PH125 Honors General Physics I

Patrick LeClair

Contact

- pleclair@ua.edu
  - Put “PH125” in subject
- office
  - 208 Gallalee (enter through 206)
- office hours
  - MWF 11-12
  - email for other times

- ODS accommodations? Let me know as soon as you can.

Graduate Assistants

- assist with labs, exercises, etc.
- you'll meet them next week & get contact info
- grads have pooled office hours ("help desk")
  - will post schedule when this starts

Lectures

- *principles* - new material covered in lecture
  - mostly discussion and concepts
  - worry about logic, strategies … *why*
  - read chapter ahead of time …
- *practice* – not something you can watch
  - have to *do* it!
  - read this one on your own and practice
  - will devote some time in class to group problem solving, particularly on Fridays
- Slides

Experiments

- More than just baking a cake.
- Not just experiments - this is *practice* time

- http://pages.physics.ua.edu/lab10x/
  - we may do something project-based midway through

- will start with lab introduction
- read the lab ahead of time
  - if you don't, read it before you start

- drop 1 lab at the end of the semester

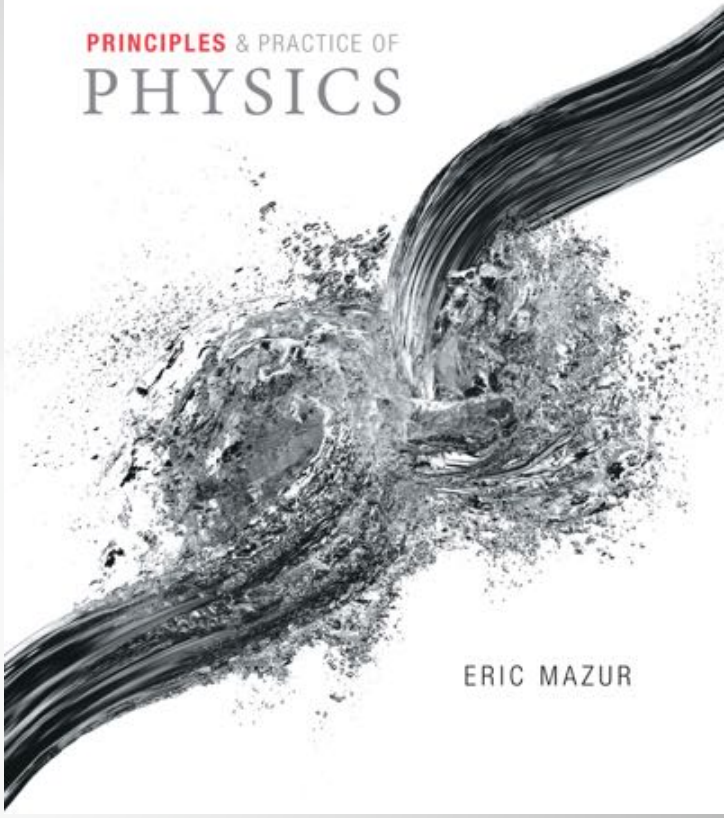
Topics

- Motion in 1D
- Acceleration
- Momentum
- Energy
- Interactions [energy]
- Force
- Work
- Motion in 2D
- Rotation & torque
- Gravity
- Periodic motion
- Waves
- Fluids
- Entropy
- Thermal energy

Syllabus

		Primary topic	Mazur	in lab	Note
24-Aug		syllabus, overview			
25-Aug		problems, lab overview	1.all		
29-Aug		1D motion	2.1-5	error analysis	drop without W by 30 Aug
31-Aug		1D motion	2.6-9	error analysis	
1-Sep		problems	2.all		
5-Sep		acceleration	3.1-5	1D motion	
7-Sep		acceleration	3.6-8	1D motion	
8-Sep		problems	3.all		
12-Sep		momentum	4.1-5	Newton's law	
14-Sep		momentum	4.6-8	Newton's law	
15-Sep		**EXAM 1**	**Ch. 2-4**		
19-Sep		energy	5.1-4	TBD	
21-Sep		energy	5.5-8	TBD	
22-Sep		problems	5.all		
26-Sep		interactions	7.1-6	friction	
28-Sep		interactions	7.7-10	friction	
29-Sep		problems	7.all		
3-Oct		force	8.1-6	work-KE	
5-Oct		force	8.7-12	work-KE	
6-Oct		**EXAM 2**	**Ch. 5, 7-8**		
10-Oct		work	9.1-5	momentum	midterm grades due 11 Oct
12-Oct		work	9.6-8	momentum	
13-Oct		problems	9.all		
17-Oct		motion in a plane	10.1-4	rotational dynamics	
19-Oct		motion in a plane	10.5-8	rotational dynamics	
20-Oct		problems	10.all		
24-Oct		gravity	13.1-8	gravitation simulations	
26-Oct		**FALL BREAK**			
27-Oct		**FALL BREAK**			
31-Oct		motion in a circle	11.1-4	Archimedes law	drop with W by 1 Nov
2-Nov		motion in a circle	11.4-6	Archimedes law	
3-Nov		problems	11.all		
7-Nov		torque	12.1-5	simple harmonic motion	
9-Nov		torque	12.6-8	simple harmonic motion	
10-Nov		problems	12.all		
14-Nov		periodic motion	15.1-7	standing waves	
16-Nov		waves in 1D	16.1-6	standing waves	
17-Nov		**EXAM 3**	**Ch. 11-12, 15**		
21-Nov		Waves in 2D, 3D	16.7-9, 17.1-3	TBD	
23-Nov		**THANKSGIVING**			
24-Nov		**THANKSGIVING**			
28-Nov		fluids	18.1-5	Boyle's law	
30-Nov		fluids	18.6-8	Boyle's law	
1-Dec		problems	18.all		
5-Dec		entropy	19.1-8	TBD	**DEAD WEEK**
7-Dec		thermal energy	20.all	TBD	**DEAD WEEK**
8-Dec		problems	review		**DEAD WEEK**

Textbook



- Principles & Practice
  - separated for a reason
  - get concepts first
- ordering of topics uncommon
  - based on education research
  - ‘builds’ better
- can get ebook with homework system
  - (cheapest overall I *think*)
- Used books are fine (but Amazon will be backlogged)

Grading

- Exams 45%
  - 3 in class, multiple choice, 10% each
  - 1 final, multiple choice, comprehensive, 15%
- Homework 15% (weekly)
- Labs 15%
- Quizzes 15% (before each lecture)
- Participation 10% (packback)

Participation?

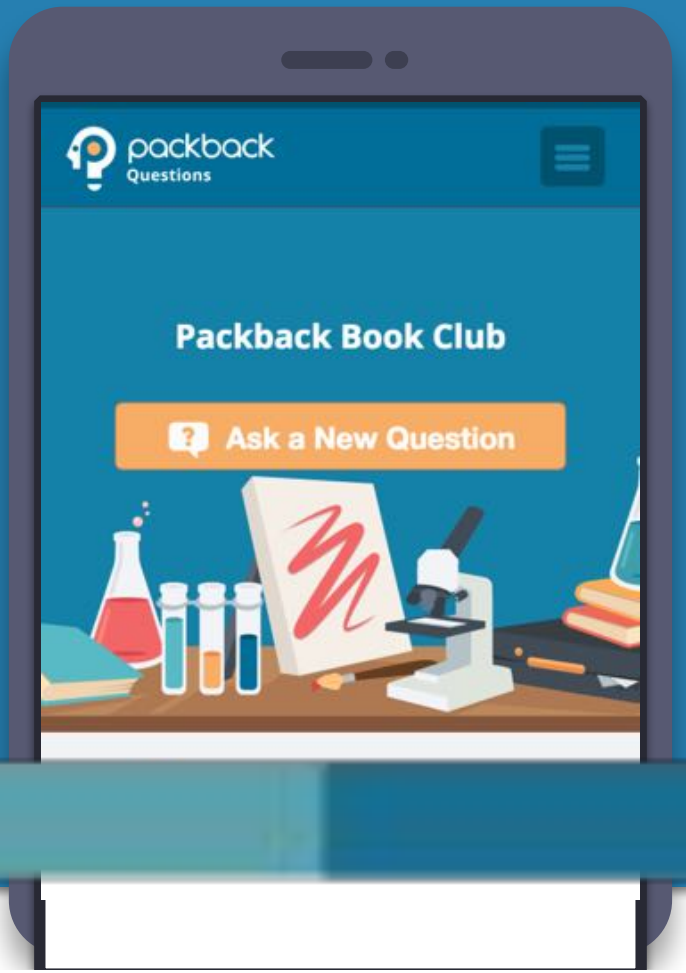
- I don’t grade attendance. You have to do something.
- Labs are one part of this.
- The main part – online discussion/QA system

packback

Fearlessly curious.

Our class is using Packback Questions for curious, out-of-class discussion.

- Earn participation points for being curious
- Read the most interesting answers from your classmates
- Ask questions about the topics that interest you most
- Learn how the things you're learning in class apply to your future



What to post in Packback Questions

Open-ended questions that have more than one right answer

- Try question starters like “How could”, “Why”, and “What might happen”
- Ask for **examples and ideas**, instead of answers and **definitions**

Questions asking for extra help that show your work

- Show your work or progress up to where you got stuck
- Provide details to explain **exactly** what you need help with!

Share a resource, article or idea that inspired you and ask for responses

- Share the resource (video, article, link) that inspired your curiosity

What not to post in Packback Questions

- X **No questions about the tests, homework, or class logistics**
  - *For example: "Is class cancelled today?" or "What's the answer to #4?"*
- X **No duplicate questions or answers**
- X **No profanity or inflammatory language; be kind and mindful**
- X **No cheating (this is not a place to get answers to homework)**
- X **No Closed-Ended Questions (Questions with only one right answer)**
- X **No plagiarism, or posts that are primarily quotes from other sources**

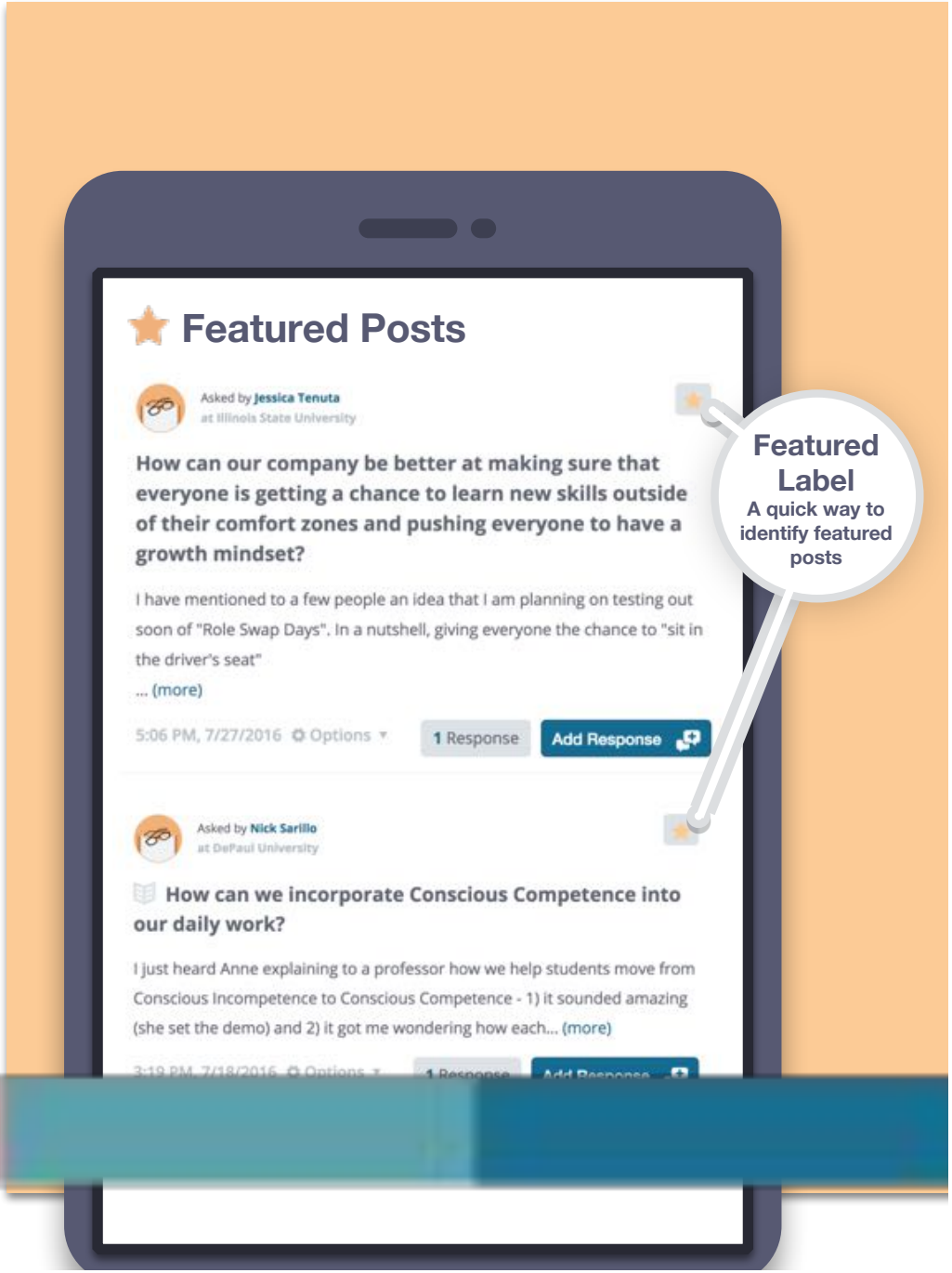
The Featured Tab

The Featured Tab keeps all the best posts in your community just one click away.

How do posts get featured?

The Community Health Algorithm suggests great posts to our moderators.

Packback Moderators or your professor hand-feature the “can’t miss” posts each week for you to read.



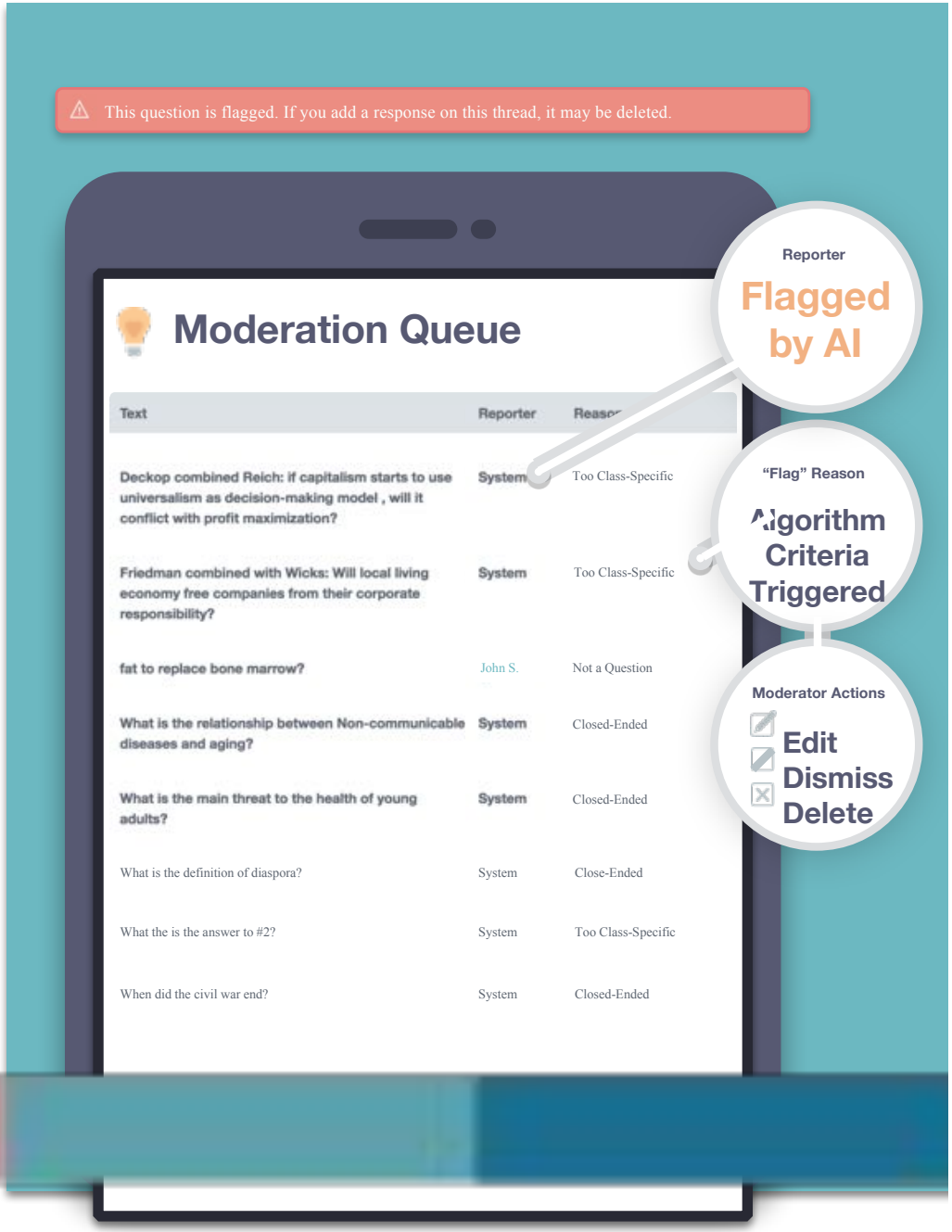
“Flagged” Posts

If your post is “Flagged”, it was flagged by a community member OR detected by our algorithm for potentially violating a Community Guideline.

Will all “Flagged” posts be deleted?

No! Flagged posts are reviewed by our Moderators. Just because a post is flagged does not mean it will be deleted.

Very short answers will always be removed.



The Learner Leaderboard

See how your Curiosity Score stacks up to your classmates in the Learner Leaderboard

How the Curiosity Score is calculated

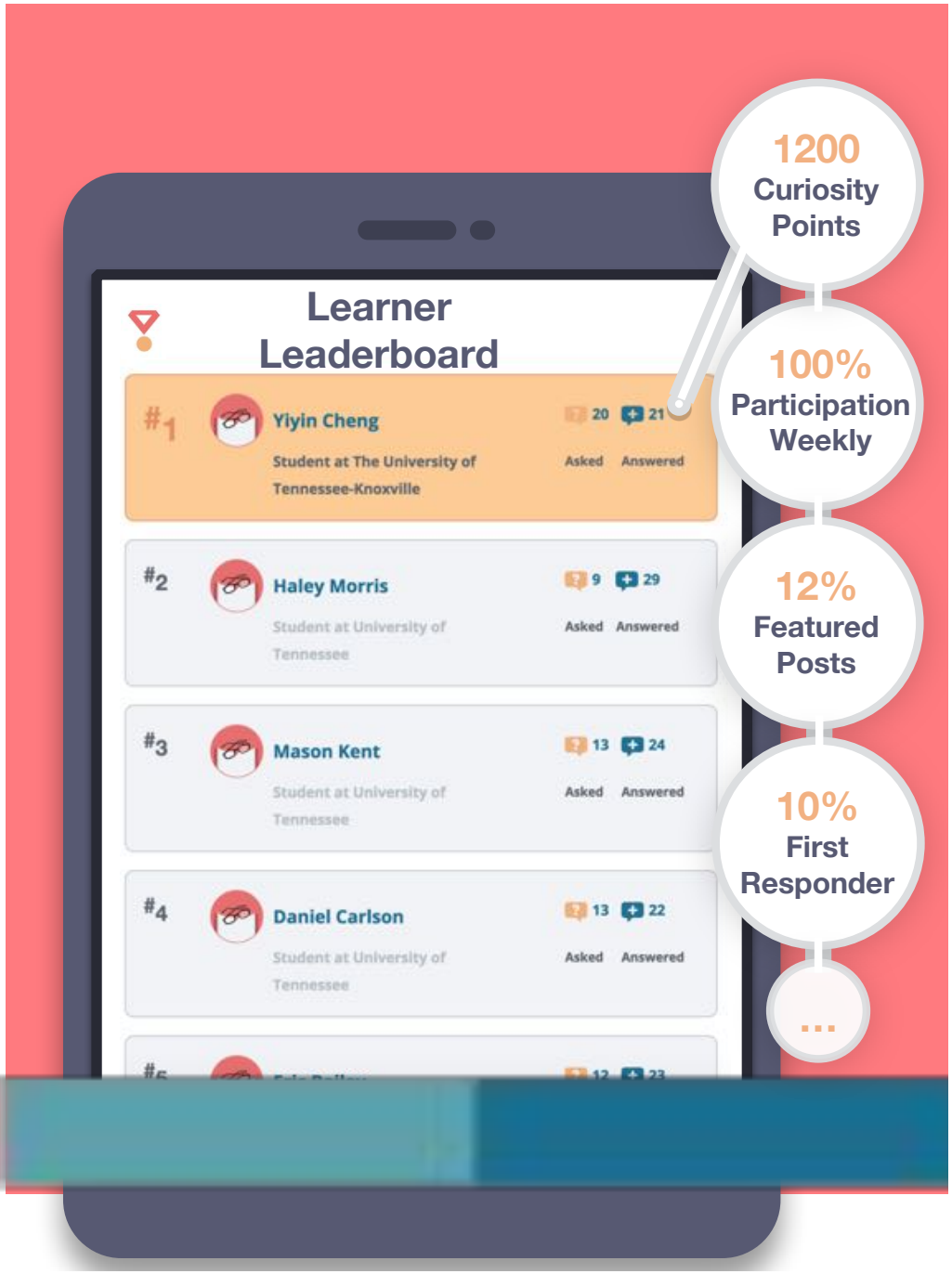
Depth: How detailed your post is

Presentation: How much effort was used

Credibility: Did your post cite sources?

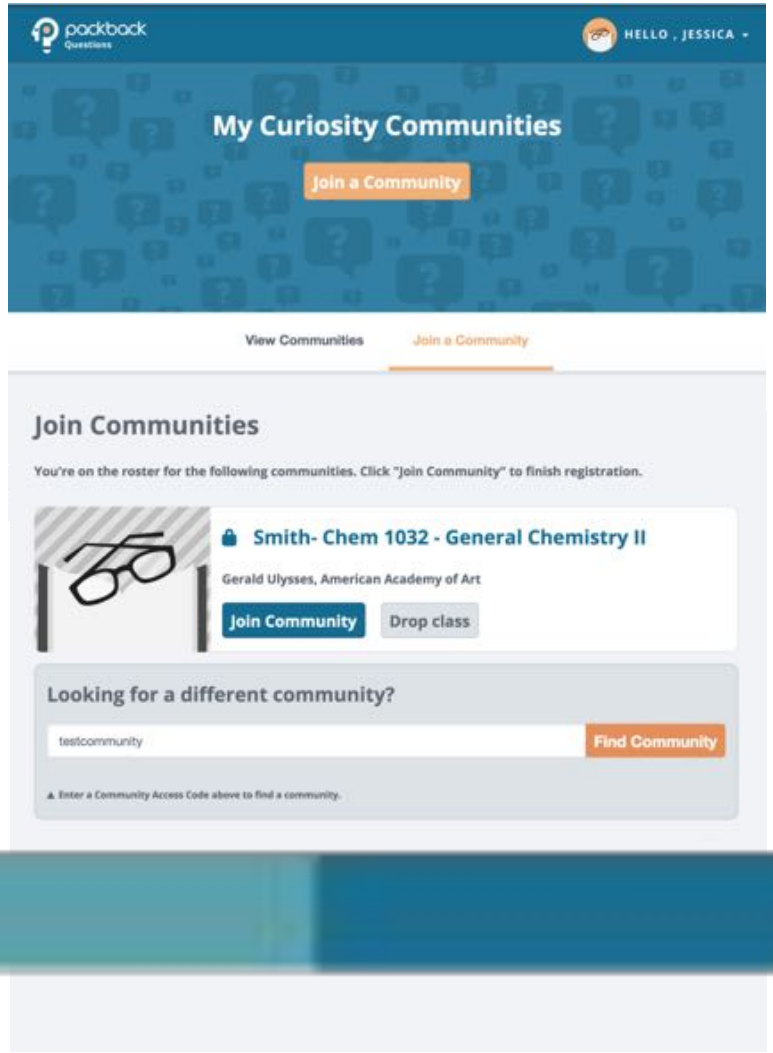
Behaviors: How did you participate?

Your professor may grade based on Curiosity Scores.



How to get started on Packback

1. **Check your inbox for an email from Packback**
2. **Finish creating your account (if you received an email) OR create a new account**
   - If you were on your professor's roster, that means we will have created an account for you. You just need to set your password.
3. **Log in & navigate to the "Join a Community" tab**
   - If you see your class, click the "Join Community" button on the community to finish registration.
   - If you do NOT see your class, enter the access code from the syllabus into "Find Community" module.



Go to packback.co
Access code:

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take a picture (also in syllabus)

Have any questions?

Click "Contact Us" or chat with us! Our average response time is 2 hours.

What should I ask Packback?

- **Why didn't my payment process?**
- **What is my Curiosity Score?**
- **Why is my question flagged?**
- Anything Packback related…

What should I ask my professor?

- **When is the next test?**
- **How should I study for the final?**
- **My dog ate my homework?**
- Anything else NOT Packback related…

Zahraa S.

Anyone know any reliable videos with visuals examples for practice with velocity with physics?

Additional help

Packback Archive > Fall 2015 Archive > [FALL 2015] Principles & Practice of Physics (LeClair) Aug 27, 2015 - 09:09 PM

Comments (0) | New Comment

Do you have the same question? Follow this Question

ANSWER THIS QUESTION Report it

Answers

Al W.

Aug 28, 2015 - 08:12 AM

Khanacademy.org is great for stuff like that! I use it all the time for math stuff too so it's a very well-rounded site if you need help with multiple subjects. <- Is that a video for what you wanted?

Comments (0) | New Comment 0 | 0 | Report it

Emily P.

Aug 28, 2015 - 06:14 PM

I like using clutchprep.com for videos. I used that website for organic, and it helps for physics too.

Comments (0) | New Comment 0 | 0 | Report it

Are the cracks in the roads caused by the friction between the asphalt and the tires?

10:25 PM, 6/19/2016 Options

Add your own Response

Answered by **Husam Ali**
at The University of Alabama

Cracks in the road are not caused by the friction between asphalt and the tires. Instead the cracks are caused by the expansion and contracting of the concrete. This is primarily caused by the suns heating and then the concrete cooling off during the night.

10:36 PM, 6/19/2016 Options

Answered by **Charles Williams**
at The University of Alabama

Water seeps into tiny spaces found on the road, freezes and expands making the cracks bigger. This happens repeatedly and eventually the road is filled with pot holes.

8:01 PM, 6/20/2016 Options

Interaction

- it is like StackExchange or Reddit
- you ask & answer questions
  up/down vote both Q & A
- **expect 3 Q+A per week** starting next week
  don't do them all on Friday
- Participation = 10% of your grade
  5% for completing the right number of Q+A
  5% more based on your curiosity score
- start next week. sign up now. ~$18 to join

Homework

- http://MasteringPhysics.com
- course code: PLECLAIRF17
- ***Register using your crimson email*** ***(why?)***
- need an access code too
  - should have received one with a new book
  - can buy one separately from site
  - can get ebook + MasteringPhysics
- new homework “every” week
  - due Friday at 5pm, **5% late per hour**
  - penalty for multiple tries, bonus for unused hints
- drop lowest single set

Quizzes

- Short reading quiz before every lecture (<10m)
  - on MasteringPhysics.com
- opens a day or two before, closes at class time
  - none on exam days
  - **first one next week Tues!**
  - no credit if late!
  - 2 attempts per question (with penalty)
- a few multiple choice questions
  - *mostly* qualitative, on that day's reading
  - read the chapter, you're OK!
- may be quizzes in lab too

From your first quiz:

Prelecture Concept Question 2.01

Part A

In the study of physics, what distinguishes a scalar from a vector?

- A scalar is specified with a single number, but a vector is specified using both a magnitude and a direction.
- Nothing—the terms "vector" and "scalar" are different names for the same thing.
- A scalar must always be positive, but vectors can be positive, negative, or zero.
- Scalars have both a magnitude and a direction, but vectors have only a magnitude.
- A scalar is a dimensionless number, while vectors are numbers that have dimensions.

Submit My Answers Give Up

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Prelecture Concept Question 2.01

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Submit My Answers Give Up

Correct

Misc

- No formal attendance policy
  - exams may rely on in-class stuff
  - we have graded labs and activities in class
  - will post slides for each lecture
- Missing in-class work/exams
  - let me know ahead of time
  - if that's not possible, ASAP after
  - acceptable reason = makeup or bye
- Will keep grades on MasteringPhysics
  - Will try to avoid Blackboard

For today

- Ch. 1 – Foundations
- should be largely review, or at least sensible
- just to ‘set the stage’

For tomorrow

- try to secure a textbook. read Ch. 1
- we'll go over a bit more about labs
- we'll do some problem solving

For Tuesday

- make sure you sign up for Mastering Physics
  - first reading quiz is due Tues by class time
- make sure you sign up for PackBack Answers
  - first 3 Q & A due by next Friday
- begin reading Ch. 2 of Mazur
  - 2.1-2.5 before Tues class

Quick activity

- Figure out who is sitting next to you.
- I’m not going to assign seating/lab partners, but would like lab groups to be stable & productive

Chapter 1 Foundations

Concepts

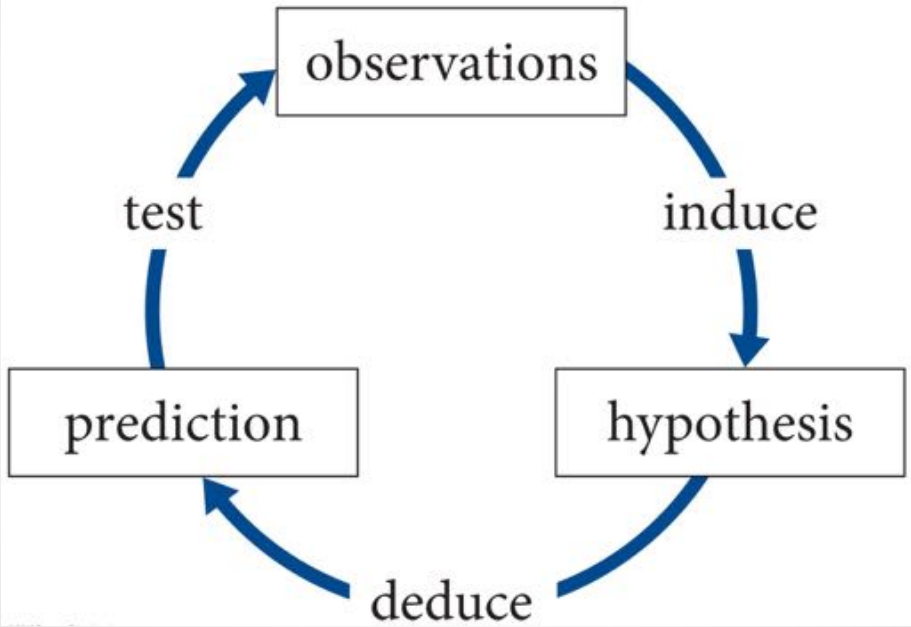
Section 1.1: The scientific method

- Physics is about discovering the unifying patterns that underlie all physical phenomena
  - Ranging from the scale of subatomic particles to the DNA molecules and cells, and to the scale of stars and galaxies.

- The goal is to find the most fundamental laws that govern the universe and to formulate these laws in the most simple and precise way possible.
  - Some things are simpler than others

Section 1.1: The scientific method

- **The Scientific Method** is an iterative process by which scientists endeavor to construct these laws of nature.



- If the prediction is inaccurate you modify the hypothesis
- If the predictions prove to be accurate test after test it is elevated to the status of a **law** or a **theory**.

Section 1.1: The scientific method

Exercise 1.1 Hypothesis or not

Which of the following statements are hypotheses?

(a) Heavier objects fall to Earth faster than lighter ones.

(b) The planet Mars is inhabited by invisible beings that are able to elude any type of observation.

(c) Distant planets harbor forms of life.

(d) Handling toads causes warts.

Section 1.1: The scientific method

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Section 1.1: The scientific method

Exercise 1.1 Hypothesis or not (cont.)

SOLUTION (*a*), (*c*), and (*d*).

A hypothesis must be experimentally verifiable.

a) I can verify this statement by dropping a heavy object and a lighter one at the same instant and observing which one hits the ground first.

b) This statement asserts that the beings on Mars cannot be observed, which precludes any experimental verification and means this statement is not a valid hypothesis.

Section 1.1: The scientific method

Exercise 1.1 Hypothesis or not (cont.)

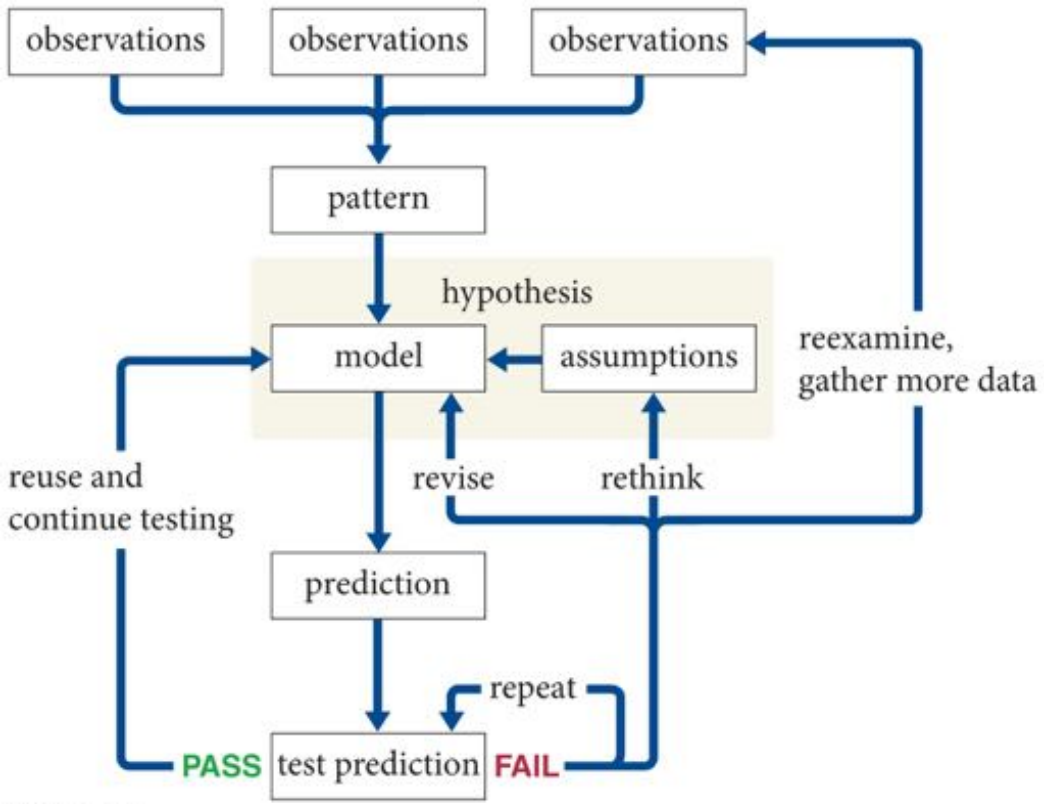
SOLUTION

c) Although we humans currently have no means of exploring or closely observing distant planets, the statement is in principle testable.

d) Even though we know this statement is false, it *is* verifiable and therefore is a hypothesis.

Section 1.1: The scientific method

- forming a hypothesis almost always involves developing a **model**
- a **model** is a simplified conceptual representation of some phenomenon.



Section 1.1: The scientific method

Exercise 1.2 Dead music player

A battery-operated music player fails to play when it is turned on.

- Develop a hypothesis explaining why it fails to play.
- Make a prediction that permits you to test your hypothesis.
- Describe two possible outcomes of the test and what you conclude from the outcomes.

Section 1.1: The scientific method

Exercise 1.2 Dead music player (cont.)

SOLUTION (one example):

Hypothesis: The batteries are dead.

Prediction: If I replace the batteries with new ones, the player should work.

Possible outcomes: (1) The player works once the new batteries are installed, which means the hypothesis is supported; (2) the player doesn't work after the new batteries are installed, which means the hypothesis is not supported and must be either modified or discarded.

Checkpoint 1.2

1.2 In the music player example, each outcome had a hidden assumption.

Hypothesis: The batteries are dead.

(1) The player works once the new batteries are installed, which means the hypothesis is supported;

(2) The player doesn't work after the new batteries are installed, which means the hypothesis is not supported and must be either modified or discarded.

Checkpoint 1.2

"supported" isn't the same as "proven correct"

"unsupported" isn't the same as "proven incorrect"

That the player works with new batteries doesn't mean the old ones were dead *necessarily*.

- perhaps the old ones were in backwards?
- perhaps changing the batteries fixed a loose contact?

That the player doesn't work with new batteries doesn't mean the player is broken *necessarily*.

- batteries could be in backwards both times
- new batteries might be dead too

Section 1.3: Matter and the universe

- The goal of physics: describe all that happens in the universe.
  - At least in principle
- The use of **physical quantities** is pivotal in developing concepts that describe natural phenomena.
- The fundamental physical quantity by which we map the universe is **length**:
  - The SI unit of length to be a **meter** and is abbreviated m.
  - The current definition of the meter is precisely defined through the (constant) speed of light

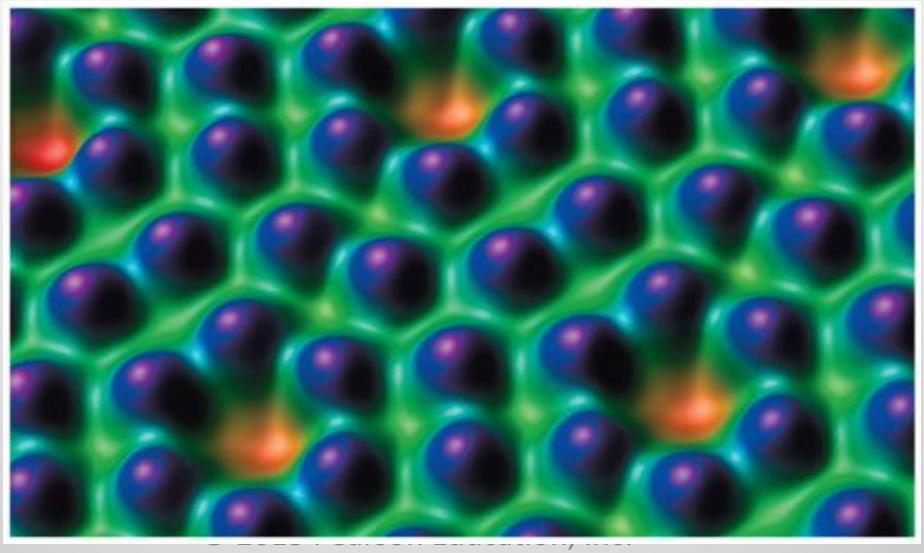
Section 1.3: Matter and the universe

- Because of the vast range of size scales in the universe, we often round off any values to the nearest power of ten.
- The nearest power of ten is called an **order of magnitude**.

- Any number between 0.3–3, call it 1
- Any number >3 but <30, call it 10
  - Example: 3 min = 180 sec or 1.8×10^2 s. Since $1.8 < 3$, the order of magnitude value is 10^2 s.
  - Basically: "about 100" rather than "about 10 or 1000"
  - "Two orders of magnitude larger" means ~100x
  - Example: Earth's circumference = 40,000,000 m = 4×10^7m. Order of magnitude value = 10^8 m.

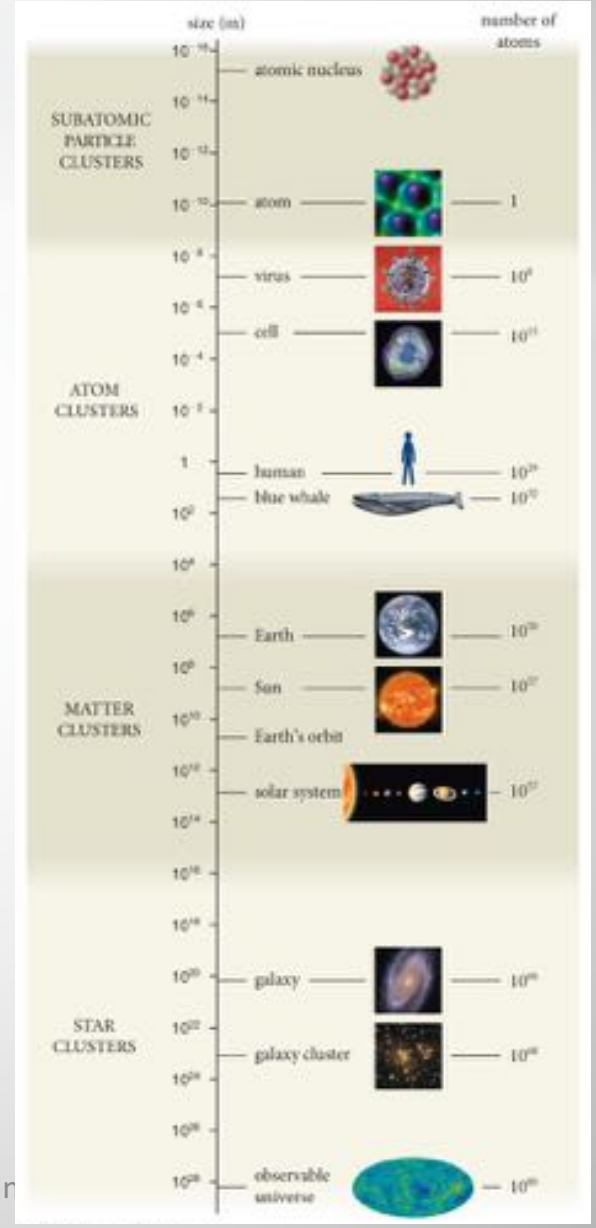
Section 1.3: Matter and the universe

- All ordinary matter in the universe is made up of basic building blocks called atoms
  - Nearly all the matter in an atom is contained in a dense central nucleus, which consists of **protons** and **neutrons**.
  - A tenuous cloud of **electrons** surrounds this nucleus.
- Atoms have a diameter of about 10^{-10} m.
- The nucleus has a diameter of about 10^{-15} m.



Section 1.3: Matter and the universe

- The figure shows the relative size of some representative objects in the universe.
- can you neglect things above/below a certain order away?
- One distinction between BIO, CH, PH



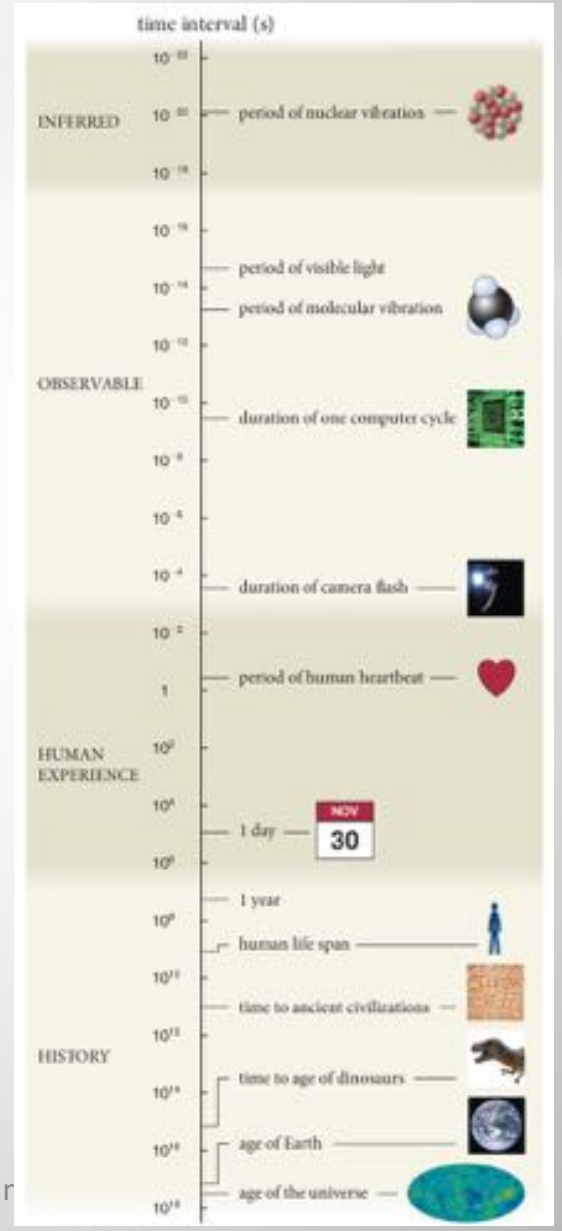
Section 1.4: Time and change

- Whereas we can freely choose the direction in all three dimensions of space, time flows in a single direction.
- This "arrow of time" only points to the future, and allows us to establish a causal relationship between events, which leads to the **principle of causality**:

  Whenever an event A causes event B, all observers see event A happen first.

Section 1.4: Time and change

- The standard unit of time is the **second** (abbreviated s).
- The second is *defined* as the duration of 9,192,631,770 periods of certain radiation emitted by cesium atoms.
- Essentially, based on the constant speed of light
- Neglect processes far slower/faster than what you're interested in?



Checkpoint 1.8

1.8 A single chemical reaction takes about 10^{-13} s. What order of magnitude is the number of sequential chemical reactions that could take place during a physics class?

Checkpoint 1.8

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Physics class is about 10^2 min or 6×10^3 s, of order 10^4.

In 1 s, one can fit 10^{13} reactions

In 10^4 s, one can fit $10^4 \times 10^{13} = 10^{17}$ reactions

Estimates like this are useful to see the 'shape' of the answer.

Estimate *before* investing a lot of time in an exact solution

Section 1.5: Representations

- develop **representations** to visualize physical phenomena
- develop scientific models that explain them.
- recognize that representations can possess a range of information from abstract to concrete.
- classify representations into graphical and mathematical ones.

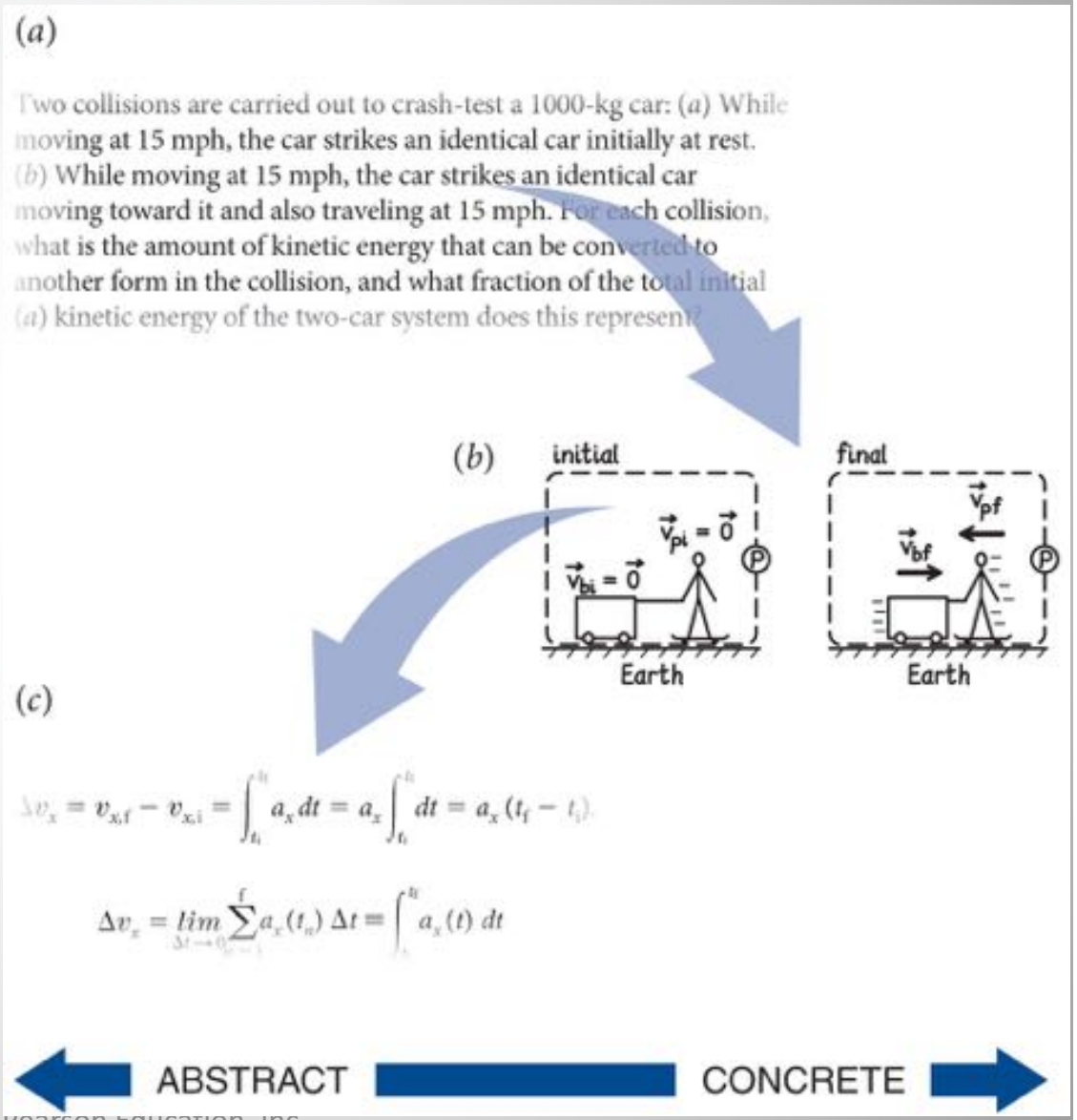
Section 1.5: Representations

- An essential first step in solving a problem: make a **visual representation** of the available information

- Helps develop a qualitative understanding of the problem, and organize the information

Section 1.5: Representations

- Visual representations are an integral part of getting a grip on physics problems and developing models
- Catalog what you know, what you want to find
- Sketch the situation noting these



Section 1.5: Representations

Exercise 1.5 Stretching a spring

- One end of a spring is attached to a horizontal rod so that the spring hangs vertically.
- A ruler is hung vertically alongside the spring.
- The stretching properties of the spring are to be measured by attaching eight identical beads to the spring's free end.
- With no beads attached, the free end of the spring is at a ruler reading of 23.4 mm.
- With one bead attached, the end of the spring drops to 25.2 mm.

Section 1.5: Representations

Exercise 1.5 Stretching a spring (cont.)

A total of six beads are added, giving the following readings:

bead number	ruler reading (mm)
2	26.5
3	29.1
4	30.8
5	34.3
6	38.2

Section 1.5: Representations

Exercise 1.5 Stretching a spring (cont.)

Going forward?

(a) Make a pictorial representation of this setup.

(b) Tabulate the data *[mostly done]*

(c) Plot the data on a graph, showing the ruler readings on the vertical axis and the numbers of beads on the horizontal axis.

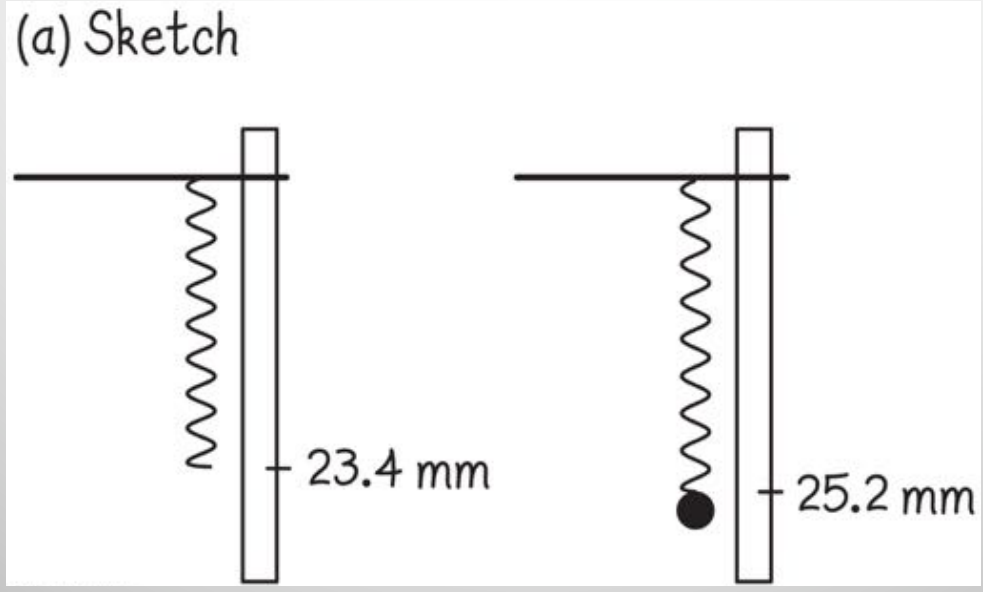
(d) Describe what can be inferred from the data.

Section 1.5: Representations

Exercise 1.5 Stretching a spring (cont.)

SOLUTION (*a*) sketch

- Key items needed: spring, rod, ruler, and typical bead
- Indicate how the ruler readings are obtained.
- Don't need to show all beads, one example is enough.
- Represented the general procedure of adding beads one (or two) at a time and how each addition changes the position of the spring end.



Section 1.5: Representations

Exercise 1.5 Stretching a spring (cont.)

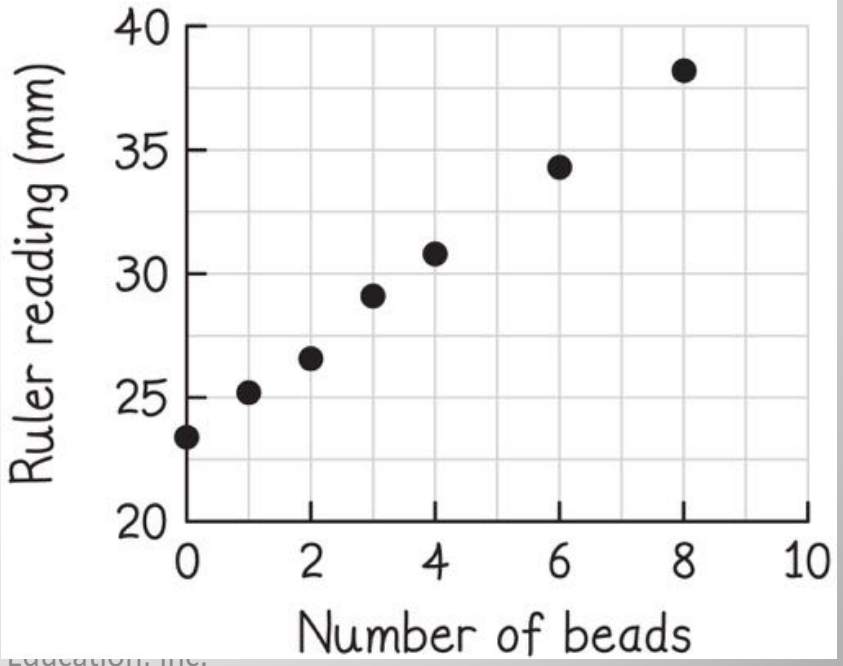
SOLUTION (*b*) complete table (*c*) make a plot (label axes! units! metric!)

(*d*) Ruler readings vs. the numbers of suspended beads is linear. Each additional bead stretches the spring by about the same amount.

(b) Table

Number of beads	Ruler reading (mm)
0	23.4
1	25.2
2	26.5
3	29.1
4	30.8
6	34.3
8	38.2

(c) Graph



Chapter 1: Self-Quiz #1

Two children in a playground swing on two swings of unequal length. The child on the shorter swing is considerably heavier than the child on the longer swing. You observe that the longer swing swings more slowly.

Formulate a hypothesis that could explain your observation.

How could you test your hypothesis?

Chapter 1: Self-Quiz #1

- No, really - formulate a hypothesis that could explain your observation. Come up with a way to test your hypothesis

Chapter 1: Self-Quiz #1

Answer

Two *plausible* hypotheses to start with

(1) Longer swings swing more slowly than shorter swings.

Make swings the same length and have them swing again.

(2) Heavier children swing faster than lighter ones.

Ask them to trade places

(Turns out the first one is better. Many things are *possible*, what nature has chosen is not always the most sensible thing.)

Chapter 1 Foundations

Quantitative Tools

Section 1.6: Physical quantities and units

- Name and understand the seven **base units** of the SI system of units.
- Use **power of 10 notation and metric prefixes** to represent large and small numbers and calculations involving them.
- Define the **density** of matter and its relationship to the mole and Avogadro's number.
- Perform **unit conversions** by use of a ratio of units.

Section 1.6: Physical quantities and units

- The symbols of some of the physical quantities we use throughout this course.

Table 1.1 Physical quantities and their symbols

Physical quantity	Symbol
length	ℓ
time	t
mass	m
speed	v
volume	V
energy	E
temperature	T

Section 1.6: Physical quantities and units

- The system of units in science is called *Système Internationale* or **SI units**.
- The SI system consists of seven base units from which all other units can be derived.

Table 1.2 The seven SI base units

Name of unit	Abbreviation	Physical quantity
meter	m	length
kilogram	kg	mass
second	s	time
ampere	A	electric current
kelvin	K	thermodynamic temperature
mole	mol	amount of substance
candela	cd	luminous intensity

Let's be honest …

- You have no feel for the metric system.
  - We stand with Liberia and Myanmar!
- 1m ~ 1yd ~ 3ft
- 1m/s ~ 2mph
- 1kg ~ 2lbs on earth's surface
  - kg is *mass*, lbs are *weight*
- second/ampere/etc are fine
- Kelvin/Celcius
  - 310K = 38C = hot day in AL (100F)
  - 295K = 22C = room temp (71F)
  - 285K = 12C = cold day in AL (53F)
  - 273K = 0C = water freezes (32F)

Section 1.6: Physical quantities and units

- Often we deal with quantities much less or much greater than the standards of 1 m, 1 s, etc.
- Prefixes for powers of 10 to make things easier
- Multiples of 3 are the only ones used commonly

Table 1.3 SI prefixes

10^n	Prefix	Abbreviation	10^n	Prefix	Abbreviation
10^0	—	—			
10^3	kilo-	k	10^{-3}	milli-	m
10^6	mega-	M	10^{-6}	micro-	μ
10^9	giga-	G	10^{-9}	nano-	n
10^{12}	tera-	T	10^{-12}	pico-	p
10^{15}	peta-	P	10^{-15}	femto-	f
10^{18}	exa-	E	10^{-18}	atto-	a
10^{21}	zetta-	Z	10^{-21}	zepto-	z
10^{24}	yotta-	Y	10^{-24}	yocto-	y

Section 1.6: Physical quantities and units

- The **mole** (abbreviated mol) is the SI base unit that measures the quantity of a given substance.
- The mole is defined as the number of atoms in 12×10^{-3} kg of the most common form of carbon, carbon-12.
  - This number is called the Avogadro number N_A, and the currently accepted experimental value of N_A is

$$N_A = 6.0221413 \times 10^{23}$$

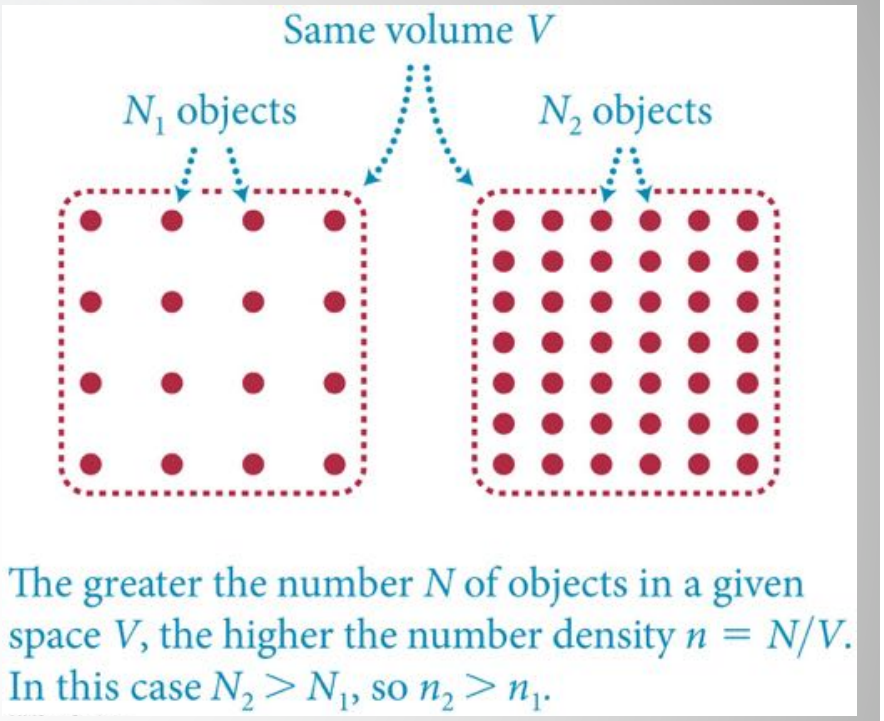
Section 1.6: Physical quantities and units

- An important concept used in physics is density:
  - Density measures how much of some substance there is in a given volume.
- The number of objects per unit volume is called **number density (*n*)**. If there are N objects in volume V, then

$$n \equiv \frac{N}{V}$$

- **Mass density ρ** is the amount of mass m per unit volume:

$$\rho \equiv \frac{m}{V}$$



The greater the number N of objects in a given space V, the higher the number density $n = N/V$. In this case $N_2 > N_1$, so $n_2 > n_1$.

- Why? So our solution works for *any* container, not just one particular case.
- We make a big deal out of *reduced quantities* like density, pressure that allow problems to be more abstract / independent of particulars

Section 1.6: Physical quantities and units

- It is important to be able to convert back and forth between SI units and other units.
- The simplest way to convert from one unit to another is to write the conversion factor as a ratio equal to one. For example we can write

$$\frac{1\text{ in.}}{25.4\text{ mm}} = 1 \text{ or } \frac{25.4\text{ mm}}{1\text{ in.}} = 1$$

- Because multiplying by 1 does not change a value, these ratios are easily used for unit conversions.
- As an example, if we want to convert 4.5 in into millimeters:

$$4.5\text{ in} = (4.5\cancel{\text{in}}.)\left(\frac{25.4\text{ mm}}{1\cancel{\text{in}}.}\right) = 4.5\times 25.4\text{ mm} = 1.1\times 10^{2}\text{ mm}$$

Section 1.6: Physical quantities and units

Exercise 1.7 Unit conversions

Convert each quantity to a quantity expressed either in meters or in meters raised to some power:

(a) 4.5 in.

(b) 3.2 acres

(c) 32 mi

(d) 3.0 pints

Section 1.6: Physical quantities and units

Exercise 1.7 Unit conversions (cont.)

SOLUTION See Appendix C for conversion factors. Or Google. Really.

$$(a) \quad (4.5 \text{ in.})\left(\frac{2.54\times10^{-2}\,\text{m}}{1 \text{ in.}}\right) = 1.1\times10^{-1}\,\text{m}$$

$$(b) \quad (3.2 \text{ acres})\left(\frac{4.047\times10^{3}\,\text{m}^2}{1 \text{ acre}}\right) = 1.3\times10^{4}\,\text{m}^2$$

Section 1.6: Physical quantities and units

Exercise 1.7 Unit conversions (cont.)

SOLUTION

$$(c) \qquad (32\ \text{mi})\left(\frac{1.609\times10^{3}\,\text{m}}{1\ \text{mi.}}\right)=5.1\times10^{4}\,\text{m}$$

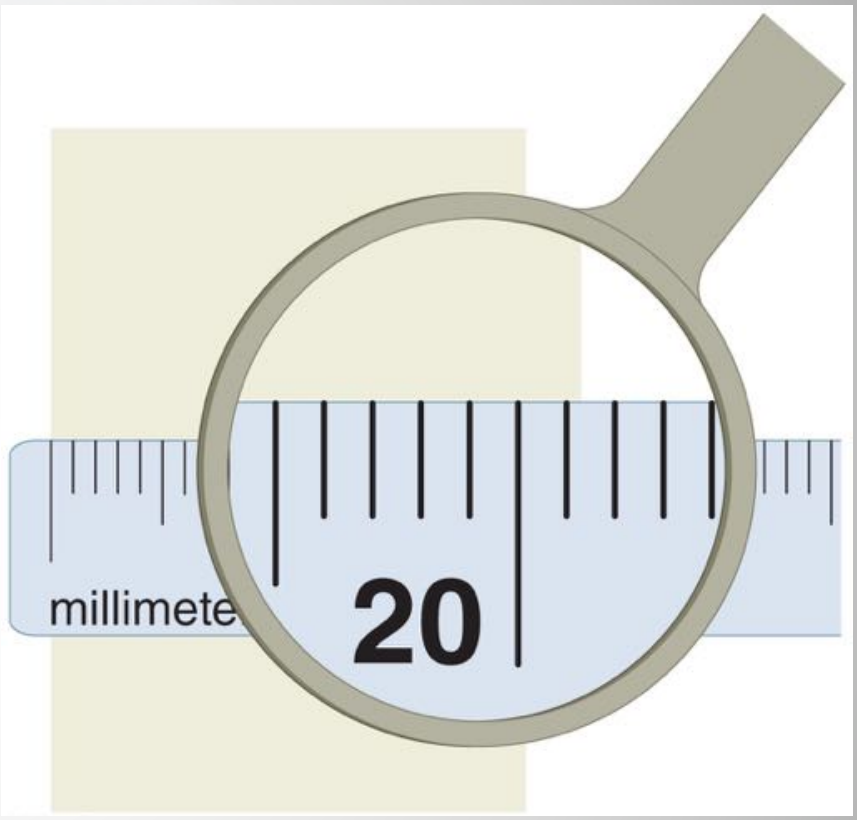
$$(d) \quad (3.0\ \text{pints})\left(\frac{4.732\times10^{-4}\,\text{m}^{3}}{1\ \text{pint}}\right)=1.4\times10^{-3}\,\text{m}^{3}$$

Section 1.7: Significant digits

- Identify **significant digits** as the number of digits in a number that are known reliably.
- Enumerate the **number** of significant digits in a measurement.
- Apply the rules of significant digits in **calculations** involving measured quantities.

Section 1.7: Significant digits

- Know how to precisely state what you know about a situation.
- Suppose you measure the width of a paper and it falls between 21 mm and 22 mm, but closer to 21 mm.
  - We might guess that it is 21.3 mm, but cannot be sure of the last digit.
  - By recording 21 mm, we are indicating the actual value lies between 20.5 and 21.5 mm.
  - The value 21 mm is said to have two **significant digits.**
- **Number of digits implies accuracy**



Section 1.7: Significant digits

- By expressing a value with the proper number of significant digits, we can convey the precision to which that value is known.
- If a number does not contain zeros, all digits are significant:
  - 21 has two significant digits, 21.3 has 3 significant digits.
- Zeros that come between nonzero digits are significant:
  - 0.602 has 3 significant digits.
- Leading zeros are never significant:
  - 0.037 has two significant digits.

Section 1.7: Significant digits

- Trailing zeros to the right of a decimal point are significant:
  - 25.10 has 4 significant digits.
- Trailing zeros that do not contain a decimal point are ambiguous.
  - 7900 can have two to four significant digits.

- More obvious with scientific notation:
  - 7.900×10^3 has four significant digits.
  - 7.9×10^1 has one significant digit.
- For simplicity, consider all trailing zeros to be significant.

Section 1.7
Question 5

The number 0.03720 has _____ digits, _____ decimal places, and _____ significant digits?

1. 6, 5, 4
2. 5, 5, 3
3. 6, 5, 3
4. None of the above

Section 1.7
Question 5

The number 0.03720 has _____ digits, _____ decimal places, and _____ significant digits?

1. 6, 5, 4
2. 5, 5, 3
3. 6, 5, 3
4. None of the above

Section 1.7: Significant digits

- The rules for working with significant digits:
  - When **multiplying or dividing** quantities, result has same significant digits as **least accurate** input
  - When **adding or subtracting** quantities, the number of decimal places in the result is the same as the input that has the **fewest decimal** places.
- Don’t overthink it.
  - Least accurate thing wins in a calculation
- Don’t report every digit your calculator gives

Section 1.8: Solving problems

You will learn to

- Develop a **systematic** four-step procedure to solve problems.
- Apply this procedure to some problems of interest to physicists.

Section 1.8: Solving problems

Procedure: Solving problems

- No single fixed approach
- Helps to break problems into steps
- Follow a systematic approach
- Book uses a four-step procedure

Section 1.8: Solving problems

Procedure: Solving problems (cont.)

1. **Getting started.**

   Given: carefully analyze information given.

   Find: what are you supposed to find/do?

   Sketch: organize with a sketch (or table of data)

   Concepts: determine concepts which apply

   note assumptions

Section 1.8: Solving problems

Procedure: Solving problems (cont.)

2. **Devise plan.**

   What do you need to do to solve the problem?

   Which relationships/equations do you need?

   In what order do you need to use them?

   Do you have enough equations vs. unknowns?

Section 1.8: Solving problems

Procedure: Solving problems (cont.)

3. **Execute plan.** Execute your plan, and then check your work for the following five important points:

   Vectors/scalars used correctly?

   Every question asked in problem statement answered?

   No unknown quantities in answers?

   Units correct?

   Significant digits justified?

Section 1.8: Solving problems

Procedure: Solving problems (cont.)

4. **Evaluate result.** There are several ways to check whether an answer is reasonable.
   - Expectation based on your sketch & information given (e.g., has to be more than X or less than Y)
   - If your answer is an algebraic expression, check special (limiting) cases for which you already know the answer. (e.g., no friction)
   - Make an estimate using a simpler but less precise calculation
   - Everyday experience – sounds plausible? (rare)

Section 1.8: Solving problems

Procedure: Solving problems (cont.)

4. **Evaluate result.** Sometimes there may be an alternative approach to solving the problem
   - If so, see if it gives the same result. If it doesn't, check math & assumptions
   - If none of these checks can be applied to your problem, check the algebraic signs and order of magnitude.
   - Always check that the units work out correctly.

Done

For Tomorrow: try to get a textbook. Read it

For Tuesday!

Mastering Physics

do the reading quiz by 3pm Tues

PackBack sign-up