PHYS1002 Fundamentals
Module 2

Mechanics

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These lecture notes are available online at

http://www.physics.usyd.edu.au/~helenj/Mechanics.html

or via WebCT

Module content

Knight, Jones & Field (KJF): College Physics

- Chapters 4 & 5: Force and Newton's Laws
- Chapter 6: Circular motion
- Chapters 7 & 8: Torque and equilibrium
- Chapter 9: Momentum
- Chapter 10: Energy and Work

What is Mechanics?

Kinematics describes **how** objects move

Mechanics explains **why** objects move using the concepts of

- force
- energy
- momentum

Study of objects sitting still (forces are balanced)
⇒ statics

Study of causes of motion ⇒ dynamics

FORCE

KJF chapters 4 & 5

Forces

What is force? (Crudely speaking)
A force is a push or a pull that can

- change the velocity of an object
- cause a distortion in the size or shape of an object

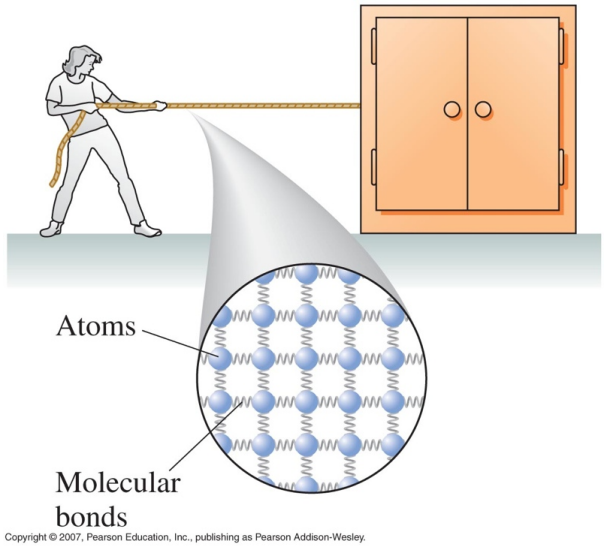
Examples?

KJF §4.2

Forces in Mechanics

Contact forces include

- Tension in rope
- Friction
- Drag
- Pushes / Pulls



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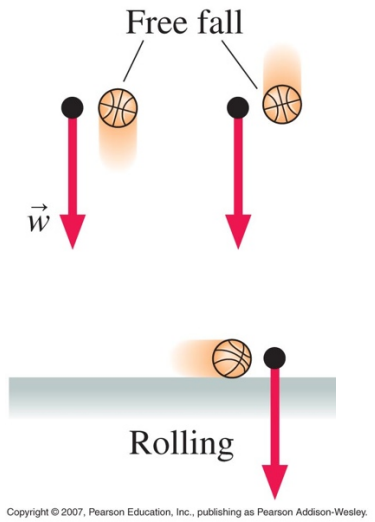
(virtually all common contact forces are actually electromagnetic)

KJF §4.3

Forces in Mechanics

Long-range forces

- Gravitational
- Electric & magnetic



The gravitational force between us and earth we call our weight

KJF §4.3

Fundamental Forces

Present theory says that all known forces can be shown to be due to three fundamental forces in nature:

- Gravitational — between masses
- Electroweak (electromagnetic+weak nuclear) — between charges
- Strong nuclear force — between particles in nucleus

Vectors

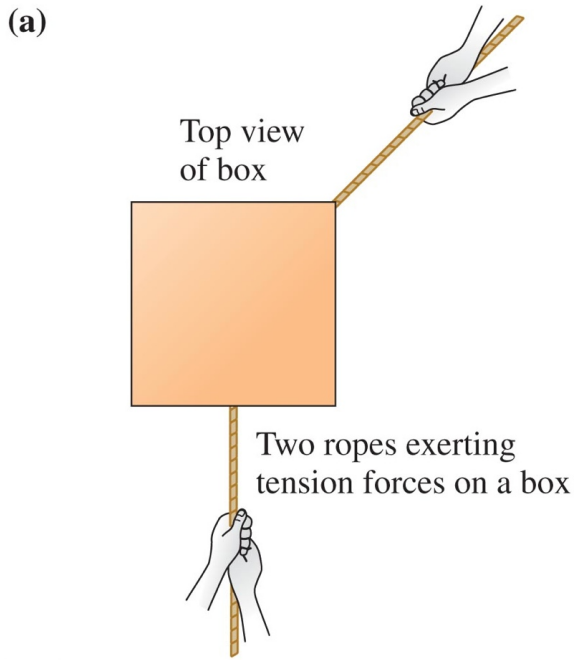
Force is a vector: it has direction & magnitude.

S.I. Unit of force: newton, N (or kg m s^{-2})

- Can be resolved into components at right angles
- Two or more forces acting on the same object are added by the rules of vector addition (resultant or net force)

KJF §4.2 & see "Vector Algebra Notes"

Adding Vectors



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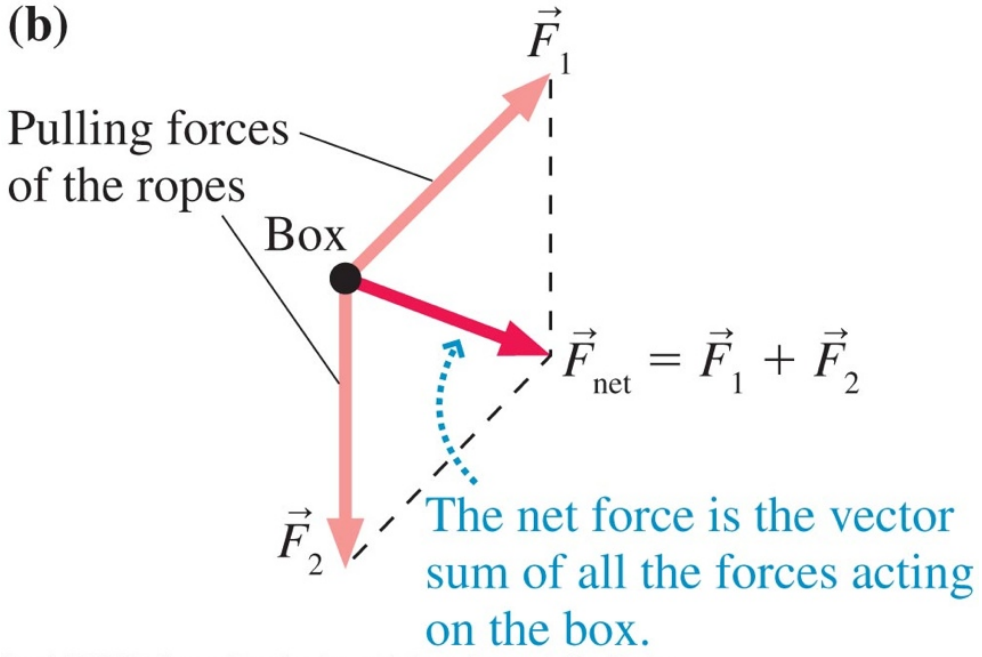

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KJF §4.2 & see "Vector Algebra Notes"

Newtons First Law
or Law of Inertia

If no net external force is applied to an object, its velocity will remain constant ("inert").

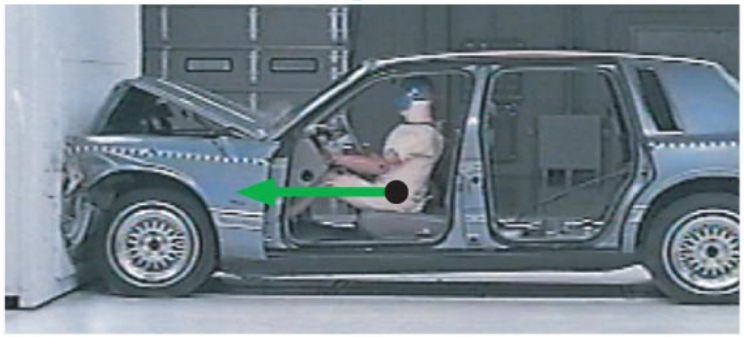
OR

A body cannot change its state of motion without outside influence.

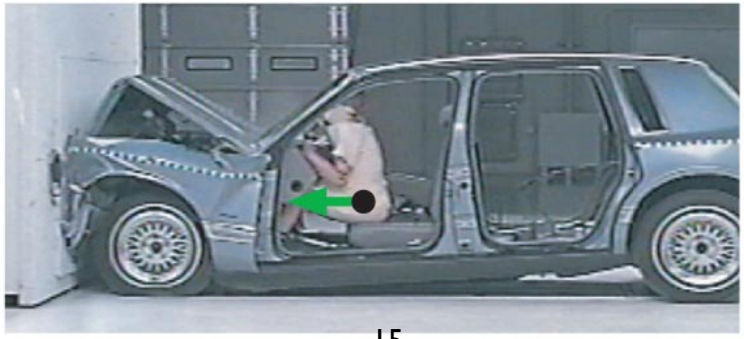
KJF §4.1

At the instant of impact, the car and driver are moving at the same speed;

The car slows as it hits, but the driver continues at the same speed . . .



. . . until he hits the now-stationary dashboard. Ouch!



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Remember:

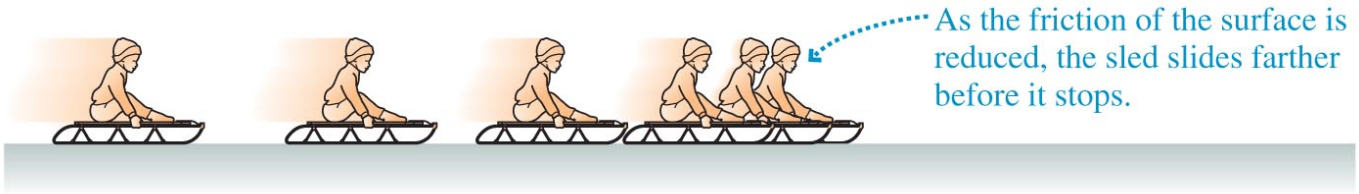
- Both magnitude $|\underline{v}|$ and direction are constant!
- An object “at rest” $\underline{v} = 0$, will remain at rest
- Applies if resultant force = 0 ("net" means resultant)

This law only applies in a non-rotating, non-accelerating frame of reference (called an “inertial frame”).

"frame of reference" means "point of view"

2000 years to change from Aristotle's view — that a body needed a force to keep it moving.

Seems contradictory because we forget about gravitational and frictional forces acting on us in our everyday life.



(a) Smooth snow

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(c) Frictionless surface

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Example

A hockey puck on a string, being rotated rapidly on a horizontal sheet of ice

(i.e. we can ignore vertical forces & friction)

Let go of string.

Which way does it go?