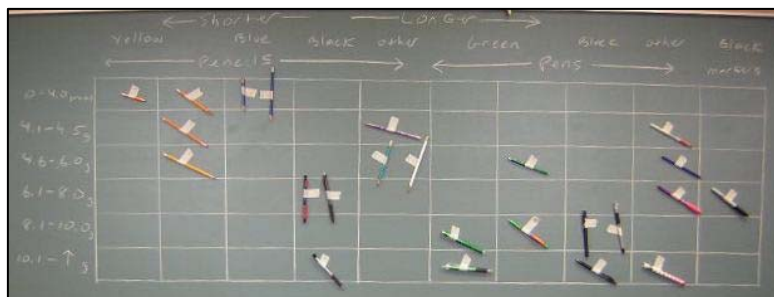


Teacher Notes- “Periodic Pencil Classification- Understanding Chemistry’s Cornerstone”

The periodic table is the cornerstone of chemistry, so it deserves to be taught well. But it can be very intimidating to students who have never studied it. This activity is designed to help students not just overcome their fear of all the strange letters and numbers on the table, but to appreciate how well the periodic table summarizes and groups elements with similar properties.

In today’s lesson students will progressively organize a group of pens and pencils into a chart using a scheme they devise themselves. The table they end up with will relate in many ways to the periodic table.



Materials:

- 2-rolls of masking tape
- 4-balances
- 1-periodic table wall chart in your room (or the page number in your book having one)
- 1-pencil from your principal (optional)
- 1-digital camera (optional)
- a few pieces of candy (optional)
- PowerPoint (see last page)

Beforehand:

1. Draw the chart you see to the right on your chalkboard. It is 10 columns across by 6 columns tall. Ideal individual square size is 20 cm wide x 10 cm high.



Start with the perimeter box- 200 cm long (which is exactly 2 meter sticks) by 60 cm high. Make your tick marks, then connect with lines. When deciding where to put this on your chalkboard, leave room at the top and left side for labels. Draw it the afternoon before since it takes about 20 minutes to do. You’ll be so much more relaxed the next morning knowing it’s already done (if the custodians didn’t erase it!).

2. Set up the balances.
3. If possible, hang a large periodic table near the table you just drew on the chalkboard. You’ll be referring to both tables today frequently.

4. Have a table or desk in the front of the classroom where students can lay their pen, pencils, and markers at the beginning of the activity. And since students will make several trips to the chalkboard to move their pens, pencils, and markers, clear that walkway as much as you can of chairs and cords.
5. This activity can adapt to be used with classes that run 25-45 minutes. It is presented in its barest form, so there's plenty of room to add to it. At the end is a list of "accessories", which are further topics you can add on which will lengthen and deepen the discussion. Leave 10 minutes at the end to give students a chance to retrieve their pencils and complete question #1 for homework.

Procedure:

1. Have a couple of student helpers go around the room and give each student about 2 inches of masking tape.
2. Introduce the lesson:

“Students, some people believe that Dmitri Mendeleev’s idea in 1869 to arrange the 60 known elements at the time in a system we still use was one of the single greatest ideas of all time. He did it by increasing mass, but then added a twist. He noticed a cycle that repeated every 8th element. When he arranged the elements by increasing mass and this cycle he came up with the basis of a periodic table that we still use today. It’s simple but brilliant.

You may be sitting there looking at the periodic table, and all you see are letters and numbers that don’t mean anything to you.... at least yet.*¹

I need each one of you to donate a pen, pencil, or marker to science today. Don’t worry, you’ll get it back. In fact, you’ll be putting your name on it, so don’t hesitate to choose your good one. If you brought more than 1 to class today, choose which you think is the *most unique*. After all, your pens and pencils will be representing the elements, and there are some very unique elements.”

3. Have students write their name on the piece of masking tape they’ve been given.
4. Next, tell your class that in the next 2 minutes they need to:
 - weigh their pen, pencil, or marker using a balance
 - write the mass on their tape
 - wrap the tape around their pen, pencil, leaving half of the sticky part exposed so it can stick to the chalkboard (demonstrate this so the idea “sticks”)
5. When the pens, pencils, and markers are all ready have each student lay theirs on the table in front of the classroom.
6. If you’re taking pictures of each step from today’s activity (to review with tomorrow) get your first shot now. If you have a digital camera, at least get a shot of the final table at the very end to show all your classes what each others’ looked like.



7. Referring to the table full of pens, pencils, and markers, say:

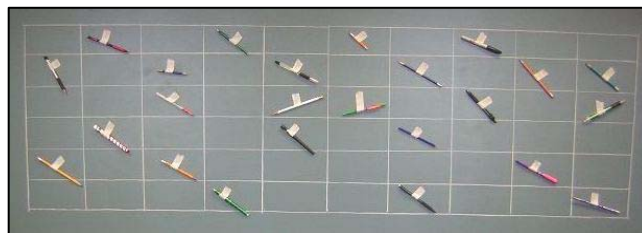
“How much order would you say is here among all these? (mixed responses, but mostly “none” and “random”)

You’re right. There is almost no order here. The reason I say *almost* no order is because each of you chose the place to lay your pen, pencil, or marker. The only way this could be any more random would be if I threw them all up in the air and let them drop. But let’s use the word “random” to describe these, because they still are.



What year did I say Mendeleev created the periodic table? (1869).
Good! And before there was a periodic table, what do you think it was like trying to keep track of the 60 or so elements that were known of at that time without any chart like this? (chaotic)
So that’s where we are. These pens and pencils right now are a pre-1869 chaotic mess.”*2

8. Now have students come up and put their pen, pencil, or marker in any square they choose on the chalkboard. Make sure they don’t hurry, and not to cry if someone else takes the square they wanted. Give the last 2 students a piece of candy as a reward for their patience (make sure they aren’t diabetic).



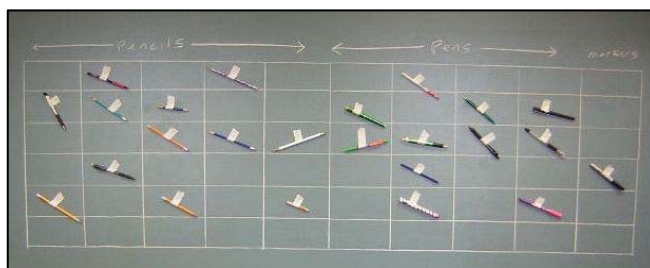
9. If you’re taking digital pictures, take #2 now. From now on, take another each time a change is made on the board.
10. When students sit down, they’ll be studying their chart, already thinking about ways to organize and group. Give them a good minute of observation time before speaking (you’ll need that time to anticipate the next few steps). Ask:

“So, is having the pens and pencils up there on the chart any better than having them on the table? (*most will answer ‘no’, but listen for one or two yes’s.*)

I think so too! It’s still a random mess, but what is it about the chart that makes it just a little better? (they each have their own square).
Good. We’ll call this an organized mess.*3

Obviously we need more order. You’ve had some time to think, so tell me how you’d like to start organizing your chart. What would be the best way to start organizing? (*ideas: by color, whether it’s a pen, pencil, or marker, by mass, length, eraser or not, cap or not, mechanical pencil or not, brand, if it’s been chewed on*)”

11. You can choose any property, but it's best to first classify by type. Write "Pencil, Pen, and Marker" across the top of the chart, allowing the first 5 columns for pencils, 4 for pens, and 1 for markers. Not perfect, but ok (if you're working with 25 pencils and 3 pens- don't laugh, it's happened!- you'll obviously need to give pencils more columns.)



***The 3 traits you'll go through with most classes are type (meaning whether it's a pencil or pen), mass, and color. As long as you do color last, it doesn't matter which of the other 2 go first.**

12. Ask those students who need to move their pen, pencil, or marker come up and move them. Point out that many will not need to move since it's already in the right place.
13. As students move their pens, pencils, and markers, 1 or 2 tell you they have a problem, like there's not enough room for all the markers. Have them make their own decision about what to do, and later we'll bring it up for the class to talk about.
14. Study the new grid:

"Are things any better? (yes, much better).

How so? (all the pencils are on the left, pens to the middle and right, and markers to the far right).

Ah, finally a little bit of order. We're getting there.

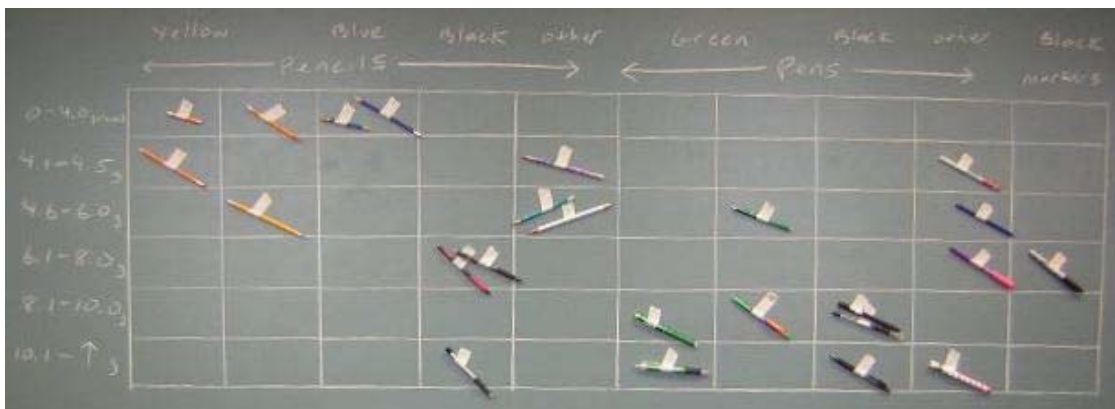
(Move your hand left to right over the table as you say...) And now that we have them divided by type, something happens as you move across the chart. What happens as we go this way across the chart? (we go from pencils to pens to markers) *4

Right, everything has its place. Well, almost everything. Were there any problems or exceptions when we put the pens and pencils up? (yes. Those 2 pens are in the same square).

Hmm...yes they are. And I think I can see why they did that...there was really no other choice. Or does anyone else have another suggestion? (we could have...)*5

We've just learned another valuable lesson about the periodic table, and about science too. There are *always* exceptions! Take mercury. Does anyone know what makes mercury special? (it's the only metal that is a liquid at room temperature). And, lookie here at elements 18 and 19- their atomic masses go down and not up, unlike the rest of the elements on the chart.

So this problem on the board is really nothing to be upset about. But it's there and it still has to be dealt with. Do you want to leave it or move it?"



15. If students choose to go by mass next, you'll need to do some quick polling so that you'll have 4 or 5 on each row. Ask how many weigh between 0 – 4.0 grams? If only 2 hands go up, go from zero to 4.5, or 4.75, or higher until you get 4 or 5 students who are in that range. If you're not careful you could end up with 20 on one row and none on the next two.

Write the range you end up with beside the beginning of the first row. The rest usually go by about 1 1/2 gram increments (so row 2 will be from about 4.6 - 6.0, then 6.1 to 7.5, and so on), but keep going through the mass ranges so you won't end up with 2 pencils on one row and 10 on the next.

16. After all ranges have been written down, have students come up (if necessary) and change squares so they fit in with the new category.
17. Look the board over. Move your hand in a downward motion over the board and ask:

"Now that we have mass listed, what's happening as you go down the chart? (mass increases).

And as you go up? (mass decreases).

You know what we can do now? Watch me combine our two sets of characteristics. If I put my hand, say, up here (*don't look where you're pointing*), what's there? (lightweight pencils)

How abouthere? (heavy pens)."

18. Add another characteristic. If you haven't done by color yet, do that (after, of course asking the class what they want to do, and then going with that one). To choose colors, look at the pencil section and ask what the predominant color is. If more than half are yellow, write "yellow" across to the top of half the columns in the pencil

section. Blue and black usually get their own column too. If there are a few odd or mixed colors, call that column “other”.

19. Whenever you’re done adding characteristics say:

“Suppose Mrs. (principal’s name)*⁶ walked in the room right now and looked at our chart. You’ve created one that is meaningful and that anyone could figure out just by looking at it. Well, our principal isn’t going to walk in, but (*hold up your principal’s pen or pencil*) she did give me this. This is hers, and she’s wondering if it has a place on our chart. (yes, right there).

Outstanding. You created this amazing chart. And you’ve taught yourselves how to read the Periodic Chart.”*⁷

20. Leave 10 minutes at the end of class to explain the homework assignment and give students a few minutes a chance to get the first question completed.

21. Hand out the 4-question homework assignment and give students remaining time to get started on it.

Homework Questions-Periodic Pencil Classification

1. Draw the table we made today (with empty boxes). Include all titles and labels.
2. Add to your chart two other ways we could have classified the pens, pencils, and markers. Be creative!
3. At the end of activity would it have been worse to switch 2 pens/pencils that were next to each other or 2 from on opposite sides? Explain.
4. Look at a periodic table in your book and compare it with the one we made today in class. Name something they both have in common.

22. Tomorrow, review using

“PowerPoint-Day 2 Review-Yesterday’s Images” and make more points about the chart. If you took your own pictures, insert and use those in the PowerPoint.

Accessories: Other sub-topics you can add for more length and depth.

- *¹ “Well, let’s take care of that right now. (move over to the periodic table and pick a random element, like Tantalum) What do the letters “Ta” mean? (that’s the symbol for the element Tantalum). How about this number 73 below? I think there’s one...maybe two people that know this. (that’s the number of protons in the nucleus). And this 180.84788? (that’s the atomic mass). Yes! Just like when you step on a scale and weigh yourself, we also know how much an atom of each element weighs.
- *² To help your students understand how much easier it is to memorize organized things do this: tell them you’ll be giving them a test in which they have to name every kind of pen, pencil, or marker on the table right now. Without any order, most would only get a few right. Check back on this at the end, and it’s amazing how easy it is to remember them then.
- *³ During this step most classes will leave one area of the table empty and another crowded (hey, that’s just like their behavior in the hallways). Ask if anyone had a reason for this, or what was their thinking when they decided where to put their pen, pencil, or marker.

- *⁴ Referring to the real periodic table you've hung nearby, tell students that moving "longitudinally" across it has meaning also. The further left you go, the more unstable the elements become. The alkali metals, in group number 1, are so unstable that they all react explosively with water. The further right you go on the periodic table, the more stable the elements become.
- *⁵ This is an excellent time to remind students just how unpredictable real science is. Sometimes we're guilty of using too many worksheets and reciting too many laws, which conveys to students that science is always perfect. Actually, in real life it seldom is! Tell your students about demos gone bad. And how a hypothesis made at the beginning of an experiment that isn't fulfilled is not a bad thing at all. Two pens in the same square represents the way things go in a genuine science experiment. You didn't/couldn't predict it. But they're there, and you have to do something with them, so make a decision and move on.
- *⁶ Besides your principal, if you happen to know someone who's well-known and a celebrity, at least in your community, and could get a pen, pencil, or marker from them, that would also get your students' attention.
- *⁷ Looking at the completed chart, there are three additional topics you can add:
 - Mention to students that blanks on this chart do not mean that that pen, pencil, or marker does not exist. Point to a blank and have students tell you exactly what should go there. That was an immediate benefit to the modern periodic table- being able to predict and know things about elements that hadn't even been discovered yet.
 - Ask if it would be possible to add onto the chart by making it longer. If they aren't sure what you're asking, ask what else you can write with besides pencils, pens, and markers (crayons, colored pencils, paint). The chart can also expand downward- by increasing the mass.
 - Before removing the pen, pencils, and markers, have students pick one at random and look at the others surrounding it. Most others around it are similar. But, when you look 5 or 6 squares away what happens to the resemblance? It diminishes. This is also so with elements on the periodic table- most of those around each will have "cousin-like" similarities- they're not identical, but there are similarities.

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PowerPoint



Homework Assignment

ANSWERS- Homework Questions-Periodic Pencil

1. Draw a rectangle that is 6 lines high. This represents the periodic table on the board that we made today (don't put all the boxes inside). Put the same labels on/around it that we had on our table.

Suggested:



2. Now add to your chart two other ways we could have classified the pens, pencils, and markers. Be creative!

...whether the pen clicks or not, pencil has eraser/not, been chewed on, by length, etc...

3. How similar was the pen or pencil next to yours compared with one 5 or 6 rows away (i.e. which was more different- those closer or further away)?

Pens/pencils right next to yours will be very similar. Besides being the same type of implement, it will be similar in color and mass. The further from it you go on the table, the more different they become- types change, as do masses and color.

4. Look at a periodic table in your book and compare it with the one we made today in class. Name something they both have in common.

Both periodic tables are arranged by increasing mass, so mass increases as you go down. They are also similar in that everything immediately surrounding it will be similar to it.

QuickNotes

Teacher Quick Notes- "Periodic Pencil Classification"

Materials:

- 1-roll of masking tape
- 4-balances
- 1-periodic wall chart in your room (or the page number in your book having one)
- 1-pencil from your principal (optional)
- 1-digital camera (optional)
- a few pieces of candy (optional)

Beforehand:

1. Draw the chart on your chalkboard. It's 10 columns wide (each 20 cm across) by 6 columns high (each 10 cm high).
2. Set up the balances.

Procedure:

1. Have a student helper go around the room and give each student about 2 inches of masking tape.
2. Weigh pens and pencils, and put information on tape sticking to it.
3. Ask everyone to come up front and lay their writing instrument on a front table. Discuss.
4. Have students put pens and pencils on the chalkboard. Discuss.
5. Separate by type. Discuss.
6. Separate by mass. Discuss.
7. Separate by color. Discuss.
8. Hand out the 4-question homework assignment (located in the "Resources" folder) and give students remaining time to get started on it in case they have questions.