Weight and Mass
Life on Mars

- So imagine that you are on planet Mars. Is the amount of matter that makes you up different?
- Is the force pulling you downward different?
Weight

• **Weight** – The force pulling down on an object created by earth’s gravity (9.8 m/s\(^2\))
  - Weight is a FORCE
  - Therefore, units = **NEWTONS (N)**

• Your **Weight** will be different on Earth and Mars
  - Earth’s gravity = 9.8 m/s\(^2\)
  - Moon’s gravity = 1.6 m/s\(^2\)
  - Weight changes with gravity
Calculating Weight

Formula: \[ \text{Force Weight} = \text{Mass} \times \text{Gravity} \]

Symbols

\[ F_w = m \times g \]

Units

\[ (N) = (kg) \quad (m/s^2) \]

- Remember to use Newtons NOT Pounds since we are Scientific.
  \( (1 \, N = 2.2 \, lbs) \)

Look Familiar?

Formula: \[ \text{Force Weight} = \text{Mass} \times \text{Accel due to Gravity} \]

Symbols

\[ F_w = m \times g \]

Formula: \[ \text{Force} = \text{Mass} \times \text{Accel} \]

Symbols

\[ F = m \times A \]
Calculating Weight

Example:

If you have a mass of 22kg on Earth (9.8m/s²), what is your weight?

- $F_w = 22\text{kg} \times 9.8\text{m/s}^2$
- $F_w = 215.6 \text{kg*m/s}^2$
- $F_w = 215.6 \text{N}$

If you have a mass of 22kg on Mars (with $1/3$ the gravity of Earth), what is your weight?

- $F_w = 22\text{kg} \times ((9.8\text{m/s}^2) \times (1/3))$
- $F_w = 22\text{kg} \times 3.27\text{m/s}^2$
- $F_w = 71.94 \text{kg*m/s}^2$
- $F_w = 71.94 \text{N}$
Mass

- **Mass** – amount of matter that makes up an object.
  - Units = kg

- Your **Mass** will be the same on Earth or Mars.
  - You have the same amount of matter everywhere.
Weight vs. Mass

- **Weight** is measure of the force of gravity acting on your mass
  - Weight will be different everywhere
  - Units = N (because it is a FORCE)

- **Mass** is the same everywhere, regardless of gravity
  - Mass will always remain the same
  - Units = kg
Friction

• If gravity is always pulling us down (or if we are moving) we are always going to be in contact with something.

• **Friction** is a force that results from the relative motion between objects
  
  • AKA: The force that works against and slows motion because the surface of any object is rough
Friction

• Some friction is useful
  • Walking (friction between ground and foot)
  • Driving (friction between ground and tire)
  • Brakes (friction between brake pad and the disc (attached to wheel))
  • Writing (friction between paper and pen/pencil)
  • Throwing (friction between hand and ball)

• Some friction is unwanted
  • Overheating in a machine/engine is caused by friction
  • Any moving that slows down when it is not wanted
  • Friction makes moving heavy objects much harder
Without Friction, we may struggle...

Man

And his best friend
Recap - Weight, Gravity and Friction

- Gravity pulls everything toward center of earth.
  - $9.8 \text{m/s}^2$ (Acceleration)

- Weight is a measure of the force of gravity pulling on an object’s mass.

- Friction is a force caused by the relative motion between 2 objects.
Multiple Forces Acting At Once

There will always be MORE than 1 force acting on an object at a time.

- **Net force** = total of all forces

There are 2 options:

- **Balanced forces**
  - **Equilibrium** = all forces on an object are balanced and no change in movement occurs

- **Unbalanced forces**
  - Net forces do not equal zero
  - Motion will occur in the direction of the Net Force
Free Body Diagrams - HONORS

- There is a box on the table.
- What forces are acting on this box?
  - Weight
    - Gravity pulling down on the box
  - Normal Force
    - Table pushing up
- What other forces can act on the box?
  - Push to the right (or pull from the right)
  - Friction force
    - In the opposite direction of the push
Free Body Diagrams - HONORS

- Identify the value for:
  - Force of Weight:
  - Normal Force:
  - Friction Coefficient:
  - “Push”:

- Is this box moving?
  - If so, which direction and with what unbalanced force?
Free Body Diagrams - HONORS

- This can be shown 2 different ways:
  - Arrows pointing towards the center of the object
  - Arrows originating from the center of the object.