

AP Physics

IMPULSE AND MOMENTUM

I. Momentum

- Momentum is a vector quantity that all masses possess.
- Closely related to inertia; quantifies inertia.
- The momentum of an object is directly proportional to its mass and velocity.
- The direction of momentum is the same as the velocity

▫ $p = mv$

$p =$ momentum

units: $\text{kg}\bullet\text{m/s}$

II. Changes in Momentum

- Changes in momentum are due to unbalanced, outside forces acting on an object over a given time interval.
- Forces create accelerations and changes in velocity.
- Speed may remain constant, but a change in direction gives a change in velocity and momentum.

III. Impulse

- Impulse is the product of force acting on an object over a time interval ($F\Delta t$).
- Impulse may oppose the motion or be in the same direction as the motion. (must identify direction of motion and maintain consistency)
- The direction of the impulse will match the direction of the net force acting on the object.

IV. Impulse-Momentum Theorem

- The impulse acting on an object is equal to the object's change in momentum.
 - $\Delta p = F\Delta t$
 - More than likely you will not know the change in momentum, but you will know the velocities so

- You will make the following substitution:

- $mv_f - mv_o = F\Delta t$

- You must keep track of direction with the force and velocities. Positive and negative values must be assigned correctly.

Applying Newton's 3rd Law

- In a closed system, the objects that interact exert and equal but opposite force on one another.
- They are also in contact for the same amount of time, so their impulses and changes in momentum are equal.

- If there are external forces acting on an object, then impulse and changes in momentum may differ.
 - Ex: A person hits a ball with a bat. The ball-bat interaction has a net external force acting on it from the person. The ball's momentum will change more than the bat's since the net external force is present.

V. Graphs of momentum and impulse