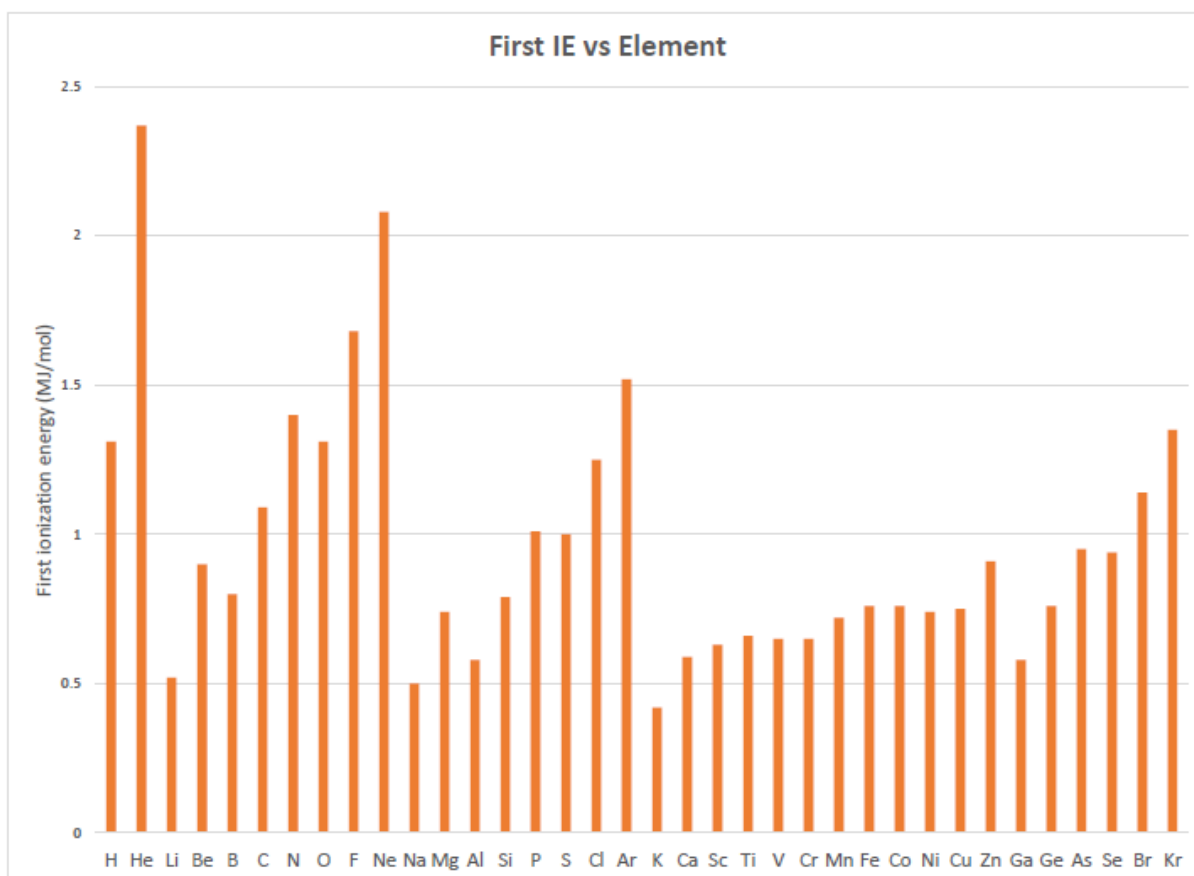


## AP Worksheet 1d (Periodicity)

Please answer the following questions on a separate sheet of paper.

1. Explain each of the following observations.
  - a. Sodium has a lower first ionization energy than lithium.
  - b. Oxygen has a lower first ionization energy than nitrogen.
2. Consider the ionization energy plot shown below. Explain each of the following.



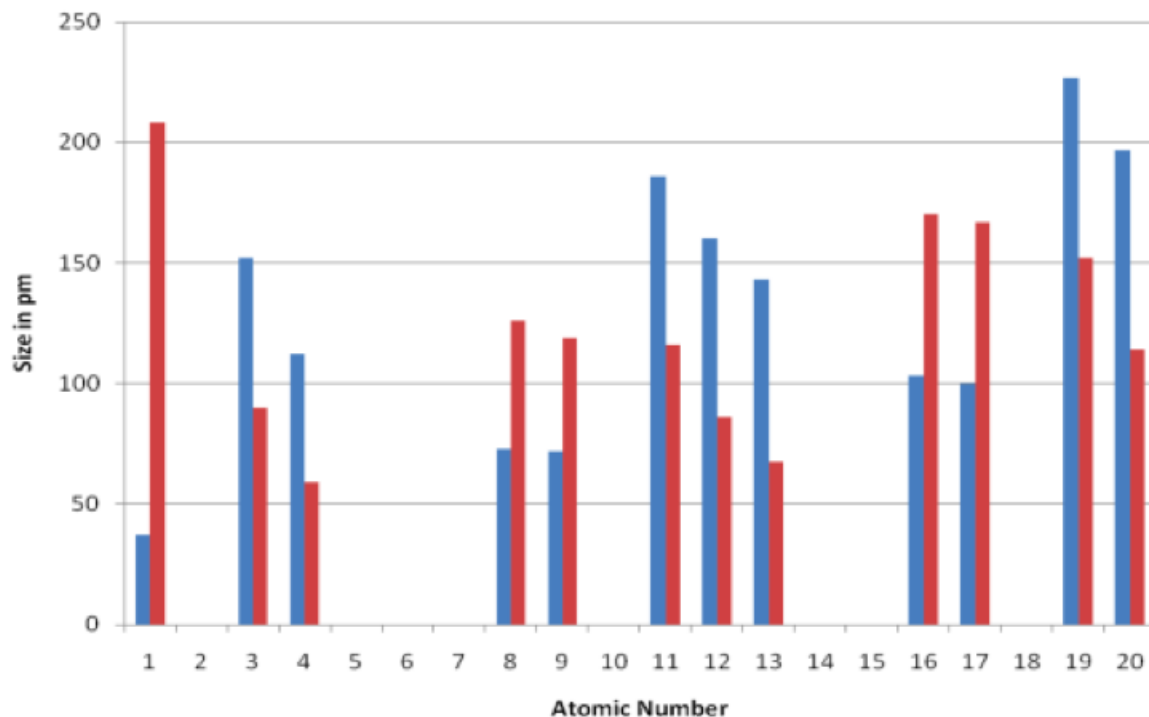
- a. There is a general increase in the first-ionization energy from sodium to argon.
- b. Boron has a lower first ionization energy than beryllium.
- c. The first ionization energy of neon (atomic number 10) is significantly higher than that of argon (atomic number 18) but significantly lower than the first ionization energy than helium (atomic number 2), despite all three elements being in the same group.
- d. Helium has the highest first ionization energy of all the elements shown.

3. Consider the ionization energies of elements X and Y shown below, in  $\text{kJ mol}^{-1}$ . Elements X and Y are in the same period of the periodic table and are adjacent to one another.

	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup>	8 <sup>th</sup>	9 <sup>th</sup>
X	1680	3375	6050	8409	11022	15165	17868	92038	106440
Y	2080	3950	6122	9370	12180	15239	20000	23068	115375

- In which group would one find element X. Explain.
  - Does element X lie to the right or left of element Y in the periodic table. Explain.
  - Which is the first period on the period table that these elements could be in? Explain your answer.
  - Why are the second ionization energies of both elements larger than their respective first ionization energies?
  - It is found that Y has the largest first ionization energy in the period that it is found. What does this tell us about Y?
  - It is found that element Q, which is in the same period as X and Y but lies to the left of element X in the period table, only has values for its first four ionization energies. Suggest a reason for this observation.
4. Write an equation to show the second ionization process for calcium.
5. In each of the following pairs, pick the larger species. Explain your answer in each case.
- Cu and  $\text{Cu}^{2+}$
  - F and  $\text{F}^-$
  - Na and K
6. Identify and explain the trend in atomic size for the following transitions in the periodic table.
- Moving vertically from Ar to He
  - Moving horizontally from Na to Ar
7. Only **one** of the following statements is correct. Which one?
- All cations are larger than their corresponding atoms.
  - All anions are smaller than their corresponding atoms.
  - Atomic size increases on transitioning from left to right across period 2 of the period table.
  - The most common ion of chlorine is smaller than a chlorine atom.
  - The most common ion of strontium is larger than a strontium atom.
  - The most common potassium ion is larger than the most common sodium ion.
  - The ions most commonly formed by group 16 elements are smaller than their corresponding atoms.

8. Consider the plot below that shows atomic and ionic radii of the most commonly formed ion (in units of pm) for selected elements, plotted against atomic number.



- Which color represents the plot for atomic radii? Explain your answer by using any element as an example.
- What do the elements that have smaller ionic radii than their corresponding atomic radii have in common?
- Suggest a reason for the absence of comparative atomic and ionic radii for elements with atomic numbers of 2, 10 and 18.
- Identify the element with atomic number 19, identify the formula of the ion that it commonly forms, and convert the radii of both the atom and the ion to units of cm.
- What common feature can be identified for all of the non-metals on the plot?
- What accounts for the sharp increase in height of the blue lines that occurs at elements with atomic numbers 3, 11 and 19 respectively?
- Make a prediction about the relative heights of the blue line and the red line if data were added to the plot for the element with an atomic number of 15. Explain.
- The element with atomic number 1 has a red line that is significantly taller than its blue line. Under what circumstances would the red line be shorter than the blue line for this element?
- If data were added to the plot for the element with atomic number 7, which would be taller, the blue or the red line? Explain.