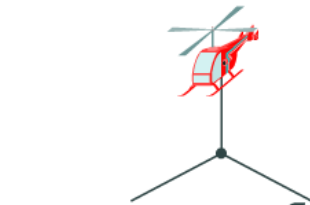


Conservation of Energy and Momentum



Work

Work is the end result of when force acts upon an object to cause a displacement of that object.

Work = Force (in the same direction) × Displacement (Displacement) = Force × Distance

Energy

Work done by a force is called a transfer of energy.

Work done by a force = Force × Distance = Energy transferred.

Work done by a force = Force × Distance = Energy transferred.

Work done by a force = Force × Distance = Energy transferred.

Problems

Many students find it difficult to solve problems involving conservation of energy and momentum. This is because they often do not understand the concepts of work, energy, and momentum. They often do not know how to apply the formulas correctly.

If you have any difficulties, you can contact me for help. I will be happy to help you with your problems.

When doing a problem, it is important to read the question carefully. You should identify the given information and what you are asked to find. You should then plan a strategy to solve the problem.

3 Different Equations

Elastic Collision: When two objects bounce off each other
 $m_1 v_{1i} + m_1 v_{1f} = m_1 v_{2i} + m_2 v_{2f}$

Inelastic Collision: When two objects stick together
 $(m_1 + m_2) v_f = m_1 v_{1i} + m_2 v_{2i}$

Explosion: When two objects repel each other
 $(m_1 + m_2) v_i = m_1 v_{1f} + m_2 v_{2f}$



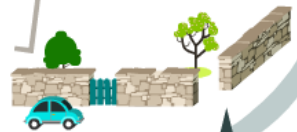
Momentum Continued

Impulse-Momentum Theorem
 $F \Delta t = p_f - p_i$
 the stiffer the amount of time, the greater the force.

Power

Power is the rate at which work is done or energy is transferred.

Power = Work / Time



Momentum

Momentum is the product of an object's mass and velocity.

Momentum = Mass × Velocity



Conservation of Energy and Momentum



Work

Work is the end result of when force acts upon an object to cause a displacement of that object.
 $W = F \times d$ (displacement)
 $W = M \times a \times d$ (displacement)
 $W = M \times v \times t$

Energy

Energy is the ability to do work.
 Kinetic Energy: Energy of motion.
 $E_k = \frac{1}{2}mv^2$
 Potential Energy: Energy stored in an object due to its position.
 Gravitational Potential Energy: Energy stored in an object due to its height.
 $E_p = mgh$
 Elastic Potential Energy: Energy stored in a stretched or compressed spring.
 $E_{pe} = \frac{1}{2}kx^2$
 Total Mechanical Energy: Sum of Kinetic and Potential Energy.
 $E_{me} = E_k + E_p$
 Energy is conserved in a closed system.

Problems

1. A 1000 kg car is moving at 20 m/s. It hits a wall and bounces back at 10 m/s. How much work was done on the car?
 2. A 500 kg object is lifted 10 m. How much work was done on the object?
 3. A 1000 kg car is moving at 20 m/s. It hits a wall and stops. How much work was done on the car?
 4. A 1000 kg car is moving at 20 m/s. It hits a wall and bounces back at 10 m/s. How much work was done on the car?

3 Different Equations

Elastic Collision: When two objects bounce off each other
 $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$

Inelastic Collision: When two objects stick together
 $(m_1 + m_2) v_f = m_1 v_{1i} + m_2 v_{2i}$

Explosion: When two objects repel each other
 $(m_1 + m_2) v_i = m_1 v_{1f} + m_2 v_{2f}$



Momentum Continued

Impulse-Momentum Theorem
 $F \Delta t = p_f - p_i$
 The smaller the amount of time, the greater the force.



Power

Power is the rate at which work is done.
 $P = \frac{W}{t}$
 $P = \frac{F \times d}{t}$
 $P = F \times v$



Momentum

Momentum is the product of an object's mass and velocity.
 $p = m \times v$
 Impulse is the change in momentum.
 $J = \Delta p = m \times \Delta v$
 The impulse-momentum theorem states that the impulse applied to an object is equal to the change in its momentum.





Work

Work is the end result of when force acts upon an object to cause a displacement of the object

Work= Force(Displacement)

$W = \text{Mass} \times \text{Acceleration} (\text{Displacement})$

$\text{Nm} = \text{N} (\text{m})$

Energy

Kinetic Energy: When an object is in motion

$$KE = \frac{1}{2} (m) v^2$$

Gravitational Potential Energy: When an object is at a stand still

$$gPE = m (g) h$$

Mechanical Energy: The sum of Kinetic and Potential Energy

$$ME = gPE + KE$$

Elastic Potential Energy: Stored in springs, trampolines and bungee cords

$$ePE = \frac{1}{2} (k) d^2$$

Energy is measured in Joules (J).

Power

Definition: The time rate at which work is done or energy is transferred

Power= Work/time

$P = W/t$

Watts (w)= Nm/sec (s)

Momentum

Definition: The speed of an object

Momentum= Mass (Velocity)

$$p=m(v)$$

$$\text{kgm/s} = \text{g(m/s)}$$

If Velocity = 0 then Momentum = 0

Momentum can be negative

Momentum is conserved (Can't create or destroy it, only change it)

Momentum

Continued

Impulse-Momentum Theorem

$$F \Delta t = p_f - p_i$$

the smaller the amount of time, the greater the force



3 Different Equations

Elastic Collision: When two objects bounce off each other

$$m_1 v_{1i} + M_1 V_{2i} = m_1 v_{2f} + M_{2f} V_{2f}$$

Inelastic Collision: When two objects stick together

$$M_1 V_{1i} + M_2 V_{2i} = (M_1 + M_2) v_f$$

Explosion: When two objects repel each other

$$(m_1 + m_2)v_i = M_1 V_{1f} + M_2 V_{2f}$$



Problems

Missy Diwater, the former platform diver for the Ringling Brother's Circus, had a kinetic energy of 12,000 J just prior to hitting the bucket of water. If Missy's mass is 40 kg, then what is her speed?

If this rhino were elastically ramming a non-moving rhino with mass of 4000kg what would its final velocity be? (assume same velocity as #1. rhino #2 has final velocity of 4 m/s)

When doing a chin-up, a physics student lifts her 42.0 kg body a distance of 0.25 meters in 2 seconds. What is the power delivered by the student's biceps?

Conservation of Energy and Momentum



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 $W = M \times a \times d$ (displacement)
 $W = F \times d$

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 Kinetic Energy: Energy of motion
 $E_k = \frac{1}{2}mv^2$
 Potential Energy: Energy stored in an object due to its position or configuration.
 Gravitational Potential Energy: Energy stored in an object due to its height above the ground.
 $E_p = mgh$
 Elastic Potential Energy: Energy stored in a stretched or compressed spring.
 $E_e = \frac{1}{2}kx^2$
 Total Mechanical Energy: Sum of kinetic and potential energy.
 $E_{total} = E_k + E_p$
 Conservation of Energy: Energy cannot be created or destroyed, only transformed from one form to another.

Problems

1. A 1000 kg car is moving at 20 m/s. It brakes to a stop over a distance of 50 m. How much work is done by the brakes?
 2. A 500 kg object is lifted 10 m. How much work is done by the lifting force?
 3. A 2 kg object is moving at 10 m/s. It collides with a 3 kg object at rest. After the collision, the 2 kg object is moving at 4 m/s. What is the velocity of the 3 kg object?
 4. A 1000 kg car is moving at 20 m/s. It collides with a 1500 kg car at rest. After the collision, the 1000 kg car is moving at 10 m/s. What is the velocity of the 1500 kg car?
 5. A 1000 kg car is moving at 20 m/s. It collides with a 1500 kg car at rest. After the collision, the 1000 kg car is moving at 10 m/s and the 1500 kg car is moving at 10 m/s. What is the coefficient of restitution?

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Momentum Continued

Impulse-Momentum Theorem
 $F \Delta t = p_f - p_i$
 The smaller the amount of time, the greater the force.



Power

Power is the rate at which work is done or energy is transferred.
 $P = \frac{W}{t}$
 $P = \frac{F \cdot d}{t}$
 $P = F \cdot v$



Momentum

Momentum is the product of an object's mass and velocity.
 $p = m \cdot v$
 Conservation of Momentum: The total momentum of a closed system remains constant.
 $p_{total} = p_1 + p_2 + \dots + p_n$
 Elastic Collision: $p_{total} = p_{total}$
 Inelastic Collision: $p_{total} = p_{total}$
 Explosion: $p_{total} = p_{total}$

