Newton's Second Law

Mass and Acceleration

- In which of the two workout routines shown will the weightlifter be able to pump the weights up and down quicker?
- Why?
- **Using the same force, the weightlifter is able to accelerate (change the velocity of) the smaller mass more.**

The Second Law

- Newton's Second Law = the acceleration of an object is equal to the net force divided by the mass

$$\textbf{acceleration} = \frac{\textbf{net force}}{\textbf{mass}}$$

$$a = \frac{F_{net}}{m}$$

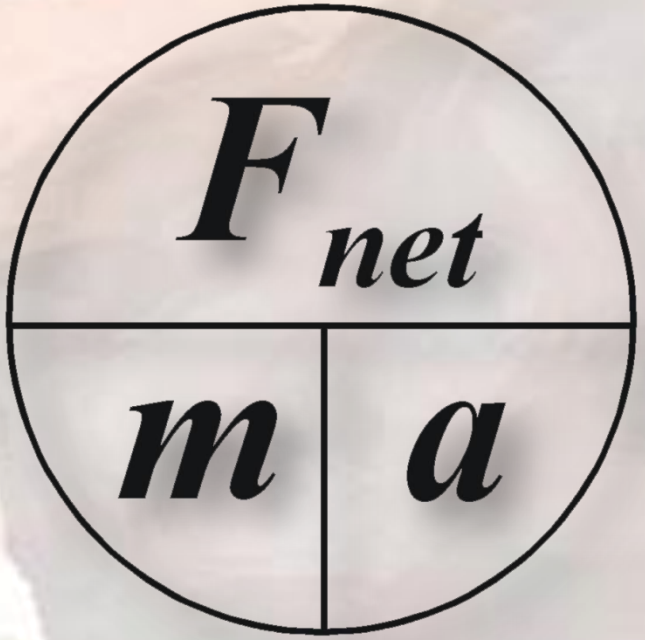
- In other words, as you observed earlier, the larger the mass is, the smaller the acceleration is that it gets from a given force.

Calculational Formulas

- If:

$$\text{acceleration} = \frac{\text{net force}}{\text{mass}}$$

$$a = \frac{F_{net}}{m}$$

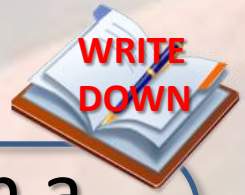


- Then:

$$F_{net} = ma$$

- Units of force
  - Newtons (N)
  - 1 N = 1 kg•m/s^2

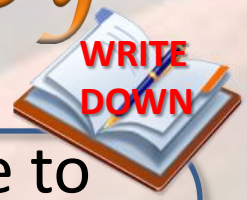
Sample Problem



What is the acceleration of a 10 kg box with a net force of 5 N acting on it?

- $a = \frac{F_{net}}{m}$
- $a = \frac{5\ \text{N}}{10\ \text{kg}}$
- $a = \frac{5\ \text{kg}\cdot\text{m/s}^2}{10\ \text{kg}} = 0.5\ \text{m/s}^2$

Acceleration of Gravity

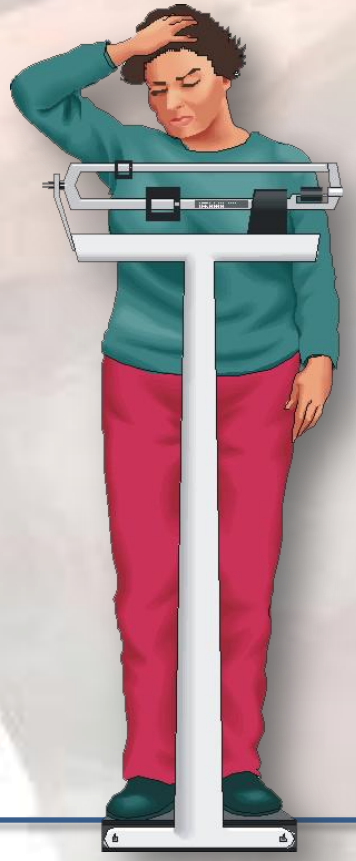


- Gravity = force of attraction between objects due to mass
- Weight = the size of the gravitational attraction due to gravity
  - acceleration due to gravity (g): $g = 9.8\ m/s^2$
  - Weight (W): $W = mg$ *or* $m(9.8\ m/s^2)$

    NOTE: $W = mg$ is the same as *$F = ma$*
- Weight vs mass
  - Weight is the downward force of gravity on an object.
  - It depends on location.
  - Mass is the amount of matter in an object. It is not effected by location.

Gravity Problem

A student has a mass of 60 kg. What is the student's weight?



- $F = ma$ *or* $W = mg$

- $W = (60\ kg)(9.8\ m/s^2)$

  $= 588\ kg \cdot m/s^2 = 588\ N$