Heat of Solution of $NaOH_{(s)}$

Purpose:

The purpose of this laboratory activity is to determine the heat of solution of sodium hydroxide.

Prelab:

Final temperature, t_f	28.2 °C
Initial temperature, t_i	21.1 °C
Mass of NaOH	4.05 g
Mass of Styrofoam® cup & NaOH solution.	157.24 g
Mass of empty, dry Styrofoam® cup	2.13 g

Soln: water + NaOH
$NaOH_{(aq)}$ is dissolved
does not affect Cp

Using the data given, complete the following calculations:

1. Calculate the temperature change, Δt, for the reaction by subtracting the initial temperature, t_1, from the final temperature, t_2 ($\Delta t = t_2 - t_1$).
2. Calculate the mass of water (Soln) that absorbed the heat.
3. Calculate the heat absorbed by the water solution. Use 4.184 J/g°C as the specific heat of the solution.
4. Determine the heat released by the reaction. (That is opposite the heat absorbed by the water solution)
5. Determine the moles of NaOH used.
6. Determine the heat change for the solution per mole of NaOH. This is the ΔH of solution.

Safety Procedures

1. Wear your safety goggles while performing this lab.

PROCEDURE

1. Obtain and wear goggles.
2. Connect the Temperature Probe to LabQuest.
3. Determine the mass of an empty, dry Styrofoam® cup.
4. Place a Styrofoam® cup into a 400 or 600 mL beaker for support. Measure out 150 mL of water into the Styrofoam® cup. Place the temperature probe in the water in the cup.
5. Press the power button on LabQuest to turn it on. Choose New from the File menu.
6. On the Meter screen, tap Rate. Change the data-collection length to 300 seconds. Select OK. You are now ready to begin collecting data.

Heat of Solution of NaOH(s)

i) Obtain about 4 grams of NaOH(s) in a weighing boat (do this right before you are going to add it as it reacts with the air – ***ALSO*** – keep the lid on the NaOH bottle closed) Record the mass accurately.

ii) Press start to begin data collection.

iii) After about 10 seconds have elapsed, slowly add the sodium hydroxide pellets to the water in the cup. Gently stir the solution with a glass rod and not the temperature probe to ensure good mixing.

iv) A real-time graph of temperature *vs.* time will be displayed on the screen during data collection.

7. Temperature readings (in °C) can also be monitored in a display box to the right of the graph.
8. Once the temperature has stopped changing, determine the mass of the Styrofoam® cup and the NaOH solution.
9. Dispose of the reaction products as directed by the teacher, and then rinse the cup with tap water. Dry the Styrofoam® cup and return it to the cart.
10. When data collection is complete, a graph of temperature *vs.* time will be displayed. Click ANALYZE and select Statistics – Temperature on the LabQuest and determine the initial temperature, ***ti*** and final temperature, $t_f - t_i$ is the minimum and t_f is the maximum temperature. Record the temperature values in your data table.

DATA TABLE (TO BE REPLICATED IN YOUR LAB NOTEBOOK)

Final temperature, t_f	°C
Initial temperature, t_i	°C
Mass of NaOH	g
Mass of Styrofoam® cup & NaOH solution.	g
Mass of empty, dry Styrofoam® cup	g

ANALYSIS - PROCESSING THE DATA (DO NOT NUMBER YOUR CALCULATIONS)

7. Calculate the temperature change, Δt, for the reaction by subtracting the initial temperature, t_1, from the final temperature, t_2 ($\Delta t = t_2 - t_1$).
8. Calculate the mass of water that absorbed the heat.
9. Calculate the heat absorbed by the water solution. Use 4.184 J/g°C as the specific heat of the solution.
10. Determine the heat released by the reaction. (That is opposite the heat absorbed by the water solution)
11. Determine the moles of NaOH used.
12. Determine the heat change for the solution per mole of NaOH. This is the ΔH of solution.

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13. Determine your percent error – the accepted value for this reaction is -44.2 kJ/mol of NaOH.

DISCUSSION: (DO NOT NUMBER YOUR ANSWERS, RATHER, CRAFT A DISCUSSION USING THESE QUESTIONS AS A GUIDE)

1. Discuss the flow of heat in this process.
    a. For which part is it endothermic? Exothermic?
    b. How do you know?
2. What are some possible sources for error?
    a. What affect would those errors have on your final value for ΔH?
    b. Would they make it higher or lower – and WHY?
3. Why is heat a stoichiometric quantity?
4. Just what **IS** a heat of solution?

CONCLUSION:

1. Report your value for the ΔH of solution.