Impulse - Momentum Class

Notes and Homework

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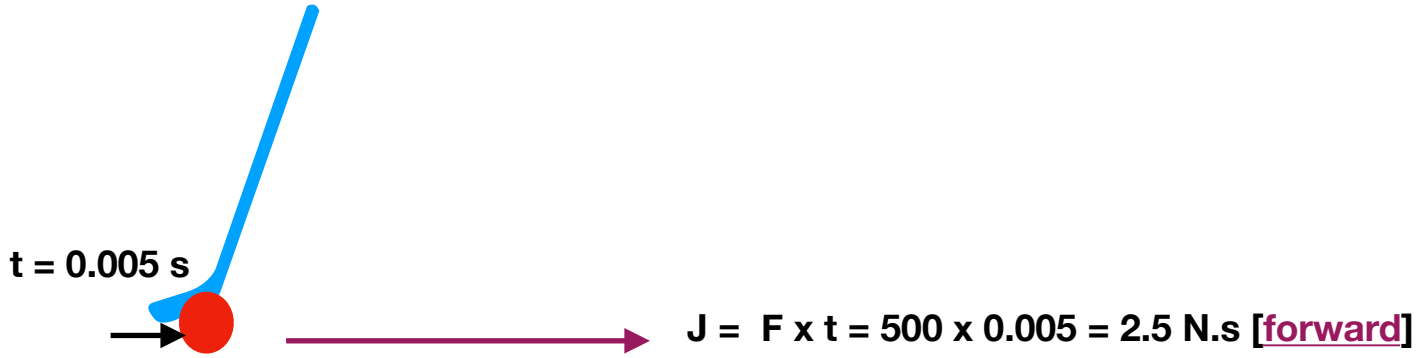
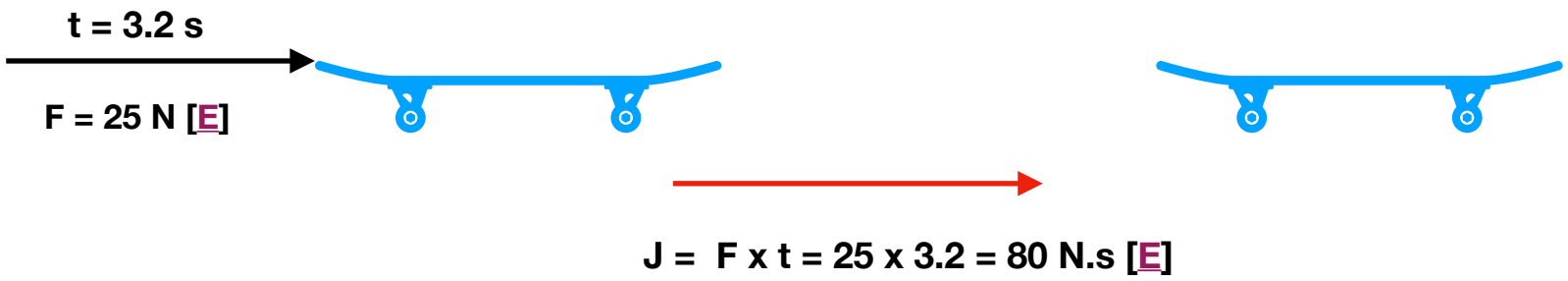
Example 1:

What is the impulse given to a golf ball by a club if they are in contact for 0.005 second, during which time the club exerted an average force of 500 N on the ball?



Homework 1, a), b) , c)

Impulse the force have the same direction: Force for a very short period of time.



J = F x t = 25 x 3.2 = 80 N.s [E]

a) What is the impulse (J) exerted by a force of 25 N[E] on a dynamic cart for 3.2 s?

$F = 25\ N\ [E]$

$\Delta t = 3.2\ s$

$$\text{impulse} = J = F \times \Delta t$$

$$J = F \times \Delta t$$

$$= 25 \times 3.2$$

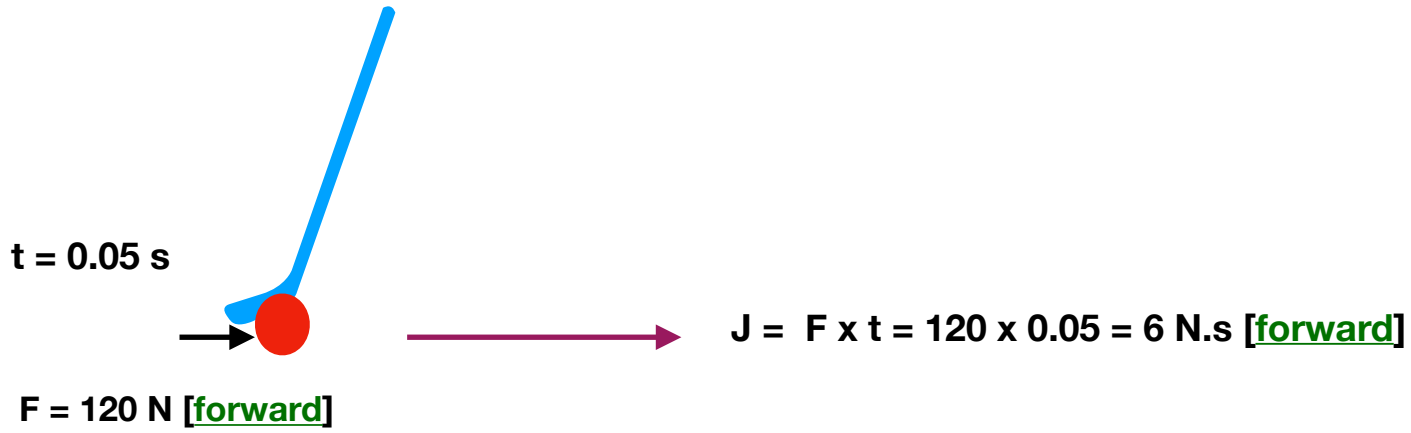
$$= 80\ N.S\ [E]$$

b) What is the impulse exerted when a hockey stick exerting a force of 120 N on a puck during the 0.05 s they are in contact?

$F = 120$ N

$\Delta t = 0.05$ s

$$J = F \times \Delta t$$
$$= 120 \times 0.05$$
$$= 6 \text{ N.s [Forward]}$$



c) What is the impulse exerted when the Earth is pulling down

(g = 9.8 m/s^2) on a 12 kg rock during 3.0 s it takes to fall from a cliff?

m = 12 kg

The Earth is pulling the rock with a gravitational force (F_g):

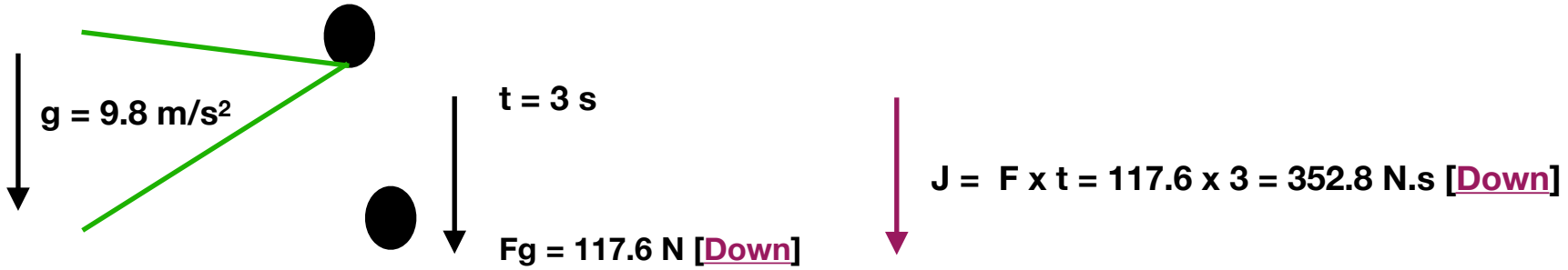
$F_g = W = m \times g = 12 \times 9.8 = 117.6$ N

$\Delta t = 3.0$ S

$$J = F \times \Delta t$$

$$= 117.6 \times 3$$

$$= 352.8 \text{ N.S [down]}$$



Objects (m) in motion (V) have momentum (p)

$$p = m \times V$$

Impulse (J) is a force (F) during a short period of time (t)

$$J = F \times t$$

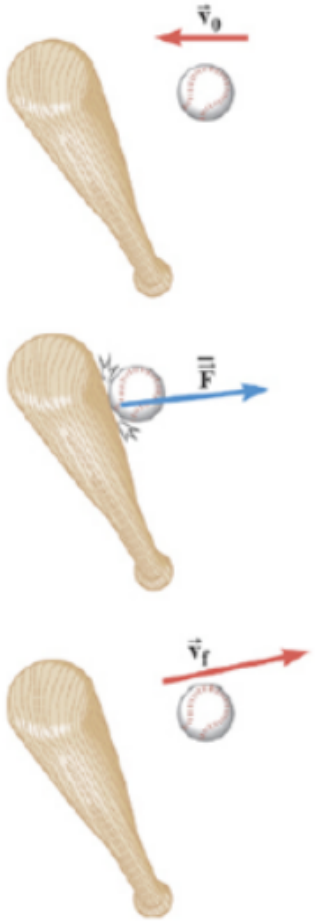
Impulse related to momentum (Impulse - Momentum Theorem)

(F x t) related to (m x V)

Before collision: Ball (m) has a initial velocity (Vo);
Initial Momentum p = (**m x Vo**) **(1)**

During collision: Force for a short period of time
Impulse J = (**F x Δt**) **(2)**

After collision: Ball (m) has a final velocity (Vf);
Final Momentum p = (**m x Vf**) **(3)**



+ direction

1 + 2 = 3

$(m \times V_o) + (F \times t) = (m \times V_f)$

$(F \times t) = (m \times V_f) - (m \times V_o)$

Impulse = Final momentum - Initial momentum

Data Table				
F	v_f	v_o	m	Δt
?	58 m/s	-38 m/s	0.14 kg	1.6×10^{-3} s

$(F \times \Delta t) = (m \times V_f) - (m \times V_o)$

$F \times 0.0016 = (0.14 \times 58) - (0.14 \times -38)$

$F \times 0.0016 = (8.12) - (-5.32)$

$$F \times 0.0016 = 8.12 + 5.32$$

$$F \times 0.0016 = 13.44$$

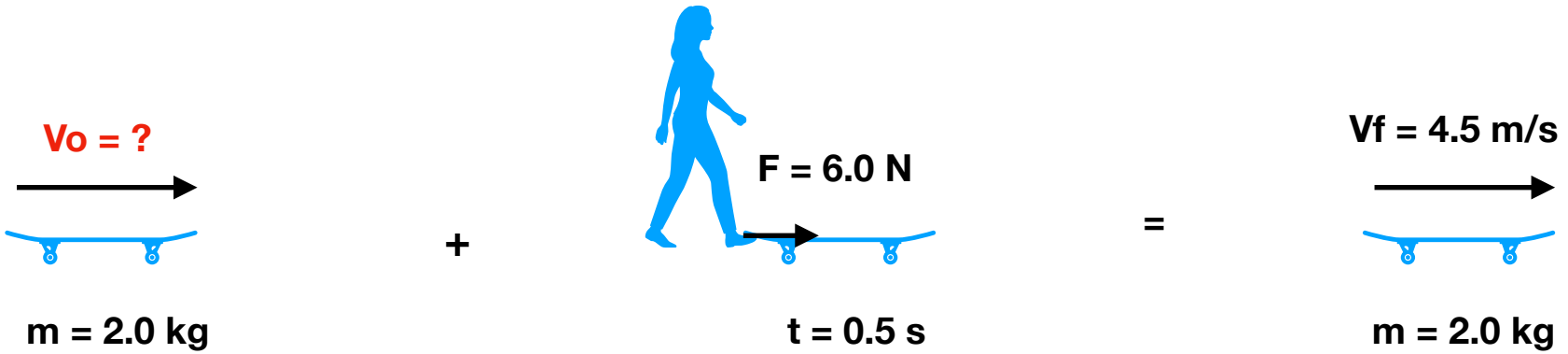
$$F \times \frac{0.0016}{0.0016} = \frac{13.44}{0.0016}$$

$$F = \frac{13.44}{0.0016}$$

$$F = 8400 \text{ N}$$

Homework (3)

A 2.0 kg skateboard is rolling across a smooth flat floor, when a small girl kicks it, causing it to speed up to 4.5 m/s in 0.50 s without changing direction. If the average force exerted by the girl on the skateboard in its direction of motion was 6.0 N, with what initial velocity was it moving?



momentum		Impulse		momentum
(m x Vo)	+	(F x t)	=	(m x Vf)

$$(2.0 \times Vo) + (6 \times 0.5) = (4.5 \times 2)$$

$$(2.0 \times Vo) + 3 = 9$$

$$(2.0 \times Vo) + 3 - 3 = 9 - 3$$

$$(2.0 \times Vo) + 0 = 6$$

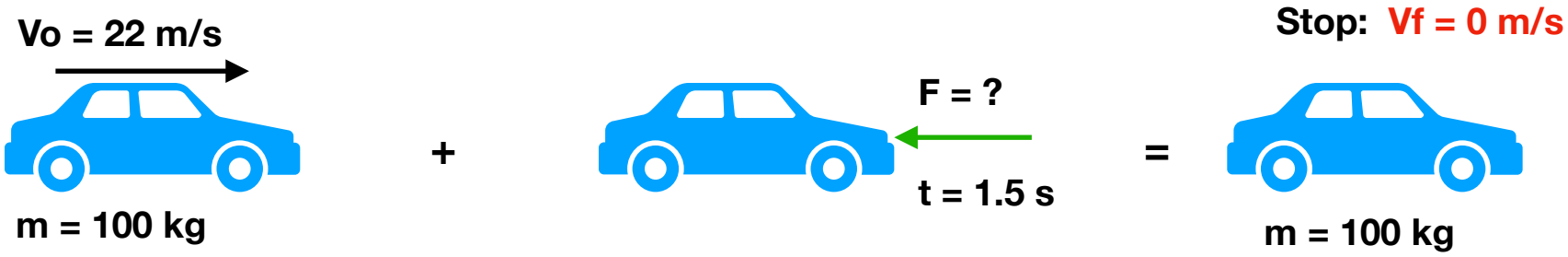
$$2.0 \times Vo = 6$$

$$\frac{2.0 \times Vo}{2.0} = \frac{6}{2.0}$$

$$Vo = 3 \text{ m/s [forward]}$$

Homework (4)

What average force will stop a 100 kg car in 1.5 s if the car is moving at 22 m/s?



momentum	+	impulse	=	momentum
(m x Vo)	+	(F x t)	=	(m x 0)
(100 x 22)	+	(F x 1.5)	=	(100 x 0)
2200	+	(F x 1.5)	=	0
2200 - 2200	+	(F x 1.5)	=	0 -2200
0	+	(F x 1.5)	=	-2200

$$F \times 1.5 = -2200$$

$$F \times \frac{1.5}{1.5} = \frac{-2200}{1.5}$$

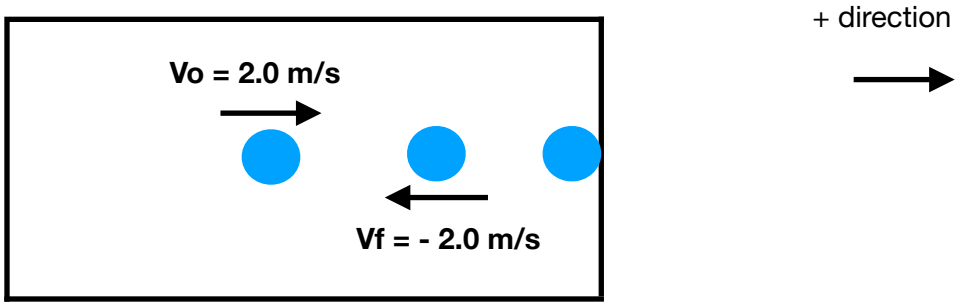
$$F = -1{,}466.66\ N = -1500\ N$$

Homework 2:

A billiard ball of mass 0.2 kg rolls towards the right hand cushion of the billiard table at 2.0 m/s and rebounds straight back at 2.0 m/s

a) What is the change in momentum as a result of hitting the cushion? (Answer: - 0.80 kg. m/s [right])

b) b) What impulse is give to the ball by the cushion? (Answer: 0.80 kg. m/s [left])



Change of momentum = Final momentum - Initial momentum

$$= (m \times Vf) - (m \times Vo)$$

$$= (0.2\ kg \times -2.0) - (0.2\ kg \times 2.0)$$

$$= (- 0.4) \quad - \quad (0.4)$$

$$= - 0.4 \ - 0.4 = - 0.8 \text{ kg .m/s}$$

b) Impulse J = change in momentum = 0.8 kg. m/s [left]