Forces

Force Diagrams (FBD)
Net Force Equations

Forces

- A **force** is a push or pull upon an object resulting from the object's *interaction* with another object.
- Whenever there is an *interaction* between two objects, there is a force upon each of the objects.
- When the *interaction* ceases, the two objects no longer experience the force.
- Forces only exist as a result of an interaction

Types of Forces

- **Applied Force—F_a**
- **Gravity Force (also known as Weight)—F_g Or W**
- **Normal Force—F_N**
- **Friction Force—F_{fk} or F_{fs} or F_f**
- **Tensional Force—F_t or T**
- **Air Resistance Force—F_{air}**
  - **Note that each of these begins with an F, and the subscript tells which type**

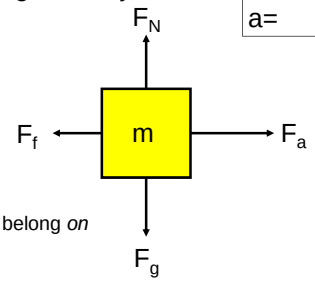
Force Diagrams

- Referred to as **free-body diagrams**
- Shows only 1 object and all the forces acting on it
- Is used to find the **net external force** acting on a thing—using vector analysis
  - **Net external force** is the vector sum of all the forces acting on an object – if an object is not moving or is moving with a constant velocity, then there is no acceleration and the net force is equal to 0.

Free-body diagrams

- ***All*** forces acting on an object and ***only*** those forces acting **that** object

F_a applied force
F_g gravity force (weight)
F_N normal force
F_f force of friction
m mass of the object
acceleration does not belong *on* the diagram itself

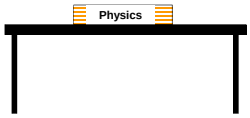


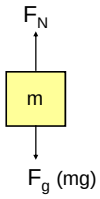
Normal Force

- The normal force is one which prevents objects from 'falling' into whatever it is they are sitting upon.
- It is always perpendicular to the surface with which an object is in contact.
- It is ***ALWAYS*** present when the object is in ***CONTACT*** with a surface.
- It is ***ONLY*** present when the object is in ***CONTACT*** with a surface.

Normal Force

- A physics text book weighing 20 N is sitting on a table.
  - Gravity is pulling down with a force of 20 N.
  - The table is pushing up with a force of 20 N (Newton's 3rd Law)





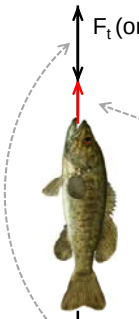
- Before we move on with free body diagrams, let's look at some examples of motion in the y-direction

- If the fish is held at a constant height, what is the acceleration?
  $0\ m/s^2$
- What is F_t relative to F_g?
  $F_t = F_g$

- If the fish is moving at a *constant* velocity (up or down), what is the acceleration?
  $0\ m/s^2$
- What is F_t relative to F_g?
  $F_t = F_g$

- If the fish is *dropped* (with the hook in it's mouth), what is the acceleration?
  $-9.8\ m/s^2$
- What is F_t relative to F_g?
  $F_t = 0$

- If the fish is accelerating *up*, what is F_t relative to F_g?
  $F_t > F_g$
- If the fish is accelerating *down*, what is F_t relative to F_g?
  $F_t < F_g$



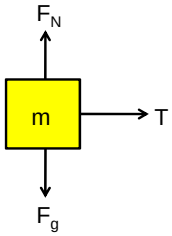
- When the fish is accelerating upwards, it is the ***DIFFERENCE*** in forces (the red arrow) that causes acceleration.

Let's try drawing one!

Starting simple: a kid pulling a sled

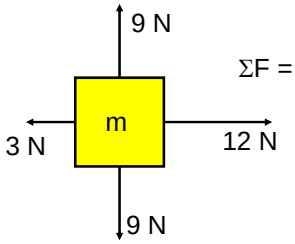
What are the forces involved?

Normal Force, Weight, & Tension



Practice

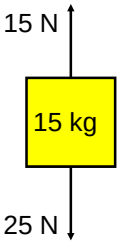
Find the net Force (ΣF) acting upon the object.



ΣF = 9 N to the right

Practice

Calculate the ΣF



ΣF = 15 N – 25 N

ΣF = -10 N

Calculate the a

ΣF = ma

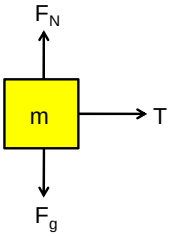
-10 N = (15 kg)a

$a = -0.67\ m/s^2$

Net Force Equations

Remember ΣF = ma

Write net force equations for the X and Y



ΣF_x : T = ma

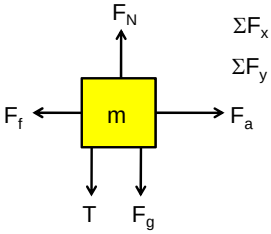
ΣF_y : $F_N - F_g = ma$ → 0

If the object is sitting on a desk, is it accelerating in the y direction?

Net Force Equations

Remember ΣF = ma

Write net force equations for the X and Y



ΣF_x : $F_a - F_f = ma$

ΣF_y : $F_N - F_g - T = ma$