
Remarks:

- Use appropriate units. Note: SI units are always acceptable.
- If you take apart the test, write your team number on every page in the space provided.
- Sometimes, the answers won't make sense. This is okay.
- Good luck!

Lab Portion

Before you, you have a mixture of NaCl and CaCl₂, as well as some other materials. Use boiling point elevation to determine the percentages of each by mass.

Please note that due to the volatility of boiling point elevation, you may end up with negative numbers - **do not restart the experiment**. You will be graded on your application of concepts and equations, **not** your final answer.

Fill in each of the below areas as you progress.

Procedure:

Data:

Calculations: (Please circle or otherwise distinguish your final answer)

Written Portion

1. The process $A + B \rightarrow 3C$ has a ΔH of +142.7 J.
 - a. Is the process endothermic or exothermic?

 - b. Say A has a molar mass of 43.1 g/mol. If you react 55.0 g of A with excess B, how much heat would be transferred? Assume that the forward reaction occurs until completion.

2. On Earth, a particular battery-powered balloon-blowing machine can blow up 120 balloons with 25.0 cm diameter before it runs out of power.
 - a. How much work is done by the machine? Assume the balloons start out completely deflated.

 - b. On Mars, the atmospheric pressure is approximately 600 Pa. How many balloons of similar size can be blown up on Mars if the machine does as much work as it does on Earth?

3. Nick buys 20 Big Macs. However, instead of eating them, he manages to extract all of the energy in the Big Macs to melt some ice. How many kg of ice could Nick melt with the Big Mac energy? (One Big Mac contains 540 Calories)

4. The density of aluminum is 2.70 g/cm^3 .
- Let's say you have a solid ball of aluminum with a diameter of 50.0 cm. Would this ball float or sink in water?
 - You have another solid ball with diameter 50.0 cm that floats in water. You know that this ball is composed of two materials, one of which is aluminum. You also know that aluminum makes up 37.2% of the mass of the ball. What is the maximum density of the other material?
 - Consider a spherical shell of pure aluminum with uniform thickness that stays suspended in water. The interior of this shell is a vacuum. If the exterior diameter of this shell is 50.0 cm, what is the thickness of the shell?

5. A resistor with a uniform cross-section has a resistance of 100Ω .
- Which of the following could be done to the resistor to lower the resistance to 50Ω ? Circle all that apply.

double the length halve the length double the cross-sectional area quadruple the cross-sectional area

- Explain the difference between resistance and resistivity.

6. Omar is thirsty. Instead of going to the water fountain like a normal person, he creates some water by reacting a certain amount of hydrogen gas with excess oxygen. This gives Kevin the perfect opportunity to carry out his assassination plan against Omar. While Omar isn't looking, Kevin reacts 23.1% of Omar's water with oxygen to create 48100 mg of hydrogen peroxide (H_2O_2).
- Find the initial amount of hydrogen gas, in moles.
 - If Omar's process released 110.3 kJ of energy, what is the standard heat of formation of water? (Note: this may not be consistent with the actual ΔH_f°)
 - ΔH_f° for H_2O_2 is -187.8 kJ/mol. How much heat was transferred during Kevin's process? Use the true value of ΔH_f° for water, -285.8 kJ/mol.
7. 90.2 g of chlorine gas are cooled from room temperature to -90.0°C . The energy released by the chlorine is collected and used to heat 10.0 mL of water, also starting at room temperature. If the energy is transferred with 78.2% efficiency, at what phase and temperature is the water now?

8. Explain why testing for the presence of manganese frequently involves the formation of potassium permanganate, as opposed to other variations of manganese such as manganese dioxide.

9. As of now, the elements in group 18 (the rightmost row of the periodic table) are helium, neon, argon, krypton, xenon, radon, and oganesson. Below is a table of some of their properties.

Element	Atomic Number	Atomic Radius	Ionization Energy
Helium	2	28 pm	2372.3 kJ/mol
Neon	10	58 pm	2080.7 kJ/mol
Argon	18	106 pm	1520.6 kJ/mol
Krypton	36	116 pm	1350.8 kJ/mol
Xenon	54	140 pm	1170.4 kJ/mol
Radon	86	150 pm	1037.0 kJ/mol
Oganesson	118	157 pm	839.4 kJ/mol

Say the next element in that group was discovered. Below are several physical properties of said element. For 8a, give an exact numeric value; for 8b and 8c, give an approximate numeric value and then explain why the trend you identified occurs:

a. Atomic number

b. Atomic radius

Explanation:

c. Ionization energy

Explanation:

10. Adam has a cup with 100. mL of water at room temperature.
- Adam likes his water cold, so he takes three ice cubes and puts them in the cup, then waits for the temperature to stabilize. If Adam wants his water at 10.0°C , what is the mass of each of the ice cubes? Assume that the ice cubes are identical and start at 0°C and that energy is only transferred between the ice and the water.
 - When Adam measures the temperature of his water, he finds that the temperature of the water is actually 9.43°C . What is the calorimetry constant of the cup? Assume that there is no energy transfer with the surrounding air.
 - Disgusted, Adam gives his cup of water to Andrea. Andrea decides to boil the water to make some ramen, so she takes a heated piece of lithium and puts it into the cup. If Andrea has 21.2 g of lithium, what temperature does it need to be to boil the water?
 - Andrea heats the lithium to the correct temperature, but is shocked to find that 1.17 g of the lithium has evaporated away. Fortunately, she has seven 3.00 g samples of metal that she keeps at a constant $310.^{\circ}\text{C}$, which she decides to add to the water alongside the remaining heated lithium. What does the specific heat of the metal need to be for Andrea to be successful in making ramen?