CH34 [1.4] - Calorimetry - Test

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VCE Chemistry ¾
Calorimetry [1.4]
Test

20 Marks. 16 Minutes Writing.

Results:

Test Questions	________ /15 9
Extension	________ / 5

Section A: Test Questions (15 Marks)

Question 1 (3 marks)

Tick whether the following statements are **true** or **false**.

	True	False
a. The primary purpose of a stirrer in a calorimeter is to ensure the reactants mix together evenly.		✓
b. An electric heater is used when a reaction of known change in enthalpy takes place in order to determine the calibration factor for a calorimeter. chem		✓
c. Typically there are two changes in temperature that occur during an experiment involving a calorimeter: one for calibration and the other for the relevant reaction.	✓	
d. Heat loss during calibration can be accounted for by extrapolating the temperature back to when the current was turned on.	✓	
e. Calorimeters are typically a more accurate instrument for determining a reaction's enthalpy change than a spirit burner.	✓	
f. When extrapolating back, it is assumed that the rate of heat loss varied throughout the time the calorimeter was operating.		✓

Space for Personal Notes

Question 2 (6 marks)

$\Delta H = \frac{E}{m}$ $E = \Delta H \times m$

An experiment was conducted to determine the heat of combustion of a 250 g energy bar using solution calorimetry. Firstly, the calorimeter was chemically calibrated by reacting 0.23 mol of benzoic acid ($C_7H_6O_2$), which has a known heat of combustion of $-26.38\ kJ/g$. This raised the temperature of the water from 25.0°C to 29.31°C.

a. Find the calibration factor, in $kJ/°C$, of this calorimeter. (2 marks)

m(benzoic) = n × Mr = 0.23 × 122 = 28.06 g
q = ΔH × m = 26.38 kJ/g × 28.06 g = 740.2 kJ ① energy
CF = E/ΔT = 740.2 kJ / (29.31 − 25) = 172 kJ/°C
= 1.7 × 10² kJ/°C ① ans

b. The energy bar was then reacted such that it increased the water's temperature by 2.4°C. Calculate its heat of combustion, in kJ/g. (2 marks)

E = CF × ΔT = 172 kJ/°C × 2.4°C = 412 kJ ① energy
ΔH = E/m = 412.2/250 = −1.6 kJ/g ① ans & sign

c. Had heat loss from the calorimeter been accounted for **only during calibration,** what effect would this have had on the calculated enthalpy of the energy bar? Justify your reasoning. (2 marks)

ΔH lower ① ans
Results in more heat loss during experiment, resulting in lower calculated ΔT. As E = CF × ΔT, E (bar) will be lower.
As ΔH = E/m, as E is lower, ΔH is lower. ① exp

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Question 3 (6 marks)

A student is trying to calculate the molar heat of solution of dissolving table salt, NaCl, in water. A section of their logbook is tabulated below:

Calibration:

Volume of water in calorimeter	200 ml
Initial temperature of water	?
Final temperature of water	296 K
Current passed through wires	2.5 A
Potential difference	5 V
Run time	5 minutes

The student mistakenly forgot to note down the water's starting temperature, which they knew was lower than the final temperature, so they asked a friend and used that information to obtain a calibration factor of 0.98 $kJ/°C$.

a. What initial temperature, in °C, must the student have used in obtaining this calibration factor? (3 marks)

E = VIt = 5 × 2.5 × 5 × 60 =
ΔT = E/CF = 3.75 kJ / 0.98 kJ/°C =

b. The student then performed the experiment and noted down the following:

Mass of NaCl	20.2 g
Temperature change of water	−8 K

Hence, write the thermochemical equation of the dissolution of sodium chloride in water. (3 marks)

n(NaCl) = m/Mr = 20/(23+35.5) =
E = CF × ΔT = 0.98 × 8 =
ΔH =

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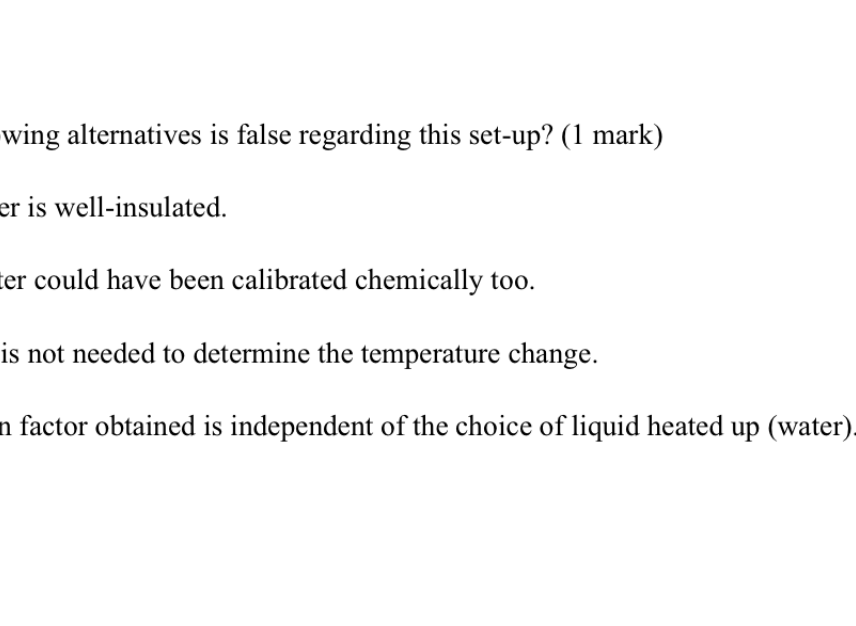
Section B: Extension (5 Marks)

Question 4 (5 marks)

a. A solution calorimeter was calibrated by passing an electric current through the heating coil of 3.00 A and a potential difference of 10.0 V. This caused the water in the calorimeter to increase in temperature, according to the graph below.

Hence, which of the following is the best estimate for the calibration factor of the calorimeter? (1 mark)



A. 0.63 $kJ/°C$

B. 0.83 $kJ/°C$

C. 0.75 $kJ/°C$

D. 0.94 $kJ/°C$

b. Which of the following alternatives is false regarding this set-up? (1 mark)

A. The calorimeter is well-insulated.

B. This calorimeter could have been calibrated chemically too.

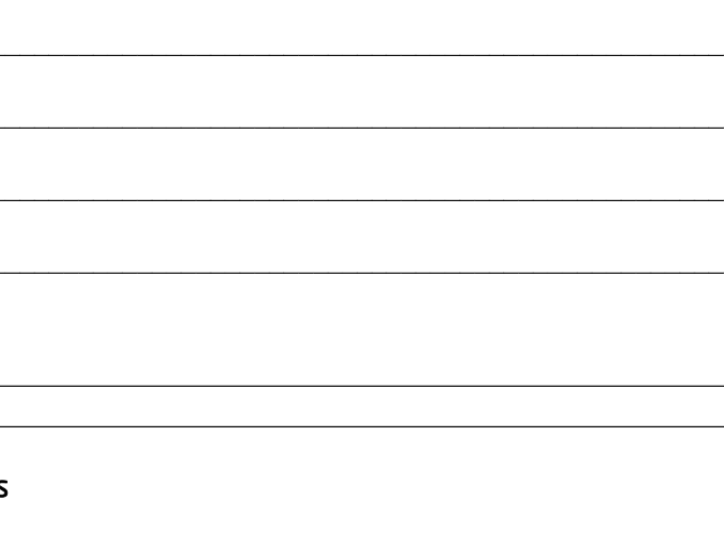
C. Extrapolation is not needed to determine the temperature change.

D. The calibration factor obtained is independent of the choice of liquid heated up (water).

c. This calorimeter is then used to determine the enthalpy change for the dissolution of one mol of anhydrous calcium chloride, $CaCl_2$, in water.

$$CaCl_2(s) \rightarrow CaCl_2(aq)$$

6.038 g of solid anhydrous calcium chloride, $CaCl_2$, was added to the water. The mixture was stirred until all the solids had dissolved. The temperature was monitored before and after the addition of the calcium chloride. The results are shown in the graph below.



Use the calibration factor from **part a.** to calculate the enthalpy change for the dissolution of 1.00 mol of $CaCl_2(s)$. The molar mass of $CaCl_2$ = 111.1 $gmol^{-1}$. (3 marks)

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