

Name: \_\_\_\_\_

Physics 11

### Lesson 2.2 – Newton's Second Law

Newton's **first** law told us that if no net force acts on an object, its acceleration is zero.

So, it's fair to assume that if there *is* a net force (a.k.a. unbalanced force, resultant force), then the acceleration will be not zero.

Newton's **second** law tells us how to calculate that acceleration:

Net force  
(or resultant force)

Newton's (N)

kilograms (kg)

meters per second squared (m/s<sup>2</sup>)

- Greek letter "sigma"  
- Means "sum of"

$$\Sigma \vec{F} = m \vec{a}$$

Newton's Second Law

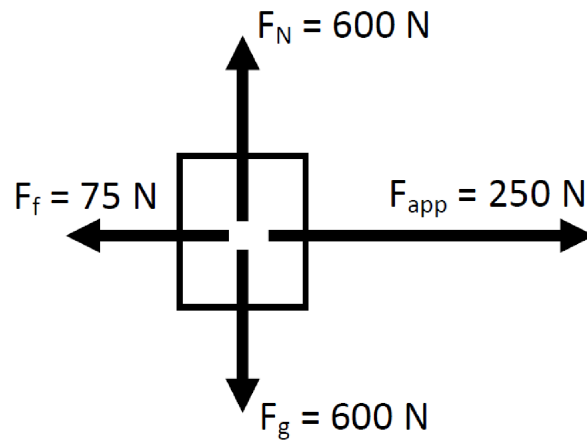
Take a look at the units on both sides...

$$\begin{aligned}\Sigma \vec{F} &= m \vec{a} \\ \text{N} &= (\text{kg})(\text{m/s}^2)\end{aligned}$$

**Example:** A 650 kg car accelerates at 4 m/s<sup>2</sup> south. What is the net force acting on it?

$$\begin{aligned}\Sigma \vec{F} &= m \vec{a} \\ &= (650)(-4) \\ &= -2600 \text{ N} \\ &= 2600 \text{ N South}\end{aligned}$$

**Example:** Determine the magnitude and direction of the net force on the object below.



| Graphical Method                                                                                                                                                                                                                                     | Algebraic Method                                                                                                                                                                                                                                                                             |   |   |                  |                  |                 |                  |                  |       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|------------------|------------------|-----------------|------------------|------------------|-------|
| <p>A graphical representation of the net force. It shows a rectangle with a width of 250 and a height of 600. The bottom edge is divided into two segments: a red segment of length 175 and a blue segment of length 75. The total width is 250.</p> | <table> <tr> <th>X</th><th>Y</th></tr> <tr> <td><math>\Sigma \vec{F}</math></td><td><math>\Sigma \vec{F}</math></td></tr> <tr> <td><math>(250) + (-75)</math></td><td><math>(600) + (-600)</math></td></tr> <tr> <td><math>= 175\text{ N}</math></td><td><math>= 0</math></td></tr> </table> | X | Y | $\Sigma \vec{F}$ | $\Sigma \vec{F}$ | $(250) + (-75)$ | $(600) + (-600)$ | $= 175\text{ N}$ | $= 0$ |
| X                                                                                                                                                                                                                                                    | Y                                                                                                                                                                                                                                                                                            |   |   |                  |                  |                 |                  |                  |       |
| $\Sigma \vec{F}$                                                                                                                                                                                                                                     | $\Sigma \vec{F}$                                                                                                                                                                                                                                                                             |   |   |                  |                  |                 |                  |                  |       |
| $(250) + (-75)$                                                                                                                                                                                                                                      | $(600) + (-600)$                                                                                                                                                                                                                                                                             |   |   |                  |                  |                 |                  |                  |       |
| $= 175\text{ N}$                                                                                                                                                                                                                                     | $= 0$                                                                                                                                                                                                                                                                                        |   |   |                  |                  |                 |                  |                  |       |
| <p>Answer: The net force (or resultant force) is <u>175 N right</u></p>                                                                                                                                                                              | <p>Answer: The net force (or resultant force) is <u>175 N right</u></p>                                                                                                                                                                                                                      |   |   |                  |                  |                 |                  |                  |       |