Momentum

Objective:

Define & calculate momentum.

Explain the relationship between momentum & impulse.

Use the impulse equation to solve for the missing variable.

Momentum

The product of mass and velocity of an object.

- inertia in motion
- vector quantity

$p = mv$

Units: kg·m/s

MOMENTUM

A bus can have a **large momentum** even if it is moving very slowly, because it has a **large mass.**

(**mass**)(velocity) = **momentum**

A bullet can have a **large momentum** even if it has a small mass, because it is moving at **high velocity**.

velocity

(mass)(**velocity**) = **momentum**

MOMENTUM

If an object is **at rest**, it has **no momentum** - no matter how large its mass. Momentum is not the same as inertia.

momentum = (**mass**)(0) = 0

Momentum Questions

1. Determine the momentum of a ...

a.) 60 kg halfback moving eastward at 9 m/s.

p = 540 kg*m/s, east

b.) 1000 kg car moving northward at 20 m/s.

p = 20,000 kg*m/s, north

c.) 40 kg man moving southward at 2 m/s.

p = 80 kg*m/s, south

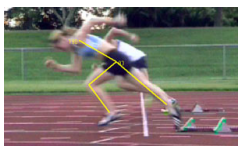
Ways to Change Momentum?

Change in mass

Or

$\Delta p = m \cdot \Delta v$

Change in velocity



Change Momentum Problem

m = 1 kg

v_1 = 0 m/s v_2 = 4 m/s

$\Delta p = m \Delta v$

$4\,kg \cdot \frac{m}{s} = 1\,kg \cdot 4\,\frac{m}{s}$

$\Delta vel = v_f - v_i$

What causes the change in momentum?

$F = ma$

$F = m\frac{\Delta v}{t}$

$F \cdot t = m \Delta v$

$\Delta p = m \Delta v$

Change in momentum = Impulse (J)

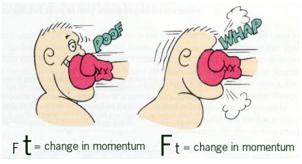
$\Delta p = m \cdot \Delta v$	$\Delta p = F \cdot t$
Units: kg·m/s	Units: N·s

Impulse

Forces applied over time periods create impulses.

Impulse = $F\Delta t = m\Delta v = \Delta p$

(J)



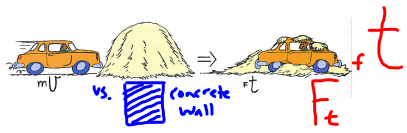
Roll with punches!

Impulse

Forces applied over time periods create impulses.

Impulse = $F\Delta t = m\Delta v = \Delta p$

(J)



Impulse Problems

If the halfback experienced a force of 800N for 0.9 seconds to the north, determine the impulse.

J = ? $J = F \cdot t$

720 N·s = 800N · 0.9s

Impulse Problems

A 0.10 kg model rocket's engine is designed to deliver an impulse of 6.0 N·s. If the rocket engine burns for 0.75 seconds, what is the average force that the engine produces.

F = ? $J = F \cdot t$

6 N·s = (F) · .75 s

F = 8 N

Impulse Problems

A bullet traveling at 500 m/s is brought to rest by an impulse of 50 N·s. What is the mass of the bullet?

$m = ?$ $J = m\Delta v$

$50\ N\cdot s = m \cdot 500\ m/s$

$m = .1\ kg$

Impulse Problems

F = 400 N for t = .01 sec

m = .05 kg

v = ?

$\Delta p = F \cdot t$

$4\ N\cdot s = 400N \cdot .01\ s$

$\Delta p = m(\Delta v)$

$4\ N\cdot s = .05\ kg \cdot (\Delta v)$

$v = 80\ m/s$

↑vel – ↑force or ↑time

follow through!

Impulse Problems

v_1 = 40 m/s t = .02 sec

m = .1 kg F = ?

$\Delta p = m\Delta v$

$4\ kg\cdot\frac{m}{s} = .1\ kg \cdot 40\ \frac{m}{s}$

$\Delta p = (F)\cdot t$

$4\ kg\cdot\frac{m}{s} = (F)\cdot .02\ s$

$F = 200N$

to decrease force,

$J = \downarrow F, \uparrow t$

Assignments . . .

- Begin Ch 6 Homework # 1 - 5