1,000 m/s and flow at the rate of 4.5 kg/s.

SMALL | MEDIUM | LARGE

Type your answer in the box.

The initial momentum is _____ kg.m/s.

The final momentum is _____ kg.m/s.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The exhaust gases from a rocket have a velocity of 1,000 m/s and flow at the rate of 4.5 kg/s.

SMALL MEDIUM LARGE

Type your answer in the box.

The thrust produced by the gases is _____ kN.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Impact

An **impact** is a collision between two bodies that occurs in a very short interval of time and involves relatively large forces which the two bodies exert on each other.

We will only consider direct central impact, i.e. the kind of collision in which the two bodies move along the same straight line before and after the collision.

The conservation of momentum principle applies during impact, enabling us to write an equation relating total momentum before impact to total momentum after impact.

What does the following describe: a collision between two bodies that occurs in a very short interval of time and involves relatively large forces which the two bodies exert on each other?

Click the correct answer.

- An impact
- An impetus
- An impulse
- A reaction
- A reflection

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

An _____ is a collision between two bodies that occurs in a very short interval of time and involves relatively large forces which the two bodies exert on each other.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

This concept can be extended to cover a system with more than two bodies.

The conservation of momentum in the case of impact between two bodies

If we let m_A and m_B be the masses of bodies A and B, and v_{0A} and v_{0B} be their initial velocities, the total momentum before impact is given by:

$$m_A v_{0A} + m_B v_{0B}$$

Similarly, if v_A and v_B are the final velocities, the total momentum after impact is:

$$m_A v_A + m_B v_B$$

Conservation of momentum for the system means that the total initial momentum equals the total final momentum, therefore:

$$m_A v_{0A} + m_B v_{0B} = m_A v_A + m_B v_B$$

GIVE FEEDBACK

OK

Which of the following is the correct equation for the conservation of momentum applied to a system of two bodies?

Click the correct answer.

$m_A v_{0A} + m_B v_{0B} = m_A v_A + m_B v_B$

$m_A v_{0A} - m_B v_{0B} = m_A v_A + m_B v_B$

$m_A v_{0A} + m_B v_{0B} = m_A v_A - m_B v_B$

$\frac{m_A v_{0A}}{m_B v_{0B}} = \frac{m_A v_A}{m_B v_B}$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match each of the symbols from the equation $m_A v_{0A} + m_B v_{0B} = m_A v_A + m_B v_B$ with the correct description.

Drag statements on the right to match the left.

m_A	The mass of body A
m_B	The mass of body B
v_{0A}	The initial velocity of body A
v_{0B}	The initial velocity of body B
v_A	The final velocity of body A
v_B	The final velocity of body B

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

When considering the conservation of momentum, the solution of problems involving the impact between two bodies usually contains two final velocities which are not known. To solve these problems we must examine the effect of deformation and subsequent restitution of the colliding bodies during impact.

Other considerations for the solution of problems involving the impact between two bodies

The extent of restoration of the original shape immediately after collision depends on the elastic properties of the material.

If the bodies are completely elastic, they will rebound and return to their original shape, like billiard balls.

If the bodies are completely plastic, they will stay permanently deformed and travel together with the same velocity, like two lumps of putty, after collision.

GIVE FEEDBACK

OK

Type your answer in the box.

If the bodies are completely _____, they will rebound and return to their original shape, like billiard balls.

If the bodies are completely _____, they will stay permanently deformed and travel together with the same velocity, like two lumps of putty, after collision.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following statements about elastic and plastic collisions are correct?

Check all that apply.

- [ ] If the bodies are completely elastic, they will rebound and return to their original shape, like billiard balls
- [ ] If the bodies are completely plastic, they will stay permanently deformed and will travel together with the same velocity after collision
- [ ] If the bodies are completely plastic, they will rebound and return to their original shape, like billiard balls
- [ ] If the bodies are completely elastic, they will stay permanently deformed and will travel together with the same velocity after collision

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Coefficient of restitution

The measure of the ability of the bodies to regain their original shape is called the **coefficient of restitution**.

Mathematically, it is defined in terms of relative velocities before and after impact.

‹

Type your answer in the box.

The measure of the ability of the bodies to regain their original shape is called the _____ of _____.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following is the correct definition of the coefficient of restitution?

Click the correct answer.

- The measure of the ability of the bodies to regain their original shape
- The measure of a body's original shape
- The ratio of one body's shape to the shape of another body
- The difference between one body's shape and the shape of another body
- The relative location of one body compared to the location of another body

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The mathematical definition of the coefficient of restitution

Mathematically the coefficient of restitution is defined in terms of relative velocities before and after impact.

The equation defining the coefficient of restitution ε is:

$$\varepsilon(v_{0A} - v_{0B}) = (v_B - v_A)$$

GIVE FEEDBACK

OK

Match each of the symbols from the equation $\varepsilon(v_{0A} - v_{0B}) = (v_B - v_A)$ with the correct description.

Drag statements on the right to match the left.

ε	The coefficient of restitution
v_{0A}	The initial velocity of body A
v_{0B}	The initial velocity of body B
v_B	The final velocity of body B
v_A	The final velocity of body A

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following is the correct equation for calculation of the coefficient of restitution?

Click the correct answer.

$\varepsilon(v_{0A} - v_{0B}) = (v_B - v_A)$

$\varepsilon(v_{0A} + v_{0B}) = (v_B + v_A)$

$\varepsilon(v_{0A} + v_{0B}) = (v_B - v_A)$

$\varepsilon(v_{0A} - v_{0B}) = (v_B + v_A)$

$\varepsilon = (v_B - v_A) + (v_{0A} - v_{0B})$

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The numerical value of the coefficient of restitution in the case of a completely plastic collision

The value of the coefficient of restitution for a completely plastic impact is zero.

$$\varepsilon = 0$$

GIVE FEEDBACK

OK

Type your answer in the box.

The coefficient of restitution for a completely plastic collision is _____.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

What is the coefficient of restitution for a completely plastic collision?

Click the correct answer.

- 0
- 0.2
- 0.4
- 0.5
- 0.75
- 0.8
- 0.95
- 1.0

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The numerical value of the coefficient of restitution in the case of a completely elastic collision

The value of the coefficient of restitution for a completely elastic impact is 1.

$$\varepsilon = 1$$

For collisions between completely plastic and completely elastic materials, the value of ε is between zero and 1.

For example, for steel on lead, ε is about 0.12; for lead on lead, ε is 0.2; for glass on glass, ε is 0.93.

GIVE FEEDBACK

OK

Type your answer in the box.

The coefficient of restitution for a completely elastic collision is _____.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

What is the coefficient of restitution for a completely elastic collision?

Click the correct answer.

1.0

0.9

0.75

0.67

0.5

0.2

Do you know the answer?

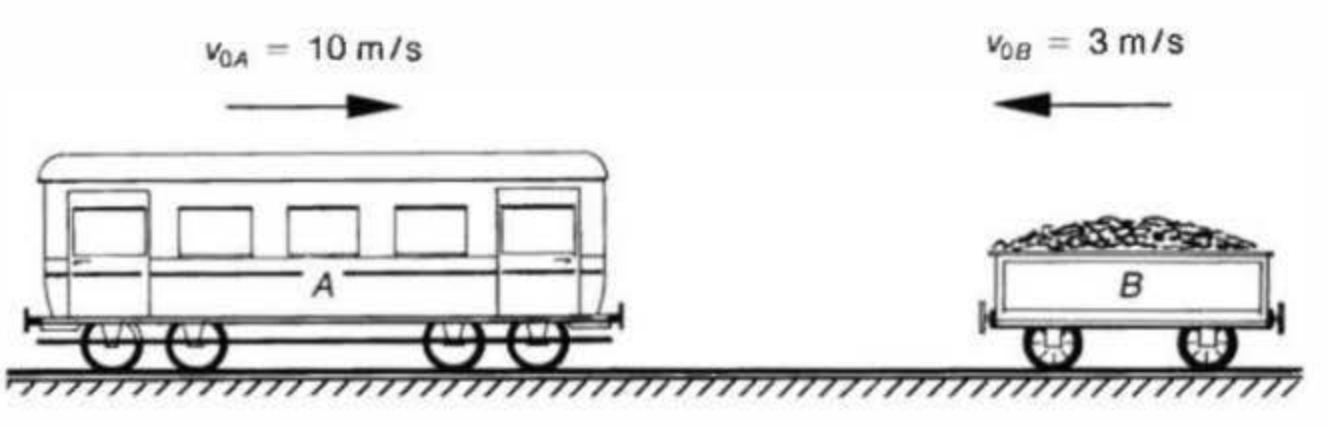
I KNOW IT | THINK SO | UNSURE | NO IDEA

Determine the initial and final velocities of two bodies in a direct central impact

A railway car of mass 18 t, moving at a speed of 10 m/s to the right, collides with another car of mass 12 t which is moving to the left at 3 m/s.

The coefficient of restitution is 0.6.

Determine the final velocities of the two cars.



Example	Given information	Solution	Conclusion

GIVE FEEDBACK

OK

Determine the initial and final velocities of two bodies in a direct central impact

The following information is given:

$$m_A = 18\,\mathrm{t} \qquad v_{0A} = 10\,\mathrm{m/s}$$
$$m_B = 12\,\mathrm{t} \qquad v_{0B} = -3\,\mathrm{m/s}$$
$$\varepsilon = 0.6$$

Since the velocities are vector quantities the sign convention of positive to the right and negative to the left will be used in the solution.

Substitution gives:

$$m_A v_{0A} + m_B v_{0B} = m_A v_A + m_B v_B$$
$$18 \times 10 - 12 \times 3 = 18 v_A + 12 v_B$$
$$144 = 18 v_A + 12 v_B \quad (1)$$

and

$$\varepsilon (v_{OA} - v_{OB}) = v_B - v_A$$
$$0.6 (10 + 3) = v_B - v_A$$
$$7.8 = v_B - v_A \quad (2)$$

Solving the two equations yields:

$$v_A = 1.68\ \text{m/s}$$
$$v_B = 9.48\ \text{m/s}$$

Both answers are positive, meaning that the two cars will move to the right after the collision, but with new velocities.

A railway car of mass 15 t, moving at a speed of 8 m/s to the right, collides with another car of mass 9 t which is moving to the left at 5 m/s.

The coefficient of restitution is 0.5.

SMALL | MEDIUM | LARGE

Type your answer in the box.

By substitution into the equation $m_A v_{0A} + m_B v_{0B} = m_A v_A + m_B v_B$, the following equation is obtained:

[ ] v_A + [ ] v_B = [ ] kg.m/s.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A railway car of mass 15 t, moving at a speed of 8 m/s to the right, collides with another car of mass 9 t which is moving to the left at 5 m/s.

The coefficient of restitution is 0.5.

SMALL | MEDIUM | LARGE

Type your answer in the box.

Using the coefficient of restitution equation gives the following equation $v_B - v_A =$ [ ].

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A railway car of mass 15 t, moving at a speed of 8 m/s to the right, collides with another car of mass 9 t which is moving to the left at 5 m/s.

The coefficient of restitution is 0.5.

SMALL MEDIUM LARGE

Type your answer in the box.

Solving these two equations gives v_A = [ ] m/s and v_B = [ ] m/s (correct to two decimal places).

Both answers are positive, meaning that the two cars will move to the right after the collision, but with new velocities.

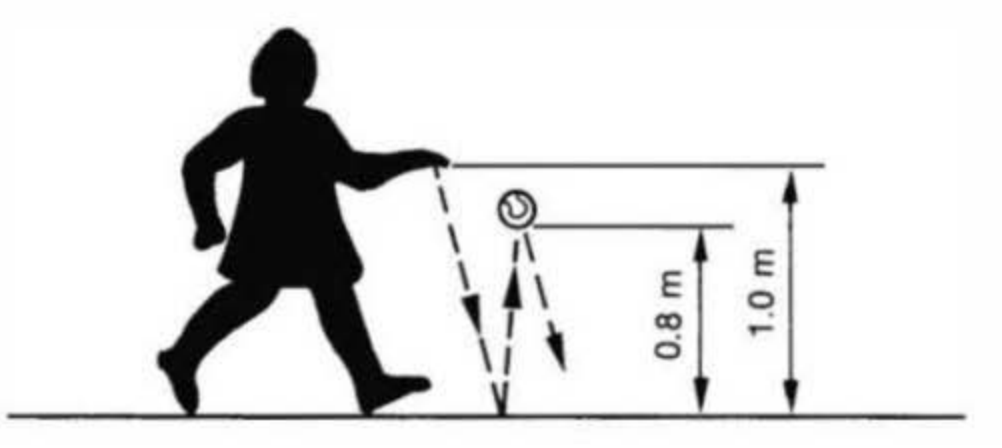
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Determine the coefficient of restitution of two bodies in a direct central impact

A tennis ball of mass 150 g is dropped from a height of 1 m and rebounds to a height of 0.8 m.

What is the coefficient of restitution between the ball and the ground during the impact?



Example	Before impact	After impact	Solution

GIVE FEEDBACK

OK

Kinetic energy before impact:

$$\begin{aligned} KE_1 &= PE_1 \\ &= m\,g\,h_1 \\ &= 0.15 \times 98.1 \times 1 \\ &= 1.47\ \text{J} \end{aligned}$$

Velocity before impact:

$$v_{OA} = 4.43\ \text{m/s (negative)}$$

Kinetic energy after impact:

$$\begin{aligned} KE_2 &= PE_2 \\ &= m\,g\,h_2 \\ &= 0.15 \times 9.81 \times 0.8 \\ &= 1.18\,\text{J} \end{aligned}$$

Velocity after impact:

$$V_A = 3.96\ \text{m/s (positive)}$$

Velocity of the ground:

$$v_B = v_{0B} = 0$$

Substitute in $\varepsilon(v_{OA} - v_{OB}) = (v_B - v_A)$:

$$\varepsilon(-4.43 - 0) = (0 - 3.96)$$
$$\therefore \varepsilon = 0.89$$

Example | Before impact | After impact | Solution

GIVE FEEDBACK

OK

A basketball of mass 0.5 kg is dropped from a height of 1.5 m and rebounds to a height of 1.3 m.

SMALL MEDIUM LARGE

Type your answer in the box.

The kinetic energy before impact is _____ J (correct to two decimal places).

Therefore the velocity before impact is _____ m/s (negative) (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A basketball of mass 0.5 kg is dropped from a height of 1.5 m and rebounds to a height of 1.3 m.

SMALL MEDIUM LARGE

Type your answer in the box.

The kinetic energy after impact is _____ J (correct to two decimal places).

Therefore the velocity after impact is _____ m/s (positive) (correct to two decimal places).

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A basketball of mass 0.5 kg is dropped from a height of 1.5 m and rebounds to a height of 1.3 m.

SMALL | MEDIUM | LARGE

Type your answer in the box.

The velocity of the ground $v_B = v_{0B} =$ [ ].

Substitution into $\varepsilon, v_{0A} - v_{0B} : = , v_B - v_A !$ gives $\varepsilon =$ [ ].

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA