My Teaching at PACS

This document is intended to provide information to the teacher who takes over my position at PACS. Some of the information is factual, such as the location of material in the classroom and storage rooms. Other information is also factual in terms of my lessons and classroom layout, but this information is offered recognizing that my replacement will have their own ideas, and that what I did in my seven years at PACS provides only examples. *Please contact me at stolzenb@ucla.edu or 310-433-1907 with any questions.*

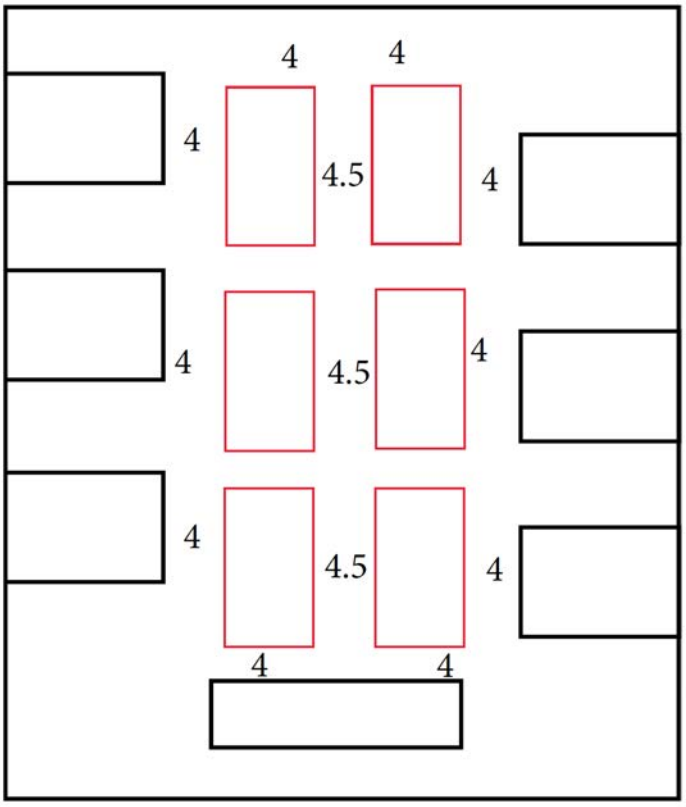
When I left the classroom in June 2024 I put a bunch of classroom stuff in the cabinets just to the left of the door, but then just before school started I came to the classroom and took all that material out. Here are the things that Mr. Sy may not have used:

- Several magnetic holders for markers and a shiny metal holder that was where the student put their restroom cards (see section on classroom routine).
- Magnetic letters and numbers for putting the date on the board - this is a complete set for the entire school year.
- A digital clock that hangs from hooks at the top of the left side of the front white board. This clock was the "official" clock for the classroom. Regrettably, it loses about 5-10 seconds a week, so every Monday I reset it to agree with my iPhone. This is important because the students are very aware of the time down to a second.
- Letters and origami figures for the class norms on the bulletin board to the right of the front white board.

Classroom

Tables and Chairs

The figures below show a photo and a diagram of the arrangement of tables in the classroom, reflecting my preference for groups of four students. **The numbers on the figure refer to the number of floor tiles between objects.** This arrangement has worked well for me.



The table tops on both the moveable and permanent tables are very durable, but they can be scratched relatively easily. The largest scratches you see were the result of a careless summer cleaning crew that turned the moveable tables over onto the side tables to facilitate floor cleaning and waxing. **It is a very good idea to speak to the building manager about this in early June to prevent them from doing this. I think last year they turned them over but put cardboard between them. This seemed to work.**

Students have scratched graffiti into the table tops, but not too much, except for one table that has the only F word in the classroom. I have tried to find a touch up method to fill the scratches, but so far nothing has worked. But I recently found that if I added my own scratches I can change the F word to "book" pretty easily.

Of course every day students write on the tables with pencil, pen, whiteout, etc. Although I list it as one of our classroom expectations at the beginning of the year, I have not done regular graffiti checks to try to catch offenders (I do speak to them if I actually see them doing it) - it's just a battle I decided not to choose. They also put tape on the table tops and table sides and legs (playing with tape is one of their main pleasures apparently). I scrape this off using the scraper tool in the desk drawer box I have left for you.

I come in early each day and clean the graffiti off of all the tables with Clorox wipes. This helps remove food and sweat stains also. Students will of course put gum under the table and chairs. I have not tried to clean that up. Tape on the table tops gets removed with the daily cleaning - other tape gets removed every semester or a bit more often.

Classroom Storage Cabinets

All the cabinets in Room 305 are opened with key 85 - a small silver one. Try not to lose or break this key as who knows how long it will take to get a replacement. Unless noted otherwise below cabinets are kept locked.

The upper storage cabinets with the glass fronts are mainly for supplies - all the glassware goes here. The exceptions to being locked are the cabinets nearest the doorway that I use for the student notebooks.

The lower cabinets that are against the wall are also for supplies, but in general the items here are used less frequently. See the figure below for a key to what is in these cabinets.

The larger, but shallower, cabinets at the end of the table units are generally for less breakable material. The locks on several of these cabinets do not work well. See the figure below for a key to what is in these cabinets as well as an indication of which are kept locked.

The drawers in the front fixed table are locked with the 85 key and contain supplies that are used relatively often (pens, tape, etc). I do not keep these locked during the school year.

The only other locked cabinet is the two-drawer file cabinet. It is opened with a W460 key (small and silver). I keep larger supplies in here like the paper cutter and do not have it locked. The desk drawer lock does not work.

There is a cabinet for safety goggles in the back of the room that is opened with key 2035 (small and bronze). I keep this unlocked except for the summer

The computer cabinet combination is kept locked at night - see Mr. Cervantes the IT guy for a new lock.

There are unlocked storage areas under the sinks in the classroom. I generally do not put anything in these areas.

Classroom Safety Equipment

There are five pieces of safety equipment in the classroom:

- The fire extinguisher near the hood. This is never locked, of course. There is another one just inside the storage room.
- The safety blanket at the back of the room.
- The safety shower at the back of the room.
- The eyewash station at the back of the room.
- The safety goggles at the back of the room

I go over the location and use of these safety equipment items at the beginning of the year. I have a handout that they use to mark the location of these items as well as lab equipment. I also have them go over the safety rule handout and put it in their notebook. See the summary of notebook contents.

Sinks

There are seven sinks in the room. Some do not drain well and at least one sprays water when it is turned on. They all have the rubber hose adapter on the faucet, which can lead to excessively fast flow when the water is turned on. I used the sinks at the four corners of the room and next to the hood for water supply and washing, and the others for liquid disposal only. If I had a wish it would be that the bad drainage was fixed and that the nozzles would be replaced by regular household nozzles that would not spurt out too quickly.

Electrical Outlets

There are outlets in the walls around the room and in the fixed desks. I prohibit any use of these outlets by the students except for powering lab equipment (lights, hot plates, etc.). They are NOT allowed to charge up phones or their own computers. The exception is the charging station I maintain on top of the computer cabinet in the back of the room.

Lights

I generally turn on all the lights available by pressing all buttons except Quiet Time.

Heating and Air Conditioning

As far as I know there is actually no working thermostat in the classroom, so there is nothing you can adjust when it is too hot or too cold. If the temperature is interfering with my teaching I email the Vice Principal in charge of facilities with a copy to the Physical Plant Manager and the Principal. There are two fans in the back storage room (one is still in a box) you can bring out if it is too hot.

Hood

The hood works as it is supposed to, I think, but I never use it. Instead I use it as a short-term storage location for material related to the lesson I am currently teaching. It has to be cleaned out when the safety people inspect.

Mobiles

I left two mobiles hanging up even though they say to take everything off the ceiling.

Recycle Bins

I put the two largish recycle bins in the cubby just to the left of the door. They should be in the storage room during the summer.

Doors

The back door has a sign saying do not use, and I am very strict about this as I want to have knowledge and control of who comes in and out of the classroom. **I CANNOT OVERSTATE HOW IMPORTANT THIS IS. TEACHERS WHO HAVE LOST CONTROL OVER THEIR SECOND DOOR ARE MISERABLE.**

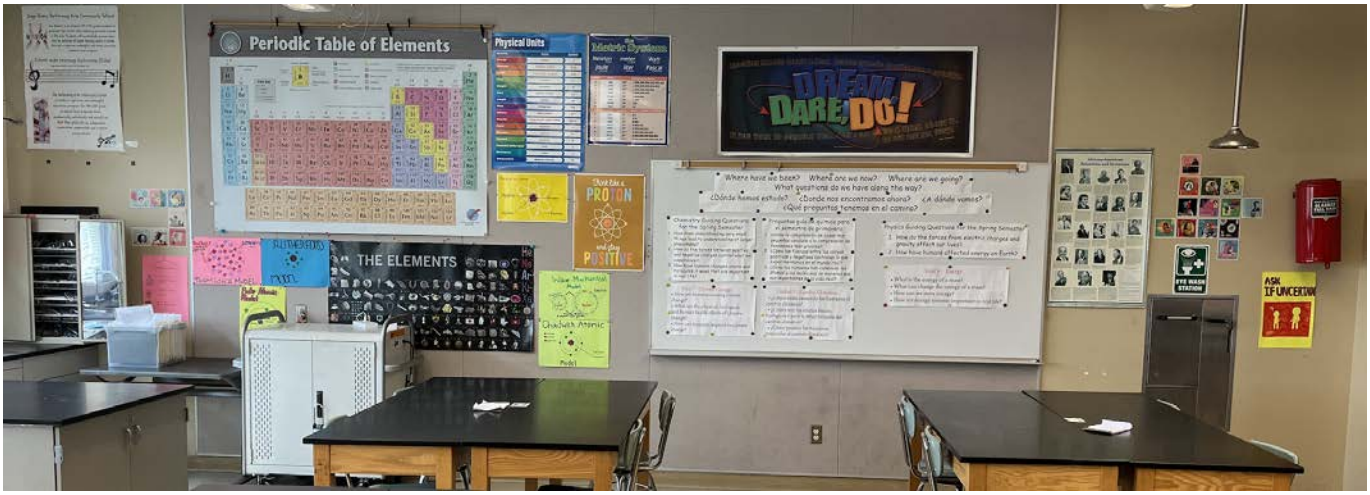
Wifi

The wifi in the room is generally reliable, if a bit slow sometimes. You can tell whether it is out by looking at the unit on the ceiling. I think a solid blue light means it is working. Even when it is working it can be pretty slow, however.

Materials on the Classroom Walls

The walls on the window side of the room have nothing on them except a safety poster over a sink and two posters about Latino scientists. There is space above the windows for materials to be put on the walls, but I never had the energy to use that space. To the far left there is a hood that works (the fan goes on), but I never use it for that purpose. It serves as an intermediate to longish term storage area (last year I put there all the notebooks and folders of students who left the class because occasionally one of them will return.

The walls on the back side of the room have a lot of material, including the flag, the school vision and mission, two periodic tables, safety posters, women and black scientists, and other science stuff, including student work. There is a cabinet for safety goggles. The white board has the guiding questions for the semester and the current unit. The computer cart is there also, and a file box with all the back handouts. I put a set of phone chargers on the computer cabinet (I do not allow phone charging at any wall or desk plugs). Those chargers are in the low cabinet under the goggle cabinet.



The hallway side of the room mainly has cabinets full of lab supplies except for the two glass cabinets near the door that I kept the lab notebooks in. There are holders for all the student folders also. The wall near the desk surfaces have safety posters and a few other motivational items. The wall above the cabinets has a series of science alphabet posters that were there when I came and, although some of the words are strange, I have never had the energy to take them down and possibly replace them with other material.

The “front” side of the classroom has the desk and a large fixed table with a small sink at one end and a data projector in the middle. I use the table mostly for the most recent handouts and as for the material I am projecting. There is a bookshelf in front of the table that has science books and text books. These are stored for the summer in one of the glass cabinets. On top of the bookshelf there are containers for pencils (I keep this filled by buying more constantly), clear plastic tape, poster markers, colored pencils, rulers, scissors, and glue sticks. These are stored for the summer in the most leftward (under the hood) and most rightward (under the flag) lower cabinets. During the year students are free to use these materials whenever they need them.

The data projector is stored for the summer in the back area of room 306 on top of the computer cabinet. It is the hub for all projection from the ceiling projector. There is a power cord that goes down a hole in the desk to a plug in the lower part of the table. A very heavy duty cable comes out of the upper back part of the table and provides the connection to the overhead projector. Another cable comes out of the back of the data projector and goes to whatever computer you want to project from. You can switch from the computer input to the data projector input using a button on the data projector (it is the one on the left with no plastic over it). I used one laptop computer on my desk for projecting and another laptop computer for everything else, including taking attendance.

There is also a large flat screen at the right and I used a third computer at the end of the table near the desk to project to the flat screen using an HDMI cable. This works well, although it takes a bit of getting used to because when the computer is plugged in the stuff on the screen is really small. Of course, the flat screen has many other functions you can learn about, but which I rarely used. One is to mirror the flat screen with a computer using a WIFI app called Screen Share. I mainly used the screen to project the daily agenda. Sometimes I used the whiteboard function - there is a stylus in the box of flat screen materials.

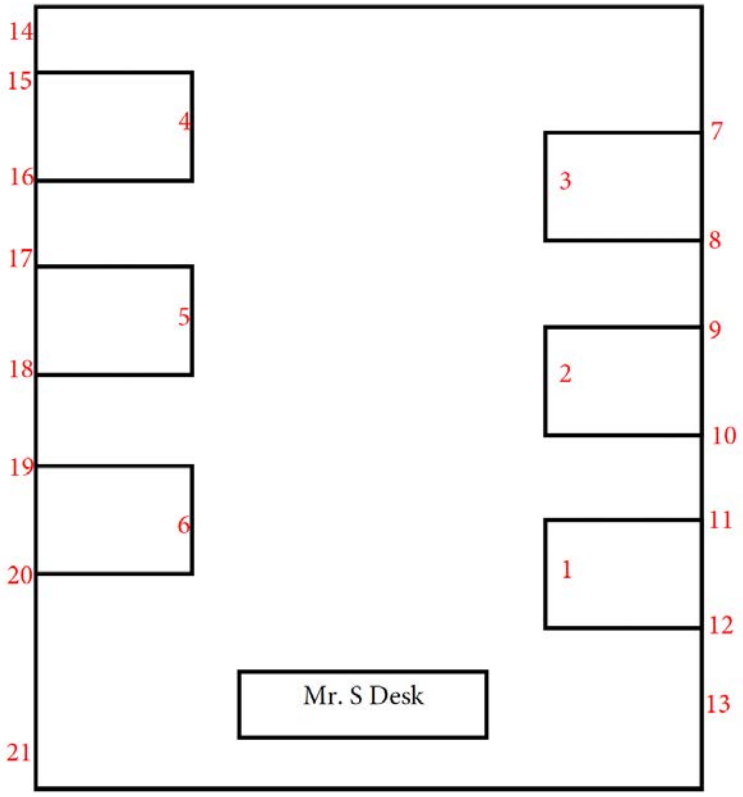
From left to right the front wall has the clock, the bathroom pass card and marker holder, the schedule and date, the screen, the classroom flag, the class norms surrounded by origami figures, and a low file cabinet. On both sides of the screen there are motivational posters. See the figure for all this. The flag and the posters are in the storeroom behind the door. I use the low file cabinet to store things like paper pads, extra bathroom passes, etc.

Material location in the classroom and storage rooms

Classroom

It should be pretty obvious what is stored in the upper shelves with the glass fronts. The two upper cabinets near the front door were used for storing all the lab notebooks.

Here is a diagram of the classroom with the lower cabinets numbered and a key to what is in each cabinet:



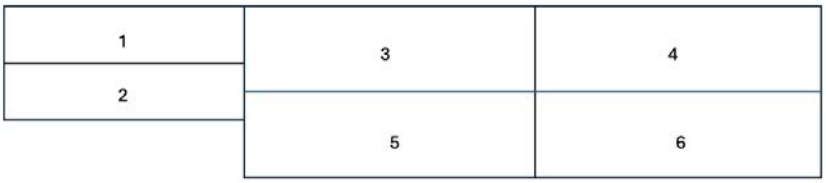
Cabinet #	Contents
1	Wooden ramps; base for tall tripod (legs are in storeroom); plastic channel; rags
2	Ring stands
3	Ring stand attachments
4	Some paper supplies; science games and kits; two APES lessons
5	Misc. science books; small clipboards
6	Paper supplies
7	Small beakers and flasks
8	Test tubes; erlenmeyer flasks
9	Filtering flasks; erlenmeyer flasks
10	Filtering flasks; crucibles; metal connectors; pH meters; plastic test tube racks; Wash bottles; squeeze bottles; test tube supports
11	Wooden test tube racks; Buchner funnels; culture tubes
12	Litmus paper; test tubes
13	Buchner funnels
14	Lab aprons; misc classroom supplies stored here during the summer
15	AP Chemistry kits - the chemicals are in the storeroom - each has the kit number written on it.
16	AP Chemistry kits - the chemicals are in the storeroom - each has the kit number written on it.
17	Empty
18	Empty
19	Empty
20	Calculators; water testing kits for APES
21	Misc classroom supplies stored here during summer

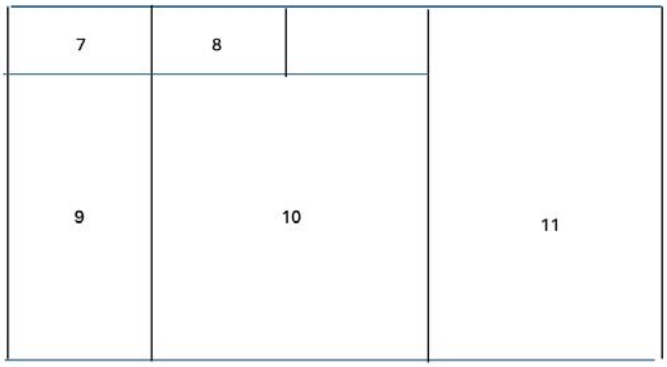
Material and Supplies in Room 302

This room serves as a lunch room for staff and teachers and also as a storage room for material and supplies used in lessons, mostly for the chemistry/physics teacher. There are no chemicals

stored in this room. Below are the locations of materials and supplies in the cabinets and drawers in this room.

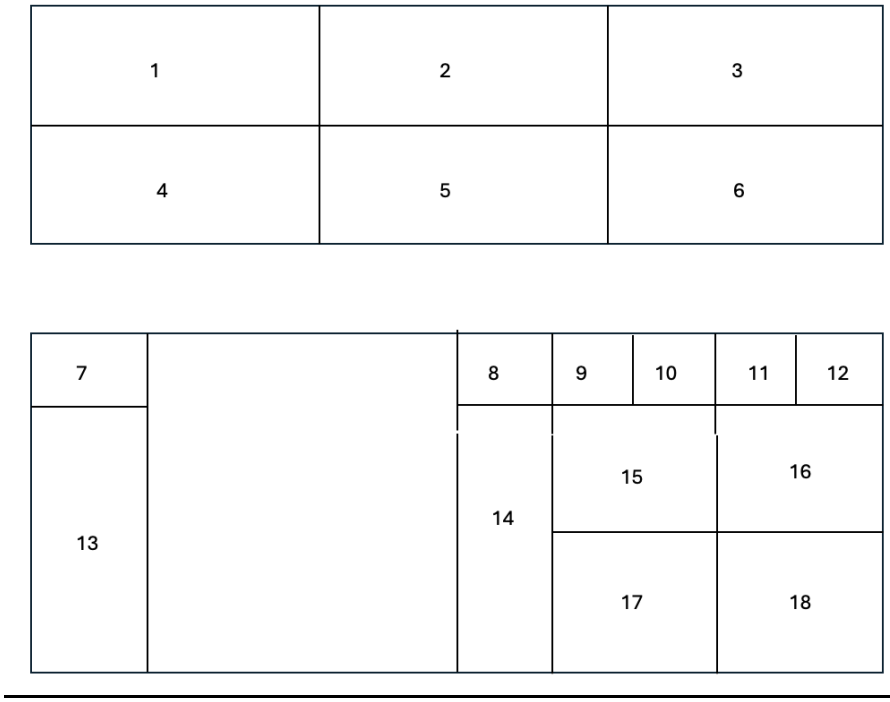
Right Side of Room





Cabinet #	Contents
1	Old and new multimeters
2	Old and new multimeters
3	Legos; stopwatches; sand bags; pulleys; small block and tackle
4	Clay; multimeters; mystery tube supplies; category lesson supplies
5	Centrifugal force lab; spring scales; pulleys; candles and nutholders; stirling engine; mini centrifuge; tuning forks
6	Kitchen supplies
7	Empty
8	KilaWatt meters
9	Optical experiments
10	Mystery tube models and other cylinders
11	Misc bags

Left Side of Room



Cabinet #	Contents
1	Element lab supplies; tape measures; big plastic chips; shells; cheese cloth
2	Soldering iron; pith ball experiment; battery eliminator; static electricity demos
3	Straws; cups; dishes
4	Weight sets; marbles; aluminum trays; hair drier; ph strips; bonding game; small plastic chips; small springs
5	Aluminum cans; iron filings; balloons; misc. electrical supplies
6	Roller coaster kits; glass and plastic containers and dishes
7	Compasses
8	Magnets
9	Wires and LEDs
10	Electric motor supplies
11	Rail gun; electromagnet supplies; 9 v batteries
12	Small energy system supplies

13	Mystery tubes; push/pull force meters
14	Ropes; phone cords; musical instruments
15	Felt board lessons and projectile launchers
16	Supplies for egg catcher
17	Felt board lessons and projectile launchers
18	Big block and tackle; phone cords

Chemical Storage

All potentially hazardous chemicals are stored in locked cabinets in either the front or back part of Room 306. All the combinations are now set to zeros, but you might want to change that:

- In the first room there is one cabinet with all the chemicals that were in the room when I came to PACS. These have not been sorted by storage type and may be expired. The chemicals near the front of the shelves are the ones I use most often - mostly for the lab where we make solid “boba” balls using sodium alginate. There is also a bit of potassium permanganate that makes a nice purple dye for visualizing water movement. The bromothymol blue indicator is also there - I use that in the ocean acidification lesson.
- In the back room there are two black wooden cabinets that have:
    - All the AP Chemistry chemicals sorted by storage code.
    - A shelf of miscellaneous chemicals used by the biology teacher.

In the back room there are also the metal cabinets for acid, volatile, and corrosive wastes. During my time at PACS these cabinets have never had a lock, so that is something you can think about adding.

In the first room there are kitchen “chemicals” in one of the lower shelves. These include vinegar, salt, alginate, food dye, baking soda, etc.

Storeroom 306

The front part of this room serves as a lunch room for the science teachers and as the location for some classroom supplies. This room is accessed using key 9561 from the hallway and from both science classrooms. The cabinets in the front room are locked using key 1087, which is also a key you want to make sure you do not lose or break. Most cabinets have obvious kitchen and food preparation and cleaning materials. One of the lower cabinets has non-toxic lesson materials such as baking soda, vinegar, salt, etc. There is an autoclave that has never been used, but is too big to put anywhere else. As noted in the chemical storage section above, there is one lower cabinet that has the oldest chemicals.

The room is divided into a front and back room with the door in between also opened with key 9561. The back room, also opened with key 9561, is where all the biology materials are stored and some chemistry, physics and APES material. Here are some important details:

- All the cleaning implements are here (broom, dustpan, etc.). During the year we generally keep the floor scraper, broom, and dustpan, in the front room to be easily accessible. It is important to keep these implements in the back room during vacations or the cleaning staff may take them.
- There are four large fans for use in the classrooms. Only two have been assembled.

- There is a precision balance (on floor near fans) and a spectrophotometer (top open shelf on the right) in their original boxes. These were bought for AP Chem have never been used.
- There are games, but the school is discouraging use of these in the classroom. I used to have them out during Advisory, but not recently.
- There is APES material on the left most open shelves - sample bottles, sieves, etc.
- There are two kinds of climate change games.
- There is a pneumatic launcher intended for a physics demonstration of the falling monkey. This also includes the electromagnet that would be on the ceiling somewhere.
- There are constant velocity cars, frictionless cars, and velocity gates in a big tupperware box
- There are Happy Atom kits in another big tupperware box. These are GREAT for chemistry.
- There is a Van der Graff generator in a box near the fans.
- There are two very frictionless dollys for physics and two that are regular dollys that are not so frictionless.
- There are supplies (cardboard boxes, big plastic dishes, tupperware dishes, lead weights, plastic wrap) for making solar stills.

Daily Routine

The following is a summary of my daily routine, including some ideas about classroom management.

Note that there are three heavy duty posters with the daily bell schedules for the week in the back of room 306 on the cabinet with flat drawers to the left of and behind the door as you come in. Every day I would put the date and one of those posters on the board to the left of the projection screen with the date up above. When not in use the schedule sheets and the date/time material were on the board behind the screen. Everything was stuck to the board using magnets that are in the second large supply drawer in the front table.

Notebooks and Folders

Each student has a 100-page college-ruled composition notebook. For the last several years I have just bought these at Staples during the summer when you can get 30 at a time for 50 cents each. I used to sell them to the students, but so many said they did not have the money that I just gave up. I also bought colored folders for them to keep larger papers (handouts and assessments). The notebooks are stored in the glass cabinets to the left of the door and the folders in holders below those cabinets.

Each morning when the students come in I have their notebooks put out in piles of two on the table near the door. If I want them to access the folders I put them out also on the other side of the table. At the end of class the students return the folders to the holders and put the notebooks in two piles on the table where they picked them up.

I give the students their notebooks and folders during the first week of class. At that time they write their names, period numbers, etc. and also number the pages according to my instruction. I also give them library card stick on pockets to hold the bathroom pass and their name card. It is important that they write everything in black marker to make sure it is visible and durable. The notebooks have pages at the front (numbered W1, W2, etc.) for warmups, followed by pages for lesson handouts numbered F1, F2, … in the Fall and S1, S2, … in the Spring. When it is time to grade material in the notebooks and folders I take them home in Trader Joe bags (the best) using the carrying carts. This system has worked well for me.

Texts

Every student gets a disposable copy of the HMH California Science Dimensions text for either chemistry or physics. They can also view the text online, either in a lesson mode or a pdf replica mode. The fact is that I never used these texts for the following reasons:

- The text did not align well with my lesson sequence or with the material sequence within a lesson.
- I found the writing in the text to be potentially difficult for my students to read.
- There is no Spanish supporting material for the texts.

Supporting English Learners

I supported English learners in several ways:

- I copied almost all the handouts in Spanish and English.
- I worked with the ELA teacher to seat English learners near each other with one advanced English learner if possible.
- Asking for Spanish speaking aides for periods with a lot of English learners.

Warm Ups

Almost every day (unless we are pressed for time) I project a warm up question on the whiteboard screen. This question ranges from quantitative (what is the number of protons in

this element?) to subjective (how worried are you about climate change?). The students write the date and their answer to the question in their notebooks. After I do the attendance I come around and stamp the warm ups. Then at the end of the grading period I count them up and give them a generously weighted (they can miss several classes and still get a 4) score under the Accountability category. About half the time I will take the time to discuss the warmup question. There are stamps in the top supply drawer. I use the check mark stamp for warmups because you can tell when it is showing through to the other side of the page - a subtle logistical issue.

Agenda

I put the agenda for the day on the flat screen. Also any recent assignments so students who were absent can see what they missed. Sometimes other material related to the lesson or unit. I would say there is room to do more with the flat screen, but I did not have it long enough to play around with possibilities.

Lessons

Generally I had the following kinds of lesson components:

- Observation and reflection - these lessons were often the first assessment in a unit.
- Direct instruction - showing them something on the front screen. Sometimes this is just instructions about another lesson component like a lab and sometimes it is a full lecture using fill in the blank notes (see the example notebooks).
- Labs - for these I usually provide handouts with space for data to be taken, for calculations, and for conclusions and reflections to be written. When the lab instructions were substantial I had them copy them onto lined paper that fit into the notebook.
- Class discussions - sometimes using white boards or felt boards.
- Readings with pre and post reading exercises to complete
- Calculation practice
- Project work - usually the last assessment in a unit.

End of Class

I experimented with exit tickets using Plickers for a year or two, but the time spent did not seem worth what we all got out of it, so in the end I have not used exit tickets much at all. When the time for the class to end approaches I ask them to get ready to leave. One class rule is that they may not congregate near the door. I usually let them out 15-20 seconds before the actual end of the period - this is why the clock needs to be accurately set.

Classroom Management

This is such a big topic that I can only say a few things about what I have found works for me after seven years here at PACS:

- Of course, getting to know them well is the best idea. Spending two minutes every day for a week with a student who is acting out is a good idea if you can make the time.
- Always being positive - four compliments to every one criticism.
- Be positive and supportive. When I take a student who has been acting out to the hallway I always start with, “How can I help you succeed in this class?”. This offers support rather than criticism and passes the ball to them to respond.
- If you show students you care about them, they will care about you and behave accordingly.

- Be careful about drawing a line in the sand, such as, “I want absolute silence in the classroom now.”, because they will just begin to test this limit and all learning will grind to a halt.
- A lot of their energy goes into getting the attention of their peers by making you react, so not reacting goes a long way. I had one class that would make whistle sounds, and it was impossible to know who was doing it, so I just pretended it wasn’t happening and they stopped.
- For cell phones what worked this year was to issue a clear warning to everyone and then if you want to take a phone tell them if they give you the phone (you then lock it in one of the notebook cabinets) then they can get it back at the end of the period, otherwise you will call the office and they will lose their phone for the whole day. This worked well this year because the office actually responded and sent people when I called. But I am pretty sure they did not actually take the kid’s phone for the whole day and this news eventually leaked out and made the threat less real. But still it worked well enough that people would give me their phones to hold. There are plans for a new system for cell phones next year, so perhaps this advice will not be relevant.
- Moving a student to a new seat often helps a lot, but I do not do this as punishment. I always tell the student how I think the seat move will help them and others learn better.
- For extremely disruptive students I have called the office and asked that they be removed from the classroom, but this is only a short term response to whatever is the larger issue with the student. The office is really not equipped to handle students sent out of a classroom.

<u>First Days of School</u>

Here is what I did during the first week of school:

- Day 1
    - Intro to Mr. S
    - Students make name cards
    - Icebreaker - I used a classroom bingo for this - the templates are with the other handouts
    - Pass out parent information sheets to be returned
- Day 2
    - Complete online Help Mr. S Get to Know You
    - Set up notebooks
- Day 3
    - Community norms circle
    - Review of safety equipment
- Day 4
    - Safety rules - start posters
- Day 5
    - Finish safety posters
    - Syllabus
    - Mindset

Lesson plans

A couple of years ago I found a book called *Teaching for Understanding* by Blythe (https://pz.harvard.edu/projects/teaching-for-understanding). This book changed my lesson planning and grading completely. Each unit now has the following components:

- Guiding questions (these are in addition to the guiding questions for the semester)
- Applicable Standards
- Lessons done either individually or in groups. The evidence for their having completed a lesson is on a handout that is assigned a specific page in their notebook. I stamp lessons that are completed with good effort. At the end of the grading period students get a score based on the number of stamps they have.
- Three assessments students do individually. The criteria for getting an A or a B are spelled out precisely. Most, but not all, units have the following arc to the assessments:
    - An observation of a phenomena
    - A task related to what they learned in lessons
    - A "project" that integrates what they learned in the unit and that stresses real-world applications.

  Assessment handouts are on 8.5x11 paper that goes in their folder. Often they may make a poster, Google Slide presentation, Google Doc, or some other way to show their work and their understanding. I will often go around the classroom offering "coaching" on their assessment completion.

  A super important aspect of this system is that when I score the assessments in Schoology I give explicit feedback as to how they can raise their score. There is no deadline for revisions other than the end of the semester.
- At the end of each unit students complete an online metacognitive reflection. They get 4 points for completing this, but I generally do not try to read them all.
- Each unit has its own grading category in Schoology.

Grading system

I use a mastery grading system with a 4 point scale.

A = 3.5-4.0
B = 2.5-3.5
C = 1.5-2.5
F = 1.0-1.5

On assessments an A is called Amazing and a B is called Must Have. There is no D grade on this scale, but I will sometimes give a D to a student if I think it is warranted.. I will often give the higher grade to someone close to a grade cutoff. **Students have an unlimited amount of time to revise or complete lessons or assessments.**

At the end of each grading period the students complete a "grade check", on which they show me they know the basis for their grade and which asks them to reflect on how they got their good scores, why they got their low scores, and how they can raise the low scores. This score is part of the Accountability grading category.

The Mastery Score for each unit grading category and for Accountability is computed by averaging the scores within each grading category. The final GPA is the average of all the Mastery Scores. Grading examples are given in the syllabus for each course.

Advisory

PACS has struggled to come up with and "enforce" an advisory curriculum with specific activities for each grade level. At the last School Governance Council meeting a renewed commitment was made to this effort.

Here are the activities I have used in Advisory..

- Keeping a daily journal - when advisory had A, B, C, … grades I gave credit for entries made.
- Career and College - this will be important particularly in the last two years a student is at PACS..
- Digital portfolio - each student is supposed to develop over the four years at PACS a digital portfolio using Google Sites to document their academic progress by posting class material. This can also be used to prepare components of a resume.
- Life skills such as financial literacy, etc. I was not successful in engaging my Advisory in this activity, but I believe it is worth trying.
- Digital citizenship - there is a required curriculum about this, but it is kind of wimpy in my opinion. There is also a curriculum offered by commonsense.org that liked, but that had no Spanish support.
- Compassionate communication - sometimes called non-violent communication. I did this for a couple of years and thought it was very worthwhile.
- Door decoration for holidays and theme months

I also was known for providing snacks in Advisory. I did this every other Thursday as a bribe to get them to do what I wanted on the other days.

Lesson Content and Handouts

Digital copies of the lesson material for the 2023-24 academic year can be found at this Dropbox link: https://www.dropbox.com/scl/fo/6u4in445ogkibr4i6zbyp/AF0YfDTwdWXkaoQDebTYbok?rlkey=cl30fxj3vzsics2m1t2uxc014&dl=0 and at these Google Drive links to my Teaching Folders (note that some material from 2022-23 was not copied to 2023-24): https://drive.google.com/drive/folders/1nONNgwBlsFZPtiX3K_zH0XeG2VUFS0i6?usp=sharing and https://drive.google.com/drive/folders/1sVrdRFA0daGILJXvuheLQnommvTUnKSy?usp=sharing.

The teaching folder material is also found here: https://www.dropbox.com/scl/fo/fko4ypa1hwgj3hr7bjga1/ACifbDuTrIfx51SFEPXwZpc?rlkey=x3ek7nozojqoof1v1n5mujvv7&st=alg2yqik&dl=0. Note that in this folder all Google Docs become Word docs and all Google Slides become PowerPoint presentations and some documents are not converted correctly.

https://www.dropbox.com/scl/fo/fko4ypa1hwgj3hr7bjga1/ACifbDuTrIfx51SFEPXwZpc?rlkey=x3ek7nozojqoof1v1n5mujvv7&st=alg2yqik&dl=0

The following is a guide to the units and lessons for the 2023-24 year. See the Dropbox material for the Curriculum Maps for each unit that contain the semester and unit guiding questions as well as the applicable NGSS standards.

Chemistry

Unit 1 - Properties of Matter

Assessment 1.1 - Observing Matter: In this assessment students observed three disc magnets suspended on a rod. The idea was to get them to think about forces on matter that would be discussed in the unit lessons. This worked moderately well, although the concept of forces with a direction was difficult for many.

> Lesson 1.1 - Composition of Matter: Atomic and molecular structure of matter and units of mass and length.
>
> Lesson 1.2 - Volume, Mass, and Density: Definition of density and relationship to sinking and floating; practice calculating density.
>
> Lesson 1.3 - Forces on Matter: Properties of gravitational and electromagnetic forces.

Assessment 1.2 - Explaining Forces on Matter: Students did this assessment after learning about the source and nature of gravitational and electromagnetic forces. It was a good test of their ability to recognize these forces in a simple situation and to explain what they observed.

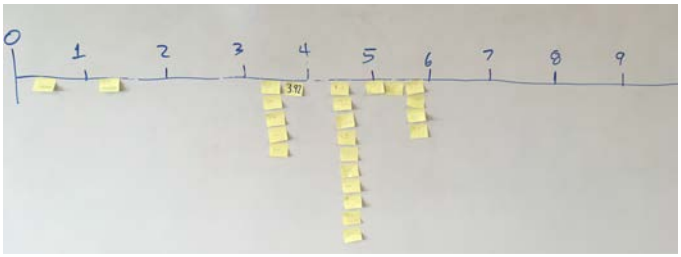
> Lesson 1.4 - Temperature and Matter: Definition and units of temperature; uses a very goodPhet simulation relating temperature to molecular motion. I referred back to this simulation many times during the year.
>
> Lesson 1.5 - States of Matter: Relationship between the three states of matter and intermolecular forces; definition of phase changes; definition of a physical change
>
> Lesson 1.6 - Solar Distillation: Phase changes in the hydrologic cycle; how a solar still works. This lesson included the construction of a solar still for each period using materials that are in the Room 306 back area. The students enjoyed this activity. I took the still home and reported back on its performance. The previous year each table group made a still and we put them out on the roof of the building, but this year they would not let us go on the roof.

Assessment 1.3 - A Water Plan for Your Home and Community: This assessment was directly related to the lesson on solar stills and was an attempt to get the students to apply this information qualitatively and quantitatively to their home and community within a scenario of scarce fresh water.

Unit 2 - Combustion

Assessment 2.1 - Observing Combustion: Students observe and reflect on a burning candle. This assessment continues the theme for the first assessment in which they are asked to describe what they see and also speculate about what they cannot see. One possible extension of this in the amazing parte would be to ask them to formulate a question about what they see that involves what they cannot see.

> Lesson 2.1 - Computing the Energy in Food: Units of energy; computing the energy per mass in food using food labels; displaying the results as a histogram of sticky notes on a number line on the back white board.



Lesson 2.2 - Biofuels Lab: Lab materials and procedure copied from a PowerPoint to a single sheet in their notebook; data on water volume and temperature and nut mass. Reflection on kinds and sources of error.

Assessment 2.2 - Calculating the Energy Increase in Water: This assessment uses the data from the biofuel lab and asks students to calculate the energy increase in their mass of water using the specific heat of water and the measured temperature increase. Students then calculate the energy going into the water per mass of nut burned and compared it to the energy per mass of food measured in Lesson 2.1. Students were asked to defend a claim about whether all the energy from the nut went into the water. This was a difficult assessment for many students, even though an example calculation was provided. They are very challenged by math calculations. They were also challenged by having to use concepts such as less than or greater than in making their claim.

Lesson 2.3 - Combustion Conference: Individual, group, and class responses to three questions about the combustion lab. I did this using a Fishbowl routine in which representatives from each table came to a central table to discuss the questions. I used the sentence starter sheets to guide the discussion. I provided the wording for the class response.

Lesson 2.4 - Combustion Video Questions: Students watched a video about combustion and filled in words from a word bank into statements taken from the video.

Assessment 2.3 - Real World Combustion Project: Each student chooses a fuel and does research on the properties of the fuel. I would say that the Amazing question about the relevance of the fuel to home, community, culture, or country needs to be more well-defined and a bit more demanding. As it is, students dash off a couple of sentences.

Unit 3 - Energy - Note this is a large unit with several distinct parts, including heat transfer, plate tectonics, and energy systems

Assessment 3.1 - Observing Lava Flowing into the Ocean: Students watch a video of lava flowing into the ocean and respond with their observations of what they can and cannot see.

Lesson 3.1 - Hot Rocks Minilab: In this lab students observe cold water being poured over heated marbles (>200C) and to measure the temperature of the marbles and water before and after they are combined. We use the IR thermometer that is in one of the lower supply drawers in the front table. The dishes and marbles are in the cabinets in the storeroom across the hall. I bought a toaster oven from home to heat the marbles.

Lesson 3.2 - Hot Rocks Discussion: We did this using the Fishbowl routine with sentence starters.

Lesson 3.3 - Heat Transfer Lab: Students heat up water using radiation, conduction, and convection. As part of the data analysis they calculate how much energy was transferred to the water.

Lesson 3.4 - Heat Transfer Reflection: After the students try to answer the question about how heat was transferred for each case I use red plastic chips to illustrate how the transfer takes place. Then I show them the class answer for them to copy. This is not a perfect way for them to learn how each kind of heat transfer works, but it seems to get the point across. A possible tweak would be to make the names of the three modes of heat transfer more prominent given how much we are going to refer to them.

Lesson 3.5 - Heat Transfer Conference: After students try to draw their individual responses each table uses a felt board and felt elements to draw what they think the answer is. This exercise is difficult because all of a sudden we are talking about more than one mode of transfer happening for each case. I walk around helping the tables make their diagrams and then each table shares its diagram. Finally, I project the class answer for them to copy.

Lesson 3.6 - Heat Transfer Video: This is a somewhat creepy but effective video for helping them remember the essential elements of each mode of transfer.

Lesson 3.7 - Plate Tectonics Video: This video is a good introduction to plate tectonics.

Lesson 3.8 - Convection Remembrance, Minilab, Video, and Reflection: The remembrance is what happened in the heat transfer lab with convection. The Minilab is a pyrex baking pan on a hot plate with a light above and potassium permanganate crystals dropped in to show the convection pattern after about 5 minutes of heating. I used to let the students do the lab, but this year I just demonstrated it at the front table using the data camera. The movie is part of the plate tectonics video. The reflection should comment on how each part of the lesson shows heated material rising upward carrying energy.

Lesson 3.9 - Dynamic Earth Reading: The lesson has a pre-read part involving vocabulary and statements about plate tectonics the student agree or disagree with. Then they do the reading and provide responses to selected sentences. The last thing they are supposed to do is go back to the statements and correct any agreement or disagreement that is wrong and for those statements that are wrong they should write what is correct. For some reason students find it hard to understand what to do in this last part.

Assessment 3.2 - Plate Tectonics: For the Must Have they make and annotate a drawing showing the basic parts of the Earth's interior and how heat is moved. For the Amazing they should say how plate tectonics has affected life on Earth.

Lesson 3.10 - Forms of Energy: This is the beginning of the last part of the energy unit. Six kinds of energy are identified - three are forms of kinetic energy and three are forms of potential energy. The scenarios have been a good way to lock in their understanding.

Lesson 3.11 - Energy Systems: This is the only place that conservation of energy is discussed. The Phet app is excellent for visualizing energy systems.

Lesson 3.12 - Energy System Minilab: This is a fun hands-on activity that uses different material. Teapots on a hotplate; large lights as radiation source; batteries; solar panels; propellers; spools; generator/motors that the spools and propellers go on; small lights; LED lights, pulleys, weights, frictionless cars. Students construct enough energy systems, usually three but sometimes two, that have all six kinds of energy.

Assessment 3.3 - Energy Systems Project: This project asks students to conceive of a real-world energy system and to answer questions about their system.

Energy Reflection: This is a fun way to end the semester by completing an artistic work (drawing, clay sculpture, poem, etc.) that expresses how the student thinks about energy. Clay has been the most popular media, so if you do this you should buy a lot of clay from Amazon or Staples. This is what I bought:

You can see the results of the last two years of this reflection at https://docs.google.com/presentation/d/1B5bu-iE6xG3_QRVsaKglTQBbGpzm4ieviKveCKPNN1c/edit?usp=sharing and https://docs.google.com/presentation/d/1ancEMCWdatOIscAvzfdXsEPLHiFmw5pq5_drTLmFd8k/edit?usp=sharing.

Unit 4 - Atoms and Elements

Assessment 4.1 - Mystery Tubes: This assessment introduces the idea of trying to figure out what is inside something when you cannot see what is inside. The mystery tubes and the materials for making model tubes are in the storeroom across the hall.

Lesson 4.1 - Atomic Model Research: Each student is assigned one of the five atomic models and does research on that model using the graphic organizer. Students at the same table have different assignments. Then students meet in groups by the model they were assigned and make a slide presentation and a poster.

Lesson 4.2 - Atomic Model Timeline: Students take notes on the presentations of each model, noting the claims made by each model.

Lesson 4.3 - Element Property Lab: Students make measurements on seven different element samples.

Lesson 4.4 - Students practice categorizing different objects and then try to categorize the element samples.

Lesson 4.5 - Periodic Table Notes: Introduces the essential features of the periodic table.

Lesson 4.6 - Periodic Table Practice: Students practice identifying the properties of elements using the periodic table notation.

Assessment 4.2 - Build an Atom: Students us a Phet app to practice building atoms with specific properties and identifying element isotopes.

Lesson 4.7 - Bohr Electron Diagram Notes: Introduces the properties of a Bohr atom and how it is represented in an electron diagram.

Lesson 4.8 - Drawing Bohr Electron Diagrams: Students practice drawing the diagrams for elements 1 through 18. This is a super important lesson because we refer to it a lot in future lessons.

Lesson 4.9 - Electronegativity: Students add electronegativity values to the Lesson 4.8 diagrams and then discuss the trends in electronegativity values.

Assessment 4.3 - Adopt an Atom: Each student is assigned a different element and does research to identify the properties of that element.

Unit 5 - Bonding and Material Properties

Assessment 5.1 - Observing a Paper Towel and Water: Students observe paper towel lifting water from one cup to another.

Lesson 5.1 - Properties of Water Lab: This is a fun, but logistical, lesson where students observe water flowing down a cord, sticking to a penny, mixing with oil and alcohol, and dissolving salt.

Lesson 5.2 - Properties of Water Lab Discussion: After the concepts of cohesion and adhesion are introduced students try to explain what they saw in the lab.

Lesson 5.3 - Lewis Dot Diagrams and Ion Formation: Student learn about these two concepts.

Lesson 5.4 - Practice forming Ions: Students use the notation to show how anions and cations are formed.

Lesson 5.5 - Bonding Between Atoms: Introduces the concept of “happy” atoms with full shells. Uses the excellent Happy Atoms that are in the back 306 room in conjunction with a bonding game.

Assessment 5.2 - Adopt a Molecule: Each student is assigned a different molecule and does research to identify the properties of that molecule.

Lesson 5.6 - Making New Material Lab: Students combine calcium chloride and sodium alginate to form solid alginate material and then show that sodium chloride will not do the same thing. There is alginate solution in the refrigerator.

Lesson 5.7 - Making New Materials Discussion: Students use felt boards to discuss why calcium chloride sticks the alginate together.

Lesson 5.8 - Polar and Non-Polar Bonds: Introduces polarity and relates it to material properties

Lesson 5.9 - Intermolecular Force Practice: A worksheet to help students understand the importance of intermolecular forces.

Assessment 5.3 - Adopt a Material: Each student is assigned a different matieral and does research to identify the properties of that material.

Unit 6 - Chemical Reactions

Assessment 6.1 - Observing a Reaction: Students observe baking soda and vinegar reacting.

Lesson 6.1 - Reaction Mass Conservation Lab: Students measure the mass of solids and liquids before and after a reaction.

Lesson 6.2 - Reaction Mass Conservation with Happy Atoms: Students use the Happy Atoms to show that the number of atoms of each element in a reaction is conserved.

Lesson 6.3 - Mass Conservation in Reactions: Students learn about molecular notation and how to use that to determine the number of molecules of reactants and products. **Note: students are not retaining what the notation $2H_2O$ means in terms of the number of each atom and also they are not retaining the idea that H_2O represents a molecule. Anything that can be done to solidify this idea for them will help in the next lessons.**

Lesson 6.4 - Reaction Mass Conservation Computations: Students learn how to compute the mass of reactants and products. **Note: I do not use moles at all in my lessons. The word "mole" appears only once in the Three Course Model writeup for Chemistry.**

Lesson 6.5 - Reaction Mass Conservation Practice: More practice showing that total mass is conserved.

Assessment 6.2 - Reaction Mass Conservation: Student are assigned one of four reactions for which they show that total mass is conserved.

Lesson 6.6 - Battery Minilab: Students make batteries out of potatoes or lemons (about 30 of each is enough - they can be reused) and measure the voltage and show that by adding elements in series the voltage goes up enough to lite a small LED.

Lesson 6.7 - The Lemon and Potato Battery Explained: Students watch a video about the invention of the battery and then take notes on how it works. **Note: in my notes the electrons end up reacting with hydrogen ions; some sources have the electrons combining with copper ions in solution to reform solid copper.**

Lesson 6.8 - Reactions and Energy: The Happy Atoms are used in conjunction with notes to show that in a reaction energy is first added to break up the reactants and then emitted when the products are formed. The concept of exothermic and endothermic reactions is introduced.

Lesson 6.9 - Ocean Acidification Minilab: This lab uses a Phet app to define pH. Students show that vinegar is acidic and will dissolve shells. Students show that adding CO_2 to water makes it more acidic.

Lesson 6.10 - Ocean Acidification Video: Provides more information about ocean acidification.

Assessment 6.3 - Adopt a Reaction: Each student is assigned a different reaction and does research to identify the properties of that reaction

Unit 7 - Climate Change

Assessment 7.1 - Climate Change Reflection: Students interpret what four graphs show in terms of climate change.

Lesson 7.1 - Climate Change Videos: Students watch videos on each of the four climate change topics.

Assessment 7.2 - Climate Change Miniquizes: Students use material provided to pass a mini-quiz on each of the four climate change topics.

Lesson 7.2 - Climate Change Simulations: Students us a simulation app to show how different emission scenarios affect the severity of climate change.

Assessment 7.3 - Climate Change Research: Students define a climate change research question and do research to answer it.

Physics

Note: Most physics courses start with motion and then move on to unbalanced forces that cause the motion. I reverse this and start with forces because in the real world most things do not have unbalanced forces.

Unit 1 - Forces

Assessment 1.1 - Observing a Car on a Hill: Students view a video of cars trying to drive up a hill, some making it and some not.

Lesson 1.1 - Experiencing Forces: Students go to stations and experience forces by gravity, friction, springs, and moving air.

Lesson 1.2 - How do Forces Act On an Object: This lesson defines body, normal, and tangential forces and shows how to draw them.

Lesson 1.3 - Forces Between Objects: Students go to stations and experience different examples of forces between two objects with the intention of learning Newton's Third Law about equal and opposite forces.

Lesson 1.4 - Free Body Diagrams: Students learn how to draw free body diagrams.

Lesson 1.5 - Practice Drawing Free Body Diagrams

Assessment 1.2 - Real World Force Analysis: Students define a situation with the three kinds of forces present and draw a free body diagram for the situation.

Lesson 1.6 - Force Lab: Students go to stations to measure gravitational force vs. mass, static friction force vs. normal force, spring force vs. spring extension, and string forces vs. pulling force

Lesson 1.7 - Force Conference: Students analyze the data from the force lab to derive linear equations that predict the force for each station.

Lesson 1.8 - Force Models and Practice: Conventional equations for gravitational force, static friction force, and spring force are defined. Students practice using these equations.

Lesson 1.9 - Force Direction Minilab: Students measure the tangential force needed to hold a car on a slope as a function of the steepness of the slope.

Lesson 1.10 - Forces as Vectors: Students learn about the vector nature of forces and how to represent force components using trigonometric functions.

Assessment 1.3 - Forces on a Car on a Hill: Students use what they have learned about forces to calculate the gravitational, normal, and tangential forces on a car on a hill.

Unit 2 - Forces and Motion

Assessment 2.1 - Observing a Collision: Students watch a video of a car crashing into a wall and record their observations.

Lesson 2.1 - Computing the Sum of Forces on an Object: Students learn how to compute the net force on an object.

Lesson 2.2 - Newton's First Law: Students us a Phet app to find that only when the sum of forces is not zero will the state of motion of an object change.

Lesson 2.3 - One-dimensional Distance and Displacement: Students learn the definitions of distance and displacement and practice by doing their own walks.

Lesson 2.4 - 2D Distance and Displacement: Students do a graphical exercise in computing 2D distance and displacement.

Lesson 2.5 - Definition and Measurement of Velocity: Students discuss the definition of velocity and use the constant velocity cars to practice measuring velocity.

Assessment 2.2 - Observe the Motion of an Object: Students observe the motion of an object at home and compute its velocity.

Lesson 2.6 - Velocity Notes and Practice: Students learn the equations for computing velocity and solve practice problems. I always do this with table groups using the large white boards.

Lesson 2.7 - Acceleration Notes: Students learn the definition of and equations for computing acceleration and solve practice problems.

Lesson 2.8 - Kinematic Equations: Students are shown the derivation of the kinematic equations and solve practice problems. **Note: it is clumsy to derive these equations without calculus. There are several ways to do it and this way seems the most intuitive, although I think few students really bother to understand the derivation. The requirement for constant acceleration should be stressed.**

Lesson 2.9 - Force, Mass, and Acceleration Lab: Students measure the time it takes a mass to go a given distance pulled by a known force. They discuss the results to derive Newton's Second Law F = ma. **Note: this is a great lab requiring them to pay attention to the setup. It can be sensitive to the table being not level and to friction on the string, but over several years it has given pretty accurate results when all the table group results are averaged (spreadsheet is in the Teaching Folders).**

Lesson 2.10 - Newton's Court: Students work in groups to check if a statement about force, mass, and acceleration are correct. **Note: after lesson 2.9 I gave each student a diploma of graduation from Newton's Law School. The Mail Merge spreadsheet is in Dropbox.**

Lesson 2.11 - Observations of Collisions: Students use the frictionless cars in either sticky (velcro) or bouncy (magnets repelling) mode to make observations of velocity of each car after a 1D collision.

Lesson 2.12 - Momentum Notes and Calculations: Students learn the definition of momentum and impulse and the application of momentum conservation to a collision. They complete practice problems.

Lesson 2.13: Momentum Minilab: Students use the frictionless cars and velocity gates to verify if momentum is conserved in a collision.

Assessment 2.3 - Analysis of a Collision: Each student at a table is assigned a different video of cars crashing that includes a slow motion version, the mass of the car, and the value of the approach velocity. Students analyze the videos to compute stopping times and then compute the stopping acceleration and distance and the force of the collision. They then calculate the necessary stopping time and distance to prevent damage to occupants of the cars. **Note: by**

this time I have introduced the students to the idea that any acceleration more than about 10 m/sec^2 is damaging.

Egg Drop Activity: In the first week of the Winter semester the students work in table groups to make either an egg catcher or an egg protector. The designs are tested by dropping them from the third floor balcony. Students complete a reflection about this activity.

Unit 3 - Gravity and Motion

Assessment 3.1 - Observing a Ball: Students watch a ball being thrown upward from a moving car. This is a good video, but the assessment needs editing to direct the students to the parts that are different.

Lesson 3.1 - Tossing a Bean Bag: Students take notes on the application of the kinematic equations to vertical motion and then after tossing a bean bag into the air and observing how high it goes they practice calculating the initial velocity, the rise time, the fall time and the final velocity. This is a very dense lesson that could be split into two.

Lesson 3.2 – Particle Trajectory Lab: Students use the projectile launchers to find the initial angle that makes the distance to impact the greatest. This is a good exercise in group measurement.

Lesson 3.3 - Projectile Trajectory Exercise: Students use the kinematic equations to calculate characteristics of a projectile launch and to compare their results with a Phet simulation.

Assessment 3.2 - Explaining a Ball: Students use projectile theory concepts expressed in words not equations to explain why the ball in Assessment 3.1 fell back into the truck and why two of the tests are different (air resistance). Make sure the assessment refers to the correct tests in the videos.

Lesson 3.4 – Investigating Gravity: Students learn about the master equation for gravity using Phet simulation and making calculations.

Lesson 3.5 – Investigating Centripetal Acceleration: Students learn the theory of centripetal acceleration and use the theory to make calculations.

Lesson 3.6 – Centripetal Force Lab: Students use experimental equipment to measure the centripetal acceleration. This is another good exercise in group measurement, but it turns out to be hard to do correctly, and there is likely a large error resulting from friction between the string and the tube. *See the spreadsheet with class data in the 2023-24 Teaching Folders.*

Lesson 3.7 – Gravity and Planets: Students learn about how gravity affects the force on objects at the surface of a planet, the orbital period of the planet, the planet escape velocity, and which gases a planet will retain in its atmosphere.

Assessment 3.3 – Design Your Own Planet: Students use the theory in Lesson 3.7 to propose a new planet and to calculate characteristics of the planet. *Note: this assessment uses the Planetary Calculator in the 2023-24 Teaching Folders. The equations used here come from a source I researched. Contact me for more details.* I think the questions on this assessment could be improved to require that the planet be habitable by humans.

Unit 4 – Electromagnetism

Assessment 4.3 – Observing a Balloon: Students observe a balloon and a sweater in a Phet simulation and record their observations.

Lesson 4.1 – The Triboelectric Effect: This lesson is intended to demonstrate static electricity forces between different materials, but it never works consistently so I would abandon it. An alternate lesson that might be interesting would be to use a balloon and a PVC rod to measure the force on the balloon by observing the angle of deflection (this would require they remember how to use trigonometry to compute forces).

Lesson 4.2 – Electrostatic Force: Students take notes to learn about electrostatic charge and forces.

Lesson 4.3 – Coulomb's Law Calculations: Students use a Phet simulation to make calculations of electrostatic force. *Note there does not seem to be any way to do this experimentally in a quantitative way.*

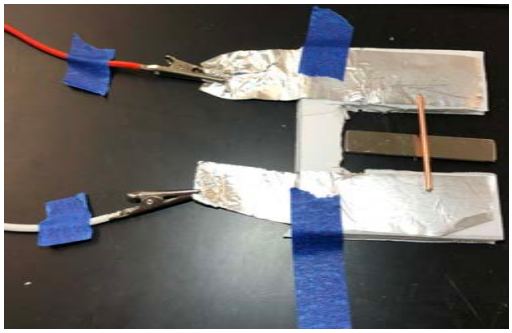
Lesson 4.4 – Magnetic Field Notes: Students take notes on magnetic fields.

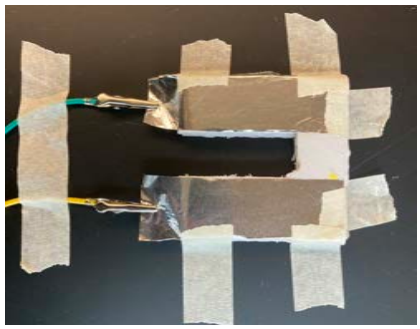
Assessment 4.2 – Magnetic Field Measurements: Students use compasses to trace the magnetic field of a bar magnet and also to answer questions qualitatively about disc magnets. *Note – the compasses and magnets are in drawers 7 and 8 in Room 302. The bar magnets are marked on one side make it easier to keep track of north and south, but the marks may have rubbed off.*

Lesson 4.5 – Magnetic Fields and Moving Charges: Students learn the theory of electromagnets and make a simple electromagnet from a nail and wire. *Note: the nails and wire and batteries and little metal pieces to attract are in drawers 9 and 11 in Room 302.*

Lesson 4.6 – Right Hand Rule Practice: Students learn about the Lorentz force and make a small reminder out of tape and a pipecleaner (*in drawer 16 in Room 302)*.

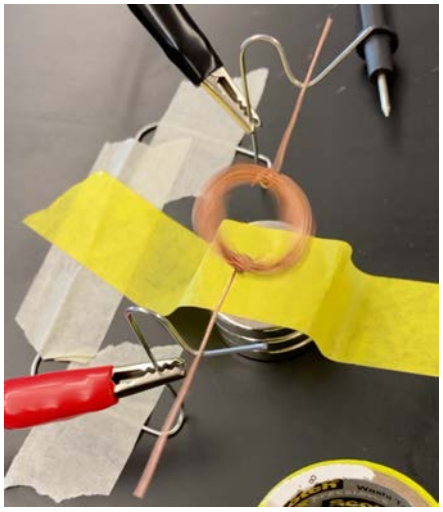
Lesson 4.7 – Rail Guns: Students work in groups to make rail guns. *Supplies are in drawers 9 and 11 in Room 302.* Note that it is important that the aluminum foil be really smooth and that the rail gun base and attaching wires be taped down to the table. *See below and note that it works better if you use two magnets stacked up.*





Lesson 4.8 – Building an Electric Motor: Students work in teams to build an electric motor. The rotor coil is made by wrapping wire around a glue stick. There are plyers in the bottom large drawer in the front desk and paper clips in the top large drawer. The paperclips and wires should be firmly taped to the table. The arms of the rotors need to be sanded to promote contact with the paperclips. Magnets wires and batteries are in the drawers in Room 302. *Note: these disc magnets are VERY difficult to handle. If they are stuck together they are hard to get apart. If they are apart and get close they will jump together forcefully and can draw blood! I think they are stored in groups of two or three. I always taped these in groups of two or three (however they are stored) onto a side table*

and moved them myself with the tape when the students had everything else ready. Note also that for the motor to work the rotor arms need to be as straight as possible and the rotor has to be as symmetrical as possible. The motor is started by spinning the rotor.



Assessment 4.3 – Electromagnetic Force Design: Students will propose a way to use an electromagnetic force to move a mass, and for maximum credit will compute the force needed and the electrical and magnetic quantities necessary to move the mass. A summary sheet about electromagnetic forces is provided. This assessment only worked partially well. Students had trouble conceptualizing the problem, remembering how to compute the force to make a mass move, and in addition it was difficult for them to come up with the electrical and magnetic quantities.

Unit 5 – Waves

Assessment 5.1 – Observing Waves: Students make waves using a variety of equipment and record their observations. The wave stations are:

- Ropes and phone cords – in Room 302.
- Slinkys – in Room 302 cabinet to the right – watch these closely – last year a student stole one.
- Waves on a desktop – I used an iPad set to a seismometer app. Students hit the desk to make the needle move.
- Waves in a water channel – I tool this home – sorry!
- Waves in a water dish – I suspended a pyrex baking dish containing about a half inch of water between two ring stands using clamps and also a light above the dish on a ring stand. Students used a pipette to drop water in the dish and observe the shadow of the waves on a white piece of paper below the dish.
- Sound waves in air. In Room 302 in a low cabinet to the left there are instruments.

This assessment is super non-challenging – perhaps a harder Amazing question could be posed.

Lesson 5.1 – Brainstorming Waves: Students worked in groups to answer four questions about waves on large poster paper (in Room 306 back room).

Lesson 5.2 – Observing Waves on a String: Students use a Phet simulation to observe waves on a string and come up with the important observable characteristics of waves. At the end of the lesson I helped them identify these charqcteristics:

- Wave shape
- Wave speed
- Wave length
- Wave amplitude or height
- Wave period and frequency

Lesson 5.3 – Measuring Waves on a String: Students measure the speed of a wave on a string for five combinations of amplitude, frequency, tension, and wavelength. They try to conclude what affects the speed (only tension) and the formula for the speed $c = f\lambda$.

Lesson 5.4 – Standing Waves: Students use a Phet simulation and ropes or phone cords to investigate the frequencies of standing waves.

Assessment 5.2 – Standing Waves: Students are assigned wave parameters to investigate using the Phet simulation. This is basically a repeat of Lesson 5.4 to be done individually.

Lesson 5.5 – Measuring the Speed of Sound: Students work in groups to measure the speed of sound in air. Then they all go to the athletic field. One group goes all the way to the east end near the fence and the other group goes to the edge of the parking lot. The first group uses the air horns to make a noise and the second group tries to measure the time it takes the noise to get to them by listening both to the noise on their phones and by ear. We tried doing this with the Sound Meter tool app in the Physics Toolbox Suite but the background noise was too high, so students just used their phone stopwatches to time the difference between the two noise pulses. The actual difference is about 0.5 seconds, which is hard to measure accurately so most measurements were to high, resulting in slower wave speeds than the correct value. But they enjoyed going out and making noise so it was well worth it.

Lesson 5.6 – Building a Loudspeaker: Students work in groups to build a working loudspeaker out of a plastic cup, small disc magnets, and a copper coil (there are many saved from the motors or they can make a new one). Then the students connect them to a music app on a computer and listen to a song – easy and fun!

Lesson 5.7 – Notes on Waves: Students take notes on waves. An important part of the notes is introducing the electromagnetic wave spectrum (not on the paper notes). *I think more time could be spent talking about EM waves as a combination of magnetic and electric fields, but maybe that is too advanced.*

Lesson 5.8 – Electromagnetic Wave Characteristics: Students research characteristics of electromagnetic waves.

Assessment 5.3 – Wave Topics Research: Students pick one of seven topics and do research to answer questions about the topic. This assessment could use some rewording to make sure students dig more deeply into their topic.

Unit 6 – Energy

Assessment 6.1 – Defining and Changing Energy: Students propose answers to two questions using Schoology Discussion questions (I think these will have to be remade). I showed the answers on a screen and guided the class to these class answers:

- Energy is the motion of a mass and is called kinetic energy.
- To change the energy of the mass its motion must be changed and this requires an unbalanced force on the mass (sum of forces not zero).

Students got two points for answering each of these. These definitions are good for thermal energy (molecules) and the KE of larger masses, but are less intuitive for electromagnetic radiation.

Lesson 6.1 – A Model for Changing the Kinetic Energy of an Object: Students use beanbags to visualize changes in kinetic energy and to formulate what kind of force decreases or increases the KE.

Lesson 6.2 – Notes on KE and W – note that there are three parts to these notes: These notes define the change in KE as equal to the work W done by an unbalance force. Three kinds of KE are defined and eight kinds of force interactions are discussed, some of which are classified as potential energy changes. *Note: the way I teach energy is the result of thinking about it for a long time, but it still needs work.*

Lesson 6.3 – Example Calculations of ΔKE and W: Students use the notes to make calculations of energy changes.

Assessment 6.2 – Calculating ΔKE and W: This assessment uses a Schoology Assessment that replicates the equations in Lesson 6.3 but with different numbers. I am afraid that assessment is probably not recoverable, but you could try.

Lesson 6.4 – Measuring Electricity: Students work in teams to use the Kill-a-Watt meters (in Room 302) to measure or calculate the voltage, current, and resistance of different electrical devices in the classroom.

Lesson 6.5 – Energy Systems: Students are introduced to the topic of energy systems and use a Phet app to explore an energy system. *Note: This is pretty much the same as Chemistry lesson 3.11. Note also that if I had more time I would have had them do Chemistry lesson 3.12.i*

Assessment 6.3 – Energy System Project: Students work individually to define an energy system and to use what they have learned to answer questions about it. *Note: this is essentially the same as Chemistry Assessment 3.3.*

What I Did Not Teach

CA Threee-Coursd Model Material

Here are the concepts and units defined by NGSS and the CA Three-Course Model that I did not include in my lessons:

- Chemistry
  - Equilibrium and Le Châtelier's Principle
  - Reaction rates
- Physics
  - Nuclear processes
  - Stars and the origin of the universe

Classroom Practices I Wish I Had Used More

Every week on Friday after school I would complete a reflection about what I did in the classroom that week, including general things as well as specific lessons, emphasizing what went well and what needed to be improved or added. Here is a list of the somewhat general things I wish I had done more of:

- More discourse – encouraging student voice
- More practice acquiring DOK material
- More demanding on A grades for assessments
- Getting to know students personally
- CER practice
- Sponge activities – what students could do when they are done with assignments
- More specific attention to SPED needs
- Science practices
    - Observing
    - Asking questions
    - Looking for cause and effect and patterns
    - Making measurements
    - Using models
    - Making claims
    - Designing experiments to get evidence
    - Analyzing evidence
    - Reasoning about evidence
    - Reflection
    - Communicating information
- Home lessons – get them to observe, question, and measure at home
- Classroom community and responsibilities – classroom self-governance
- More mindset and SEL
- Routines – see the Harvard Project Zero routines
- CAST Practice
- Peer grading
- Home contacts
- Tracking grades
- Word wall
- Action projects
- Culture integration