Practical investigation 6.1

Exothermic and endothermic reactions

NAME: **CLASS:**

AIM

To investigate the temperature change during some common chemical reactions.

THEORY

Heat energy is released during exothermic reactions and it is absorbed during endothermic reactions. As a result, a temperature increase can be measured during an exothermic reaction and (usually) a small temperature decrease can be measured during an endothermic reaction.

MATERIALS

1 mol dm^{-3} copper(II) sulfate solution
1 mol dm^{-3} hydrochloric acid
1 mol dm^{-3} sodium hydroxide solution
Anhydrous copper(II) sulfate
Potassium nitrate
Sodium thiosulfate
Zinc powder
5 test tubes
Test-tube rack
Thermometer (–10°C to 110°C)
2 × 10 cm^3 measuring cylinders
Spatula
Safety glasses

SAFETY

Wear safety glasses and a laboratory coat for this experiment. Hydrochloric acid and sodium hydroxide solution are corrosive. Copper(II) sulfate is toxic. Spills should be wiped up immediately using paper towel or dust pan, avoiding inhalation of chemical and contact with skin and eyes. Wash any chemical off skin immediately.

Refer to Risk Assessment for Practical investigation 6.1.

METHOD

1 Label the five test tubes A–E.
2 In each case, measure the initial temperature of the first solution in the test tube before you add the second reactant (either solution or solid).
3 Into test tube A place 5 cm^3 of 1 mol dm^{-3} sodium hydroxide solution and add 5 cm^3 of 1 mol dm^{-3} hydrochloric acid, stirring carefully with the thermometer. Record the final (highest or lowest) temperature in the test tube.
4 Into test tube B place 10 cm^3 of water and add half a spatula of anhydrous copper(II) sulfate. Stir to dissolve. Record the final (highest or lowest) temperature in the test tube.
5 Into test tube C place 10 cm^3 of water and add half a spatula of sodium thiosulfate. Stir to dissolve. Record the final (highest or lowest) temperature in the test tube.
6 Into test tube D place 10 cm^3 of 1 mol dm^{-3} copper(II) sulfate solution and add half a spatula of zinc powder. Stir to mix. Record the final (highest or lowest) temperature in the test tube.
7 Into test tube E place 10 cm^3 of water and add half a spatula of potassium nitrate. Stir to dissolve. Record the final (highest or lowest) temperature in the test tube.
8 Dispose of the solutions as advised by your teacher.

Practical investigation 6.1

Exothermic and endothermic reactions

RESULTS

	Initial temperature (°C)	Final temperature (°C)	Qualitative observations
Test tube A 5 cm^3 of 1 mol dm^{-3} NaOH + 5 cm^3 of 1 mol dm^{-3} HCl			
Test tube B 10 cm^3 of water + half a spatula of $CuSO_4$ (white)			
Test tube C 10 cm^3 of water + half a spatula of $Na_2S_2O_3$			
Test tube D 10 cm^3 of 1 mol dm^{-3} $CuSO_4$(aq) + half a spatula of Zn			
Test tube E 10 cm^3 of water + half a spatula of KNO_3			

QUESTIONS

No.	Question	Answer
1	Calculate the temperature change that occurred in each experiment.	

Reaction	Temperature change (°C)
NaOH + HCl	
Water + $CuSO_4$(s)	
Water + $Na_2S_2O_3$	
$CuSO_4$(aq) + Zn	
Water + KNO_3	

Practical investigation 6.1

Exothermic and endothermic reactions

<table>
<tr><th>No.</th><th>Question</th><th>Answer</th></tr>
<tr><td>2</td><td>For each of the reactions indicate whether it was exothermic or endothermic, and give the sign of ΔH (positive or negative).</td><td>
<table>
<tr><th>Reaction</th><th>Exothermic or endothermic reaction?</th><th>Sign of ΔH</th></tr>
<tr><td>NaOH + HCl</td><td></td><td></td></tr>
<tr><td>Water + $CuSO_4(s)$</td><td></td><td></td></tr>
<tr><td>Water + $Na_2S_2O_3$</td><td></td><td></td></tr>
<tr><td>$CuSO_4(aq)$ + Zn</td><td></td><td></td></tr>
<tr><td>Water + KNO_3</td><td></td><td></td></tr>
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</td></tr>
<tr><td>3</td><td>If you had added a full spatula of anhydrous copper(II) sulfate to the 10 cm^3 of water in test tube B, predict the temperature change that you would expect to observe.</td><td></td></tr>
<tr><td>4</td><td>If the reactions in this experiment could be reversed, state the temperature change that you would expect for each reaction.</td><td></td></tr>
<tr><td>5</td><td>What changes could be made to the design of this experiment to improve the accuracy of your results?</td><td></td></tr>
</table>

CONCLUSION