Newton's Law of Motion

Physics 211
Syracuse University, Physics 211 Spring 2015
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February 5, 2015

Announcements

- Homework 3 due next Wednesday (will be posted today
- Mastering Physics assignment due before class Tuesday (this one counts; will be posted today)
- Exams returned and recapped on Friday in recitation

Exam 1

- Full statistics will be posted once I get them (average around 90/150)
- You probably did better than you thought: remember the grading scheme
- Remember you can drop your lowest exam grade

Ask a Physicist: Cherenkov radiation

Newton's laws

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

- Forces on an object cause it to accelerate
- The larger the force, the larger the acceleration
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- The larger the mass, the smaller the acceleration
- You intuitively know this already
- No forces $\rightarrow$ no acceleration: not necessarily no motion!

- Forces come in pairs (Newton's third law)
  - "If A pushes on B, B pushes back on A"
  - Very important to be clear about what forces you're talking about

Newtons

We need a new unit for force: the newton

$\vec{F} = m\vec{a} \rightarrow$ Force has dimensions kg $\mathrm{m/s^2}$

- 1 N $=$ 1 kg $\mathrm{m/s^2}$: about the weight of an apple
- 4 N is about a pound
- 9.8 N is the weight of a kilogram

Force is a vector

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

- Force is a *vector*
- Multiple forces on an object add like vectors do
- Really, we should write

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

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(force table demo)

What is a force?

A force is anything that pushes or pulls something:

- Gravity: $F = mg$, so $mg = ma \rightarrow a = g$
  - Gravity pulls down on everything (on Earth) with a force mg, called its weight
  - If something isn't accelerating downward, some other force must balance its weight

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  - Are there normal forces on me right now?

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  - However big it needs to be to stop objects from sliding through each other
  - Directed "normal" (perpendicular) to the surface
  - Really caused by electric force/Pauli exclusion principle

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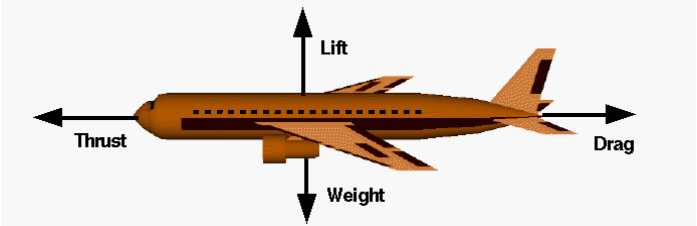
- Acceleration is not a force!
- ... it's the *result* of forces

Force diagrams

- Lots of forces, easy to get confused
- Draw a picture!



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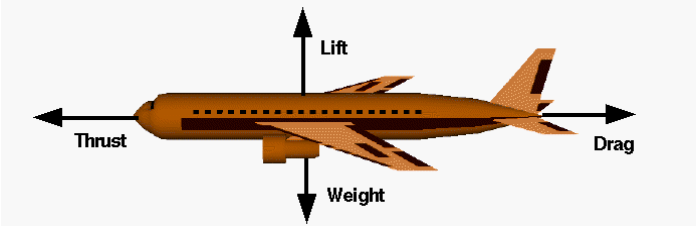

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- Label each force and its direction
- These are also called “free body diagrams”

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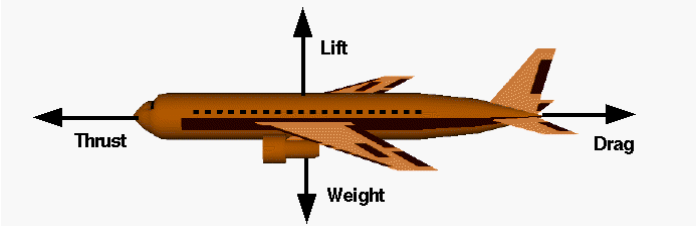

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(Examples on document camera)

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(Use $\vec{F} = m\vec{a}$ to connect force to acceleration, and then kinematics to connect acceleration to motion)

Summary

- Forces: anything that pushes or pulls
- Forces cause accelerations: $\sum \vec{F} = m\vec{a}$
  - If $\sum \vec{F} = 0$, $\vec{a} = 0$: motion at a constant velocity
- Forces come in pairs: if A pushes on B, B pushes back on A
- It's the vector sum $\sum \vec{F}$ that matters
- Draw force diagrams to keep all of this straight