Unit 1 FRQ Homework

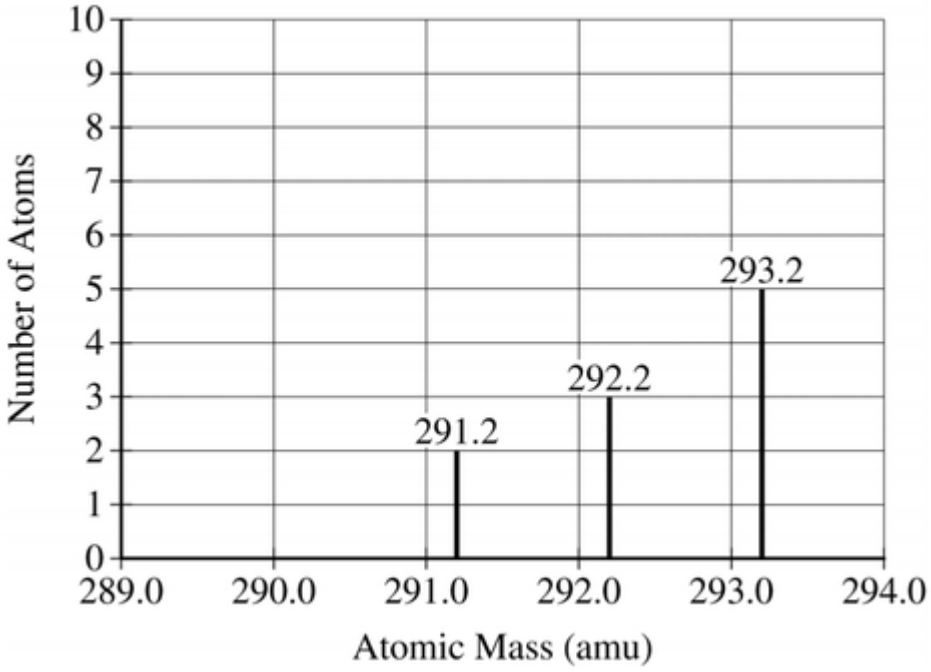
1. A new element with atomic number 116 was discovered in 2000. In 2012 it was named livermorium, Lv. Although Lv is radioactive and short-lived, its chemical properties and reactivity should follow periodic trends.

a. Write the electron configuration for the valence electrons of Lv in the ground state.

b. According to periodic properties, what would be the most likely formula for the product obtained when Lv reacts with $H_2(g)$?

c. The first ionization energy of polonium, Po, is 812 kJ/mol. Is the first ionization energy of Lv expected to be greater than, less than, or equal to that of Po? Justify your answer in terms of Coulomb's law.

d. Shown below is a hypothetical mass spectrum for a sample of Lv containing 10 atoms.



Using the information in the graph, determine the average atomic mass of Lv in the sample to four significant figures.

Unit 1 FRQ Homework

2. Answer the following questions relating to gravimetric analysis.

In the first of two experiments, a student is assigned the task of determining the number of moles of water in one mole of $MgCl_2 \cdot n\ H_2O$. The student collects the data shown in the following table.

Mass of empty container	22.347 g
Initial mass of sample and container	25.825 g
Mass of sample and container after first heating	23.982 g
Mass of sample and container after second heating	23.976 g
Mass of sample and container after third heating	23.977 g

(a) Explain why the student can correctly conclude that the hydrate was heated a sufficient number of times in the experiment.

(b) Use the data above to
(i) calculate the total number of moles of water lost when the sample was heated, and
(ii) determine the formula of the hydrated compound.

(c) A different student heats the hydrate in an uncovered crucible, and some of the solid spatters out of the crucible. This spattering will have what effect on the calculated mass of the water lost by the hydrate? Justify your answer.

In the second experiment, a student is given 2.94 g of a mixture containing anhydrous $MgCl_2$ and KNO_3 . To determine the percentage by mass of $MgCl_2$ in the mixture, the student uses excess $AgNO_3(aq)$ to precipitate the chloride ion as $AgCl(s)$.

(d) Starting with the 2.94 g sample of the mixture dissolved in water, briefly describe the steps necessary to quantitatively determine the mass of the AgCl precipitate.

(e) The student determines the mass of the AgCl precipitate to be 5.48 g. On the basis of this information, calculate each of the following.

(i) The number of moles of $MgCl_2$ in the original mixture
(ii) The percent by mass of $MgCl_2$ in the original mixture

Unit 1 FRQ Homework

3. For parts of the free response question that require calculations, clearly show the method used and the steps involved in arriving at your answers. You must show your work to receive credit for your answer. Examples and equations may be included in your answers where appropriate.

Answer the following questions related to the analysis of $\mathrm{CaBr_2}$.

(a) A student has a $10.0\ \mathrm{g}$ sample of $\mathrm{CaBr_2}$. Show the setup of the calculation to determine the number of moles of $\mathrm{CaBr_2}$ in the sample. Include units in the setup. (You do not need to do any calculations.)

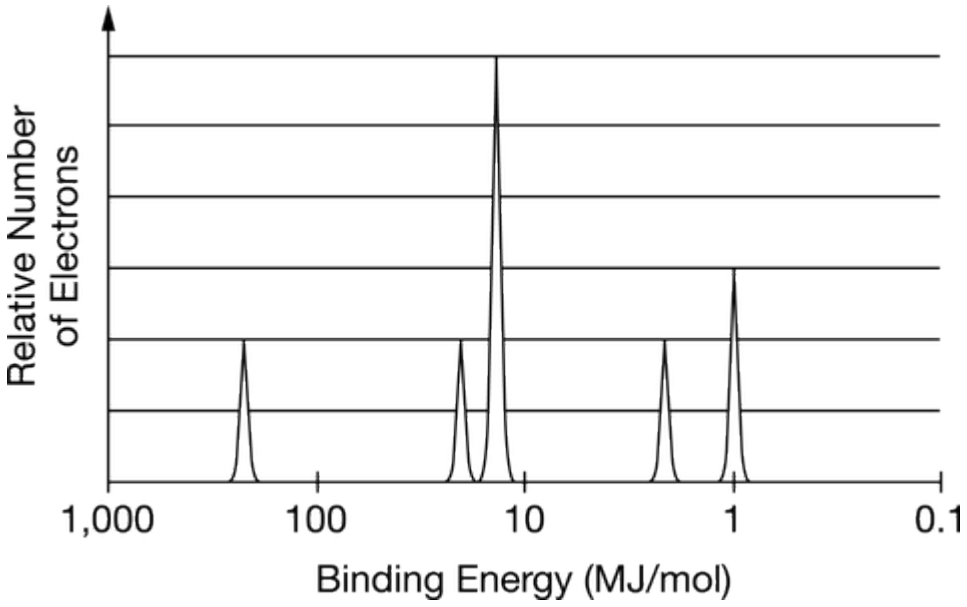
(b) What number, in addition to the answer to part (a), is needed to determine the number of atoms of Ca in the sample?

(c) A different student is given a $10.0\ \mathrm{g}$ sample labeled $\mathrm{CaBr_2}$ that may contain an inert (nonreacting) impurity. Identify a quantity from the results of laboratory analysis that the student could use to determine whether the sample was pure.

(d) Explain why $\mathrm{CaCl_2}$ is likely to have properties similar to those of $\mathrm{CaBr_2}$.

Unit 1 FRQ Homework

4. For parts of the free response question that require calculations, clearly show the method used and the steps involved in arriving at your answers. You must show your work to receive credit for your answer. Examples and equations may be included in your answers where appropriate.



The photoelectron spectrum for an unknown element is shown above.

(a) Based on the photoelectron spectrum, identify the unknown element and write its electron configuration.

(b) Consider the element in the periodic table that is directly to the right of the element identified in part (a). Would the $1s$ peak of this element appear to the left of, the right of, or in the same position as the $1s$ peak of the element in part (a)? Explain your reasoning.