

Virtual Experiment 14

Pre laboratory Problems

Name _____

- How much heat is needed to raise the temperature of 15.0 g of copper metal from 10.0°C to 25.0°C if the specific heat of copper is 0.385 J/g °C?
- When 18.45 g of an unknown metal at 100.0°C is quickly stirred into 25.00 g of water at 22.0°C in a calorimeter, the water temperature rises to 27.0°C. Assuming the calorimeter does not absorb any heat, find the specific heat of metal. The specific heat of water, s_{water} , is 4.184 J g⁻¹°C⁻¹.
 - How much heat is gained by the water?
 - When the system loses heat, the surrounding gains the same amount of heat. How much heat was lost by the metal?
 - What is the final temperature of the metal?
 - Calculate the specific heat of the metal.
- The Dulong Petit empirical relationship for the product of atomic mass and specific heat, $(MM)(s) = \text{constant}$. Using the data in the Appendix A: Physical Properties of Substances for at least four metals, calculate the Dulong Petit relationship and constant.

Metal ID	Specific heat	Atomic mass	Dulong Petit Constant
Al	0.900	26.98	
		Average	

Is the Dulong Petit method accurate? _____

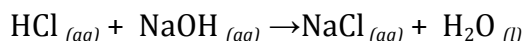
4. Using the Dulong Petit method, calculate the atomic mass of the unknown metal in the problem above and give its possible identity.

Atomic mass _____

Possible Element _____

5. In an experiment, 200.0 mL of 1.20 M HCl solution is mixed with 200.0 mL of 1.20 M NaOH solution in a constant-pressure calorimeter having a heat capacity of 402 J/°C. The initial temperature of both solutions is 22.58°C. When the two solutions are mixed, the final temperature of the mixture increases to 29.55°C. Calculate the heat of neutralization in kJ per mole of H₂O. The density of the solution is 1.04 g/mL.

The reaction is



- a) How many moles of water are produced in the reaction?
- b) If the calorimeter and aqueous solution are the surroundings, what is the heat gained by the calorimeter?
- c) What is the heat gained by the solution? The specific heat of the NaCl aqueous solution is 3.90 J g⁻¹ °C⁻¹
- d) If the heat gained by the calorimeter and the solution is equal to the heat lost by the reaction of the HCl and NaOH, what is the enthalpy of neutralization, $\Delta H_{\text{neutralization}}$? The answer should be in kJ per mole of H₂O formed in the reaction.
6. Given the above reaction, calculate the theoretical molar heat of neutralization, using the following information.

Compound	ΔH_f° (kJ/mol)	Compound	ΔH_f° (kJ/mol)
NaOH _(aq)	-469.6	H ₂ O _(l)	-285.5
HCl _(aq)	-164.4	NaCl _(aq)	-407.1