Ch. 4, 5, 13

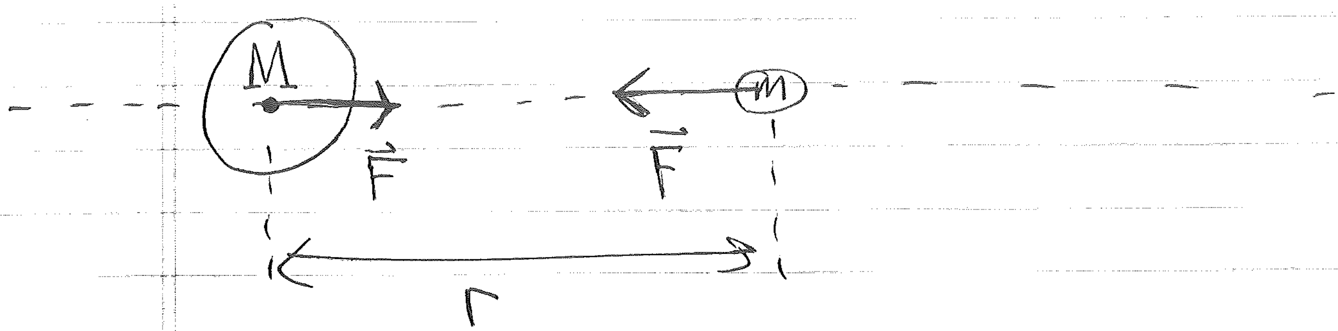
WARNING!! WARNING!!

Isaac Newton (1642 - 1727)
(3)
?

Cambrige 1665 → Farmer

1665-6 Developed Ideas.

* Law of Gravity (Universal)



* All mass attracts all other mass (Why?)

$$\underbrace{|\vec{F}|}_{\text{Gravity}} = \frac{GMm}{r^2}$$

Universal gravitation constant.

[1915 — Einstein "General Relativity"]

"Spooky" force: "action at a distance"

↳ Acts w/o touching

Newton's Laws of Motion

Newton's game, by Newton's rules. ☆

EVERY explanation you present, ☆

Force: A push or pull.
Vector.

S.I. unit "newton" (N)

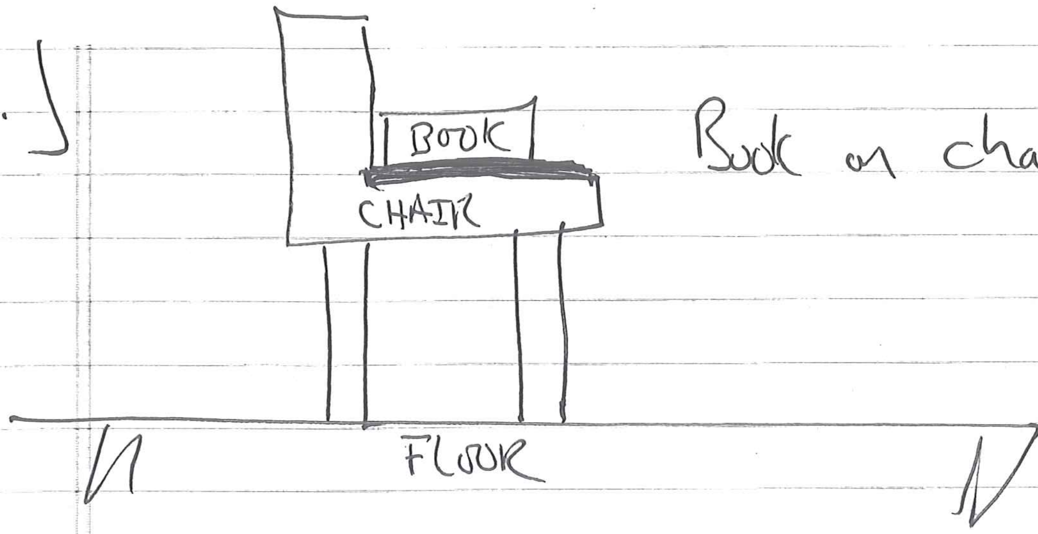
Kinds of Forces

"Spooky" — gravity

"touch"

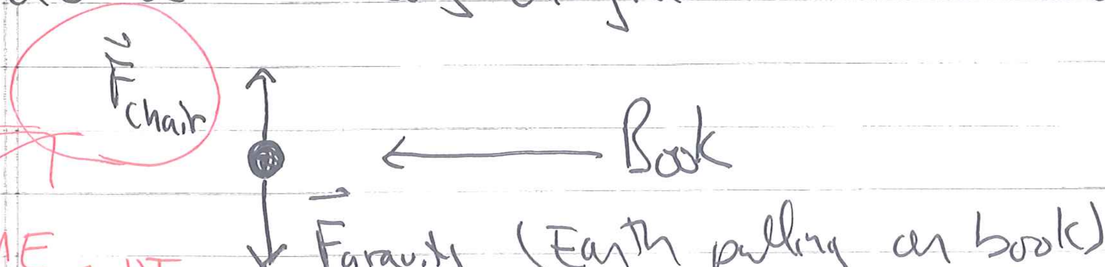
"Free-body diagram": Imagine that you are the object in question. Identify all of the forces acting on you.

Ex.)



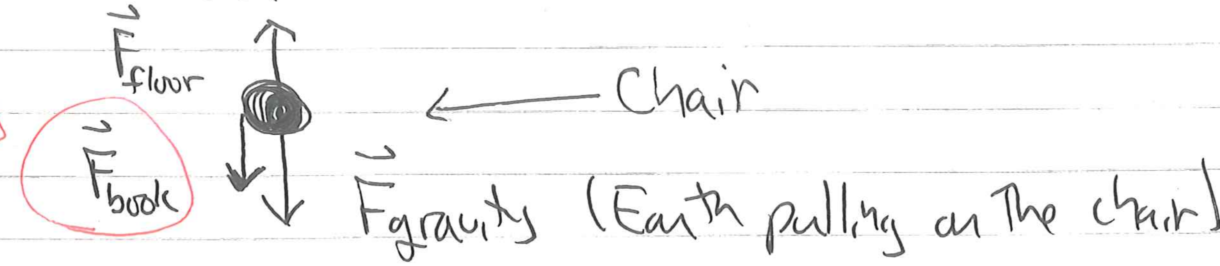
Book on chair.

Draw a free body diagram for the book.



SAME MAGNITUDE

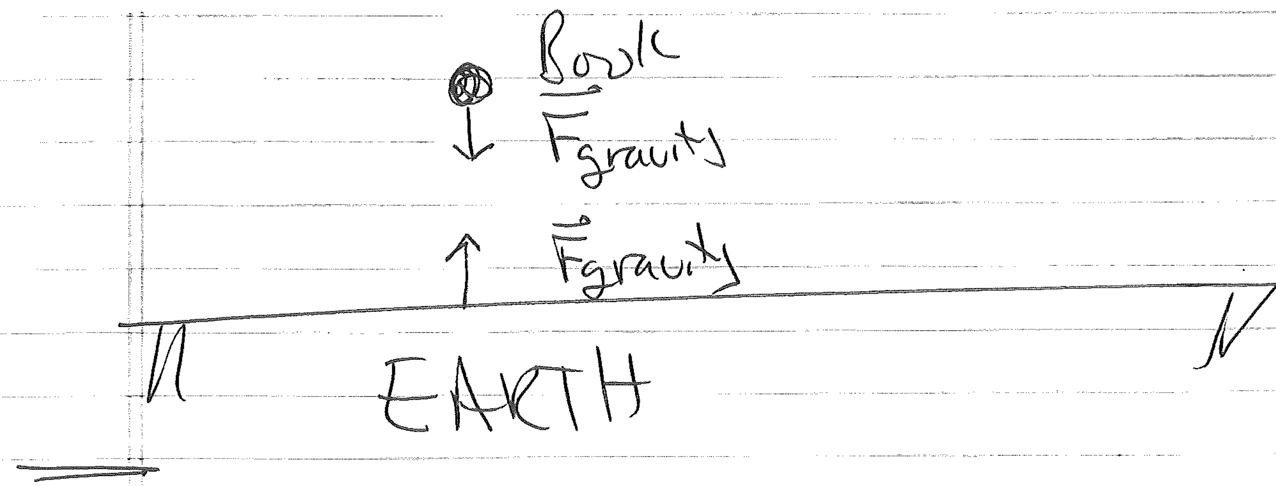
* For the chair?



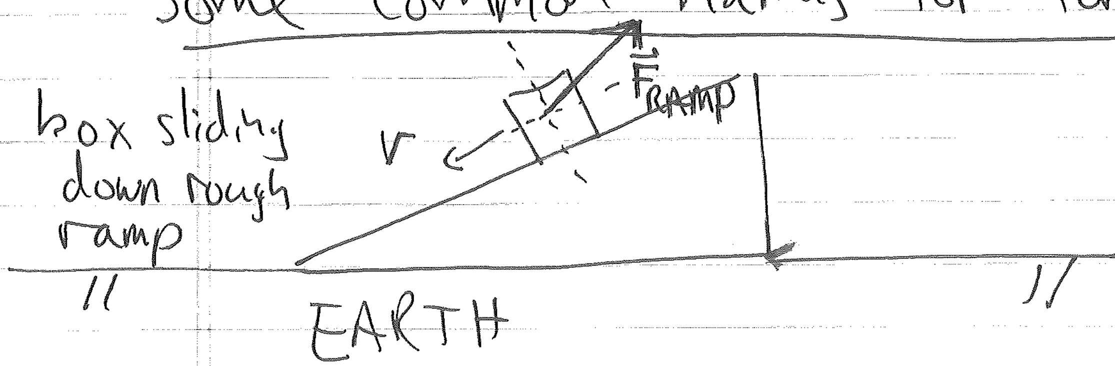
NEWTON: The interaction between two objects * is characterized by a SINGLE force (experienced from two perspectives)

"Action/Reaction" Pair

→ 3rd Law || "There are two sides to every story"

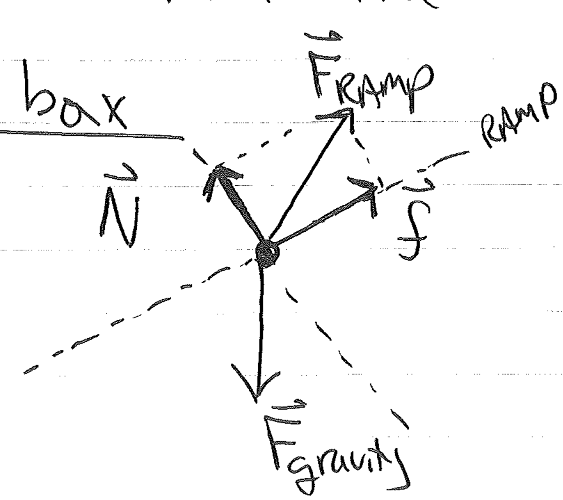


Some common names for forces



For the "touch" between two objects:
If there is a surface, usually break the force into two "forces".

For box



"Normal force" is $\perp$ to the touch

"friction" is $\parallel$ to the touch

$\vec{F}_{RAMP}$:)

Laws of Motion

1st – Forces change motion.

"Objects moving in a straight line continue to do so unless acted on by a Force"

"Law of Inertia" (Galileo)

Aristotle (384 B.C.) → like seeks like. Natural state of rest

2nd – Forces produce accelerations

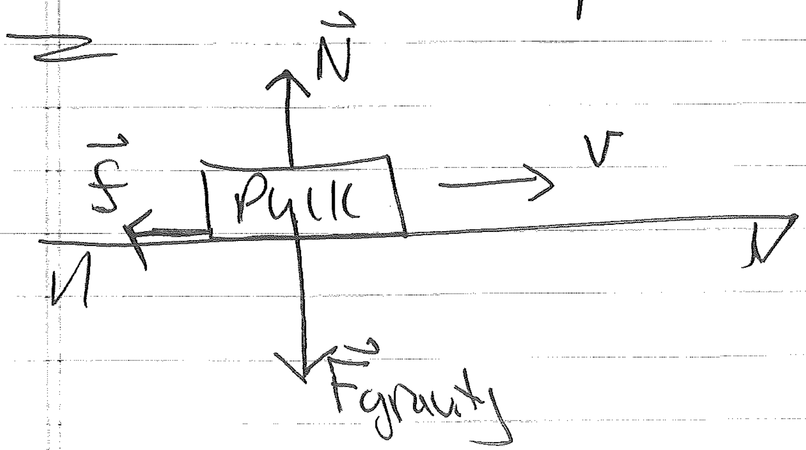
$$\vec{F} = m\vec{a}$$

VECTOR EQTN (3 eqtns.!!!)

Mass → a # indicating how much 'stuff' is present. An indication of how difficult it is to change an objects motion
(kg)

3rd – Two sides to every story. ☺

EX] A hockey player kicks a puck across the ice. At the instant when the puck is 10 m from the player, draw a free-body diagram showing all the forces on the puck.

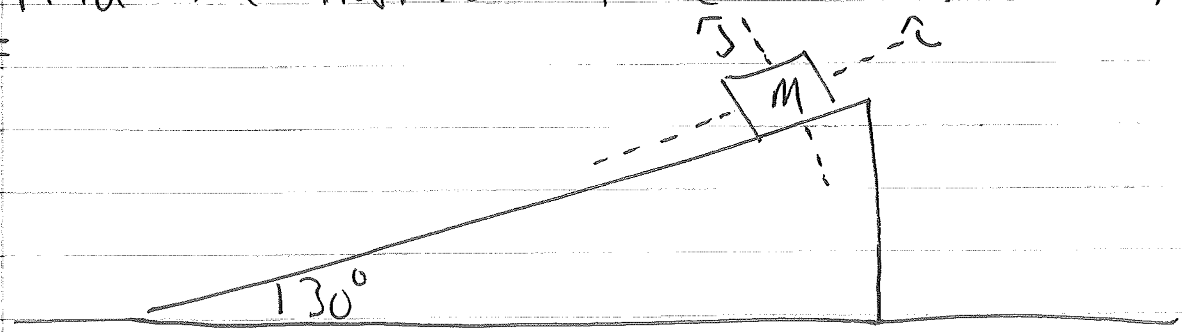


Process for solving (Applying) Newton's Law

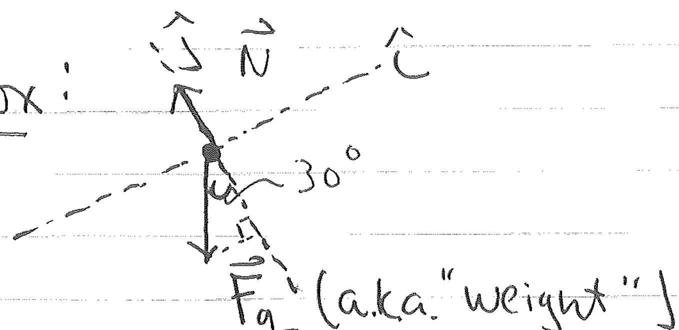
- Draw Picture
- Choose a mass to which you want to apply 2nd law
- Construct a free-body diagram for that mass.
  - Show mass as a point
  - Choose coordinate system
  - Identify forces
  - Write forces as vectors
- Apply 2nd law and Algebrate
- Repeat if needed

EX.] A 5 kg box is released from rest @ the top of a plane (smooth)* inclined @ 30°.

Find acceleration of box along the plane.
Find the normal force on the box.



for box:



* No friction

$$\vec{N} = +N\hat{j}$$

$$\vec{F_g} = -F_g \sin(30)\hat{i} - F_g \cos(30)\hat{j}$$

Aside: M_{Earth} • M_{box}

$(R_{Earth} + \text{height ramp})$

$$|\vec{F}_{GRAVITY}| = \left[\frac{G M_{Earth}}{(R_{Earth} + h_{ramp})^2}\right] M_{box}$$

$$\left|\vec{F}_{GRAVITY}\right| = \underbrace{\left[\ 9.8\ \right]}_{\text{"}g\text{"}} M_{box}$$

$$\left|\text{Weight}\right| = \left|\vec{F}_{gravity}\right| \approx m_{box}\, g \quad \Big\|\ \text{NOT } 2^{nd} \text{ LAW}$$

2^{nd} $\sum \vec{F} = m\vec{a}$

$\boxed{\hat{j}}$ $\sum F_y = m\cancel{a_y} \rightarrow 0$ no motion in $\hat{j}$

$$+N - F_g \cos(30) = 0$$

$$\therefore N = F_g \cos(30) = (5)(9.8)\cos(30)$$

$\boxed{\hat{i}}$ $\sum F_x = m a_x$