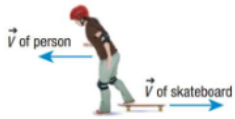
# SPH3U: 3.4 Newton's Third Law of Motion

## 1. Newton's third law

| | |
|---|---|
| Newton's third law: | For every action force, there is an equal and opposite reaction force. $\vec{F_R} = -\vec{F_A}$ |
| stepping off skateboard | As you step forward, the skateboard gets pushed back. ($F_A$ ← , $F_R$ →) |
| rocket launch | $F_A$ pushes the fuel out the bottom. ∴ the fuel pushes the rocket up ($F_R$). |

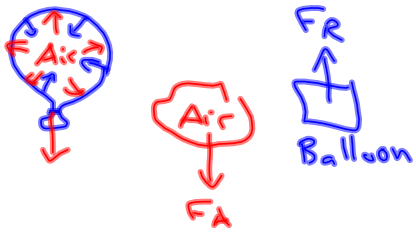



Explain each event in terms of Newton's third law:

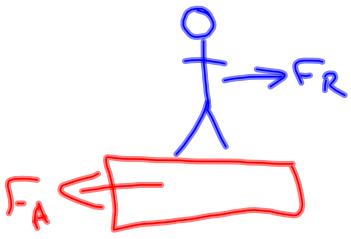
a. A swimmer moves through the water.


The swimmer pushes the water back ($F_A$). The water pushes the swimmer forward ($F_R$).

b. A small balloon releases air and flies around the classroom.




c. You start walking across the floor.



**2. Separate objects**

| | |
|---|---|
| Action and reaction force: | Act on 2 different objects. |
| two FBDs | Draw 2 FBDs always for 3rd Law problems. |

Two skaters are standing on ice facing each other. Skater 1 pushes on skater 2 with a force of 70 N [E]. Assume that no friction acts on either skater. The mass of skater 1 is 50 kg and the mass of skater 2 is 70 kg.

a. State the action and reaction forces.

$F_A$: Skater 1 pushes skater 2. $F_A = 70$ N [E].

$F_R$: Skater 2 pushes skater 1. $F_R = 70$ N [W].

b. Draw the FBD of each skater.


c. Describe what will happen to each skater.

Skater 1 will accelerate east.

Skater 2 will accelerate west.

d. Calculate the acceleration of each skater.

Skater 1: $F_{Net} = ma$

$F_{Net} = 70$ N [W]

$70 = 50a$

$a = \frac{70}{50} = \frac{7}{5} = 1.4$ m/s$^2$ [W]

Skater 2: $F_{Net} = ma$

$F_{Net} = 70$ N [E].

$70 = 70a$

$\frac{70}{70} = a = 1.0$ m/s$^2$ [E].

**3. Summary**

$F_R = -F_A$.

$F_A + F_R = 0$.

**Homework:** page 141: #2-3, 6-9