CALORIMETRY – TEST 1

QUESTION 1
The energy change during combustion of methane would be best measured in:

A A simple calorimeter
B A bomb calorimeter
C A solution calorimeter
D A gas calorimeter

QUESTION 2
A solution calorimeter would not be suitable for measurement of energy changes in reactions involving:

A The oxidation of foods
B Heats of solution
C Heats of formation
D None of the above

QUESTION 3
Cooking oil has a specific heat capacity of 2.2 J g^{-1} $^0C^{-1}$ while water's specific heat capacity is 4.184 J g^{-1} $^0C^{-1}$.

This implies that:

A Oil heats up more rapidly than water
B More heat is required to raise the temperature of water by 1 degree
C Water can store heat more effectively than oil
D All of the above

QUESTION 4
The reason it is necessary to calibrate a calorimeter before use is:

A To determine the ΔH of the calorimeter
B To determine the temperature of the calorimeter
C To establish a relationship between the amount of heat transferred and the change in temperature within the calorimeter
D All of the above

QUESTION 5
A sample of chocolate cake and a sample of carrot cake were burnt separately in bomb calorimeters to determine their energy content. It was found that the carrot cake had as much energy per gram as the chocolate cake. From this it can be deduced that:

A Carrots are fattening
B Some of the carbohydrate in the chocolate cake was not oxidised in the calorimeter
C The cellulose from the carrots was also oxidised in the calorimeter
D None of the above

QUESTION 6

The heat of neutralisation for the reaction:

$$HCl(q) + NaOH(aq) \rightarrow H_2O(l) + NaCl(aq); \Delta H = -56.1 kJmol^{-1}$$

was experimentally determined using a simple solution calorimeter. When the final calculations were completed, the value of ΔH was found to be –49.5 kJ mol^{-1}.

The most likely reason for this is that:

A The reaction did not go to completion in the calorimeter
B The calorimeter was poorly insulated and some of the heat was lost
C The temperature of the solution in the calorimeter was too cold
D An error was made in the calculations

QUESTION 7

A calorimeter containing water was electrically calibrated by applying a current of 1.97 Amperes at 5.68 Volts for 120 seconds. The temperature was found to rise by 3.66^0C.

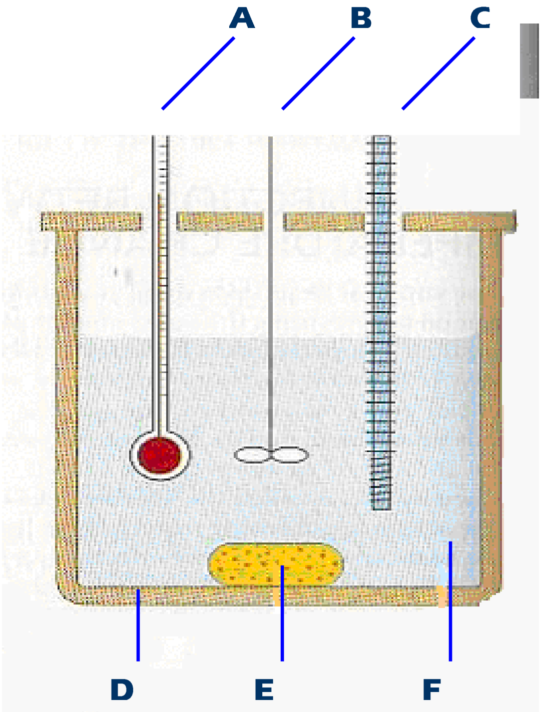
In order to investigate the heat of solution, 0.890g of sodium hydroxide were added to the water and the temperature rose by 2.33^0C.

Calculate the heat of solution of sodium hydroxide.

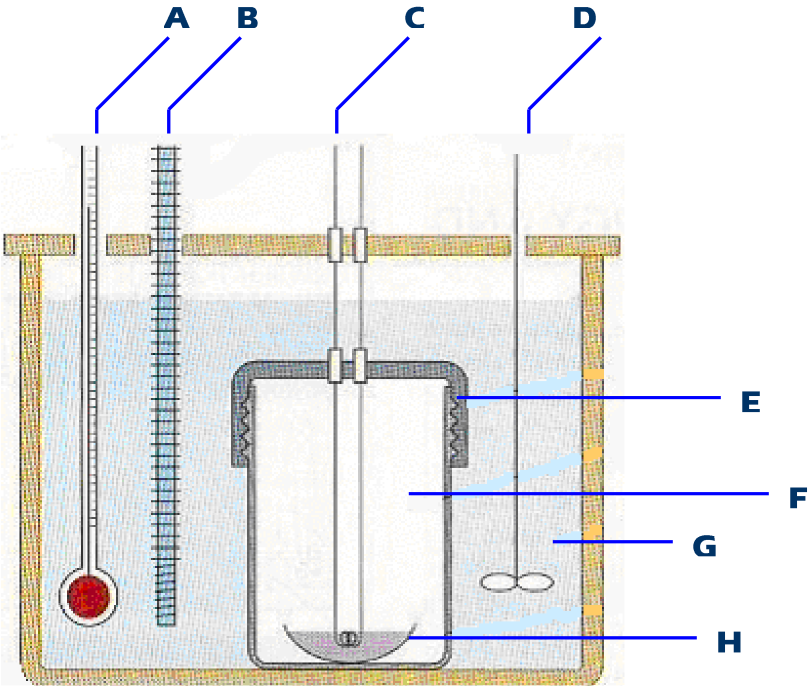
Solution

QUESTION 8
For each of the two types of calorimeters shown below, label each component designated by a letter and briefly outline its function.

1. Solution Calorimeter



2. Bomb Calorimeter



QUESTION 9

Hydrogen gas burns in oxygen according to the following reaction:

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l);\ \Delta H = -286 kJmol^{-1}$$

If 0.55g of hydrogen is burned in a bomb calorimeter with a calibration factor of 145 J^0C^{-1} calculate the temperature rise caused by the combustion of hydrogen.

Solution

QUESTION 10

A burner using methane gas is used to bring 250 mL of water to boiling point.
Methane burns in air according to the following reaction:

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l);\ \ \Delta H = -890 kJmol^{-1}$$

If the specific heat capacity of water is 4.184 J $g^{-1}\ {}^0C^{-1}$ and the initial water temperature is 21^0C, calculate the mass of methane necessary to bring the 250 mL of water to boiling point.

Solution

SOLUTIONS

QUESTION 1 Answer is B

QUESTION 2 Answer is A

QUESTION 3 Answer is D

QUESTION 4 Answer is C

QUESTION 5 Answer is C

QUESTION 6 Answer is B

QUESTION 7

1. Calculate the calibration factor:

$$Energy(Electrical) = VIt$$
$$= 5.68 \times 1.97 \times 120 = 1342.7J$$

$$CF = \frac{E}{\Delta T}$$
$$= \frac{1342.7}{3.66} = 366.9J\,^{0}C^{-1}$$

2. Calculate heat transferred by dissolving 0.890g sodium hydroxide:

$$Heat = CF \times \Delta T$$
$$= 366.9 \times 2.33 = 854.9J$$

3. Calculate ΔH by proportion:

0.89g transfer 854.9J
40.0g (1 mole) transfer xJ

$$\frac{40.0}{0.89} = \frac{x}{854.9}$$
$$\Rightarrow x = \frac{40.0 \times 854.9}{0.890} = 38422J$$
$$OR\ \ 38.4kJ$$

$$\therefore \Delta H = -38.4kJmol^{=1}$$

QUESTION 8

(a) Solution calorimeter

A: thermometer- to measure changes in temperature

B: Stirrer- to maintain a uniform temperature throughout the solution

C: Electric heater- to apply electrical energy for calibration

D: Solution with first reactant

E: Second reactant

F: Insulated container- to prevent heat loss

(b) Bomb Calorimeter

A: Thermometer

B: Heater

C: Special heater to ignite sample

D: Stirrer

E: Pressurised vessel- where the reaction occurs

F: Oxygen- fuel to burn sample

G: Water- to accept heat from reaction in the bomb

H: Sample

QUESTION 9

1. Calculate the energy released by 0.55g of hydrogen gas by proportion:

2.0g (1 mole) releases 286 kJ
0.55g releases x kJ

$$\frac{0.55}{2} = \frac{x}{286} \Rightarrow x = \frac{0.55 \times 286}{2} = 78.65 kJ$$

2. Calculate temperature change, ΔT

$$Heat = CF \times \Delta T \Rightarrow \Delta T = \frac{Heat}{CF}$$

$$\therefore \Delta T = \frac{78.65}{145} = 0.54^0 C$$

QUESTION 10

1. Calculate the energy required to raise temperature of 250g of water by 1^0C:

$$Energy = 4.184 \times 250 = 1046J$$

2. Calculate the temperature rise needed to bring water to boiling point:

$$\Delta T = 100 - 21 = 79^0 C$$

3. Calculate the total energy required to raise 250g of water by 79^0C:

$$Energy(Total) = 1046 \times 79 = 82634J$$
$$OR\ \ 82.6kJ$$

4. Calculate the mass of methane by proportion:

16g (1 mole) release 286 kJ
x g release 82.6 kJ

$$\frac{x}{16} = \frac{82.6}{890} \Rightarrow x = \frac{82.6 \times 16}{890} = 1.48g$$