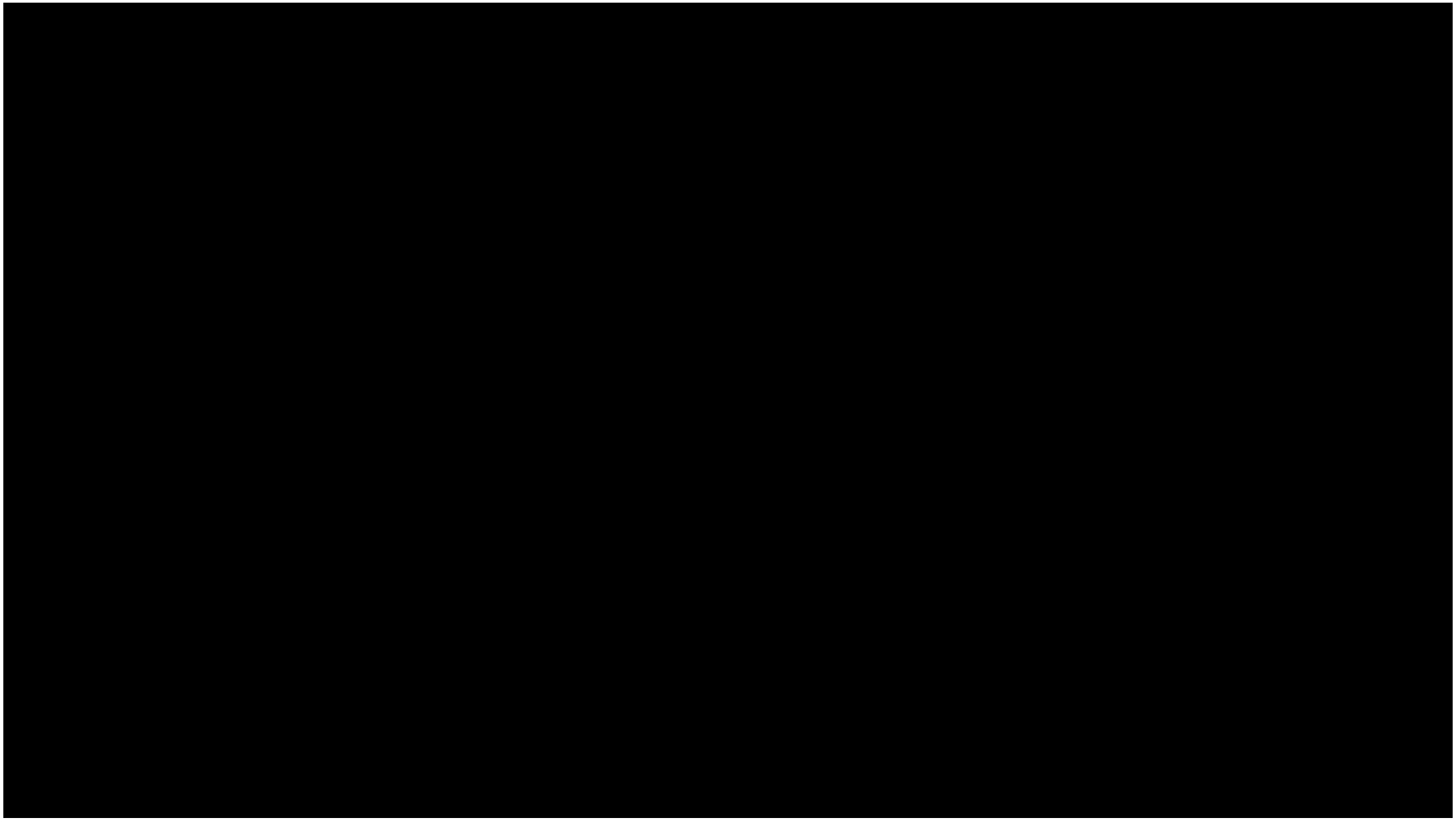
Forces

Describing Forces

What is a “force”?



The Nature of Force

- A **force** is a push or pull on an object. When one object pushes or pulls another object, we say it exerts a force on the other object.

- Forces are described by their strength (Newtons – "N") *AND* their direction.

Nature of Forces (cont.)

- **<u>Contact Forces</u>**: act on an object through direct contact
  - Ex: throwing a ball, hitting a ball with a bat

- **<u>Non-Contact Forces</u>**: act on an object without direct contact
  - Ex: gravity pulling a ball down, magnetic forces

4 Fundamental Forces

- **Strong Nuclear Force**: Strongest of the forces
  - Responsible for binding nuclei (holding protons together despite their "like" charges)
  - VERY short range (1 femtometer = 10^{-15} meters)
- **Electromagnetic Force**: exists between all particles which have an electric charge
  - Binds electrons (negative) to the nucleus (positive)
  - Long range, but diminishes quickly
  - Responsible for most of the everyday forces we observe (pushing on something, friction, etc…)
    - No two atoms can occupy the same space
  - 100 times weaker than Strong Force within 1 fm

4 Fundamental Forces

- **Weak Nuclear Force**: responsible for radioactive decay
  - Range is less than 1 fm and much weaker than the strong force
- **Gravitational Force**: force that attracts two masses together
  - Infinite range but relatively weak (*weakest of the four*)
  - Strength depends on the masses of the objects involved and how far apart they are.
- **"Familiar Forces"** – Electromagnetic & Gravitational
- **"Unfamiliar Forces"** – Strong & Weak

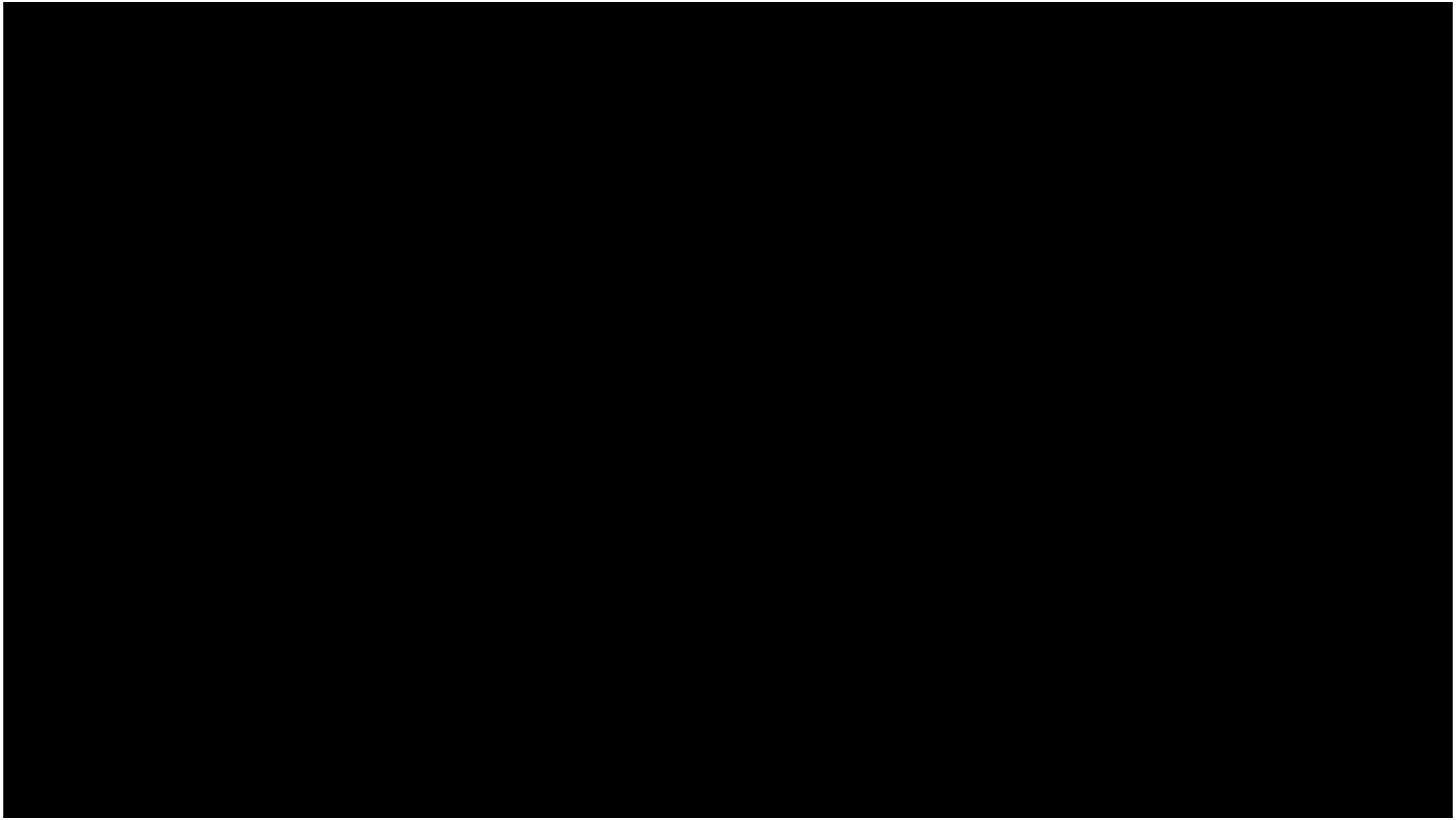
Nature of Forces (cont.)

- **Net Force** – overall force on an object (the ***sum*** of all the forces)
- **Unbalanced Forces** – the net force does NOT equal zero
  - Cause a change in an object's motion (accelerate the object).
    - speed up, slow down, or change direction.

Nature of Forces (cont.)

- **Balanced Forces** – the net force equals zero
  - equal forces acting on an object in opposite directions result in a balanced force (they cancel each other out).
    - will not change an object's motion (*no acceleration*)

What forces are acting on you right now?

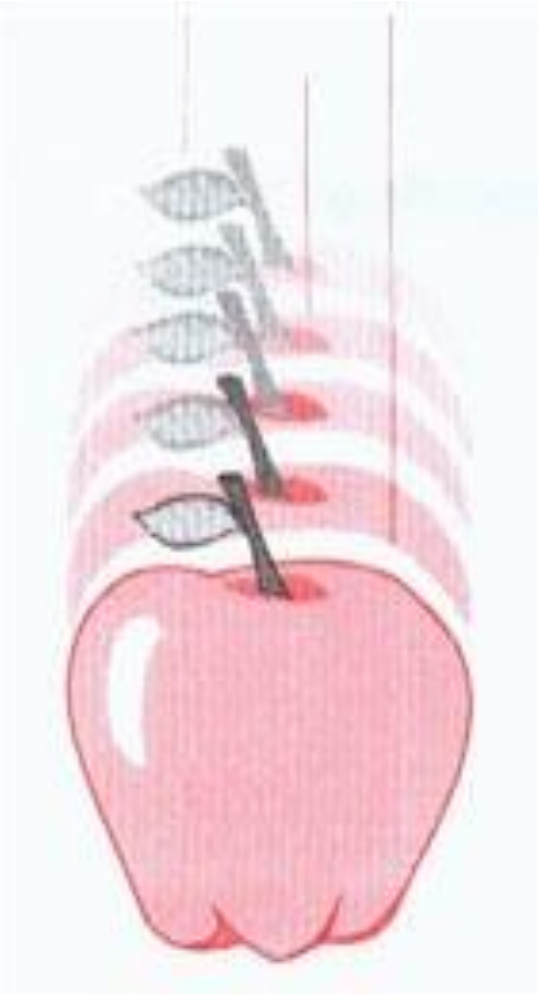


Applied Force

- The **applied force** is that which is applied to the object by another object.
  - Ex: When you kick a soccer ball
    - the force you kick with is the applied force.
  - Ex: When you push a lawn mower
    - the force you push with is the applied force.

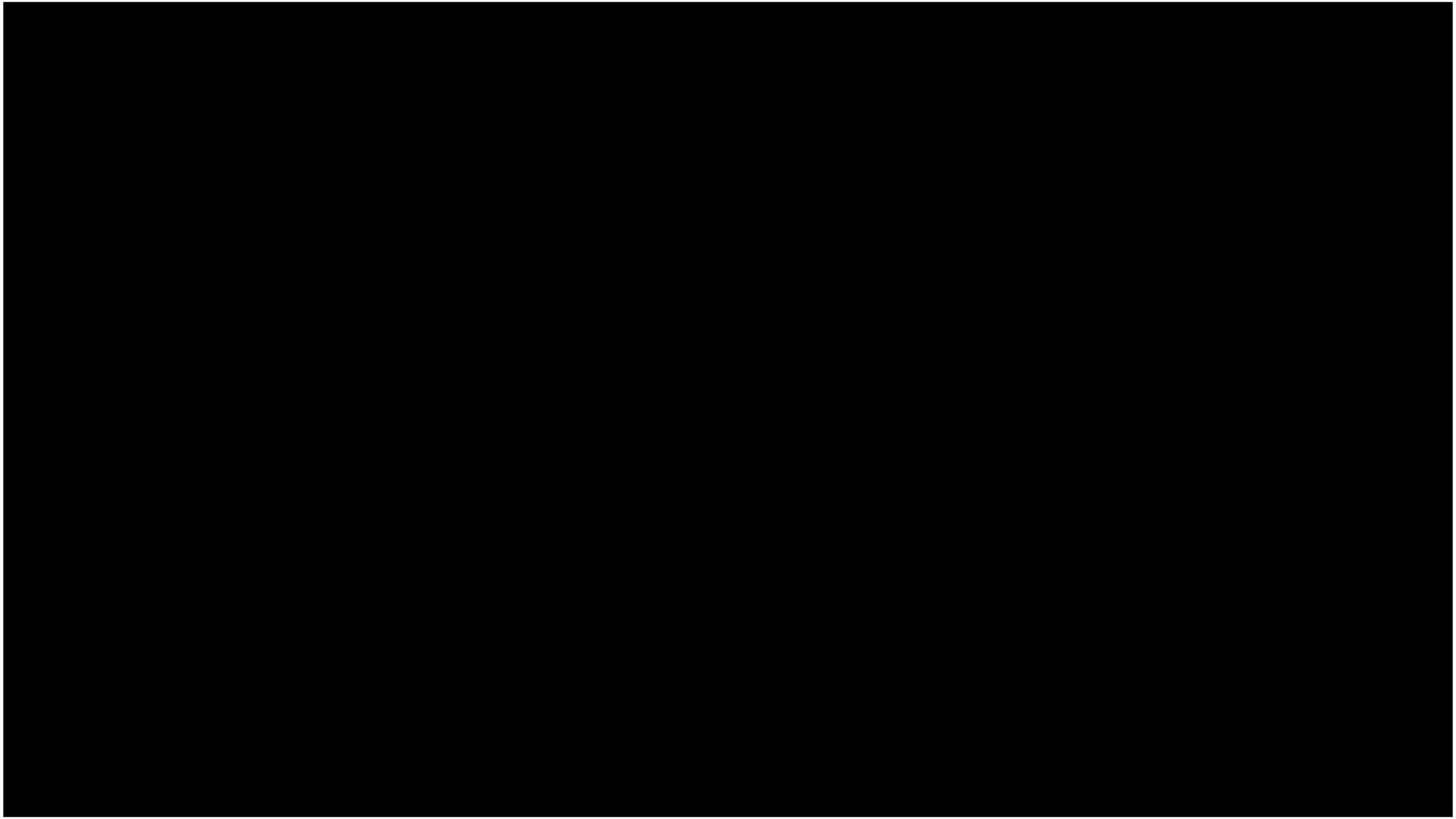
Gravity

- **Gravity** is an attractive force between objects.
  - **Any object with mass exerts a gravitational force on the objects around it!**
  - the gravity we most often refer to is that of the Earth.
- The gravitational force depends on:
  - The masses of the two objects (m_1 & m_2)
  - The distance between them (r)



$$F_g = G\frac{m_1 m_2}{r^2}$$

Normal Force

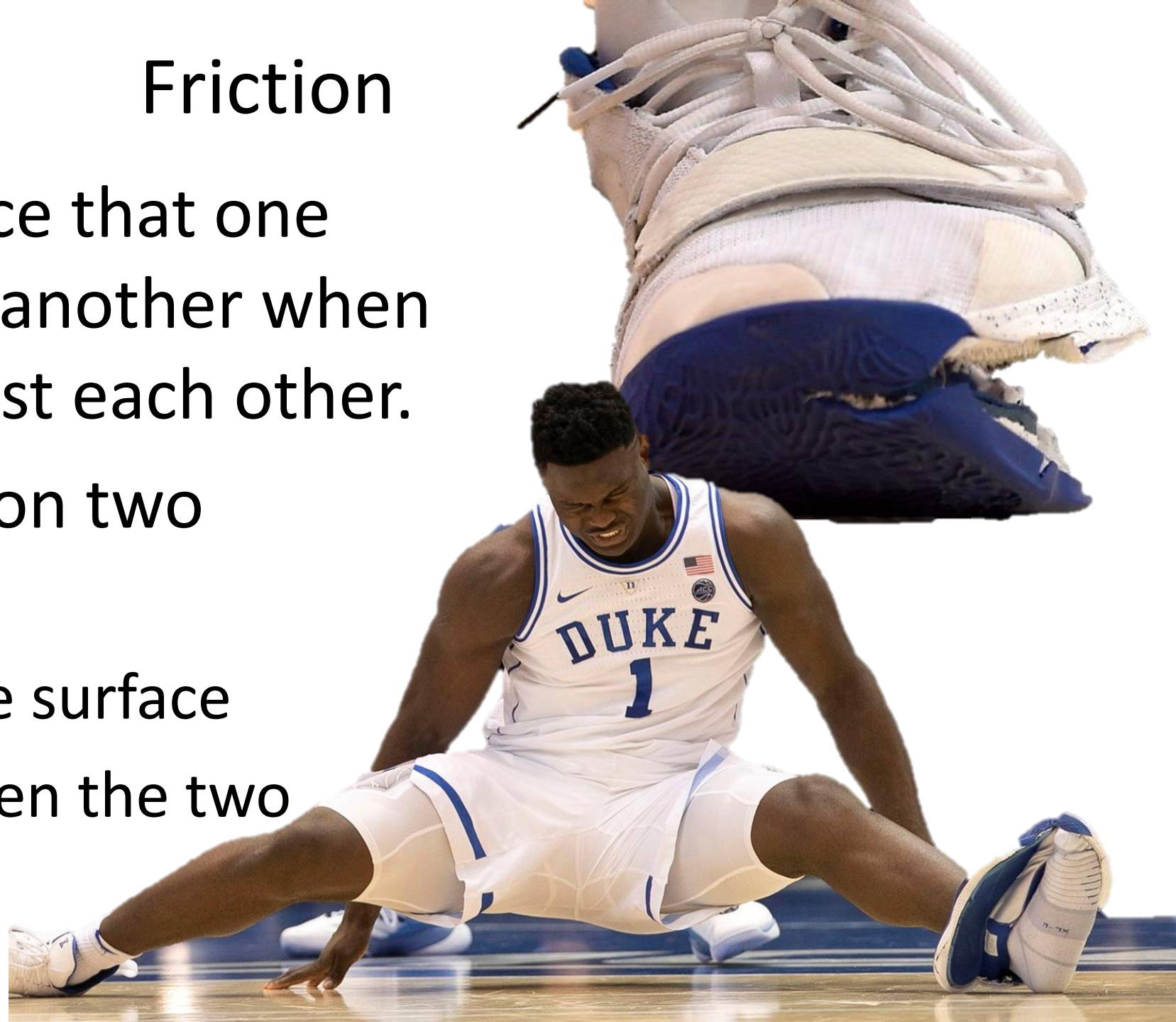


Normal Force

- *(More detail when we get to Newton's 3rd Law…)*
- The "**normal force**" is that which opposes gravity when an object is resting on a surface.
  - You are sitting in your chair…
    - Gravity is pulling you down
    - but you are not accelerating down
    - so the FORCES MUST BE BALANCED!
      - Therefore, SOMETHING MUST BE PUSHING IT UP WITH AN EQUAL BUT OPPOSITE FORCE TO GRAVITY.

Friction

- **Friction** is the force that one surface exerts on another when the two rub against each other.
- Friction depends on two factors…
  - The texture of the surface
  - The forces between the two objects



Friction (cont.)

- Friction acts in the direction opposite to that of motion (or the applied force).
  - If a book is sliding across a table to the left, then the friction force is pushing against the motion of the book, or to the right.
  - Friction is what allows you to walk…think about walking on carpet in sneakers vs. walking on ice with bare feet!

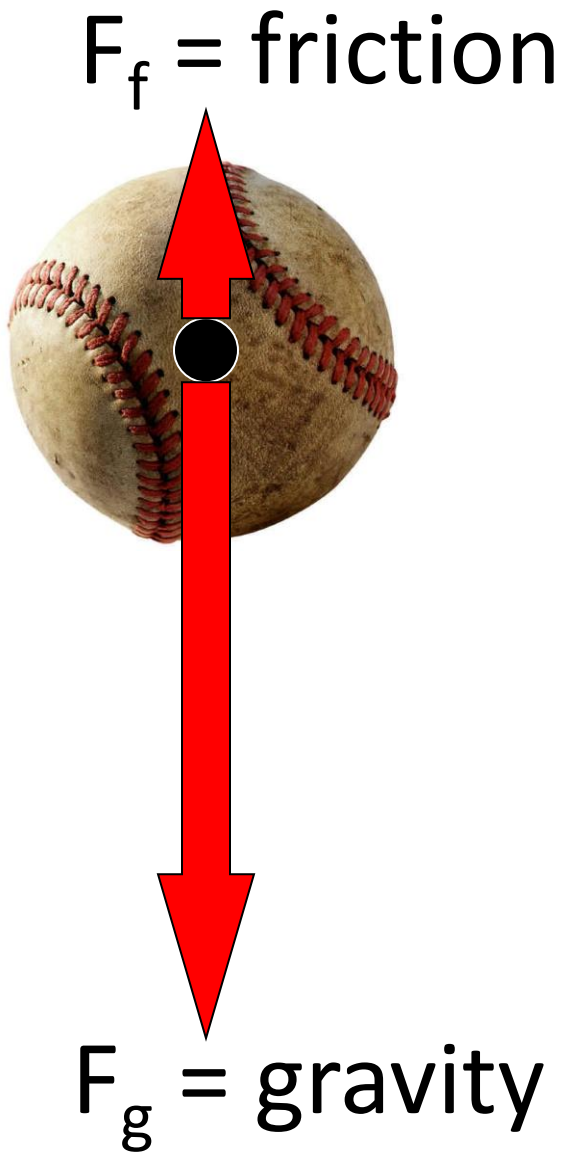
- Air resistance can be considered a form of friction.

Force Diagrams

- Step 1: Choose/Draw the object (falling ball)
- Step 2: Make a dot in the center of the object (symbolizes the center of mass)
- Step 3: Decide what forces are acting ON the object, their relative strength, and their direction.

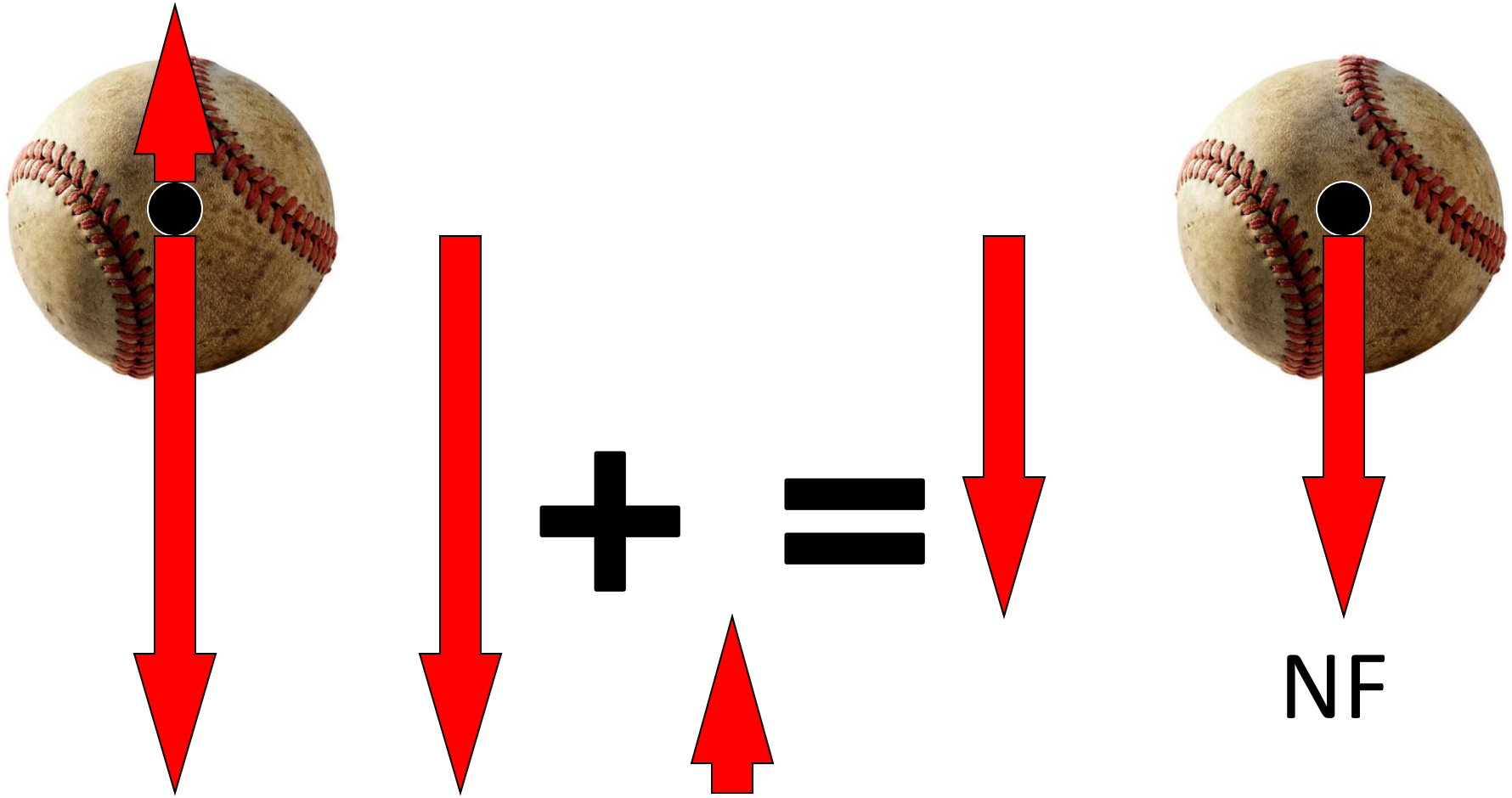
Force Diagrams

- Step 4: Draw the forces using arrows originating from the center dot
  - Their relative length represents their strength
    - The stronger the force, the longer the arrow
  - The direction of the arrow shows the direction the force is acting



Force Diagrams

- Step 5: Add up all of the forces to decide what the net force will be and in which direction.



Force Diagrams Practice

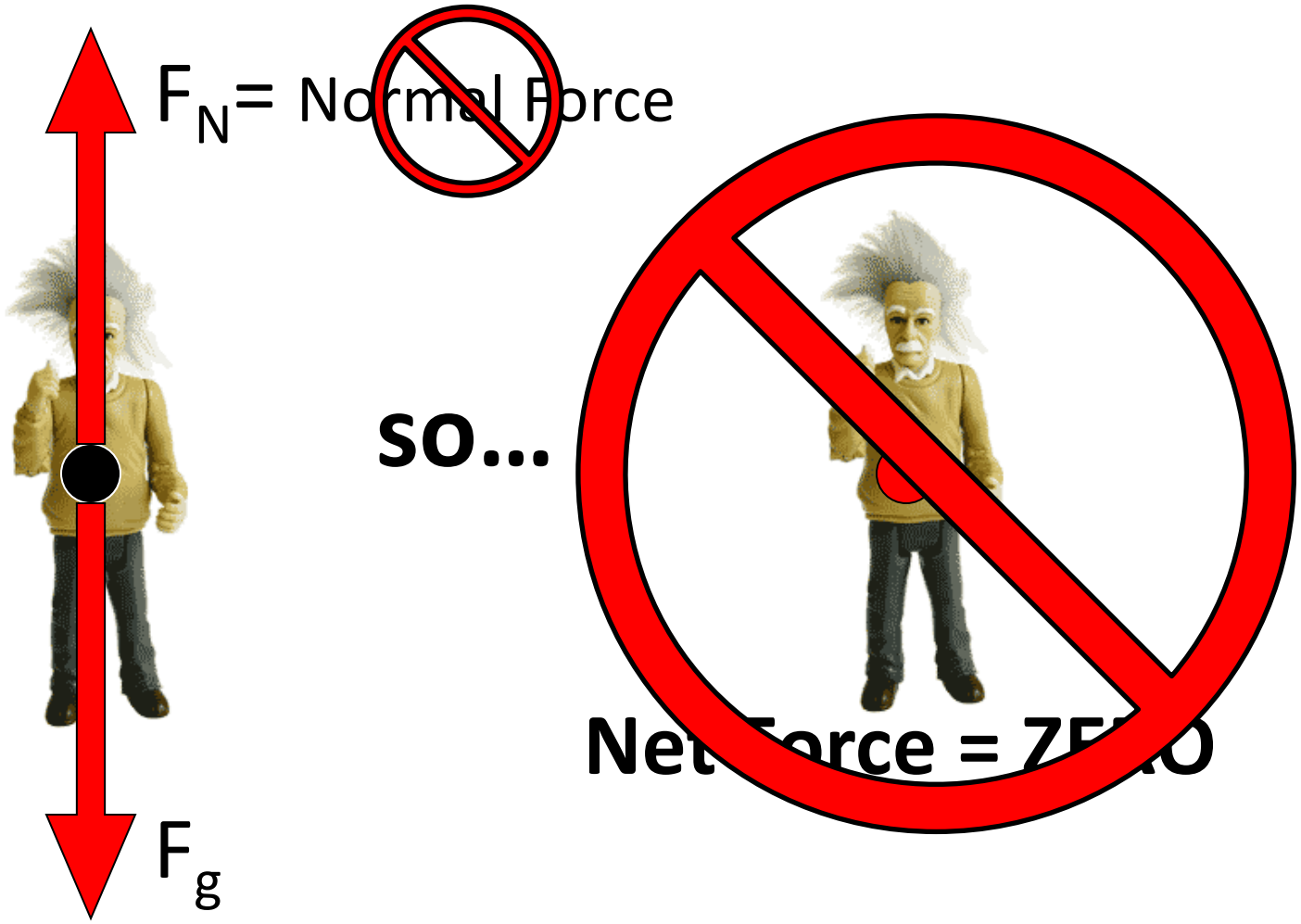
- Draw a force diagram for the Einstein “action figure” on the board.

SO…

Net Force = ZERO

Force Diagrams Practice

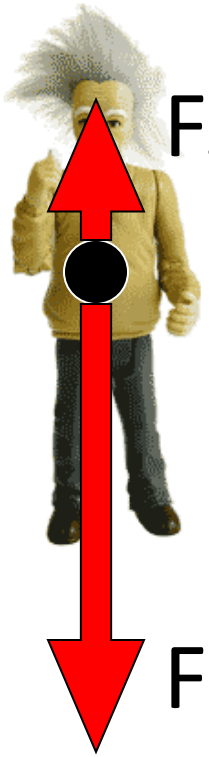
- Imagine the Einstein “action figure” in “free-fall”...



Force Diagrams Practice

- Imagine the Einstein “action figure” in “free-fall”...

Net Force = DOWN



F_f= Friction Force

SO...

F_g