Newton's Law of Motion

Physics 211
Syracuse University, Physics 211 Spring 2015
Walter Freeman

February 11, 2016

Announcements

- Homework 3 due next Friday (will be posted sometime this weekend)
- Bring your computers/tablets to class next Tuesday, and to recitation next week
- If you don't have one, check one out from the library

Exam 1

- Returned yesterday in recitation
  - A TA missed a recitation yesterday; he will go over the exam Friday.
- Grade appeal form on the course website
- Reports of some significant grade anomalies from the TA's
- If you think your grade is incorrect, *please appeal* – I want to make sure things are fair
- You can do this in person at my office hours today
- Normal office hours today, but office hours extended tomorrow: 10-12, 12:45-6, in my office in 215
- Please be patient – I will make sure things are fair, but there are a lot of you

The Facebook announcement

It has come to my attention that the TA's made at least some, and potentially quite a few, grading errors on the exams.

I was not able to supervise all of the grading directly, and one of my TA's brought to my attention that multiple students in his recitation received little credit for answers that contained quite a lot of physics that was correct.

This makes me question the accuracy of the grades you received.

While this has happened before, I haven't heard about it happening to this extent. I promise I'll make everything fair in the end and correct any mistakes the TA's made, but there is only one of me, and this will be a great deal of work; please have patience with me as I fix things.
If you believe that your grade is not fair for any problem, I encourage you to appeal it. You might speak to your recitation TA or coach to see if they agree. There is a grade appeal form which will be posted tonight on the course website, and I will give you more information in class tomorrow.

I will be holding my normal office hours tomorrow. However, I will hold extended office hours Friday from 10AM to 6PM in room 215 (my office), with a break for lunch from noon to 12:45; you may come and ask me to regrade problems in person. I don't know how many of you there will be; if there is huge demand, I will work as quickly as possible, but I will take as much time as needed to ensure that all the grades are fair.

Grading you fairly and teaching you as much physics as possible are my highest priorities.

Ask a Physicist: general relativity and gravitational waves

Newton's laws

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

- Forces on an object cause it to accelerate
- The larger the force, the larger the acceleration
- The larger the mass, the smaller the acceleration
- You intuitively know this already

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- Forces on an object cause it to accelerate
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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

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

- 1 N = 1 kg 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

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

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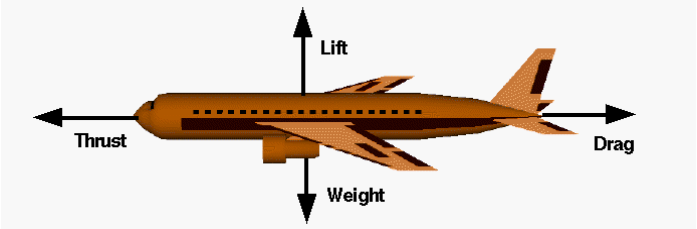
- Acceleration is not a force!
- ... it's the *result* of forces

Force diagrams

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



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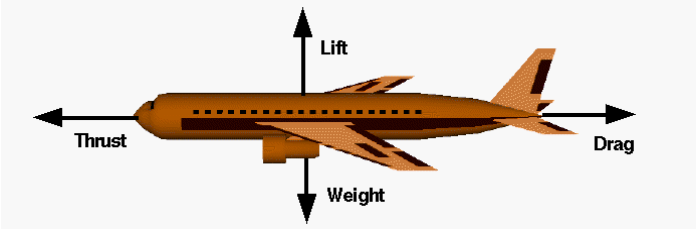

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- Label each force and its direction
- These are also called “free body diagrams”

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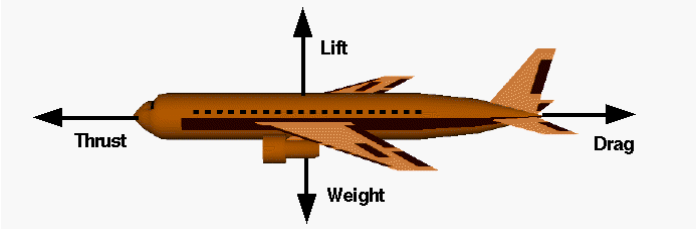

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(Examples on document camera)

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

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- If two things don't touch, or interact by gravity, electricity, etc., they don't exchange forces
- "A force is something that can send you to the doctor"

A sample problem

A stack of three books sits on a table. Each book weighs 10 newtons. Draw a force diagram for each one, and calculate the size of all the forces.

(Your answer should match what you know about how this works!)

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