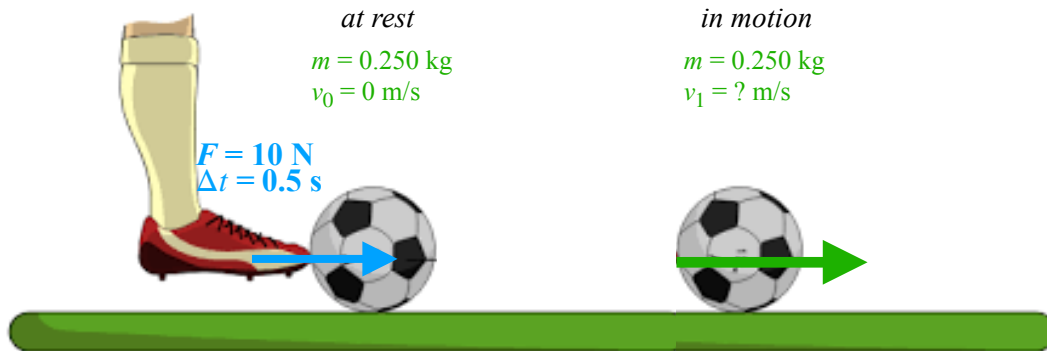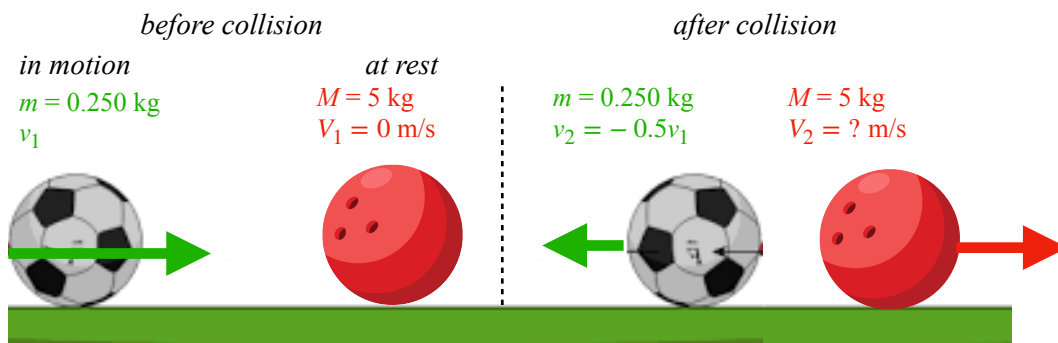# Ch. 6 HW Momentum

Show **ALL WORK**. You may be randomly selected to solve one of the problems next class which will count towards 20% of your final grade.

1) **(20 pts)** A soccer ball of mass $m = 0.250$ kg initially at *rest* gets kicked with a force of $F = 10$ N for a brief period of time, $\Delta t = 0.5$ sec.

at rest
$m = 0.250$ kg
$v_0 = 0$ m/s

$F = 10$ N
$\Delta t = 0.5$ s

in motion
$m = 0.250$ kg
$v_1 = ?$ m/s

a) **(5 pts)** calculate the *impulse* of the kick to get the ball from *rest* into *motion*

b) **(5 pts)** calculate the final speed v_1 of the ball *in motion*

c) **(10 pts)** the soccer ball *in motion* with the speed (v_1) determined in the previous part *collides* with a 5-kg bowling ball at *rest* and after the collision the soccer ball bounces back with half as much speed (choose $+x$ to the right), calculate the final speed (V_2) of the bowling ball as it moves forward

before collision

in motion
$m = 0.250$ kg
v_1

at rest
$M = 5$ kg
$V_1 = 0$ m/s

after collision

$m = 0.250$ kg
$v_2 = -0.5v_1$

$M = 5$ kg
$V_2 = ?$ m/s

2) **(5 pts)** A boxer gets punched in two different scenarios:
  i) he moves backwards, maximizing the time of impact to $\Delta t = 2$ sec.
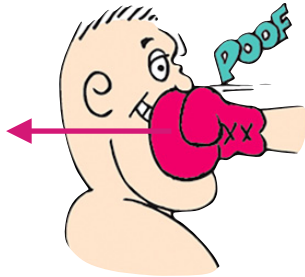 ii) he leans forward, minimizing the time of impact to $\Delta t = 0.5$ sec.
  In both cases, the *change in momentum* of the punch is 20 kg·m/s at the
  moment of impact. Calculate the *force* of impact of the punch for each case.
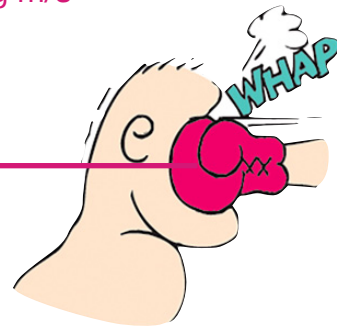
i)

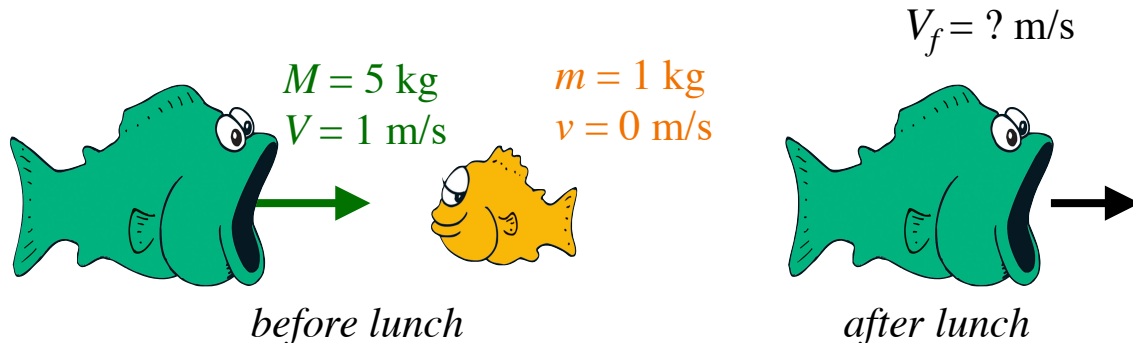$\Delta(mv) = 20$ kg·m/s
$\Delta t = 2$ s

$F_1 = ?$

ii)

$\Delta(mv) = 20$·kg m/s
$\Delta t = 0.5$ s

$F_2 = ?$

3) **(5 pts)** A fish swims towards and swallows a smaller fish *at rest*. If the larger fish has a mass of $M = 5$ kg and swims at $V = 1$ m/s toward the smaller 1-kg fish, what is the speed of the larger fish *immediately after lunch*?

$V_f = ?$ m/s

$M = 5$ kg
$V = 1$ m/s

$m = 1$ kg
$v = 0$ m/s

before lunch

after lunch

4) **(20 pts)** A vehicle of mass $m = 2000$ kg moving at a speed of $v = 5$ m/s collides with a wall for a brief period of time $\Delta t = 1$ s before coming to a halt
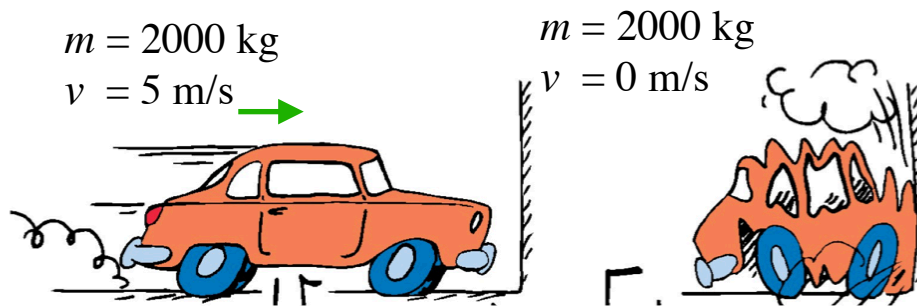
$m = 2000$ kg
$v = 5$ m/s

$m = 2000$ kg
$v = 0$ m/s

a) **(5 pts)** calculate the *change in momentum* of the vehicle

b) **(5 pts)** calculate the *force* of impact during the collision

c) **(10 pts)** if an incoming truck of mass $M = 10{,}000$ kg moving at speed $V = 10$ m/s collides with the *stationary* car and both continue to move together, calculate the final speed of the (*car+truck*) system

$M = 10{,}000$ kg
$V = 10$ m/s

$m = 2000$ kg
$v = 0$ m/s

$V_f = ?$

before collision

after collision
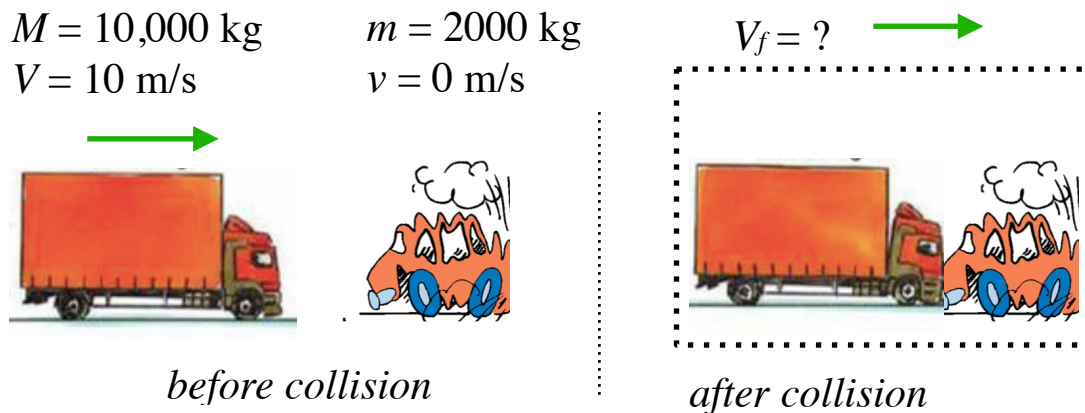
5) **(20 pts)** A vehicle of mass m = 2000 kg moving at a speed of v = 5 m/s collides with a haystack for a period of time t = 20 s before coming to a halt
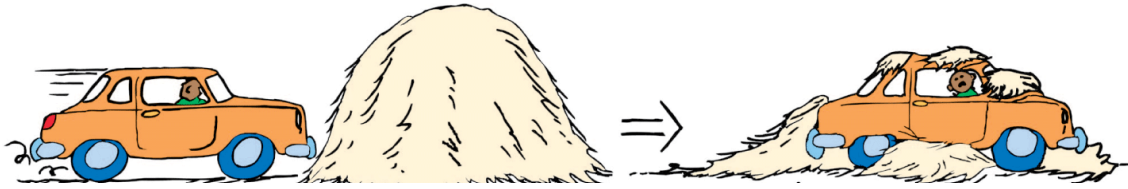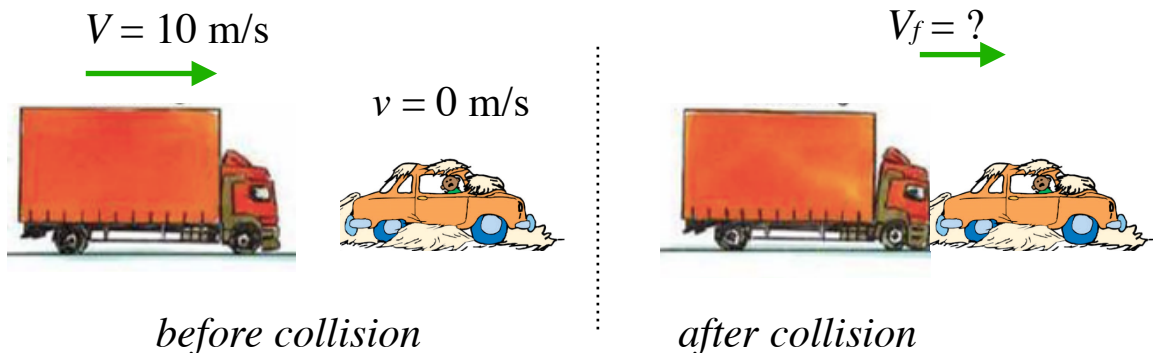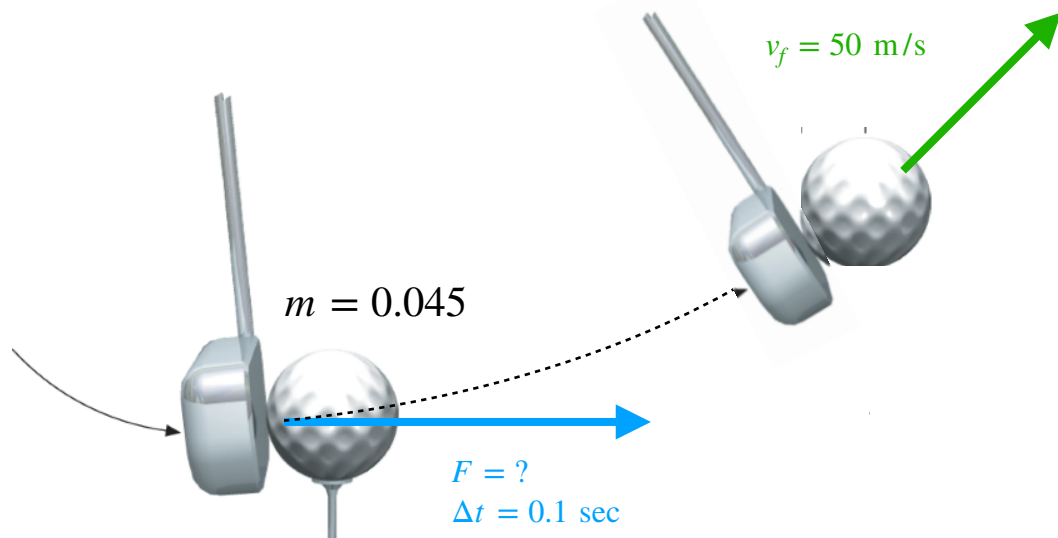

a) **(5 pts)** calculate the *change in momentum* of the vehicle

b) **(5 pts)** calculate the *force* of impact during the collision

c) **(10 pts)** if an incoming truck of mass M = 10,000 kg moving at speed V = 10 m/s collides with the *stationary* car and both continue to move together, find the final speed of the (car+truck) system

V = 10 m/s

v = 0 m/s

V_f = ?

before collision   *after collision*

6) **(10 pts)** A golf ball of mass $m = 0.05$ kg initially at *rest* gets hit with a force of F for a brief period of time, $\Delta t = 0.1$ sec, and causes the golf ball to gain a speed of 50 m/s.

$v_f = 50$ m/s

$m = 0.045$

$F = ?$
$\Delta t = 0.1$ sec

a) **(5 pts)** Calculate the *change in momentum* of the golf ball

b) **(5 pts)** Calculate what the *force of impact* applied to the golf ball

7) **(20 pts)** Jake pushes crates starting from *rest* across his classroom floor for 3 seconds with a net force as shown. For each crate (A, B and C), calculate the following and rank the following from greatest to least
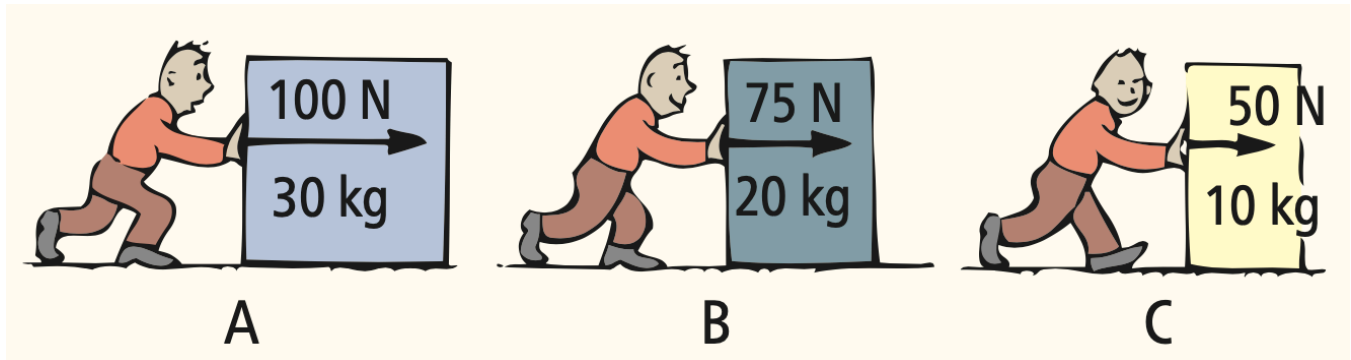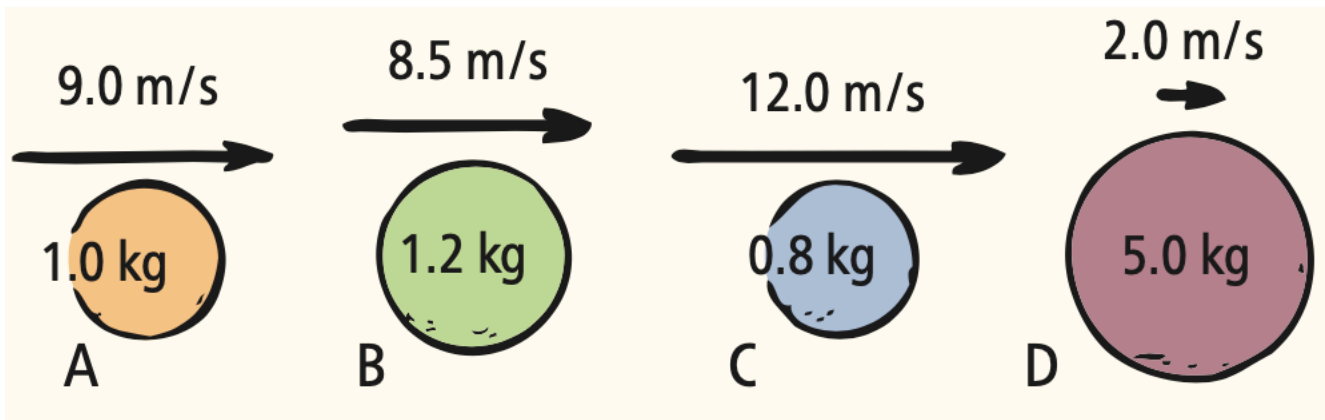

(a) **(5 pts)** *Impulse* delivered

(b) **(5 pts)** *change* in momentum

(c) **(5 pts)** Final speed

(d) **(5 pts)** Momentum in 3 seconds

8) **(10 pts)** Each ball has different masses and speeds. Calculate the following and rank them from greatest to least.

9.0 m/s   8.5 m/s   12.0 m/s   2.0 m/s

1.0 kg   1.2 kg   0.8 kg   5.0 kg

A   B   C   D

(a) **(5 pts)** Momentum

(b) **(5 pts)** The impulses needed to *stop* the balls (*Hint*: think of change in speed)