Website: contoureducation.com.au | **Phone:** 1800 888 300
Email: hello@contoureducation.com.au

VCE Chemistry ¾
Calorimetry [1.4]
Homework

Homework Outline:

Compulsory Questions	Pg 2- Pg 13
Supplementary Questions	Pg 14- Pg 27

Section A: Compulsory Questions (27 Marks)

Sub-Section [1.4.1]: Calculate Calibration Factor via Electrical & Chemical Calibration ($CF = \frac{E}{\Delta T}$)

Question 1 (2 marks)

Andrew runs 340 J of electrical energy through a solution calorimeter. He notes that the temperature of the solution increases by 1.5°C.

a. Calculate the calibration factor for the calorimeter in $J/°C$. (1 mark)

b. Calculate the calibration factor for the calorimeter in $kJ/°C$. (1 mark)

Question 2 (3 marks)

A solution calorimeter containing 150 mL of water is being calibrated.

a. 2.00 A of current is passed through the instrument for 2.50 minutes, at a voltage of 2.30 V. Calculate the energy passing through the calorimeter. (1 mark)

b. The temperature of water in the calorimeter changes from 34.5°C to 36.5°C. Calculate the calibration factor for the calorimeter. (2 marks)

Question 3 (3 marks)

A solution calorimeter is calibrated by using the following reaction, whereby 100.0 mL of 1.00 M HCl and excess NaOH are added to the calorimeter at 28.0°C, according to the following reaction:

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l) \quad \Delta H = -57.3\ kJ/mol$$

It is found that the final temperature of the calorimeter is 36.3°C. Find the calibration factor of the calorimeter in $J/°C$.

Space for Personal Notes

Sub-Section [1.4.2]: Apply Calibration Factor To Find Energy Released ($E = CF \times \Delta T$)

Question 4 (4 marks)

A calorimeter is known to have a calibration factor of 43.6 $J/°C$. Calculate the energy released, in J, in each of the following circumstances:

a. If there is a temperature change of 2.5°C. (1 mark)

_____

_____

b. If there is a temperature change of 6.75°C. (1 mark)

_____

_____

c. If the temperature changes from 49.6°C to 54.5°C. (2 marks)

_____

_____

_____

_____

Space for Personal Notes

Question 5

Chloe is using a solution calorimeter which has a known calibration factor of 42.1 $J/°C$, which contains 200.5 ml of an unknown solution. During an experiment, she notes that when a chicken drumstick is added to the calorimeter, the thermometer changes from 31.4°C to 44°C.

a. Find the energy released by the drumstick in kJ.

b. Chloe knows that the drumstick weighs 15.2 g. Calculate the energy content of the drumstick in kJ/g.

Space for Personal Notes

Question 6 (4 marks)

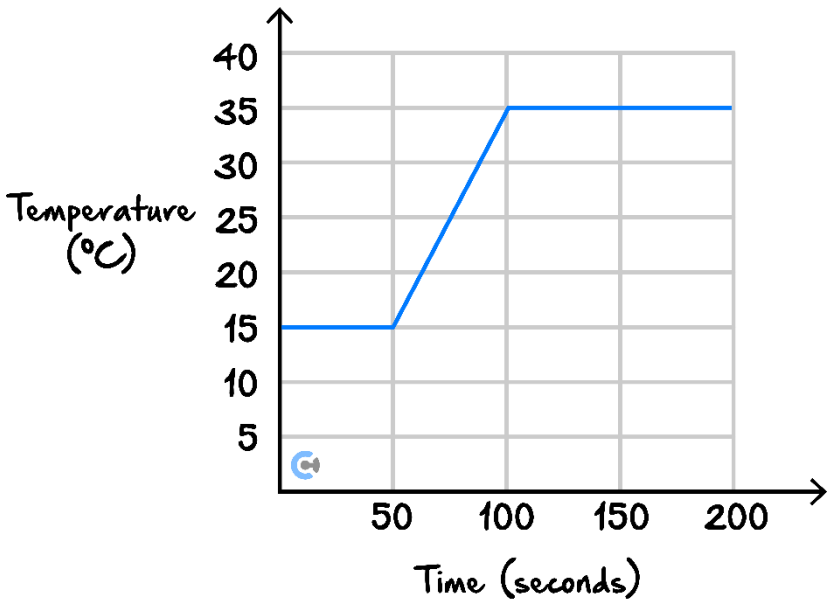
A solution calorimeter was calibrated by the passage of 5.40 A for 12.20 minutes at a voltage of 10.15 V. The temperature of the water in the calorimeter changed from 22.4°C to 31.5°C during the calibration. This calorimeter was then used to determine the heat content of a sample of potato crisps. 5.00 g of potato crisps was reacted in the calorimeter, causing the temperature of the water in the calorimeter to rise by 15.2°C. Calculate the energy content of the potato crisps in kJ/g.

Space for Personal Notes

Sub-Section [1.4.3]: Apply Temperature-Time Graphs To Calorimetry

Question 7 (2 marks)

Sam is experimenting with the following calorimeter. At 50 seconds, the calorimeter is turned on, and at 100 seconds it is switched off.



a. Using the graph, find the temperature change of the calorimeter. (1 mark)

_____

b. Given that 150 *J* of energy was released during the calibration, find the calibration factor of the calorimeter. (1 mark)

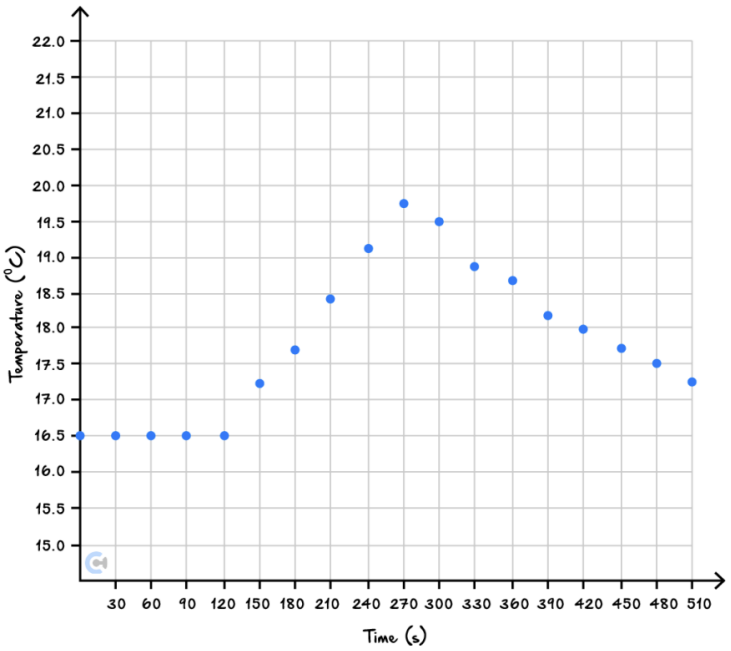
_____

_____

Space for Personal Notes

Question 8 (4 marks)

A bomb calorimeter is calibrated by passing through 2.70 A and a voltage of 5.10 V. The electric heater is turned on at $t = 120\ s$ and turned off at $t = 270\ s$. A graph highlighting this calibration is shown below:



a. Calculate the energy released in the calorimeter during calibration. (2 marks)

b. Using the graph provided, calculate the temperature change during the calibration. (1 mark)

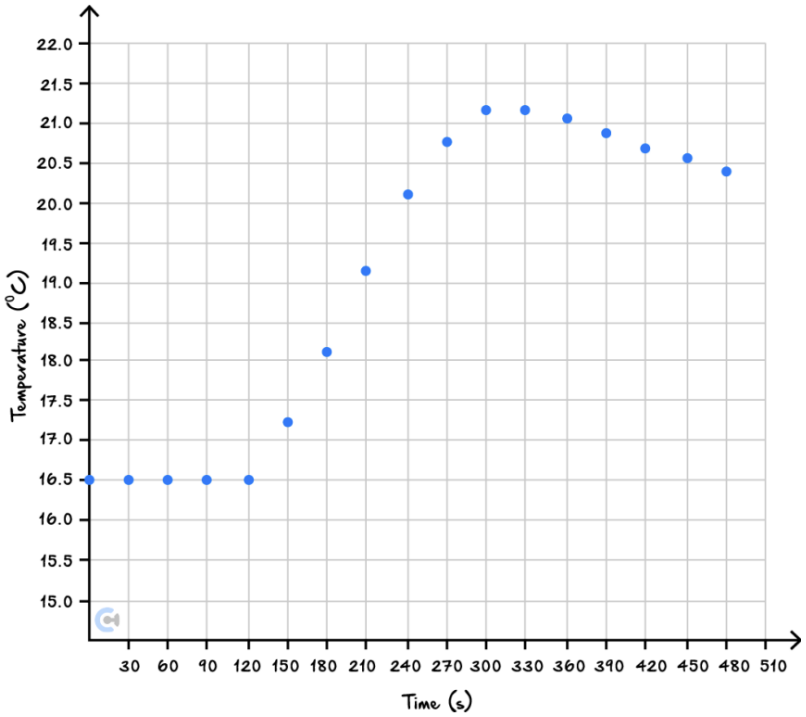
c. Calculate the calibration factor of the bomb calorimeter in $kJ/°C$. (1 mark)

Question 9 (5 marks)

A sample of 4.25 g hydrogen peroxide (H_2O_2) placed in a solution calorimeter filled with 150 mL of water at 25°C, decomposes in the solution. The thermochemical reaction is shown below:

$$2H_2O_2 \rightarrow 2H_2O + O_2 \quad \Delta H = -196.6\ kJ/mol$$

The calibration is graphed on a temperature vs time graph which is shown below:



a. Calculate the calibration factor for this calorimeter, in $kJ/°C$. (3 marks)

b. Is the calorimeter well-insulated or poorly insulated? Justify your answer. (2 marks)

_____

_____

_____

_____

Space for Personal Notes

Sub-Section: The 'Final Boss'

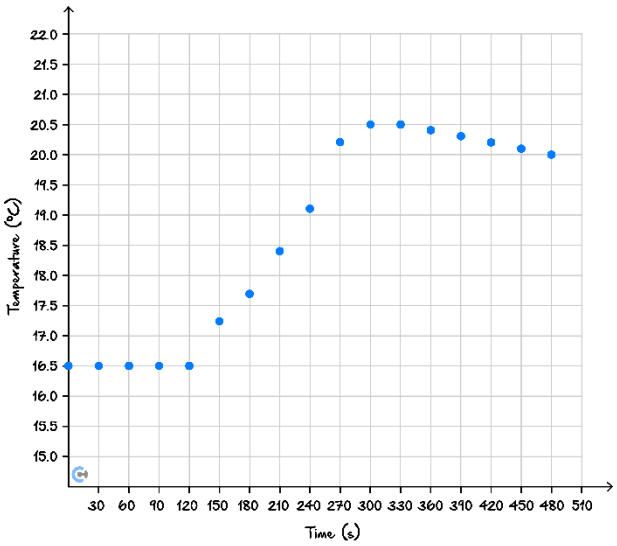
Question 10

A bomb calorimeter is used to measure the energy released during the combustion of a sample of a hydrocarbon fuel. The fuel undergoes combustion in excess oxygen, and the reaction is:

$$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g) \quad \Delta H = -9840\ kJ/mol$$

The bomb calorimeter is initially calibrated by heating an unknown solution, where the electrical input energy is measured and the temperature change is recorded. During the initial calibration, 3.50 A of current is passed through the calorimeter at 5.25 V. The calorimeter body has a heat capacity of 0.150 $kJ/°C$ and it is known that an additional 2.9 kJ of heat energy was absorbed by the water compartment.

The temperature-time graph below was graphed during the calibration of the calorimeter:



a. Consider the calibration of the calorimeter.

i. Calculate the energy input into the calorimeter.

ii. Calculate the total energy absorbed by the calorimeter.

iii. Hence, calculate the calibration factor of the calorimeter.

iv. Describe and justify the discrepancy between your answer for **part a. i.** and **part a. ii.**

b. Following the calibration, 15.0 g of the fuel is combusted in the presence of 0.0256 kg of oxygen gas. If the calorimeter was initially at 141.0°C, calculate the final temperature of the calorimeter.

Space for Personal Notes

Section B: Supplementary Questions (56 Marks)

Sub-Section [1.4.1]: Calculate Calibration Factor via Electrical & Chemical Calibration ($CF = \frac{E}{\Delta T}$)

Question 11 (2 marks)

Jamie passes 410 J of electrical energy through a solution calorimeter. The temperature rise of the solution is recorded as 1.8°C.

a. Determine the calibration factor for the calorimeter in $J/°C$. (1 mark)

_____

_____

b. Convert this calibration factor into $kJ/°C$. (1 mark)

_____

_____

Space for Personal Notes

Question 12 (3 marks)

Angela is experimenting with a solution calorimeter containing 250 mL of water. She applies 3.50 mA of current through the instrument for 1.50 hours, whilst voltage remains at 1.50 V. Interestingly, she finds that the temperature of the water changes from 24.2°C to 24.5°C. Calculate the calibration factor of the calorimeter in $kJ/$°C.

Question 13 (3 marks)

A solution calorimeter is calibrated using 120.0 mL of 1.00 M H_2SO_4 mixed with excess KOH at an initial temperature of 26.0°C. The reaction is as follows:

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l) \quad \Delta H = -114.0\ kJ/mol$$

The final temperature of the calorimeter is 35.0°C. Calculate the calorimeter's calibration factor in $J/$°C.

Space for Personal Notes

Question 14 (10 marks)

A calorimeter containing 200 mL of water is calibrated using both electrical and chemical methods.

A current of 3.00 A flows through the calorimeter for 5.00 minutes at a voltage of 4.50 V. There is an increase of 8.15°C in the temperature.

a. Calculate the energy transferred into the calorimeter. (1 mark)

b. Calculate the electrical calibration factor. (2 marks)

Next, 50.0 mL of 1.00 M H_2SO_4 is reacted with 50.0 mL of 3.00 M KOH in the calorimeter.

The reaction is:

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l) \quad \Delta H = -56.0\ kJ/mol.$$

The temperature rises from 25.0°C to 33.5°C.

c. Calculate the chemical calibration factor. (3 marks)

d. Compare the electrical and chemical calibration factor and make a conclusion on which calibration method is more efficient. (2 marks)

_____

_____

_____

_____

e. Combine the calibration results from both methods to calculate an average calibration factor for the calorimeter in $kJ/°C$. (2 marks)

_____

_____

_____

Space for Personal Notes

Sub-Section [1.4.2]: Apply Calibration Factor To Find Energy Released ($E = CF \times \Delta T$)

Question 15 (3 marks)

A calorimeter has a known calibration factor of 51.5 $J/°C$. Calculate the energy released, in J, in the following cases:

a. If the temperature change is 3.0°C. (1 mark)

_____

_____

b. If the temperature change is 7.0°C. (1 mark)

_____

_____

c. If the temperature increases from 45.5°C to 53.0°C. (1 mark)

_____

_____

Space for Personal Notes

Question 16 (3 marks)

Liam uses a calorimeter with a calibration factor of $40.5\ J/°C$ and fills it with $250.0\ mL$ of an unknown solution. During an experiment, when a piece of steak is placed into the calorimeter, the temperature rises from 30.0°C to 43.5°C.

a. Calculate the energy released by the steak in kJ. (2 marks)

b. Given that the steak weighs $20.0\ g$, compute its energy content in kJ/g. (1 mark)

Question 17 (4 marks)

A solution calorimeter was calibrated by applying a current of $6.00\ A$ for 10.00 minutes at a voltage of $12.00\ V$. During calibration, the water's temperature increased from 20.5°C to 30.0°C. This calorimeter was later used to determine the heat content of a sample of cereal. A $4.00\ g$ cereal sample caused the temperature to increase by 14.0°C. Calculate the energy content of the cereal in kJ/g.

Question 18 (7 marks)

A complex calorimeter has a calibration factor of $45.0\ J/°C$. The calorimeter has two compartments: a water and an unknown aqueous solution compartment. During an experiment:

- A $300\ mL$ aqueous solution experiences a temperature increase from 23.0°C to 42.0°C when a $12.0\ g$ sample of fuel is burned.
- At the same time, a $150\ mL$ water compartment in the calorimeter increases in temperature by 3.50°C.
- The calorimeter itself has a heat capacity of $200.0\ J/°C$ and its temperature also rises from 23.0°C to 42.0°C.

a. Calculate the total energy released by the fuel. (4 marks)

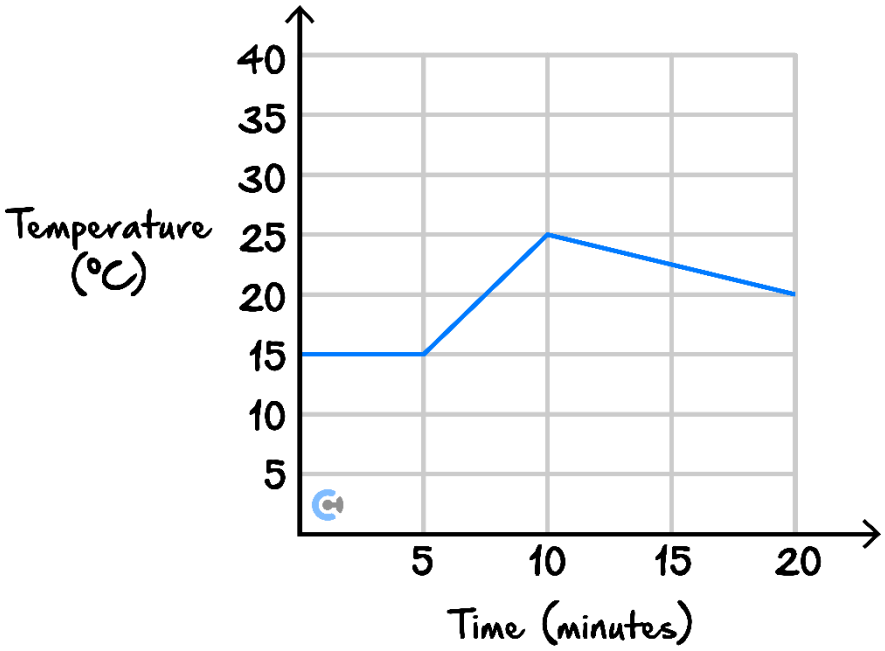
b. Determine the energy content of the fuel in kJ/g. (1 mark)

c. Sally, when analysing the calorimeter, notices that the temperature of the solution is not evenly distributed. She notices that closer to the centre, the solution is quite warm but cooler towards the peripheries. Suggest and justify an improvement that could be made to the calorimeter. (2 marks)

Sub-Section [1.4.3]: Apply Temperature-Time Graphs To Calorimetry

Question 19 (2 marks)

Alex is experimenting with a calorimeter. It is turned on at 5 minutes and switched off at 10 minutes.



a. From the graph, determine the temperature change in the calorimeter when it is turned on. (1 mark)

_____

b. If 180 *J* of energy was released during calibration, calculate the calorimeter's calibration factor. (1 mark)

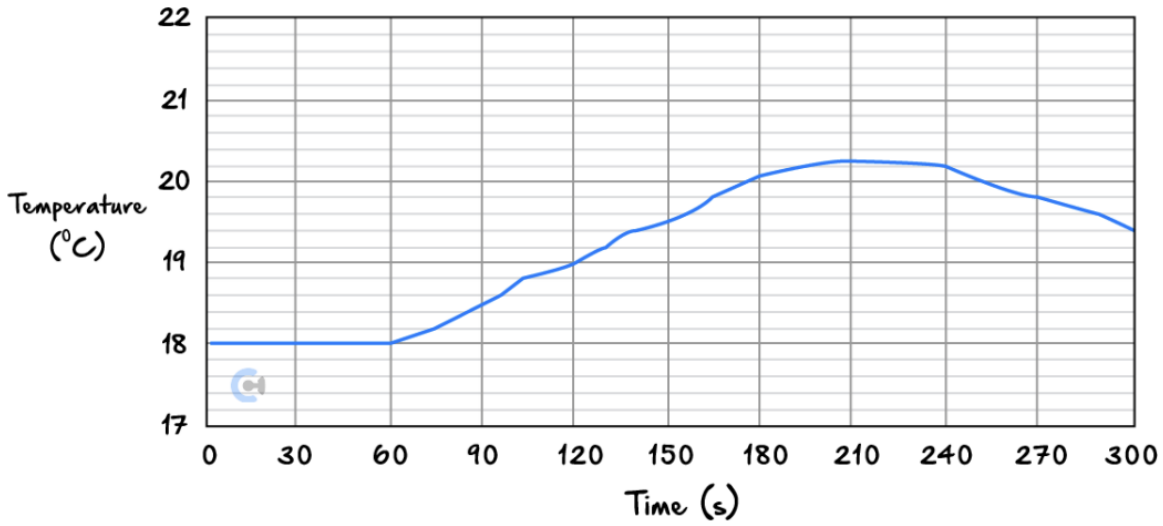
_____

_____

Space for Personal Notes

Question 20 (3 marks)

A calorimeter is calibrated with a current of 3.00 A and a voltage of 6.00 V. The heater operates from $t = 60.0$ seconds.



a. Predict when the heater in the calorimeter is turned off.

b. Determine the energy released during the calibration process. (2 marks)

c. Using the graph, compute the temperature change during calibration.

d. Calculate the calorimeter's calibration factor in $kJ/°C$. (1 mark)

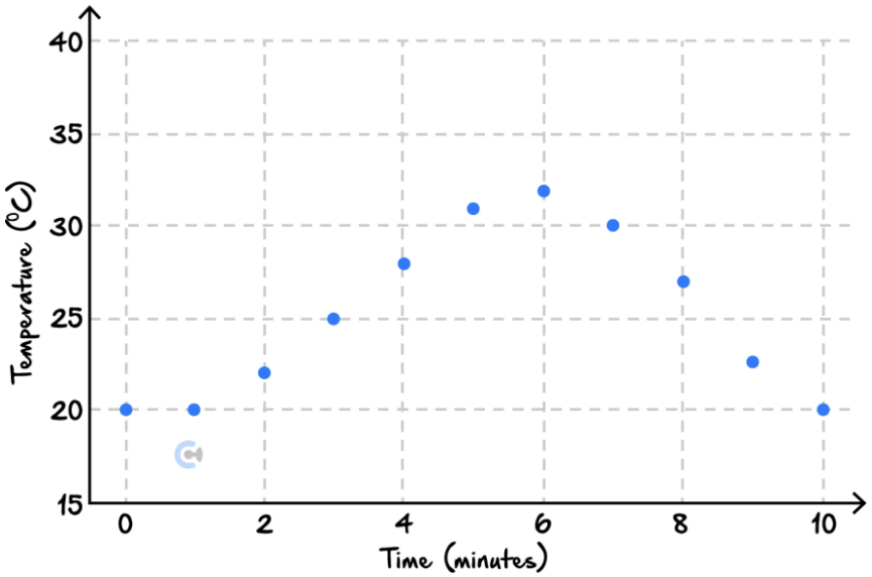
Space for Personal Notes

Question 21 (7 marks)

A 5.00 g sample of glucose is dissolved in water and reacts with oxygen in a calorimeter containing 200 mL of water at an initial temperature of 24°C. The reaction is as follows:

$$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l) \quad \Delta H = -2800\ kJ/mol$$

The temperature-time graph for this reaction is provided:



When the reaction is completed, the temperature of the calorimeter is 45°C.

a. Determine the calibration factor for this calorimeter in $kJ/°C$. (3 marks)

b. Emma claims that "*based on the graph, it is evident that the calorimeter is poorly designed to conserve energy.*" Evaluate this claim. (2 marks)

_____

_____

_____

_____

c. Suggest 2 ways in which the design of the calorimeter could be improved. (2 marks)

_____

_____

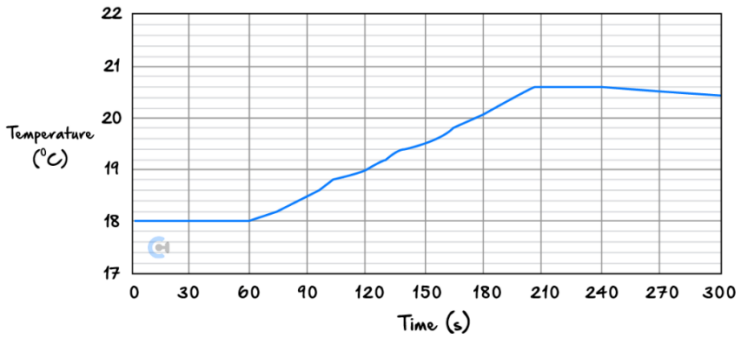
_____

_____

Space for Personal Notes

Question 22 (9 marks)

A bomb calorimeter is calibrated by passing a current of 3.50 A at a voltage of 6.20 V for 150 seconds.



a. From the temperature-time graph provided, determine the calorimeter's calibration factor in $kJ/°C$. (3 marks)

The calorimeter is then used to analyse the combustion of a 2.00 g sample of fuel, which increases the calorimeter's temperature by 15.5°C. During this combustion, it is noted that:

- A separate 100 mL water compartment outside the calorimeter absorbs 4.00 kJ of heat.
- The calorimeter itself has a heat capacity of 200 $J/°C$, which also absorbs heat during combustion.

b. Calculate the total energy released by the fuel. (3 marks)

c. Calculate the energy content of the fuel in kJ/g. (1 mark)

d. Explain whether this calorimeter has good or poor insulation. (2 marks)

Space for Personal Notes

Website: contoureducation.com.au | **Phone:** 1800 888 300 | **Email:** hello@contoureducation.com.au

VCE Chemistry ¾

Free 1-on-1 Support

Be Sure to Make The Most of These (Free) Services!

- Experienced Contour tutors (45+ raw scores, 99+ ATARs).
- For fully enrolled Contour students with up-to-date fees.
- After school weekdays and all-day weekends.

1-on-1 Video Consults	Text-Based Support
➢ Book via bit.ly/contour-chemistry-consult-2025 (or QR code below). ➢ One active booking at a time (must attend before booking the next).	➢ Message +61 440 137 304 with questions. ➢ Save the contact as "Contour Chemistry".

Booking Link for Consults
bit.ly/contour-chemistry-consult-2025

Number for Text-Based Support
+61 440 137 304