Name: ______________________

Period: ______

A Fact of Matter

Objectives

In this activity, you will explore how trends in atomic structure relate to trends in atomic radius, electronegativity, and ionization energy. You will then notice that these trends can be easily seen on the periodic table.

Materials

- 1 paper plate
- 3 markers (one red, one blue, one black)
- 1 ruler (metric only)
- 1 compass

Procedure

Part 1: Atoms are Tiny!

Atoms are incredibly small. The radius of an atom is most often measured in units called *picometers*. An atom's radius represents how far the "outer shell" electrons are from the nucleus. One picometer (pm) is equal to 10^{-12} meters. In other words, within 1 meter, there are 1,000,000,000,000 (that's one trillion) picometers. To really get a sense of how small atoms are, convert the following radius measurements from picometers (pm) to meters (m) and millimeters (mm):

The atomic radius of helium (He) is 37 pm. Use the space here to convert this measurement to meters (m), and then to millimeters (mm). Remember, 1 pm = 10^{-12} m. Show your work.

Record your final answers in the spaces below:

Element Name	Atomic Number	Radius in pm	Radius in m	Radius in mm
Helium (He)	2	37		

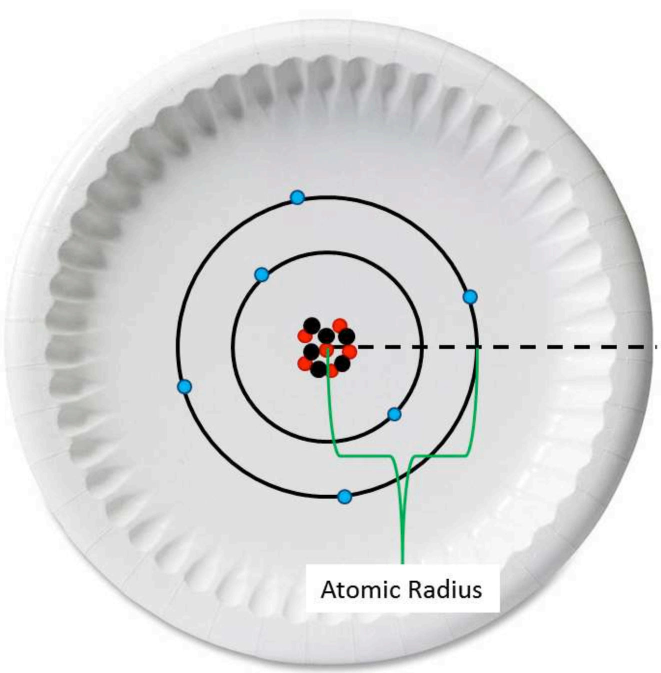
Now do the same for carbon (C). The atomic radius of carbon is 77 pm. Use the space here to convert this measurement to meters (m), and then to millimeters (mm). Show your work.

Record your final answers in the spaces below:

Element Name	Atomic Number	Radius in pm	Radius in m	Radius in mm
Carbon (C)	14	77		

Part 2: Model the Elements

As you learned in Part 1, atoms are extremely small – so small, that they are impossible to see with the naked eye. As a class, we will create paper plate models of the first 20 elements. These models will be simplified representations of atomic structure, and will be much, much larger than the actual atoms. Your teacher will assign one element to you and your partner.



Model of Carbon: Your teacher has made this model as an example.

Your teacher has created a model of carbon as an example.

In the nucleus, each **red** dot represents a **proton** and each **black** dot represents a **neutron**.

In the shells, each **blue** dot is an **electron**.

The distance from the outermost shell to the center of the nucleus is the atomic radius.

To obtain the distance between the inner energy levels to the center of the nucleus, use the atomic radius of the noble gas element of that energy level.

My assigned element is: _______________. This element has an atomic radius of ______ pm. It is element #______, and has ______ protons, ______ neutrons, and ______ electrons in its non-ionized state.

My element has ______ electron energy levels:

Energy level #	# of electrons
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________

Step 1: Your paper plate model will be a scaled-up representation of your element. For every 2 picometers in your element's atomic radius, you will use 1 millimeter of space on the plate. For example, the atomic radius of bromium (Br) is 114 picometers. Using the scale "2 picometers to 1 millimeter", a paper plate atomic model of bromium would have an atomic radius of 57 millimeters. See below.

Ex. Bromium has an actual radius of 114 pm.

$$\frac{114\ \cancel{pm}}{1} \times \frac{1\ mm}{2\ \cancel{pm}} = \frac{114\ mm}{2} = 57\ mm \text{ on the paper plate model}$$

Use the space here to scale your assigned element's actual atomic radius (in picometers) to your paper plate model's atomic radius (in millimeters). The scale we will use is "2 pm = 1 mm". Show your work using dimensional analysis.

Step 2: To obtain the distance between the inner energy levels to the center of the nucleus, use the atomic radius of the noble gas element of that energy level.

Ex. Bromium has a total of 4 energy levels. As we saw above, the outermost ring will have a radius of 57 mm on our model. The other three rings will have radii that correspond to the atomic radii of argon, neon, and helium.

Energy level	Radius of noble gas in pm
1	31 pm
2	71 pm
3	98 pm
4	112 pm
5	131 pm
6	141 pm

Remember, you will need to use the rule "2 picometers = 1 millimeter" to scale each inner ring radius on your model. Show your work and complete the table on the next page.

Show your work here

Record the radii you will use in your model here:

Energy Level	Radius in model (in mm)

Step 3: Use the markers, compass, and ruler to create your paper plate model. The nucleus (composed of protons and neutrons) will go in the center of the plate. Think carefully about how many electron shells your atom will have, and how many electrons can be placed in each shell. When you draw the electrons in the energy levels, space them so that the electrons are as far away from each other as possible (due to electron-electron repulsion).

Is there a trend in atomic radius looking **down** each group? If so, describe it. What do you think causes this trend?

Is there a trend in atomic radius looking **across (left to right)** each period? If so, describe it. What causes this trend?

Of the models your class made, which element has the largest atomic radius?

Which element has the smallest atomic radius?