Day 1 Wednesday Sept 11, 2019

- What is physics?
- Course page/ calendar/ email
- expectations
- Article on proton radius
- Lots to learn, but the fun part is that we are still learning. You are getting in on the very bottom rung, but you could learn more and never get to the bottom.
- Science is not a set of facts, but the act of expanding the set of facts by rigorous experimentation.
- We will start by learning some very fundamental terminology, but first, here's a pretest to see what you might already know.
- Pretest.
- break
- end of the world lego challenge #1
- explain units, physical quantities (parameters) point out difference between position and displacement
- Reading on vectors, position and displacement Scalars and Vectors
- Distance and Displacement for homework/quiz prep
- quiz on Thursday

Day 2 Sept 12, 2019 Thursday

- Quiz
- SI units
- Speed: displacement over change in time. Velocity, speed with a direction.
- Build the domabot (instructions here)
- Challenge #2

HW reading on speed and velocity

Day 3 Sept 16, 2019 monday

- Speed and velocity quiz
- loggerpro make sure everyone has
- ***Finish challenge 2***

Day 4 Sept 19, 2019 wednesday

- Recap. Motion diagram. Visual record of where something was each second.
- Lets think of another way to plot that: position vs time graphs.
- Back to the robot and five rotations: let's learn how to use logger pro to plot data
- Demonstration using their data.
- Challenge 3

HW: send me an email summarizing what you learned today.

Day 5 Sept 20, 2019 Thurs

- Read summaries
- Recap for missing students
- more practice with p vs. t graphs

Day 6 Sept 23, 2019 Monday

- P vs t graphing worksheet printout
- Introduction to v vs t graphs, what stopped, constant, and accelerated look like.

HW: email recap

Day 7 Sept 25, 2019 Weds

- Homework discussion. Reread the expectations for credit.
- V vs t graphs. Look at possible shapes.
- Concept builder: match the diagram

HW: email recap

Day 8 Sept 26 2019 Thurs

- Congratulations on emails. Got everyones.
- Recap of s vs t and v vs t
- Acceleration. Define. Draw.
- A vs t.

Day 9 Sept 30, 2019 Monday

- Homework check- project and have folks fill in
- PVA quiz

Day 10 Oct 2, 2019 Wednesday

- Hand back quiz and blank quiz. Students to redo. They can work with partner. I pick.
- Pay close attention to metacognition. In a document in your folder, write as much as you can on what went wrong on each problem.
- Switch partners and discuss in pairs what you wrote. Amend what you wrote in light of anything learned in the discussions.
- Distill a set of rules/key learnings that you will bring to the next quiz that will be on Thursday.

HW: send me an email with your rules/key learnings. Could be an image of what you have written, or could be retyped. Of course, retyping is going to cement the knowledge

Day 11 Oct 3, 2019 Thursday

- Go around and share one thing from cheat sheet

- Redo quiz.

Day 12 Oct 7, 2019 Monday
- Hand back quiz
- Graph matching exercise

Day 13 Oct 9, 2019 Weds
- Finish Graph matching
- Two d motion. Ballistic challenge

HW: email with what you learned

Day 14 Oct 10, 2019 Thu
- Comment on homework
- Review two d motion briefly: takehomes
- Shift gears to what's happening in physics today
- Nobel prize video
- Didier Queloz
- Jim Peebles start at minute 16

Day 15 October 17, 2019 Thu

- Intro quiz (print out)
- Experiment. Set up force sensors on carts. Ask: what will the magnitude of the force on each cart be? Test.
- Now ask: what if we increase the weight of one of the cars? Which will impart more force? Test.
- Forces come in pairs: Some thought experiments.
- Arrow notation of vectors
- Some notes on labelling force pair vectors
- Force pair handout

Homework: Lesson 4 - Newton's Third Law of Motion
1. Newton's Third Law
2. Identifying Action and Reaction Force Pairs

Day 16 Monday Oct 22, 2019
- Homework check-in
- Quiz: check up on third law. Print out before class.
- First law

- IVV first law
- Stopped corrolary: v=0
- Concept of net force (what about the force of gravity on the ice puck?

Day 17 Weds Oct 24, 2019

- Comment on homework, show marinas
- First law recap-net force, equilibrium
- Check in on third law again
- Does an object need a force applied to have a non-zero velocity?
- Inertia and the first law in everyday life demo with cinder block and hammer.
- Crash test dummies video
- In pairs Research: look at first law demos and think up one of your own. Plan and make a video demonstrating the concept of inertia. Big bonus for comparing the effects of different masses in your videos. 1 hour to do. Upload to youtube and send me a link.
- Present videos (or do them for homework)

Day 18 Thurs Oct 25, 2019

- How does increasing force on an object of constant mass affect acceleration? Guesses? What does the graph of force vs acceleration look like?
- How can we Experiment with track to answer that question: small groups 5 minutes
- Take data and determine how accceleration and force are linked.

Day 19 Mon, Oct 27, 2019

- Go over homework
- Talk about the CER format
- Work on CER, Weds
- CER's should be peer reviewed by two classmates before submission.

Homework: Using the data we gathered, write a short answer to the question, How does increasing force on an object of constant mass affect acceleration? We'll use the format: CER: First you make a claim (reword the question to be a claim), then you Give evidence that will support your claim (a graph would be good evidence in this case) and then you provide the reader with reasoning that helps them to interpret the evidence in support of your claim. Put the document entitled "Force-acceleration CER" in your folder with your CER formatted write-up. In addition, make sure you answer the following question, both graphically and verbally at the end of the document:

How would the graph of Force vs Acceleration change if you repeated the experiment with an object of double the mass?

Day 20 Weds Oct 30, 2019

- Newton's laws review
- CER peer review
- Review equilibrium
- Normal force: key points: object not accelerating off table or going thru table, so must be another f on obj to have zero net force. f of e on obj
- Normal means perpendicular
- Free body diagrams printed worksheet, work as a group.
- FBD interactive for homework. Send me screenshot of completed work

Day 21 Thurs, Oct 31, 2019

- Questions on fbds?
- Quick vector notation and addition
- Force of gravity discussion. Why do all objects fall with the same acceleration?

Day 22 Monday Nov 4, 2019

- Terminal velocity lab
    - Essential question: how does terminal velocity change with mass?
    - Essential question 2: what would drag force depend on in air?
    - Essential question 3: what does the fbd look like for an object at terminal velocity?
- 5 mins: write down ideas for experimental procedure
- 10 mins: discussion of procedure
- Get two detectors working so we can have multiple trials. Two teams, one overseer.
- At end of first hour, should have some data.

Day 19 Weds Nov 8, 2019

- Review homework
- Review newton's second and gravitational law
- Show gravitational applet
- Look at graph of terminal velocity vs filters.
- V squared vs. mass
- Free body diagrams of each set of filters
- second hour. Introduce paper format and start working on paper.

Day 20 Thurs Nov 9, 2019

- Paper work

Day 21 Monday Nov 18, 2019

- Revise peer comments and get paper ready for me to grade.

Day 22 Weds Nov 20

- Paper revisions

Day 23 Thurs Nov 21

- Final paper revision section. Hand out Rubric.

Day 24 Weds Dec 3

- Collect supercorrections
- Discuss papers
- Go over mathematics to show square root relationship.
- Add this to the discussion section and clear up my comments on paper.
- References if time allows

Day 25 Thursday Dec 4, 2019

- Collect Supercorrections
- What does friction depend on?

Day 26 Monday Dec 9, 2019

- Plan for sampling
- Make robots

Day 27 Weds Dec 11, 2019

- Experimentation

Day 28 Thurs Dec 12, 2018

- Data reduction

Day 29 Monday Dec 16, 2019

- Write-ups

Day 26 Weds Dec 18, 2019

- More work on papers

Day 27 Mon Jan 13, 2020

- General discussion about understanding vs. going through the motions
- New policy. Two people per night must hangout with me and ask 3 clarifiying questions. Assign nights.
- Discussion section discussion
- Static vs kinetic fricition
- Discussion of equation.
- Finish papers

Day 28 Weds Jan 22, 2020

- Discussion
    - How are we doing?
    - What could I be doing better?
    - Does everyone understand what I am trying to do?

    - Can anyone see the value in weekly checkin?
    - What can I do to help each of you to improve as intellectual beings?
    - If this was your ideal class, what would it look like?

Second hour:

- Quiz on friction coming up in 30 minutes. Lets review:
- Kinetic vs static recap
- Tires quick primer
- Ready for quiz?

Day 29 Thurs Jan 23, 2020

- Papers done?
- Quiz recap
- Intuition vs experimentation
- Work introduction w = fd cos theta
- Work changes energy
- Introduction to work, use the worksheet to answer questions without the app?

Day 30 Mon Jan 27, 2020

- Student recap of work and energy
- Work done by Conservative vs non-conservative forces

Dau 31 Weds Jan 29, 202

- Ball drop lab

Day 32 Thurs Jan 30, 2020

- Ball drop lab, cont

Day 33 Mon Feb 3, 2020

- Thanks for everyone doing the homework. We'll get back to your questions.
- Listened carefully to what folks had to say. We will get back to the experiment, but slightly different and perhaps easier to understand format. First, though,
- Pendulum experiment

Day 34 Weds Feb 5, 2020

- Pendulum experiment part 2

Day 35 Thursday Feb 6, 2020

- Movie https://www.youtube.com/watch?v=KUW-xcAbsVY

Day 36 Weds Feb 12, 2020

- Movie recap?
- Pendulum experiment part 2 look at final

- Pendulum experiment part 3

Day 37 Monday Feb 24, 2020

- Get with your partner and have them go over part three of pendulum experiment. Do at least one trial to make sure they see the actual period. When they have completed part two, you can go on to part four.

Day 38 Weds Feb 26, 2020

- Pendulum experiment day 4

Day 39 Thurs Feb 27, 2020

- Recap pendulum experiment day 4.
- Roller coaster app

Day 40 Mon March 2, 2020

- Test prep. Go over questions.

Day 41 Weds, March 4, 2020

- Test prep make cheatsheets
- Test

Day 42 Thurs, March 5, 2020

- Test review

Day 43 Mon, March 6, 2020

- Wave properties lab print out

Day 44 Weds, March 7, 2020

- Quiz (print out)
- Wave properties redux: frequency, period, reflection, amplitude
- Time out: waves in space vs waves in time. wavelength
- Transverse vs longitudinal
- Wave equation show animation
- Second hour, do reading

HW finish reading, send 5 questions

Day 45 Thurs, March 8, 2020

- Habits of mind and question asking
- How do you go about answering questions?

- Research one of your questions and be prepared to answer it. Send me email with your answer and be prepared to give a little lesson to your peers on monday.
-

Day 29 Weds Dec 12, 2018

- First hour, work on papers. Look at rubric
- Kinetic energy = K = $1/2mv^2$
- Gravitational Potential energy = $U_g = mgh$
- Total mechanical energy E = K + U
- Ball drop revisited with tennis ball. Predict speed at bottom. Do in class demo/investigation.

Day 30 Friday Dec 14, 2018

- Roller Coaster Applet

Day 31 Mon Dec 17, 2018

- Work and energy quiz

Day 32 Weds Dec 19, 2018

- Go over work and energy quiz
- Second hour: work and energy ranking exercises
- Debrief if time allows

Day 1 Spring semester Jan 10, 2019

- Go over final exam
- Plan for future classes

Day 2 Jan 11, 20189

- Virtual momentum PHET lab worksheet

Day 3 Mon Jan 14, 2019

- Were you able to mathematically define momentum? In other words, can you write a mathematical equation with momentum, p, on the left side of the equals sign and fill in the right side with the proper known physical quantities?
- What are the units of momentum?
- What does it mean to conserve momentum?
- How does the momentum before a collision compare to the momentum after a collision? Mathematically, that would like this: p before (<,=,>) p after, where you would choose the correct symbol from the parenthetical set.
- What is the physical manifestation of the concept of elasticity?
- Is kinetic energy conserved in a collision between two hard plastic balls?Justify your answer.

Day 4 Weds Jan 16, 2019

- Go over questions
- Watch crash test videos
- Write down all equations we have done to date and take a picture and email it to me for hw. Be prepared for a quiz on all physical quantities and equations.

Day 5 Thurs Jan 17, 2019
- review of all equations/ physical quantities
- Collision applet practice

Day 6 Friday Jan 18, 2019
- Equations/physical quantities quiz
- Collision applet math

Day 7 Weds Jan 22, 2019
- Metacognition questions
- Egg drop conversation. Do we want to do it?
- Egg drop challenge

Day 8 Thurs Jan 24, 2019
- Build edd's

Day 9 Friday Jan 25, 2019
- Finish edd's

Day 10 Monday Jan 28, 2019
- Egg drop

Day 11 Weds Jan 30, 2019
- Impulse momentum concept builder
- Problems

Day 12 Thurs Jan 31, 2019
- Conservation laws concept builder
- Impulse-mom change problems

Day 13 Friday Feb 1, 2019
- Momentum test

Day 14 Monday Feb 4, 2019
- Momentum test discussion, then write proper justification/reasoning
- Go over the friction part of the problem. See how equations guide my thinking.

Answer the following metacognition questions:

- What questions did I get wrong, and why did I get them wrong?
- Was my reported confidence in my answers borne out by my test score?
- Were there any surprises during the test? If so what were they?
- Was I well-prepared for the test?
- What could I have done differently?
- Am I receiving useful, specific feedback from my teacher to help me progress? If not, what would you have liked to have received, and how would you have liked to receive it?

Day 15 Weds Feb 6, 2019

- Quick checkin on all the known parameters/equations we have for Ocean
- Begin our investigation of thermal physics
- Ice on wood and aluminum block demo
    - Touch the wood and the aluminum, which is colder?
    - Measure temperature of each
    - Ice demo
    - discussion
- Thermal energy discussion. Molecular movement model
- Phet gas properties demo of kinetic energy
- Note adding energy is like doing work

Homework: reading on temperature/kinetic energy relationship

Thermal Physics - Lesson 1 - Heat and Temperature

Thermometers as Speedometers

- Introduction to Thermal Physics
- Temperature and Thermometers
- Thermometers as Speedometers

Day 16, Thu Feb 6

- Review Temperature
    - Avg K
    - Measured in C and K. Why K?
- Thermal energy? What is it?
- Phlogiston and Count Rumford and his cannons.
    - https://books.google.com/books?id=6lBFAAAAcAAJ&pg=PA80#v=onepage&q&f=false
- Joule and his experiments. 1849
    - https://www.thephysicsaviary.com/Physics/Programs/Labs/MechanicalEquivalentOfHeatLab/index.html
    - blender
- So we see that mechanical kinetic energy can be converted into the kinetic energy of the molecules of water.

- Q: How will the rate of change of temperature of water depend on the amount of energy added to the water?
- Simple experiment with hot plate and beaker of water
    - Keep volume the same, change the setting. Look at the power.
    - Q: can we determine how much energy it takes to raise the temperature of the water 1 degree per gram?
    - FIrst we need a new physical quantity: Power, energy/sec, J/s --- Watt.

Homework: for Monday: Answer the following thought questions:

1. What evidence do we have that mechanical energy can be converted to thermal energy?
2. If we add energy by agitating a liquid, what happens to the temperature of the liquid?
3. *Why* does the temperature go up?
4. How can we tell that the thermal energy of a liquid has increased?
5. If we increase the power of energy transfer, what happens do the rate at which the temperature of a liquid goes up?

Day 17 Mon. Feb 11, 2019

- Go over thought questions
- Q=mCdeltat: go over.
- But what is heat, Q? Units?
- **heat** is energy in transfer from warmer object to colder object.
- Key point: transfer!
- Experiment: heat water, watch what happens when it boils to temperature
- Why no change in temp?
- Go back to kinetic energy model and boltzman's distribution: what is happening to the faster molecules?
- Changes of state require energy release or gain.
- Latent heat of evaporation: very large for water. 2265 J/g
- So now we can write some equations: Q =mL, where L is the latent heat of evaporation.
- Now we can understand why hurricanes need warm water.

Thought questions for homework:

1. What is the "C" in the equation for heat transfer?
2. What is the "L" in the equation for the amount of heat needed to boil off water?
3. In order to change the state of water from liquid to gas, how much energy must be transferred to a beaker of 50 g of water at 100 C to get it all to turn to steam?
4. How many Joules must be transferred to that same beaker of liquid water to go from 50 C to 100 C without boiling?
5. How long would it take to heat 50 g of water 10 deg C, if you were to supply 100 W of power to an electric kettle (assume the kettle is 100% efficient)?

Day 17 Thursday, Feb 13

- Go over homework
- The calorie and the Kcal. food
- Heat of fusion: The **heat** of fusion for **water** at 0 °C is approximately 334 joules (79.7 calories) per gram, and the **heat** of vaporization at 100 °C is about 2,230 joules (533 calories) per gram.
- Practice problems in class: Model equation-knowns-unknowns-solve
- Homework problem:

Day 18 Friday, Feb 14

- Go over problem.
- Conservation of energy: heat lost by an object is heat gained by surroundings
- You have a 200 gram cup of coffee at 100 C, too hot to drink. How much will you cool it by adding 50 gm of ice at 0 C?

Heat lost by coffee = heat gained by ice

Do the math

See if we can duplicate experiment

- Going to send some thought questions at the end of break that will take 15 minutes, but will connect you back to the concepts so we can hit the ground running.

Day 19 Feb 25, 2019

- Go over email/ heat problem
- Types of heat transfer
    - Conduction: heatgun on wood and metal
        - Experiment: wood, copper, plastic. Predict which one will heat up more.
        - Poor conductors vs good conductors
    - Convection. Show convection video
    - Radiation:
        - The photon
        - Wavelength/frequency relationship
        - Energy and wavelength

Homework questions:

1. How are thermal conductivity and specific heat similar? How are the different? What are the units of thermal conductivity? Spend a little time googling (say 15 minutes before you give up) and see what you come up with.
2. What are the requirements for convection to occur? List at least two.
3. What are the requirements for conduction to occur? List at least two.

Day 20 Feb 27, 2019

- Show thermal conductivity graph (look at metals vs plastics vis liquids vs gas)
- Go over homework -- heat transfer through walls equation: what is it?
- Rate of heat loss = $k \cdot A \cdot (T_1 - T_2)/d$
- Window energy transfer lab

Day 21 Thu Feb 28, 2019

- Homework review
- Radiation, con't
    - Remember photons
    - Energy and wavelength
    - Spectrograph hot metal: all objects at temps above absolute zero give off photons but only become visible when above a certain temp.

        - Black body lab

Homework:

1. How are energy and wavelength related?
2. What did it take for the piece of metal to glow red? What happened to its spectrum as it cooled?
3. Were you surprised to learn that everything above absolute zero gives off photons.
4. What is the relationship between the wavelength of peak intensity of photons emitted from an object and the temperature of the object?

Day 22 Friday Feb 29, 2019

- Go over homework and window lab, and blackbody lab
- Wien's law recap lamdamax=b/T
- Graph of SED vs wavelength
    - Transparent and opaque materials (visual is easy to see)
    - IR video
    - Sun spectrum
    - Microwave oven/ absorbtion vs transparency
- Review for test

Day 23 Wednesday March 6, 2019

- Assessment

Day 24 Thursday March 7, 2019

- Assessment finish.
- Metacognition questions
- Decide what's next

Day 25 Friday March 8, 2019

- Rework assessment based on my comments on separate piece of paper
- When finished, check answer sheet
- Score your old test and your new test

Day 26 Monday March 11, 2019

- Waves on a string lab
- Prepare for quiz

Day 27 Wednesday March 13, 2019

- Quiz
- Download audacity
- sound lab

homework: short email summarizing your learning

Day 28 Thursday March 14, 2019

- IR thermometer testing

Day 29, Friday March 15 ,2019

- recap/finish first sound lab

Homework: three questions:

- How were the wave shapes of the tuning fork and the spoken voice different? How were they similar?
- What do you think accounts for the different wave shapes from Q1?
- What changes about the shape of the waves as you get farther and farther from the sound source

Day 20 Monday March 18, 2019

- Radiolab piece
- Homework review
- Time out: waves in space vs waves in time.
- What makes the voice waves more complex?
- Wave lab demo

Homework: Wave lab questions

Day 21 Weds March 19, 2019

- Homework review
- Wave superposition animations
- Definitions: Superposition, interference (destructive and constructive)
- PHEt wave superposition applet
- Superposition worksheet

Homework questions:

1. How are constructive and destructive superposition different?
2. Knowing what you know about adding waves, can you explain why your voice waves were more complex than the tuning fork waves.
3. What would superposition of water waves look like if you were on a boat at sea?

Day 21 Thurs March 20, 2019

- Homework
- Challenge question: ripple tank
- Finish superposition lab

- Prepare for assessment on what we have learned about waves so far. One page of notes. Ask yourself the metacognition questions.

Day 22 Friday March 21, 2019

- Assessment notes prep

Day 23 Monday March 24, 2019

- Assessment on waves/sound part 1

Day 24 Weds. March 26, 2019

- Assessement supercorrections

Day 25 Thurs. March 27, 2019

- Assessment answer sheet
- Doppler effect
- Sound
- Doppler applet

- Movie: https://www.acs.psu.edu/drussell/Demos/doppler/doppler.html

Homework; The physics classroom reading on doppler

Day 26 Friday March 28, 2019

- Doppler worksheet

Doppler effect applies to waves of all sorts, not just sound waves.

Day 27 Monday April 1, 2019

- Measure the speed of sound in air two groups

Day 28 Weds April 3, 2019

- Reflection, diffraction and refraction
- Ripple tank simulator

Day 29 Thu April 4, 2019

- Speed of sound day 2

Day 29 Friday April 5, 2019

- Speed of sound measurement day three, refinement and data gathering

Day 30 Monday April 8, 2019

- Speed of sound presentation work

Day 31 Weds April 10, 2019

- SOS presentation work

Day 32 Thu April 11

- Speed of sound presentations
- Go over ripple tank
- Prepare for test on speed of sound and doppler effect

Day ? Wednesday April 15

- rewrite last problem in assessment
- collect assessments
- physics girl on standing waves
- review: nodes, antinodes
- how about tubes?
- two types closed one end, and open
- blow across bottle
- visualization of the actual motion
- experiment. What is the resonant frequency of your closed tube?