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Report

A. Heat of Reaction: $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$: First Run

Time (sec)	Temperature (°C)	Time (sec)	Temperature (°C)
0 (mixing)	use the average of HCl and NaOH solution	210	
30		240	
60		270	
90		300	
120		330	
150		360	
180		390	

Calculation:

1. For run #1,

q_{soln}:

q_{rxn}:

2. Calculate the molar heat of reaction:

Report (continued)

A. Heat of Reaction: $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$: Second Run

Time (sec)	Temperature (°C)	Time (sec)	Temperature (°C)
0 (mixing)	use the average of HCl and NaOH solution	210	
30		240	
60		270	
90		300	
120		330	
150		360	
180		390	

Calculation:

1. For run #2,

$q_{soln:}$

$q_{rxn:}$

2. Calculate the molar heat of reaction:

3. Average run #1 and run #2's molar heat of reactions:

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Report (continued)

B. Heat of Reaction: $HCl(aq) + NaOH(s) \rightarrow NaCl(aq) + H_2O(l)$: First Run

Mass of NaOH used: _____

Time (sec)	Temperature (°C)	Time (sec)	Temperature (°C)
0 (mixing)	use the initial temperature of HCl solution	210	
30		240	
60		270	
90		300	
120		330	
150		360	
180		390	

Calculation:

3. For run #1,

q_{soln}:

q_{rxn}:

4. Calculate the molar heat of reaction:

Report (continued)

B. Heat of Reaction: $HCl(aq) + NaOH(s) \rightarrow NaCl(aq) + H_2O(l)$: Second Run

Mass of NaOH used: _____

Time (sec)	Temperature (°C)	Time (sec)	Temperature (°C)
0 (mixing)	use the initial temperature of HCl solution	210	
30		240	
60		270	
90		300	
120		330	
150		360	
180		390	

Calculation:

2. For run #2,

$q_{soln:}$

$q_{rxn:}$

2. Calculate the molar heat of reaction:

3. Average run #1 and run #2's molar heat of reactions:

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Report (continued)

C. Heat of Solution: $NaOH(s) \rightarrow NaOH(aq)$: First Run

Mass of NaOH used: _____

Time (sec)	Temperature (°C)	Time (sec)	Temperature (°C)
0 (mixing)	use the initial temperature of water	210	
30		240	
60		270	
90		300	
120		330	
150		360	
180		390	

Calculation:

5. For run #1,

q_{soln}:

q_{rxn}:

6. Calculate the molar heat of reaction:

Report (continued)

C. Heat of Solution: $NaOH(s) \rightarrow NaOH(aq)$: Second Run

Mass of NaOH used: _____

Time (sec)	Temperature (°C)	Time (sec)	Temperature (°C)
0 (mixing)	use the initial temperature of water	210	
30		240	
60		270	
90		300	
120		330	
150		360	
180		390	

Calculation:

3. For run #2,

$q_{soln:}$

$q_{rxn:}$

2. Calculate the molar heat of reaction:

3. Average run #1 and run #2's molar heat of reactions:

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Report (continued)

D. Verify Hess's Law:

What is the molar enthalpy of solution of NaOH solid?

What is the molar enthalpy of reaction between HCl*(aq)* and NaOH*(aq)*?

Add the above two values together. Total = _____

What is the molar enthalpy of reaction between HCl*(aq)* and NaOH*(s)*?

Do the values math within 10%? Do the values match within 1%? If not, can you suggest why not?

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Questions

1. Define the following terms:

thermochemistry

exothermic process

endothermic process

specific heat

2. State and give an example of Hess's Law.

3. Define and give an example of "heat of solution."

4. Assuming that little or no water vapor escapes from it, is the coffee cup calorimeter used in this experiment an open, closed, or isolated system? Justify your answer

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Problems

1. 75.012 g of water at 59.0°C was combined with 74.987 g of water at 23.2°C in a coffee cup calorimeter. The mixture reached a final temperature of 40.1°C. Calculate the calorimeter constant (heat capacity of the calorimeter).

_____

2. Write the net ionic reaction for the neutralization of HCl by NaOH. Calculate $\Delta H°_{rxn}$ for this reaction from the enthalpies of formation of the reactants and products.

_____

3. Calculate $\Delta H°_{rxn}$ for the following reaction

$$2\ CH_4(g) + O_2(g) \rightarrow 2\ CH_3OH(l)$$

from the following data:

$CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(l)$ $\Delta H°_{rxn} = -890.3$ kJ

$2\ CH_3OH(l) + 3O_2(g) \rightarrow 2\ CO_2(g) + 4\ H_2O(l)$ $\Delta H°_{rxn} = -1452.8$ kJ

_____

4. 4.21 g of KOH is mixed with 150. g of water at 25.3°C in a coffee cup calorimeter. The temperature rises to a maximum of 31.2 °C. Calculate the molar heat of solution of KOH. The heat capacity of the calorimeter is 92.7 kJ/°C. Take the specific heat of the KOH solution to be 3.90 J/g°C.

_____

5. 8.32 g of $CaCl_2$ is mixed with 150. g of water at 24.8°C in the same calorimeter as that described in problem 4. If the heat of solution of $CaCl_2$ is –82.8 kJ/mol, what maximum temperature will the solution reach after mixing? Assume that the specific heat of the solution is 4.00J/g°C.

_____