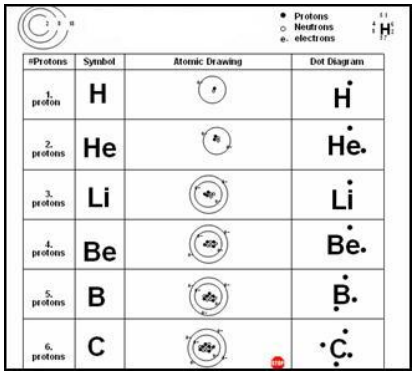
Teacher Notes- "Dot Diagramming-Understanding The Placement Of Protons, Neutrons, And Electrons"

Dot diagramming is an important bridge between 2 major chemistry concepts- atomic structure and then how these atoms combine into molecules.



At first, students may be timid about this activity. But it begins with a review of things they already know, then gradually builds. By the end, they'll be comfortably using and applying the method of dot diagramming (also known as *Lewis Structure*).

Materials:
Student handout (see last page)
Periodic table- either a poster on the wall in plain view, or from the textbook
PowerPoint-Filling In The Dot Diagram Handout (see last page)

Beforehand:

1. Take 15 minutes and fill out the worksheet yourself so you know what your students are about to experience. As you do this, notice what you're thinking, and that will help you word things better.

2. Yes, there are a few steps to this activity, and the PowerPoint gives the impression that there's a lot you'll have to remember. But having done with worksheet yourself, you'll notice all it does is move through the worksheet in an orderly way from beginning to end. After having done it yourself (point 1) you'll be more than ready to lead your students through it.

3. If applicable, find what page(s) in your textbook mention dot diagramming so you can read this section together.

4. Number from 1-18 on your chalkboard so at the end students can come up and write their answers on the board.

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.

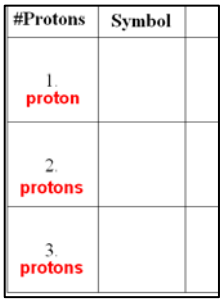
Procedure:
1. Give students the handout and have them open their textbooks to a periodic table.

2. Open the discussion by reviewing basic atomic structure (see dialogue that follows). This will help students who have forgotten what atoms are. As you ask the following questions, keep an eye on the slower learners. They're the ones you're waiting on before proceeding:

> "Imagine I sat down in front of you and asked what the 3 parts of an atom are.*[1]
> What would you say? (proton, neutron, and electron)
> What do you call that main structure in the middle? (nucleus)
> And which two particles can be found in the nucleus? (proton and neutron)
> Which of those 3 particles is most important? (proton).
> Good. And that's because the number of protons is also known as… (the atomic number).
> Right!
>
> Now imagine you were the size of an atom, which is impossible, not only because we can't change our size but also because chances are mankind will never even see an atom. But if you *were* the size of an atom and could see in plain sight a nucleus of, say, an aluminum, which has an atomic number of 13, would you literally be able to count 13 protons in the nucleus? (*Yes? students are unsure because most have only memorized that atomic number is the number of protons in the nucleus. Very few have ever thought of it this way before.*)"*[2]

3. If you are using the PowerPoint "Filling Out The Dot Diagram Handout", start it now. It will guide you and your students through the class period.

4. Tell students to look at numbers 1-18 on their worksheet and to not think of them as just a number sequence, but to attach in their minds the word "protons" after each, as in 1 proton, 2 protons, 3 protons. Have them take a minute and write the word "protons" below each atomic number.



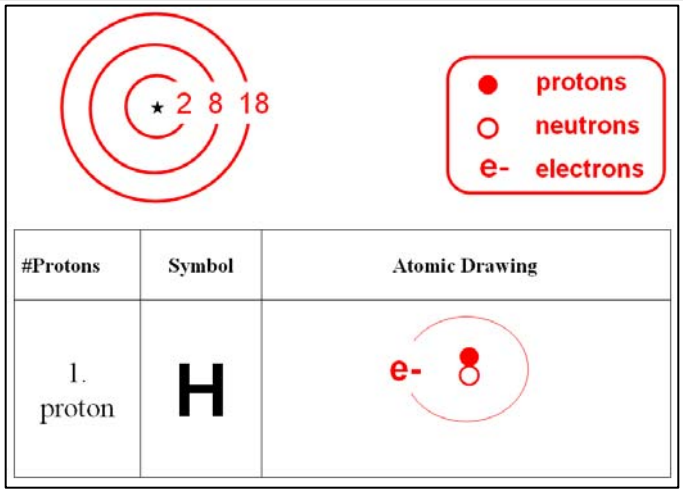
5. Next, give students 2-3 minutes to fill in the symbols for 18 elements on the handout in column one using the periodic table in their book. If you've been using the periodic table recently in class, see how many they can put down from memory.

6. Now it's time for the next column called "Atomic Drawing". That's where students will be drawing an atom of each element. Use a closed circle for protons, an open circle for neutrons, and an "e-" for electrons (see picture on next page). Have students put this key at the top of their papers, as shown on the PowerPoint.

7. Do the first couple of atomic drawings together on the chalkboard:

> "Now onto drawing the atoms.
> Let's put some things together- hydrogen is atomic number… (one).
> Good. That means there is one… (proton) in the… (nucleus).

And our symbol for proton will be…this (*point to closed circle on the chalkboard, and draw 1 proton on the board*).



And also in the nucleus this is going to be one… (neutron).*[3]
Just one? (yes, in this case; *draw an open circle next to the closed one*)
Will the number of neutrons *always* be the same as the number of protons? (not sure, now that you're asking).
The answer to that question for today will be "yes". Let's not worry about the exceptions right now.*[4]

Just about done. Our nucleus is finished, so now it's time for electrons. Who remembers where we put them? I don't expect you to remember this, but I'll be very impressed if you do. (2 go on the first ring or energy level)"

8. Advance the PowerPoint to the slide showing the rings with numbers on them. The star represents a nucleus and gives you a fixed point to refer to, so everyone knows where you're talking about. Have students copy the rings and numbers onto the top of their paper in the upper-left corner.

9. Back to Hydrogen- draw a ring around the proton and neutron nucleus of Hydrogen, put 1 electron on it, and now you've got a complete hydrogen atom.

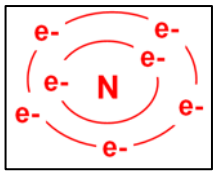
10. Draw a Helium atom on the chalkboard, talking out loud through it, then help them with lithium, since it has 2 energy levels.

11. Then let them begin to work on their own, and stop at carbon, #6 (note the stop sign). Have them to wait there for a shortcut they can use on the next 6 atoms.

12. While students work on drawing the first 6, walk around and help students who aren't catching on. Help them now while the examples are still easy.

13. Wait for all students to finish #6 before proceeding. The reason they all stopped there is because they can now start using a shortcut. And that is they can start using the symbol in place of the nucleus. This will save them from having to draw every single proton and neutron.

14. Do the first one, Nitrogen, with them by drawing it on the board.



15. Let them take off and do the next 5 on their own the same with, using the atomic symbol for a nucleus, and wait at the next stop sign.

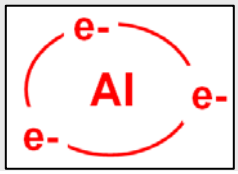
16. Again, monitor how students are working, and in particular what they do with #11-Sodium. It requires them to draw a 3rd energy level with one lonely electron on it.*[5]

17. When all students are at the stop sign on #12 it's time for one last shortcut that they'll use when drawing an atom of elements13-18, which will lead right into dot diagramming:

"Have any of you guessed what the next shortcut could be? Think of it this way- what else can we eliminate or shorten?
Have you noticed that you keep having to draw the same inner rings over and over the same way, and that the only thing that ever changes is the number of rings and how many electrons are on that outer ring?

Let's keep using the symbol in place of the nucleus, and now we'll draw just one ring around it- its outer one. We know the inner rings are there…they're now just implied.
Let's do Aluminum together. First write the symbol for our nucleus and then draw just one ring around it. Ready to think? Don't write any of this down, but get used to thinking through it this way.

How many total electrons does Aluminum have? (13).
Let's draw a mental picture of the complete atom- how many electrons does that first ring hold? (2).
Good. 2 down 11 to go. How about the second ring? (8).
2 + 8 = …. (10).
And that leaves how many for the outer ring? (3).
There you have it. Put 3 electrons on the ring around the symbol for aluminum and that one is done."



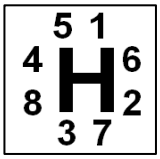
18. You might need to do the next one, Silicon, with the group, or you might not. If a student asks a question that you think the larger group is wondering, talk loud enough that most of the classroom can hear.

There are some students that you shouldn't help- those that didn't write down free answers. They obviously weren't listening and paying attention. There will be students who did pay attention who do need help, and they deserve your attention.

19. Now onto the last column-dot diagramming. **Everything up to now has been leading up to this.**

20. If your textbook says anything about dot diagramming, this is the time to read those paragraphs aloud together.

21. Advance the PowerPoint to the slide showing students the order of putting dots around the symbol*[6]. Discuss this and have students copy it onto the top of their paper.



22. Refer students back to #1, Hydrogen. Ask them this sequence of questions:

"How many total electrons does Hydrogen have? (1).
How many are on its outer ring? (1).
Good. Let's write the symbol "H" and we'll put 1 dot on it. Now, where does it go again, according to what we just read? (on top, to the right)."

23. Do helium together and then maybe one other further down (nitrogen and sodium are on the ppt) before letting them finish on their own.

24. If you have 5 or more minutes left over and if you want to, number from 1-18 on the chalkboard while students finish their last column. Then select 18 students to write the symbol and the appropriate dot diagrams beside the numbers. Check together as a class.

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

- *[1] If you did our lesson called "Clay Atoms", put together a nucleus from red and blue clay. That will (hopefully) help them recall what they did that day.

- *[2] "Class, you have 30 seconds to answer the next question. Ready? Assuming that every person in here is a proton, what element are we? (*go through the answer*)

  Now I need 2 volunteers. (*hands go up*)
  Thank you Johnny and Suzie. Would you both please go and get a drink of water and come back in one minute? *(They hesitate, and leave bewildered)*
  Ok class, we've just lost 2 protons. That means we're radioactive because we're shedding particles! (*alpha radiation occurs when an atom loses 2 protons and 2 neutrons*). Anyway, what element are we now? *(take hands)*

  What if I sent 7 more of you to the water fountain? 16 more?"

- *[3] A hydrogen atom really does not have a neutron in the nucleus. It's just 1 proton with 1 electron zipping around that single proton. That's because with a single positively charged particle there is no need for a "neutralizing" force in the nucleus to make multiple like-charged particles not repel each other, as is the case with every other element.

  This is an interesting point, but it may or may not make sense for you to even bring it up. Remember the larger picture- we haven't even gotten to the dots yet, and you don't want students confused right now.

- *[4] An *isotope* occurs when you have a different number of neutrons than protons. Examples: carbon-12, carbon-13, and carbon-14 are all isotopes of carbon because they all have 6 protons in the nucleus, but, as the isotope number indicates by being the sum of protons and neutrons, carbon-12 has 6 neutrons, carbon-13 has 7 neutrons, and carbon-14 has 8.

- *[5] "One lonely electron in that huge energy level. How do you think it feels about that? Happy or sad? Sad? You're right. An even better word might be 'unstable', because it is. Remember lithium? Why was it so unusual? (it also had 1 electron in an energy level). And it was also unstable."

- *[6] This sequence may be different than the one you're familiar with. There is no universal sequence accepted as being "right". If you prefer yours, then use it instead. You won't be hurting anything!

#Protons	Symbol	Atomic Drawing	Dot Diagram
1. proton			
2. protons			
3. protons			

...all the way to #18

#Protons	Symbol	Atomic Drawing
1. proton	H	e- 8
2. protons	He	e- e-
3. Protons	Li	e- e- e-

...stop after Carbon

Dot Diagram
H
He.
Li

Student Handout

* H

#Protons	Symbol	Atomic Drawing	Dot Diagram
1.			
2.			
3.			
4.			
5.			
6.		STOP	
7.			
8.			
9.			

*Quick*Notes

Teacher *Quick* Notes- "Dot Diagramming"

Materials:
Student handout
Periodic table

Procedure:
1. Have students open their books to a periodic table.
2. Review basic atomic structure.
3. Have students write the word "protons" below numbers 1-18.
4. Have students use their periodic tables to fill in the symbols for the 18 elements.
5. Go through the symbols for protons, neutrons, and electrons.
6. In the middle column students will be drawing an atom of each element. Do the first couple of atomic drawings together on the chalkboard.
7. Let them work on their own and stop at carbon, #6.
8. Tell students to now substitute the symbol for the protons and neutrons in the nucleus for 6-12.
9. For 13-18 allow students to now draw just the outer ringer around the symbol.
10. Now onto dot diagramming. If your textbook says anything about dot diagramming, read it together.
11. Refer students back to #1, hydrogen, and do the dot diagram for it on the board.
12. Have students do the rest.
13. If you have 5 or more minutes left over put answers on the board.