PH105 General Physics I

Patrick LeClair

Contact

- pleclair@ua.edu
  - cc lab TA; “PH105” in subject
- office
  - 208 Gallalee (enter through 206)
- office hours
  - MWF 1-2
  - TR after class 3:15-4
  - email for other times

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

(I have emailed a link to today’s slides)

Graduate Assistants

- they run the labs, 2 per section
- meet them next week
  - will get their contact info in 1st lab
- pooled office hours ("help desk")
  - will post schedule when this starts

- no labs this week
- **we do have labs next week**

Lectures

- *principles* - new material in lecture
  - mostly discussion and concepts
  - worry about logic, strategies
  - *read chapter ahead of time …*
- *practice* – not something you can watch
  - have to do it!
  - HW, extra time in lab period
- Slides

“Lab” periods

- badly named. not just ‘do the lab and go’.
  - this is *practice* time (e.g., HW)
  - first ~30 min: discuss homework/problems
- http://pages.physics.ua.edu/lab10x/

- lab introduction (possibly a quiz)
- do the lab (read ahead of time)
- Extra time: Q&A, group work

- I set the schedule, but the TAs run the labs
- 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

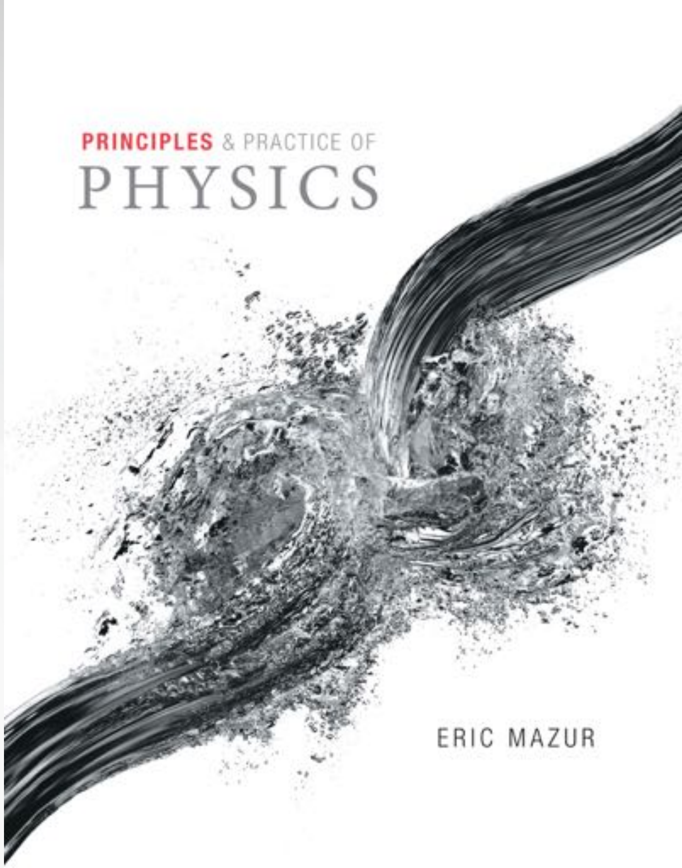
Syllabus

Schedule (subject to change)

		Primary topic	Mazur	in lab	Note
12-Jan		syllabus, overview	Ch. 1.all		
17-Jan		1D motion	2.1-2.5	Error analysis	add/drop without W by tomorrow
19-Jan		1D motion	2.6-2.9		
24-Jan		acceleration	3.1-8	1D motion	
26-Jan		momentum	4.1-5		
31-Jan		momentum	4.6-8	Newton's laws	
2-Feb		energy	5.1-4		
7-Feb		Exam 1	2-5	Friction	
9-Feb		interactions	7.1-6		
14-Feb		interactions	7.7-10	Work-KE	
16-Feb		force	8.1-6		
21-Feb		force	8.7-12	Momentum	
23-Feb		work	9.1-5		
28-Feb		work	9.6-8	TBD	
2-Mar		motion in a plane	10.1-8		midterm grades due tomorrow
7-Mar		motion in a plane	10.1-8	Rotational dynamics	
9-Mar		Exam 2	7-10		
14-Mar		SPRING BREAK			
16-Mar		SPRING BREAK			
21-Mar		motion in a circle	11.1-4	Planetary motion	
23-Mar		motion in a circle	11.4-6		
28-Mar		torque	12.1-5	Archimede's principle	drop with W by tomorrow
30-Mar		torque	12.6-8		
4-Apr		periodic motion	15.1-7	Harmonic motion	
6-Apr		waves in 1D	16.1-6		
11-Apr		waves in 2D, 3D	16.7-9, 17.1-3	Standing waves	
13-Apr		EXAM 3	11-12, 15, 18		
18-Apr		fluids	18.1-5	Boyle's law	
20-Apr		fluids	18.6-8		last day for tests, etc. is tomorrow
25-Apr		gravity	13.1-8	Calorimetry	dead week
27-Apr		thermal energy	20.all		dead week
3-May		FINAL EXAM	cumulative		8-10:30am

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
- http://packbackbooks.com - textbook rentals



Grading

- Exams 45%
  - 3 in class, multiple choice, 10% each
  - 1 final, multiple choice, comprehensive, 15%
- Homework 25% (weekly)
- Labs 15%
- Quizzes 15% (before each lecture)
- Participation 10% (5% completion, 5% score)

Interaction

what do you mean "participation"?

Look around!

- Online system for asking & answering questions
  Community discussion
- Collectively help each other out
- Your question may have been asked & answered already!

- Overall, more efficient.
  - Feel free to ask me, but you might not need to!

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

- Earn participation points for being curious
- Ask questions about the topics that interest you
- Learn how the things you're learning in class apply to your future and the real world
- Packback is a student-founded and student-run company that was seen on Shark Tank!

TechCrunch FAST COMPANY THE WALL STREET JOURNAL WSJ The Washington Post USA TODAY TEDX

packback

What to post to earn participation points:

✓ Post open-ended discussion questions

- Share a resource (video, article, link) and ask for responses
- A "How might we…." or "What would happen if…" question
- Ask for examples, rather than definitions

✓ Post questions asking for extra help

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

✓ Detailed answers to classmates' questions

- Earn points for providing great, detailed, (correct!) answers to your classmates' discussion and extra help questions.

X What won't count:

- **Anything too class specific:** (i.e. "Is class canceled today?" or "What's the answer to #4?)
- **Incorrect Answers**
- **Duplicate Answers to questions that only have one "correct" answers**
- **Any obvious cheating** (Anything that is obviously cheating-like posting homework assignments, quizzes, etc-will be immediately removed.)

What NOT to post in Packback Questions

These types of questions or answers will be removed, and will NOT count for points.

No questions about the tests, homework, or class logistics

- Examples of bad questions include: "Is class cancelled today?" or "What's the answer to #4?"

No duplicate questions or answers

No profanity or hurtful language; be kind and mindful

No cheating (this is not a place to get answers to homework)

No Closed-Ended Questions (Questions with only one right answer)

How to get started on Packback Answers:

If you got an email from them, you should be all set.

1. Navigate to **Packback.co/Questions** and click "Register as new student".

2. Register with your school email & real name

3. Enter our class community's Access Code into the "Join a new Community" module on your dashboard.

   100DB09F-4AED-CB07-5B0B-C1196109304F ← take a picture of this

4. Follow the instructions on your screen to finish registration, and then click into our class Curiosity Community.

5. You can ask your first question by clicking the "Ask a Question" button

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

Zahrea S.

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
  up to 5% more based on your score

- start next week. sign up now. ~$18 to join

Homework

- http://MasteringPhysics.com
- course code: PLECLAIRSPR17
- ***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

From your first quiz:

Prelecture Concept Question 2.01

Part A

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

- (selected) 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

Correct

Misc

- No attendance policy for lectures
  - exams may rely on in-class stuff
  - will post slides for each lecture
- Missing labs/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 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

Chapter 1 Foundations

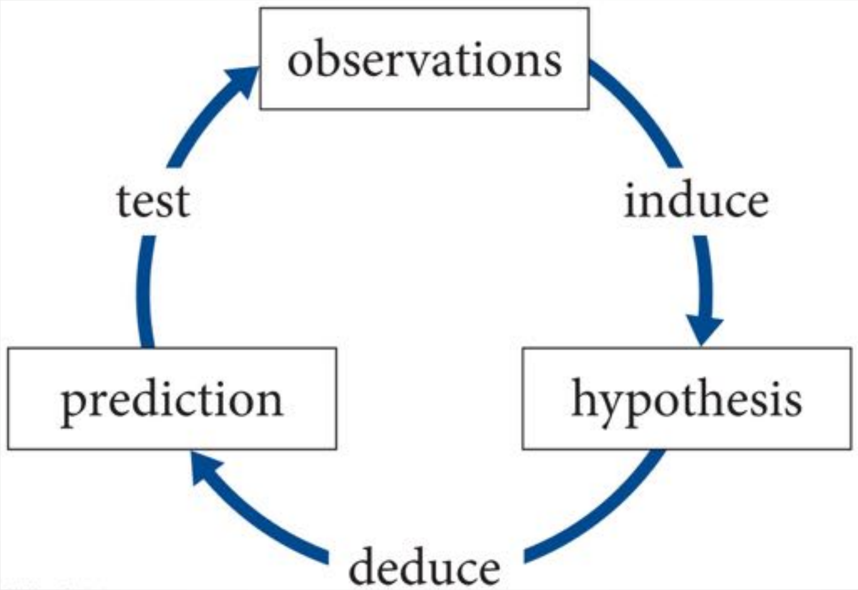
Concepts

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

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.

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.

Exercise 1.1 Hypothesis or not (cont.)

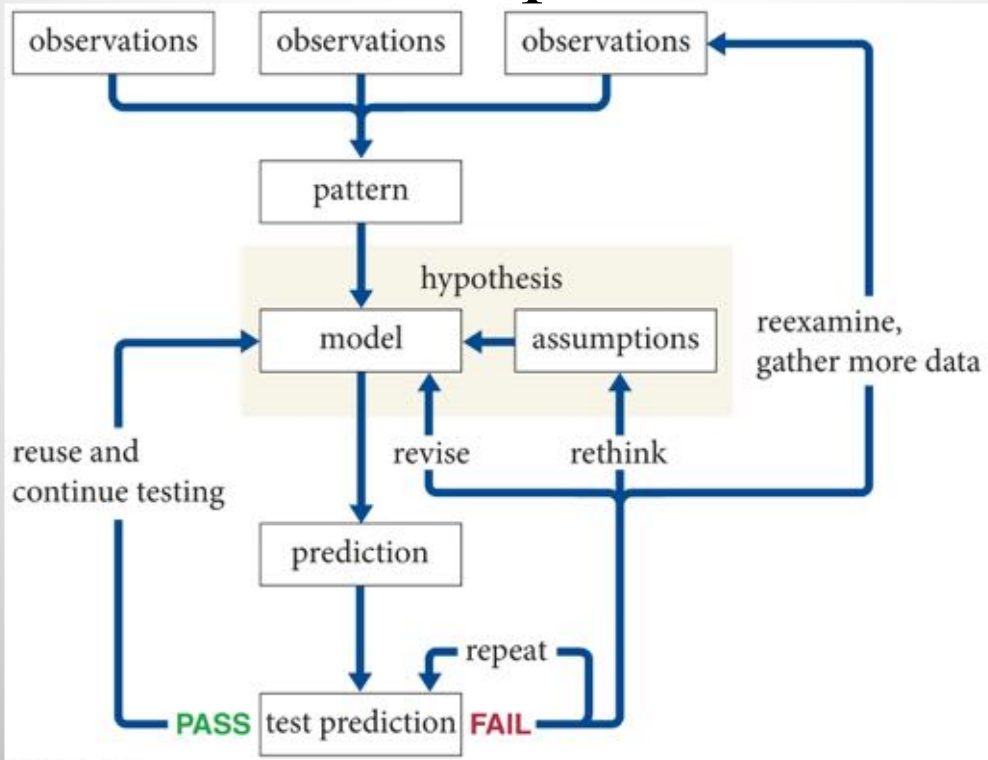
SOLUTION

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.



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.

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

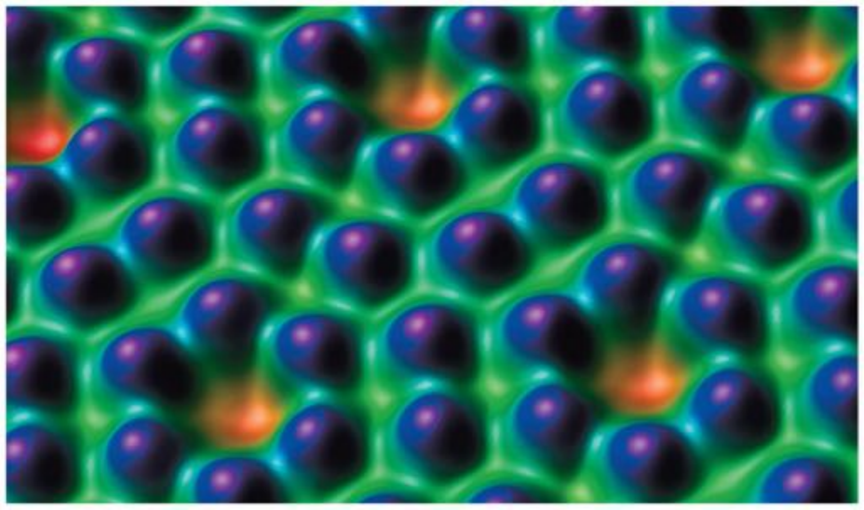
Section 1.3: Matter and the universe

- 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 minutes = 180 seconds. In scientific notation this is 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"
  - Example: Earth's circumference = 40,000,000 m = 4×10^7m. Order of magnitude value = 10^8 m.

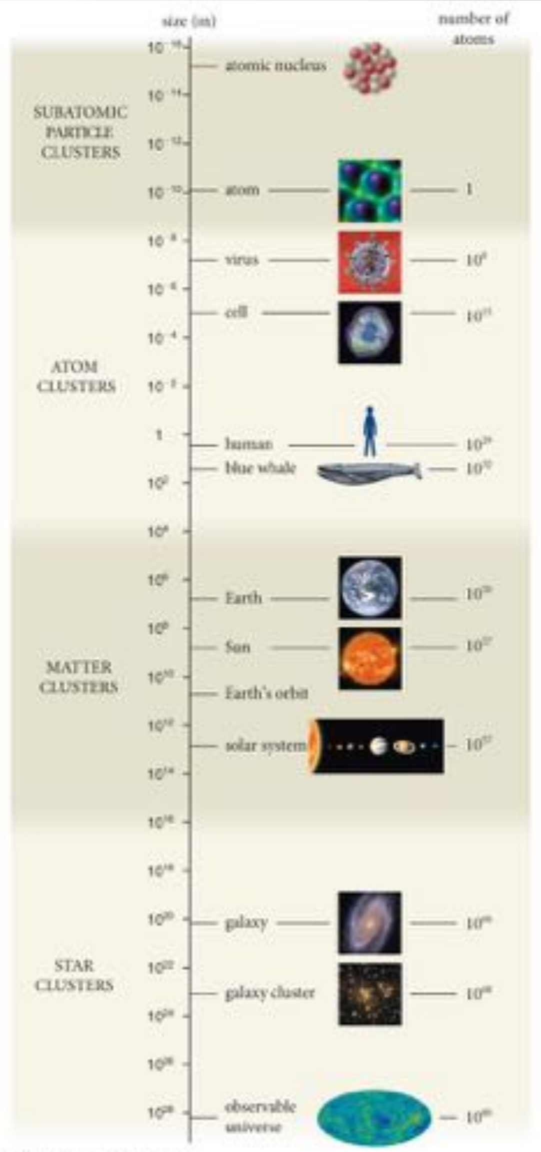
Section 1.3: Matter and the universe

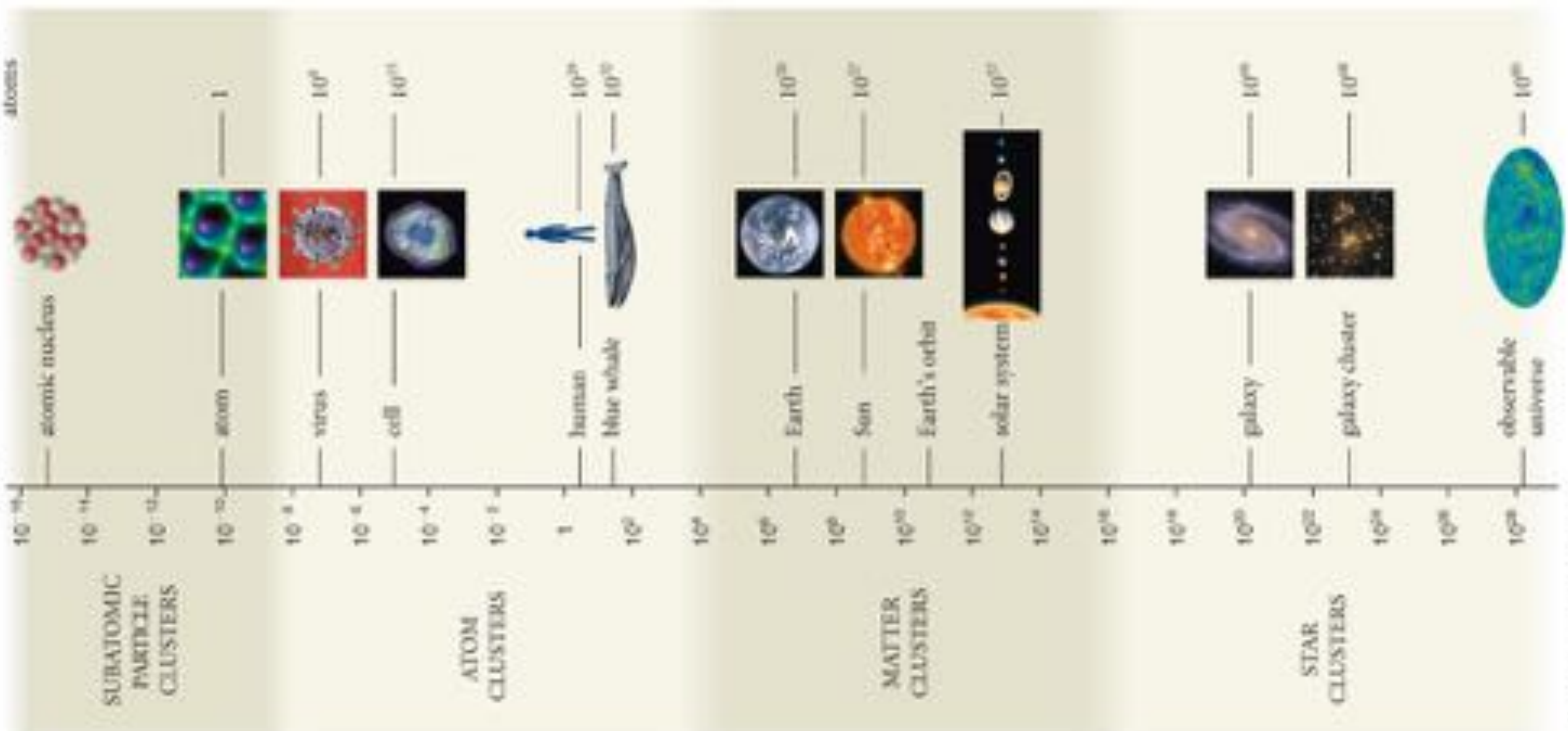
- All ordinary matter in the universe is made up of basic building blocks called atoms
  - Nearly all the matter in an atom is contained in a dense central nucleus, which consists of **protons** and **neutrons**.
  - A tenuous cloud of **electrons** surrounds this nucleus.
- Atoms have a diameter of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





number of atoms
size (m)
atomic nucleus
atom
virus
cell
human
blue whale
Earth
Sun
Earth's orbit
solar system
galaxy
galaxy cluster
observable universe
1
SUBATOMIC PARTICLE CLUSTERS
ATOM CLUSTERS
MATTER CLUSTERS
STAR CLUSTERS

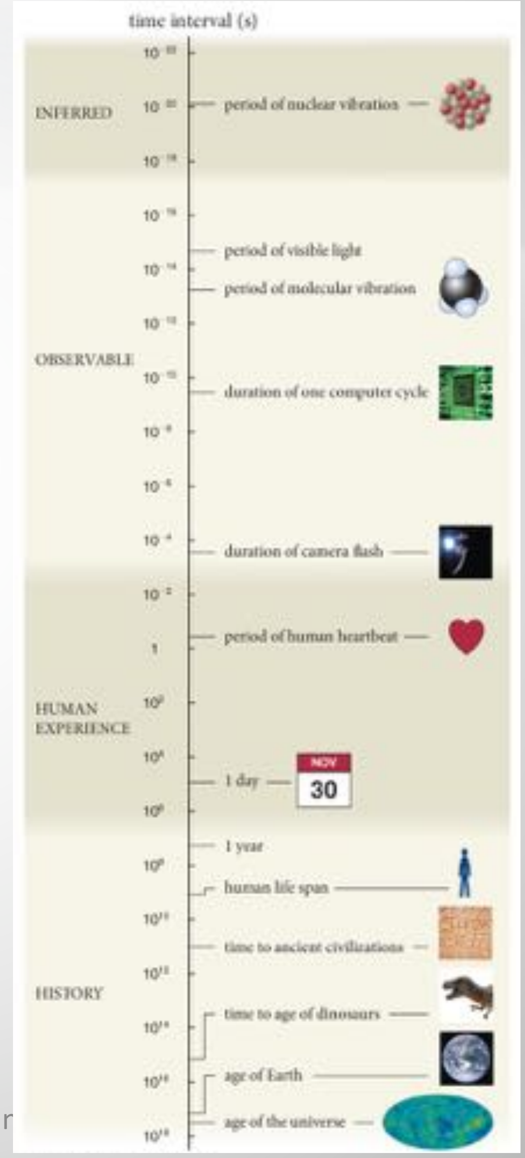
Section 1.4: Time and change

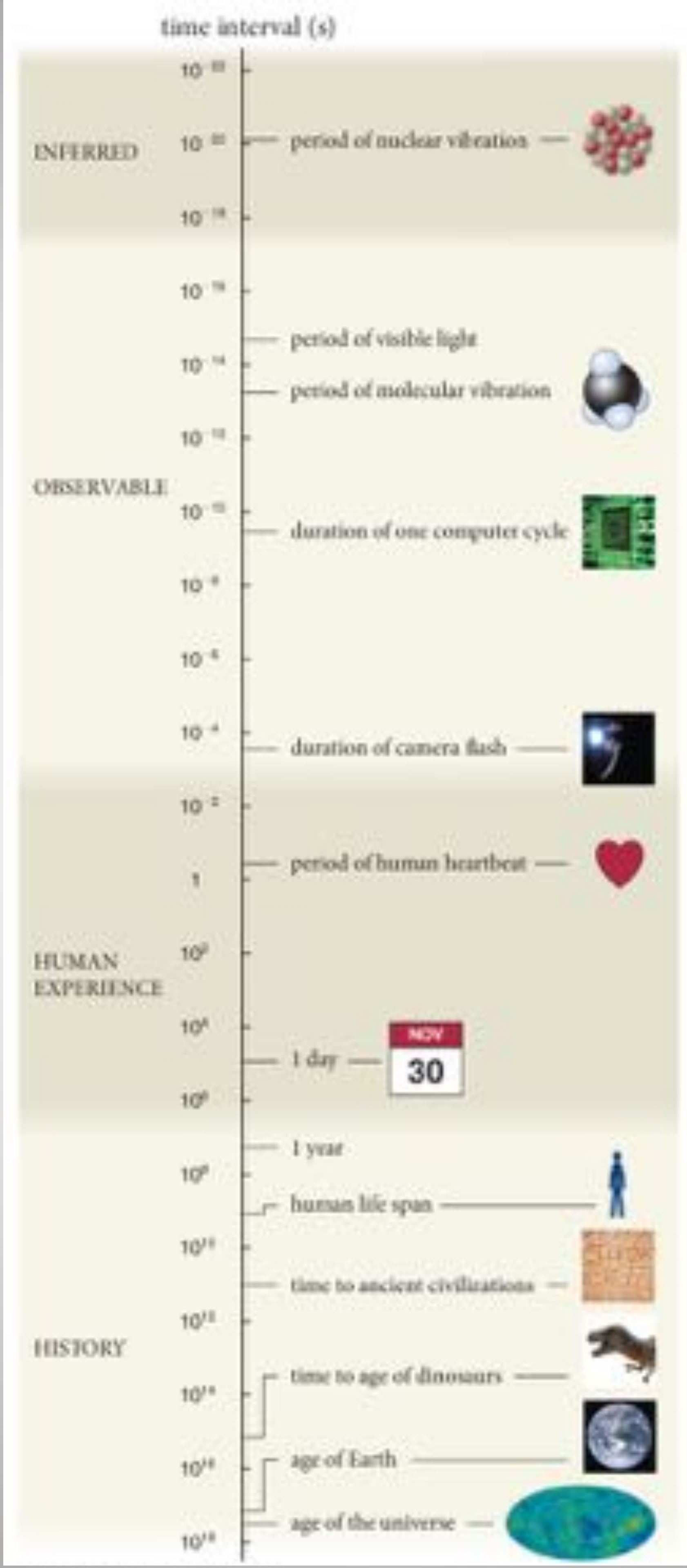
- Whereas we can freely choose the direction in all three dimensions of space, time flows in a single direction.
- This "arrow of time" only points to the future, and allows us to establish a causal relationship between events, which leads to the **principle of causality**:

  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?





time interval (s)
INFERRED
OBSERVABLE
HUMAN EXPERIENCE
HISTORY
period of nuclear vibration
period of visible light
period of molecular vibration
duration of one computer cycle
duration of camera flash
period of human heartbeat
1
1 day
NOV
30
1 year
human life span
time to ancient civilizations
time to age of dinosaurs
age of Earth
age of the universe

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

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?

Physics class is about 10^2 min or 6 x 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.

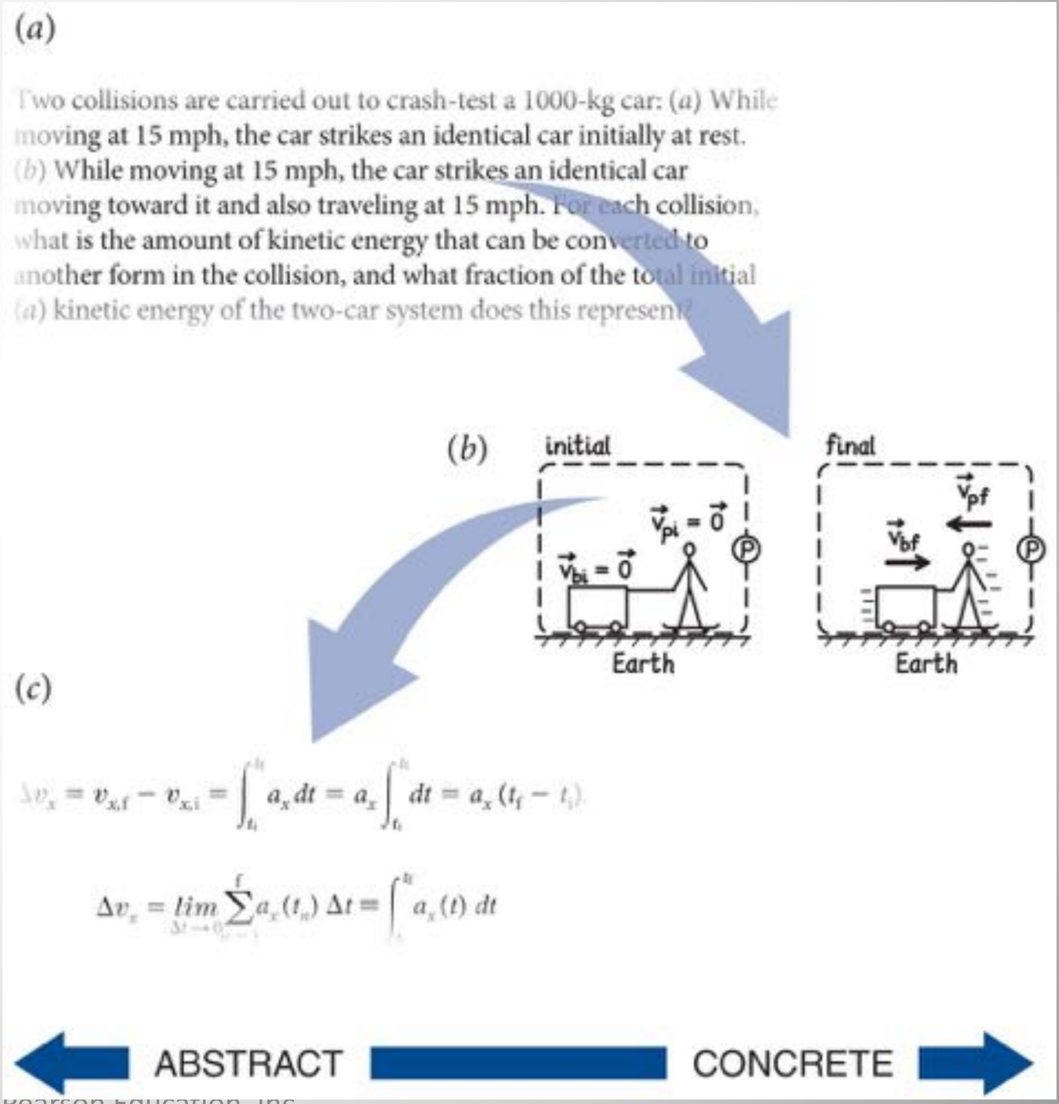
Section 1.5: Representations

- 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.

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

Exercise 1.5 Stretching a spring (cont.)

Going forward?

(a) Make a pictorial representation of this setup.

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

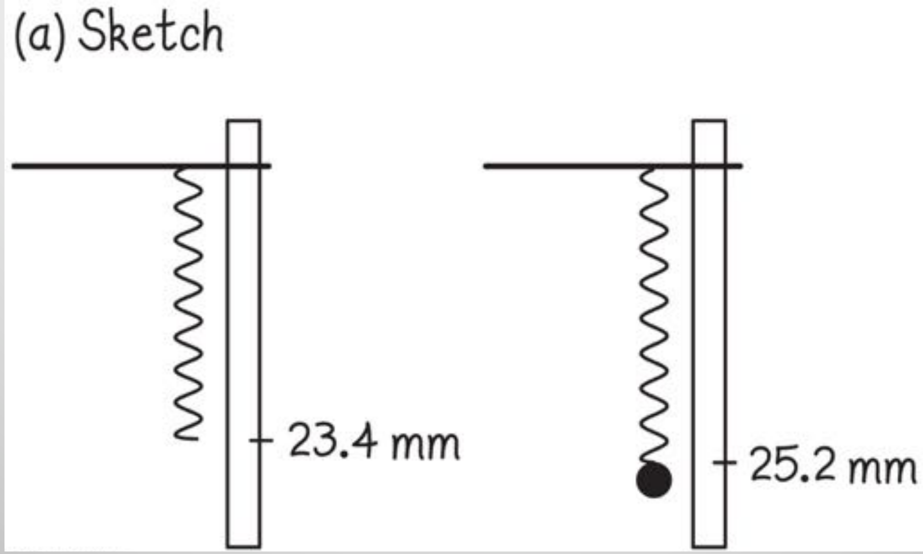
(c) Plot the data on a graph, showing the ruler readings on the vertical axis and the numbers of beads on the horizontal axis.

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

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.)

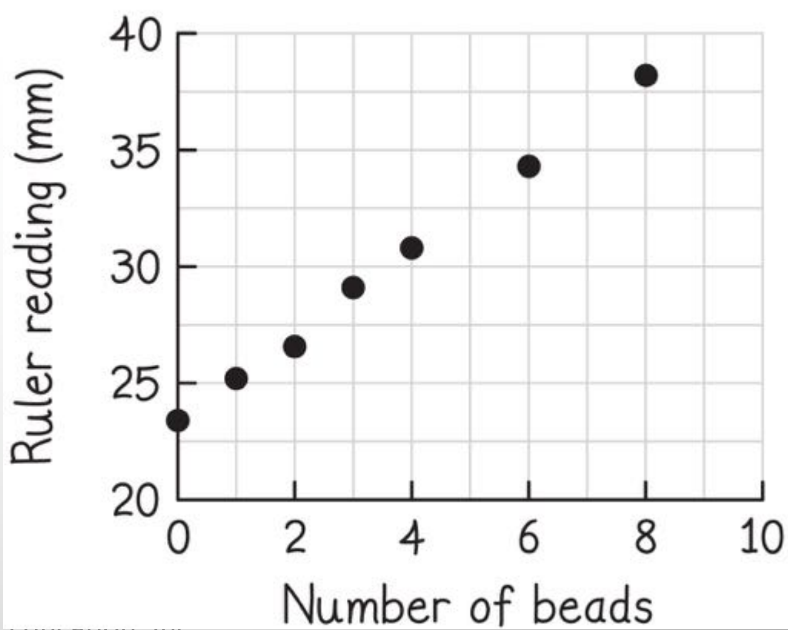
SOLUTION (*b*) complete table (*c*) make a plot (label axes! units! metric!)

(*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

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.)

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

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.
- We use prefixes to denote various powers of 10 to make things easier

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 x 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

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

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

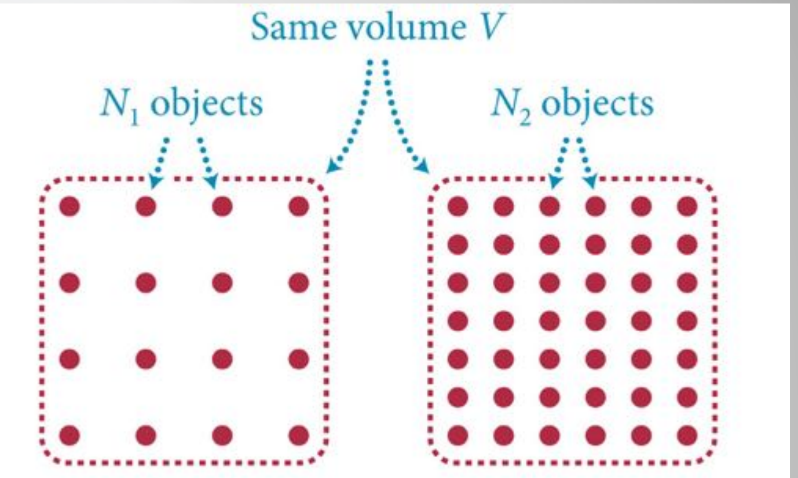
- An important concept used in physics is density:
  - Density measures how much of some substance there is in a given volume.
- The number of objects per unit volume is called **number density (*n*)**. If there are N objects in volume V, then

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

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

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

- Why? So our solution works for *any* container, not just one particular case



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 $n_2 > n_1$.

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.

$$(a)\qquad (4.5\text{ in.})\left(\frac{2.54\times 10^{-2}\text{ m}}{1\text{ in.}}\right)=1.1\times 10^{-1}\text{ m}$$

$$(b)\quad (3.2\text{ acres})\left(\frac{4.047\times 10^{3}\text{ m}^2}{1\text{ acre}}\right)=1.3\times 10^{4}\text{ m}^2$$

Exercise 1.7 Unit conversions (cont.)

SOLUTION

$$(c) \quad (32\ \text{mi})\left(\frac{1.609\times 10^{3}\,\text{m}}{1\ \text{mi.}}\right) = 5.1\times 10^{4}\,\text{m}$$

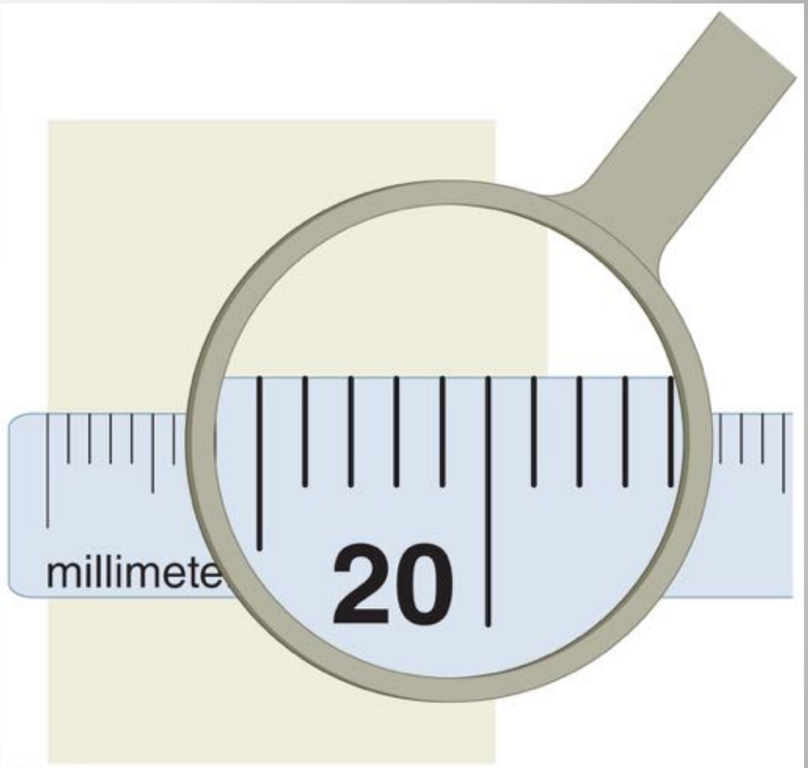
$$(d) \quad (3.0\ \text{pints})\left(\frac{4.732\times 10^{-4}\,\text{m}^{3}}{1\ \text{pint}}\right) = 1.4\times 10^{-3}\,\text{m}^{3}$$

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 Tuesday!

- **Mastering Physics**
  - **do the reading quiz by 2pm Tues**
- **textbook (or ebook)**
- **PackBack**