Calorimetry: Determining the heat of reaction of a simple redox reaction via calibration of a calorimeter

Name: _____ _____/23

Introduction

Zinc displaces copper from copper(II) sulfate solution according to the following reaction

$Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_{4(aq)}$

or

$Zn(s) + Cu^{2+}(aq)\ Cu(s) + Zn^{2+}(aq)$

In the laboratory, the heat of reaction may be calculated by using a calibrated calorimeter.

Aim

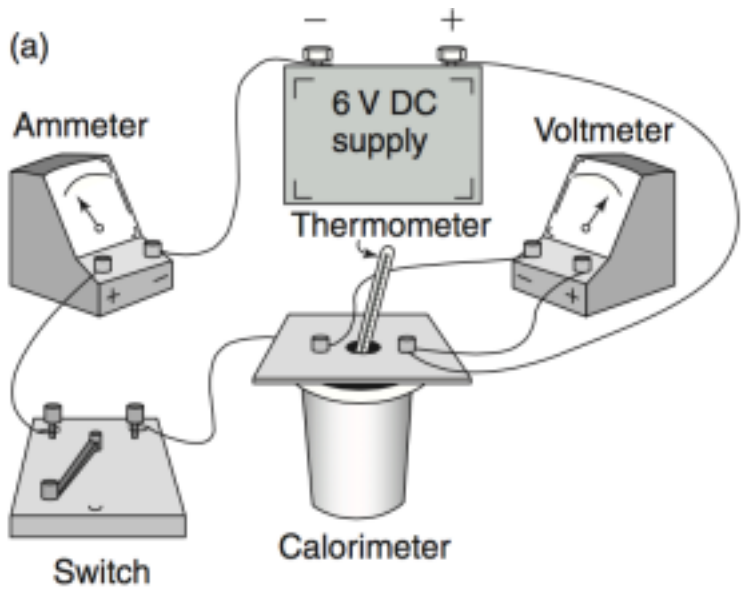
To determine the calibration factor for the calorimeter and use it to determine the heat of reaction for zinc metal and copper ions

Apparatus

- Solution calorimeter
- 6 V DC supply voltmeter
- Ammeter
- Switch
- 0.5 g of zinc powder
- 100 mL of 0.2 mol L^{-1} copper(II) sulfate solution
- Weighing scales
- Stopwatch

Part A: Calibrating the Calorimeter

1. Add 100 mL of water to the calorimeter and record its temperature.
2. Set up the apparatus for calorimeter calibration as shown below



3. Switch the power source to supply to 6 V and record the current.
4. Allow the current to run for 300 seconds.
5. Record the temperature every 30 seconds.
6. Switch the power source off and continue recording the temperature every 30 seconds for the next 240 seconds.
7. Using the graph paper provided over the page, plot a temperature time graph.
8. Using the graph record the ΔT.

Results & Calculations

Calculate the calibration factor for your calorimeter

Voltage (V)	
Current (A)	
Time (s)	
Temp rise (°C)	

Energy (joules) = V I t

My calibration factor is: _____ (3 marks)

Part B: Determining the heat of reaction

Place 100 mL of 0.500 M copper (II) sulfate solution in the calibrated calorimeter. Weigh a mass of approximately 2.00g of zinc powder using an electronic scale.

The zinc power was added to the calorimeter and monitored until the blue colour of the solution had completely faded, the zinc powdered is in excess. The temperature of the calorimeter is recorded every 30 seconds and plotted on a temperature vs time graph.

Time (sec)	0	30	60	90	120	150	180	210
Temperature(^{o}C)								

Plot the results on a temperature vs time graph and obtain the ΔT. Use the graph paper provided over the page.

Calculate the heat of reaction in kJ mol^{-1}

The heat of reaction is: _____

4 marks

Focus Questions

1. Is the reaction exothermic or endothermic? How do you know? (1 mark)

2. Write a thermochemical equation for the reaction. (1 mark)

3. Why does the blue colour of the copper(II) sulfate solution disappear? (1 mark)

4. In the experiment, an excess of zinc powder was used. Why was this done? (1 mark)

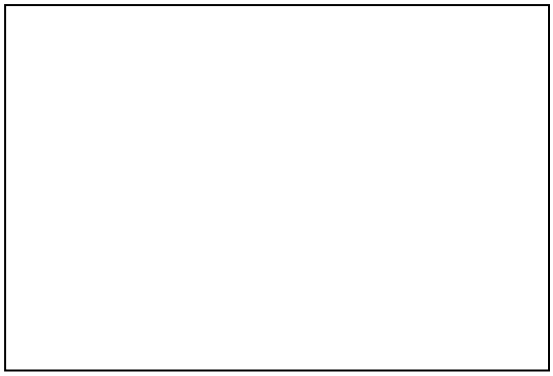
5. Draw an energy-level diagram for the reaction in the box below and clearly label:

i. Activation energy , exact value not required.

ii. Reactants and products , exact value not required.

iii. **Δ**H exact value required.

iv. Energy evolved when new bonds are formed . exact value not required. (4 marks)



6. Considering the reverse reaction, how do the activation energy and **Δ**H compare with the energy profile diagram you have indicated above? (2 marks)

7. State two sources of error in this experiment and outline how you would expect these errors to affect the value obtained for the heat of reaction for the solution (4 marks)

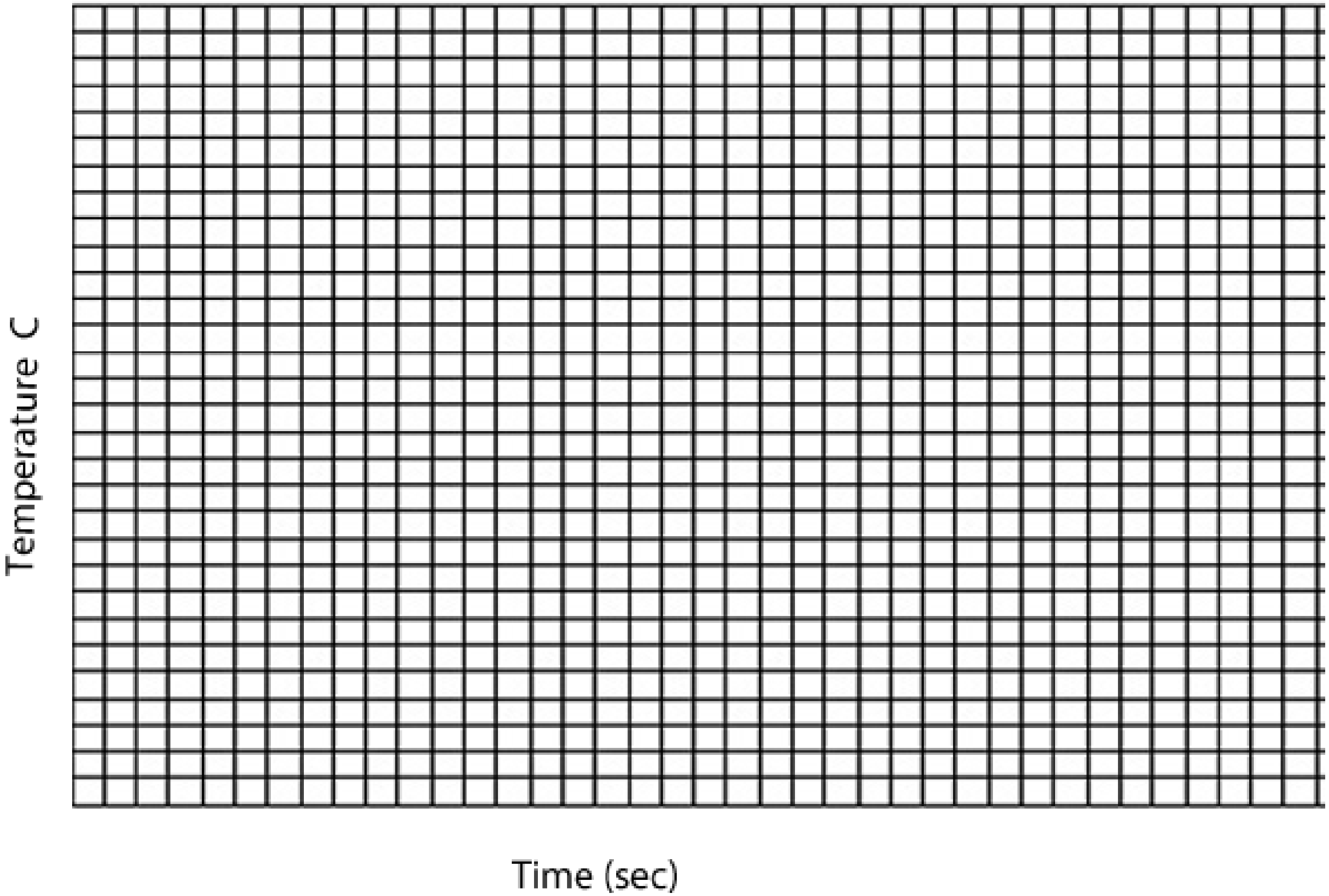
Possible source of error	**Effect of error on calculated heat of solution**

8. Outline one modification to the experimental procedure that would allow you to determine the heat of reaction more accurately. (1 mark)

Conclusion

Write a conclusion which answers your aim (1 mark)

Temperature vs time



Temperature vs time