AP PHYSICS 1 BIG IDEAS

Momentum and Impulse

A phrase that helps connect with momentum is, “Inertia in Motion”.

An equation to calculate or quantify momentum, p, is, “mass times velocity”.

Units of momentum are kg·m/s.

A change in momentum, Δp, can be calculated by, “mass · Δ velocity”

Impulse, J, causes a change in momentum. Impulse can be calculated by, “force · time”.

An impulse of 20 N·s causes a change in momentum of 20 kg·m/s.

J = f·t Knowing the impulse or the change in momentum and time of impact, you can solve to find the average force of impact.

When an object bounces, it has a greater impulse than if it just hit and stopped. This is because momentum is a vector quantity, and when it goes the opposite direction, it has negative momentum.

The area under the force vs. time graph gives you the impulse.

Conservation of Momentum (Collisions and Explosions)

Total Momentum before a collision (or explosion) is equal to the Total Momentum after the collision (or explosion).

In inelastic collisions, the two objects stick together. $m_1 \cdot v_1 + m_2 \cdot v_2 = (m_1 + m_2) \cdot v$.

In inelastic collisions, momentum is conserved, but energy is not. This is because it takes work to hold the two objects together when they want to fly apart.

Holding an object stationary, then throwing it, is the reverse of an inelastic collision. So is an explosion.

In elastic collisions, the two objects bounce off of each other. $m_1 \cdot v_1 + m_2 \cdot v_2 = m_1 \cdot v_1 + m_2 \cdot v_2$.

If two objects have the same mass and collide elastically in one-dimension, they simply switch velocities.

If two objects have the different masses and collide elastically in one-dimension, then there are two velocities to find after the collision, so two equations are needed to solve simultaneously. The second equation comes from conservation of energy (kinetic). $\frac{1}{2} \cdot m_1 \cdot v_1^2 + \frac{1}{2} \cdot m_2 \cdot v_2^2 = \frac{1}{2} \cdot m_1 \cdot v_1^2 + \frac{1}{2} \cdot m_2 \cdot v_2^2$.

The reason “Newton’s Cradle” has 1 ball and in 1 ball out, or 2 balls in and 2 balls out, and NOT 2 balls in and 1 ball out at *half* the velocity is that both momentum and energy must be conserved.

Collisions in two-dimensions can be treated as vectors. Either add vectors head to tail, or find components of x and y and see if total momentum in x before equals total momentum in x after. Do same for y.

Momentum is a vector quantity, but energy is NOT. 3 kg·m/s North plus 4 kg·m/s East equals 5 kg·m/s NE. BUT, an object moving North with Kinetic Energy of 3 Joules plus another object moving East with Kinetic energy of 4 Joules equals a total energy of 7 Joules.

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