Chapter 4 FORCES

Objectives

You will be able to …

- understand the idea of force
- categorize forces into the two main types of force
- recognize when forces exist
- Draw Free Body Diagrams (FBD)

Forces

So far we worked on observing and describing motion (Kinematics)

Our next goal will be to figure out what causes motion to change or not change.

How do objects interact?

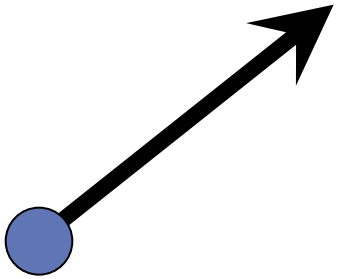
- Dragging things
- Punching a wall
- Hitting in football or hockey
- Jumping in dancing or skating
- Tossing in cheerleading
- A push or a pull

What is a Force?

- A push or pull
- Forces are the way objects interact.
- This interaction can cause the objects' motion to change (acceleration), or it could cause nothing at all depending on the circumstances and how many objects are interacting.

What is a Force

- Forces are VECTOR quantities
- They have a magnitude (SIZE) and a direction



Types of forces

- There are two types of forces
  - Contact Forces
  - Field Forces (At a distance forces)

Contact Force

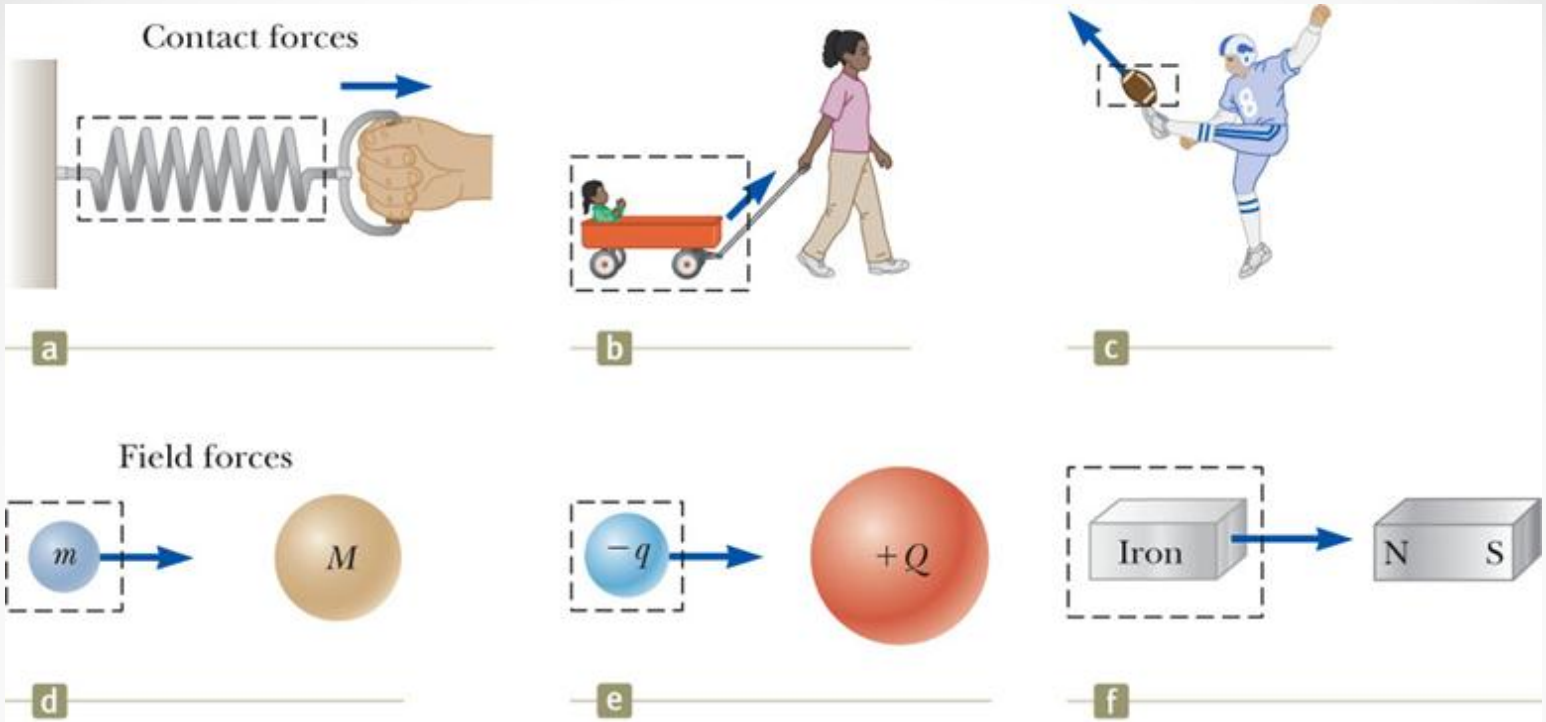
- Forces for which the two interacting objects have to be physically in contact with each other for the forces to exist.
- EXAMPLES
  - Hitting
  - Pulling with a rope
  - Lifting weights
  - Pushing a couch
  - Lying on a table
  - Poking someone
  - Sliding to block a kick
  - Hanging from a window ledge

Field Force

- Forces in which the two interacting objects are not in physical contact with each other, but are still able to exert a push or pull and interact with each other despite the physical separation.
  - *Know any?*

Not quite…

Definitely.



Contact forces involve physical contact between two objects

- Examples a, b, c

Field forces act through empty space

- No physical contact is required
- Examples d, e, f

Examples of Forces

- Contact
  - Friction Force (F_f)
  - Tension (F_T, T)
  - Normal Force (F_N, N)
  - Air Resistance (F_{air})
  - Applied Force (F_a)
  - Spring Force (F_{sp})
- At a Distance
  - Gravitational Force (F_g)
  - Electrical Force (F_E)
  - Magnetic Force (F_M)
  - Nuclear Forces

Identify the contact and field force examples in the picture.

An Aside …

4 Fundamental Forces

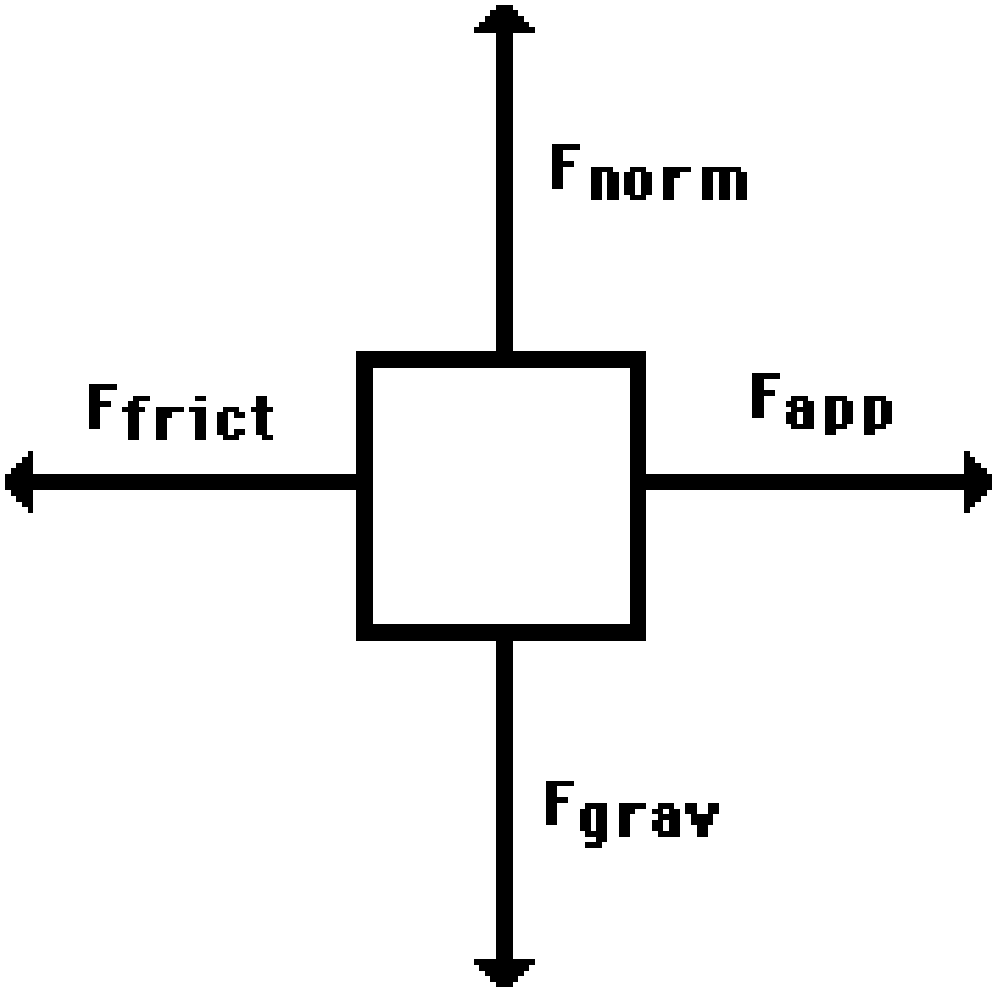
We will use a large number of forces, but there are actually only four different kinds of forces in the universe:

1. The gravitational force - how objects with mass interact with one another
2. The electromagnetic force - how charged objects interact with one another (*all contact forces can be traced to electromagnetic interactions*)
3. The strong nuclear force - holds nuclei together
4. The weak nuclear force - associated with radioactivity

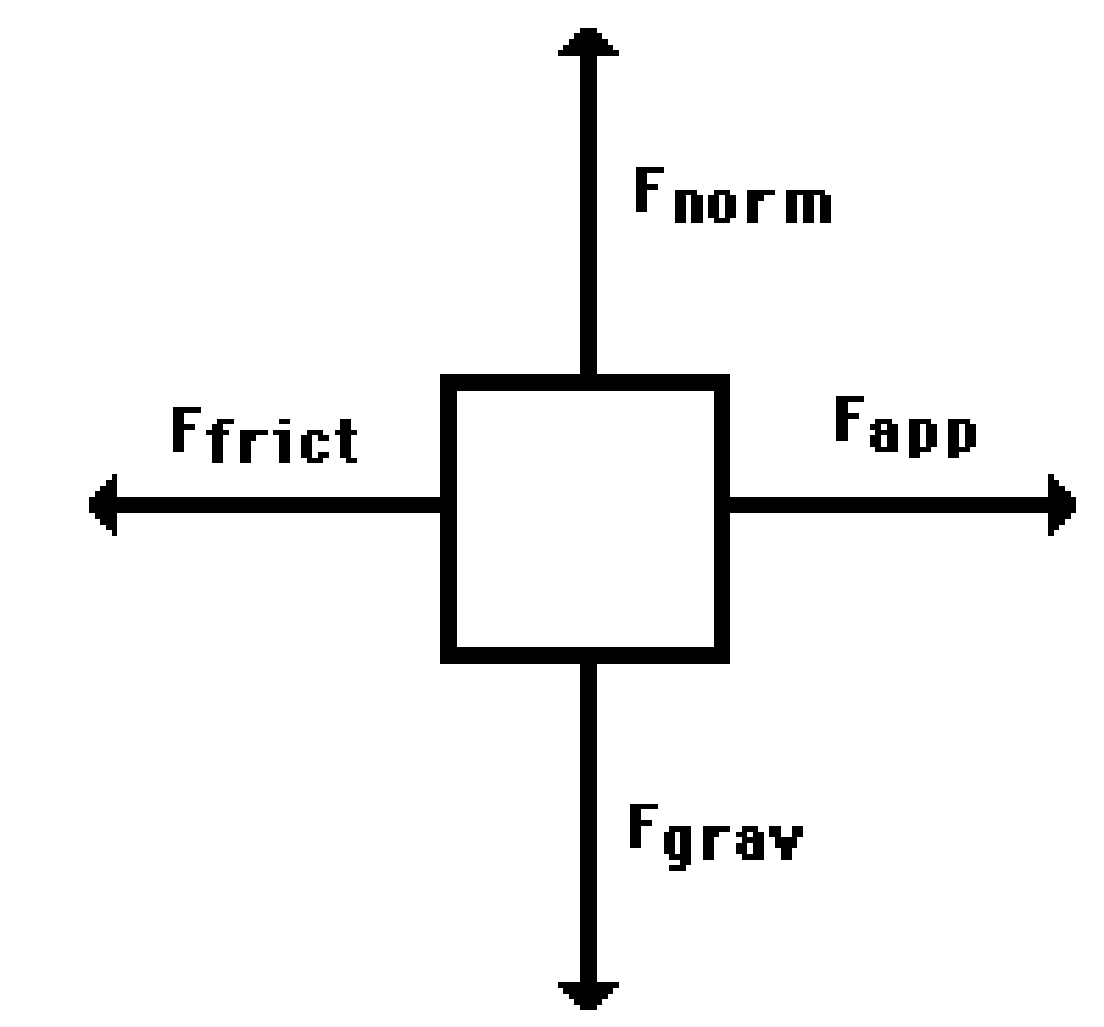
Draw a person pushing a person sitting on a chair.

Free-body diagrams

Free-body diagrams are used to show the relative magnitude and direction of all forces acting on an object. This helps analyze and isolate a situation.



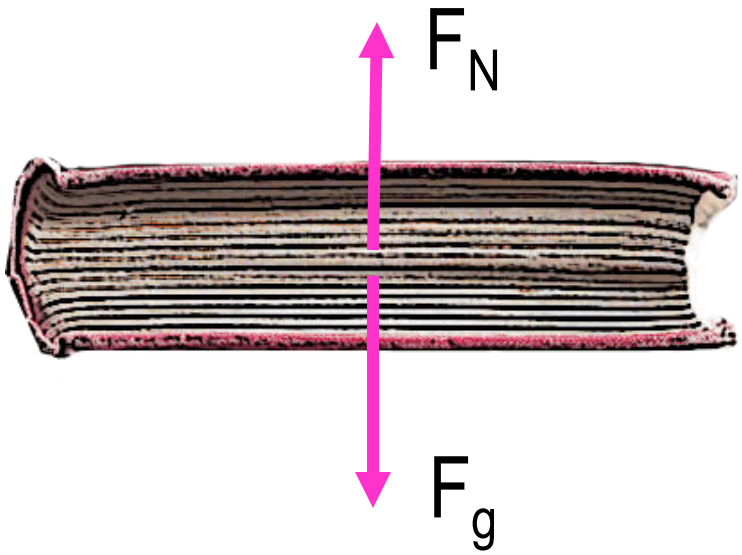
This diagram shows four forces acting upon an object. There aren't always four forces, For example, there could be one, two, or three forces.



Lets Practice Drawing Forces

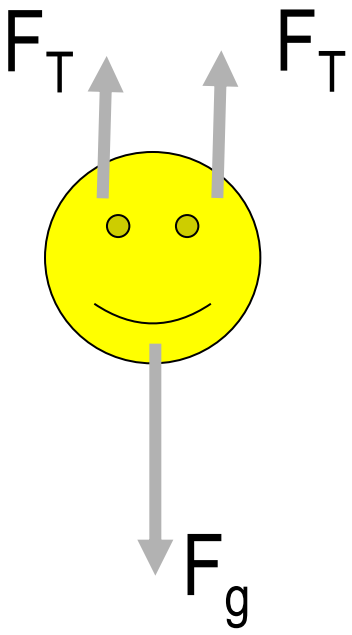
1.

- A book is at rest on a table top.



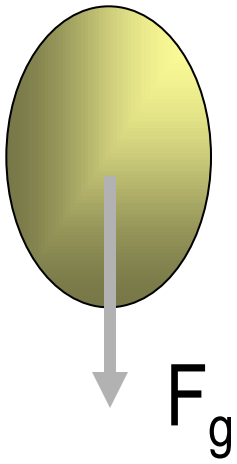
2.

- A girl is suspended motionless in the air by two ropes attached to her.



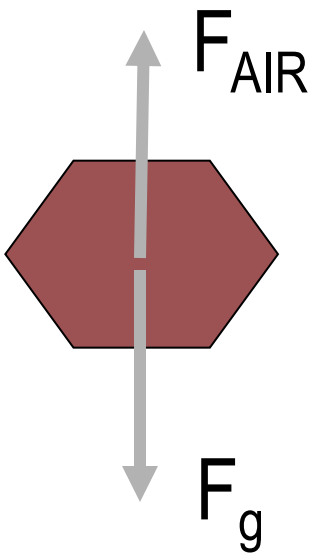
3.

- An egg is free-falling from a nest in a tree. Neglect air resistance.



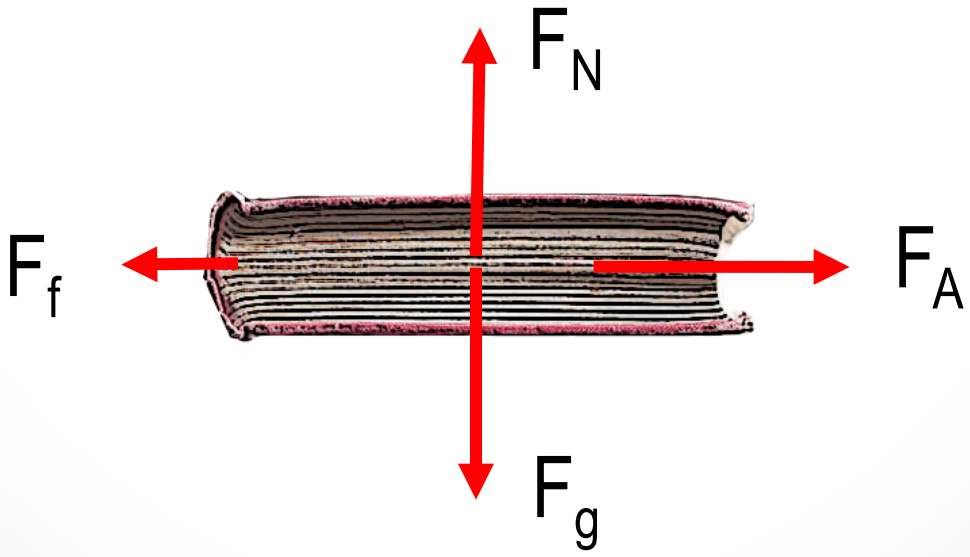
4.

- A flying squirrel is gliding (no wing flaps) from a tree to the ground at constant velocity. Consider air resistance.



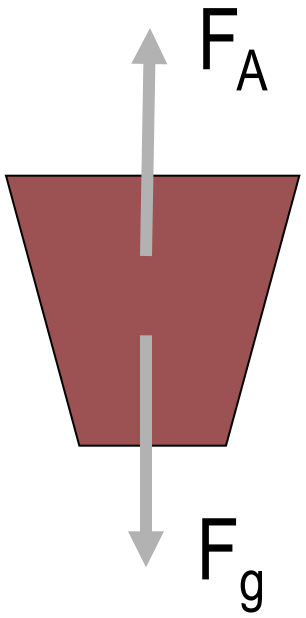
5.

- A rightward force is applied to a book in order to move it across a desk with a rightward acceleration. Consider frictional forces. Neglect air resistance.



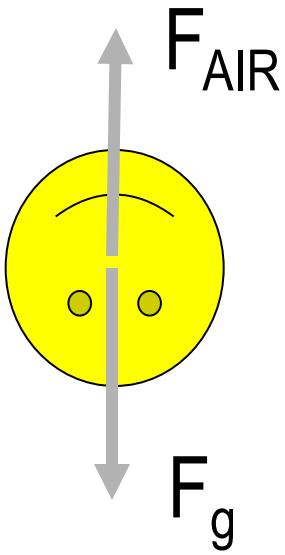
6.

- A college student rests a backpack upon his shoulder. The pack is suspended motionless by one strap from one shoulder.



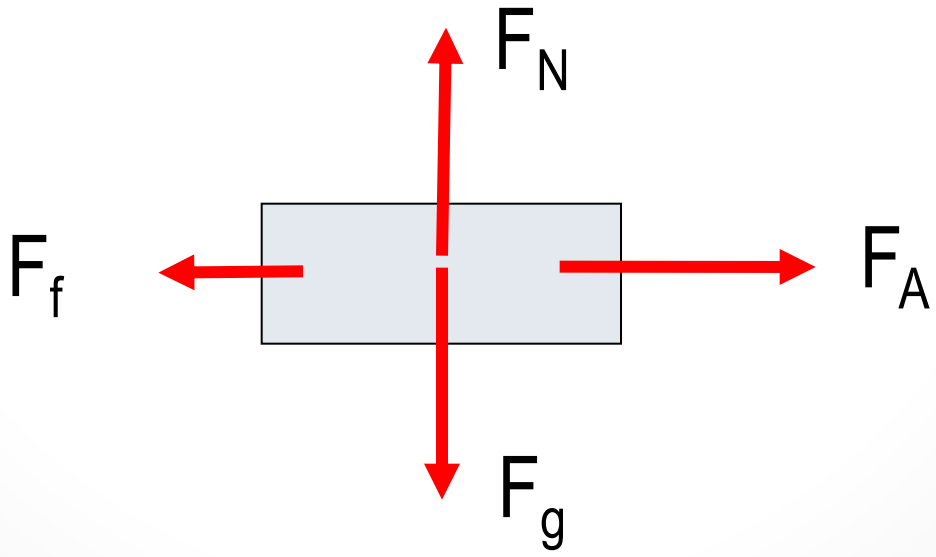
7.

- A skydiver is descending with a constant velocity. Consider air resistance.



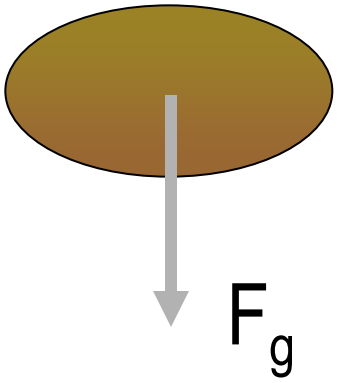
8.

- A force is applied to the right to drag a sled across loosely-packed snow with a rightward acceleration.



9.

- A football is moving upwards towards its peak after having been booted by the punter. Neglect air resistance.



10.

Three smaller kids are pulling a rope against one large kid.

- A. They are at a stand still
- B. The big kid is winning

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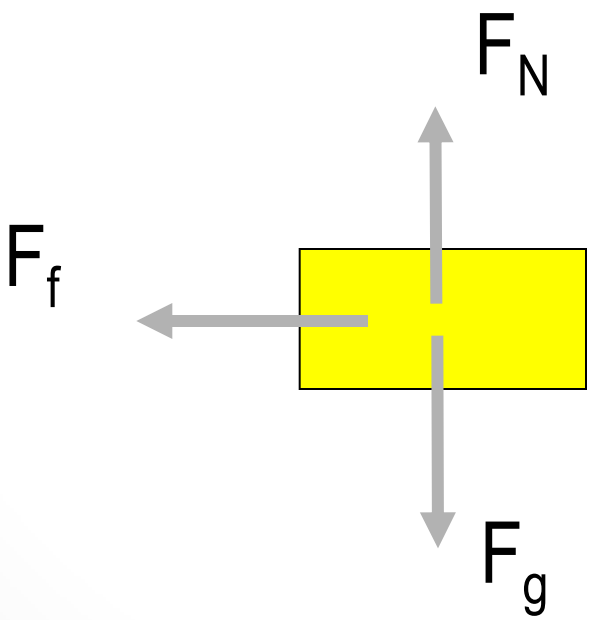
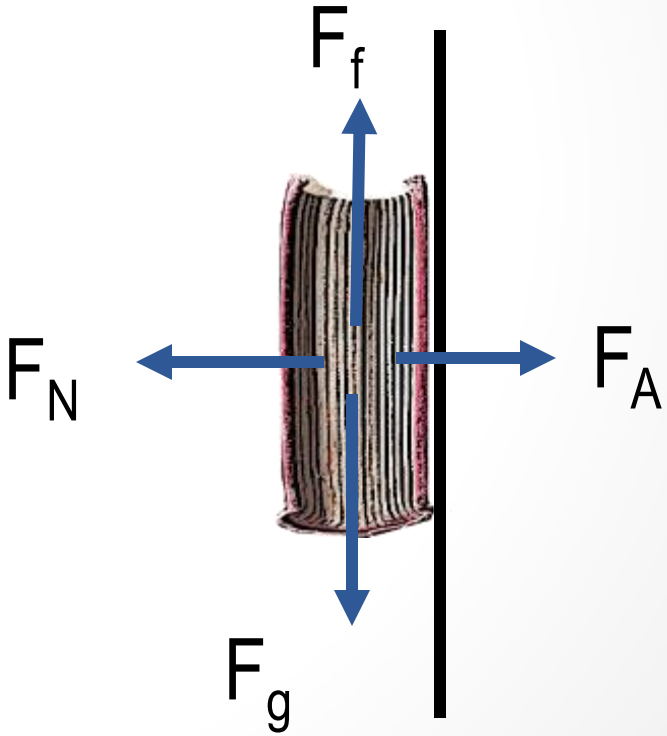
11.

- A car is coasting to the right and slowing down.



12.

- You are holding a book against a flat wall.



Balanced Forces (Statics)

- There are often situations where a number of forces are acting on something, and the object has no motion – it is STATIC or in EQUILIBRIUM.
- This means the NET FORCE on the object is zero, or in other words the forces balance each other out.
- What does this mean mathematically?

Net Force

- NET FORCE refers to the vector sum total of all forces acting on an object. It is often expressed as ΣF
- For example, if there were two leftward forces of 10 lb each, the NET FORCE would be 20 lb leftward.
- If there were one 10 lb rightward force and one 8 lb leftward force, the NET FORCE would be 2 lb rightward.
- What about if the forces were in X and Y?

unBalanced Forces (Dynamics)

- There are other situations where all the forces acting on something do not cancel each other out completely.
- This means the NET FORCE on the object is not zero, the object will change its motion and accelerate proportional to the object's mass.
- $\Sigma F = m \cdot a$