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VCE Chemistry ¾
Energy Calculations & Delta H [1.2]
Homework

Homework Outline:

Compulsory	Pg 2-Pg 11
Supplementary	Pg 12-Pg 19

Section A: Compulsory

Sub-Section [1.2.1]: Apply $\mathbf{q = Delta\ H \times n}$ to Energy Released

Question 1 (2 marks)

a. Find the amount of energy released during the complete combustion of 12.5 mol of methanol. (1 mark)

b. Determine the amount of energy released by the complete combustion of 7.45 kg of ethanol (C_2H_5OH). (1 mark)

Question 2 (2 marks)

Decane undergoes combustion according to the following thermochemical equation:

$$C_{10}H_{22}(l) + \frac{31}{2}O_2(g) \rightarrow 10CO_2(g) + 11H_2O(l);\ \Delta H = -4240\ kJ\ mol^{-1}$$

a. Determine the amount of energy released by 10.8 g of decane. (1 mark)

b. 127 kJ of energy was released by the combustion of decane. Determine the amount in mol of decane combusted. (1 mark)

Question 3 (2 marks)

a. Given that a combustion engine that uses ethanol produces 25.5 kJ, calculate the amount (in mol) of ethanol that would have been inputted to the engine, considering there is no energy loss. (1 mark)

b. A particular sample of a mystery fuel was being examined. It was found that 0.88 mol of that mystery fuel was combusted to produce 1266 kJ of energy. Determine the molar heat of combustion of the mystery fuel. (1 mark)

c. A mixture of 2.00 moles of methanol ($CH_3OHCH_3OHCH_3OH$) and 4.00 moles of propane ($C_3H_8C_3H_8C_3H_8$) is combusted. Calculate the total energy released in kilojoules.

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Sub-Section [1.2.2]: Apply Delta H in kJ/mol, kJ/g and kJ/mL to Energy Calculations

Question 4 (2 marks)

a. 15.9 kJ of energy was released when a particular amount of propane was burnt in the presence of an unlimited supply of oxygen. Calculate the amount, in moles, of propane that was burnt.

b. Diesel is a fuel being investigated.

i. A sample of 1.00 kg of diesel is completely combusted. Find the energy in kilojoules released. (1 mark)

ii. A sample of 1.00 L of diesel is completely combusted. Find the energy in kilojoules released. (1 mark)

Question 5 (3 marks)

a. A sample of octane releases 156.0 kJ of energy. Calculate the mass of the octane that underwent combustion. (1 mark)

b. A beaker of propan-1-ol underwent combustion. It was found a 14.29 g sample released 500 kJ of energy. Calculate the heat of combustion of propan-1-ol in kJ/g . (1 mark)

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c. A sample of natural gas is combusted, whereby 590 kJ of energy is released. Find the volume, in L, of natural gas combusted. (1 mark)

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Question 6 (3 marks)

a. Given that the density of propane is 0.257 g/mL, find the amount of energy released by the complete combustion of 10.0 L of propane (C_3H_8). (2 marks)

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b. Calculate the volume of butan-1-ol required to release 1.77 kJ of energy, given that the density of butan-1-ol is 0.745 g/mL . (1 mark)

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Sub-Section [1.2.3]: Apply $\mathbf{q = mc\Delta T}$ to Find Energy Absorbed

Question 5 (1 mark)

Calculate the amount of energy required to heat up 10.2 g of water by 5.0℃.

Question 6 (1 mark)

It was found that 1.15×10^4 J heated up a sample of water by 20.5℃. Determine the mass of water that must have been heated up.

Question 7 (2 marks)

In an experiment, 200.0 g of water is heated from 22.0℃ to 28.0℃. The water absorbs 5004.0 J of energy. Find the experimental specific heat capacity of water.

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Sub-Section [1.2.4]: Calculate Delta H Experimentally

Question 8 (3 marks)

A scientist is exploring the capabilities of biodiesels as a potential replacement for fossil fuels in the future. She uses a sample of methyl stearate ($C_{19}H_{38}O_2$) which is placed in a spirit burner and used to heat up a metal can with 250 mL of water.

The mass of the spirit burner across the experiment was monitored and the following values were found.

The initial mass of the spirit burner: 288.05 g
The final mass of the spirit burner: 279.51 g

a. Calculate the amount of methyl stearate (mol) that underwent combustion. (1 mark)

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b. The temperature of the water was found to increase from 25.0℃ to 37.5℃. Find the amount of energy absorbed by the water in kJ. (1 mark)

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c. Hence or otherwise, determine the heat of combustion in $kJ\ mol^{-1}$ of methyl stearate. (1 mark)

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Question 9

A sample of $1.250\ g$ of octane (C_8H_{18}) undergoes complete combustion in a spirit burner. The evolved energy is used to heat up an aluminium can containing $250\ mL$ of water. The temperature of the water rises from 15.7℃ to 22.2℃. Calculate the heat of combustion of octane in kJ/mol.

Question 10 (4 marks)

A sample of $2.00\ g$ of propane was completely burnt, and the energy released was used to heat a volume of water. The temperature of the water increases from 28.0℃ to 43.0℃.

a. Calculate the energy released during the combustion of propane, in kilojoules. (2 marks)

b. Find the volume of water, in mL, which was heated up, assuming 100% energy transfer. (2 marks)

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Sub-Section: The 'Final Boss'

Question 11 (10 marks)

An experiment was conducted to investigate the energy changes during the combustion of ethanol in a spirit burner.

a. Write the thermochemical equation for the complete combustion of ethanol. (2 marks)

b. Given that the density of ethanol is 0.789 g/mL, find the heat of combustion of ethanol in kJ/mL. (2 marks)

c. During the experiment, 12.35 g of ethanol in a spirit burner is combusted and used to heat 100.0 mL of water at SLC. After the experiment is completed, the final temperature of the water is 47.8℃. Find the experimental molar heat of combustion of ethanol. (4 marks)

d. Calculate the energy transferred to the water per mL using the total energy absorbed and the volume of water. (2 marks)

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Section B: Supplementary

Sub-Section [1.2.1]: Apply $q = Delta\ H \times n$ to Energy Released

Question 12 (2 marks)

a. How much energy (in kilojoules) is released when 3.50 moles of hydrogen are combusted completely? (1 mark)

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b. A sample contains 1.25 moles of carbon (graphite). How much energy (in kilojoules) is released when the carbon is combusted? (1 mark)

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Question 13 (2 marks)

Calculate the energy released when 10.0 grams of glucose ($C_6H_{12}O_6$) are combusted.

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Question 14 (3 marks)

A sample contains 12.0 g of butane and 8.0 g of hydrogen gas. Calculate the total energy released when both are combusted.

Question 15 (4 marks)

A 50/50 by-mass fuel mixture of ethanol and methane is combusted completely. If the total mass of the mixture is 20.0 g, calculate the total energy released.

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Sub-Section [1.2.2]: Apply Delta H in kJ/mol, kJ/g and kJ/mL to Energy Calculations

Question 16 (1 mark)

A generator burns 15.0 mL of petrol to produce energy. Calculate the total energy released during this process.

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Question 7 (4 marks)

a. The density of butan-1-ol is 0.745 g/mL, calculate the amount of energy that will be released by 1.50 L of butan-1-ol given its molar heat of combustion is 37.8 kJ/g. (2 marks)

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b. A mixture of 3.00 g of ethane and 2.00 g of carbon is combusted. Calculate the total energy released in kJ. (2 marks)

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Question 8 (3 marks)

The density of octane is 0.703 g/mL under SLC.

a. Calculate the amount of energy released by a canister containing 20.0 L of octane when it undergoes complete combustion. (1 mark)

b. Determine the volume of octane required to release 1.5 kJ of energy. (2 marks)

Question 17 (3 marks)

A ship uses 50.0 kg of kerosene during a trip.

a. Calculate the total energy released from combusting the kerosene in megajoules. (1 mark)

b. Calculate the volume, in litres, of kerosene used during the trip. (2 marks)

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Sub-Section [1.2.3]: Apply $\mathbf{q = mcAT}$ to Find Energy Absorbed

Question 18 (1 mark)

Calculate the amount of heat energy, in kJ, required to heat up a kettle containing 1.5 L of water from 25°C to 100°C.

Question 19 (1 mark)

If 21.7 kJ of energy was inputted to a pot of water to increase the temperature from 14.0°C to 44.4°C, find the volume of water which was present.

Question 20 (3 marks)

A sample of water with a volume of 500 mL at SLC absorbs 20.9 kJ of energy. Find the final temperature of the water.

Sub-Section [1.2.4]: Calculate Delta H Experimentally

Question 21 (3 marks)

A particular spirit burner contained a sample of an unknown fuel. It is used to heat up a beaker containing 150 mL of water. The following data was obtained:

- The initial mass of the spirit burner: 100 mL
- The final mass of the spirit burner: 98.5 mL
- The initial temperature of water: 25℃
- The final temperature of water: 37℃

a. Calculate the volume of the unknown fuel that underwent combustion. (1 mark)

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b. Determine the amount of energy absorbed by the water, in kJ. (1 mark)

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c. Calculate the heat of combustion of the unknown fuel in $kJ\ mol^{-1}$. (1 mark)

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Question 22 (4 marks)

A burner containing ethanol (C_2H_5OH) is used to heat 200.0 g of water. The water temperature rises from 20.0°C to 45.0°C. The initial mass of the burner and ethanol is 120.50 g, and the final mass is 119.75 g. Calculate the experimental heat of combustion of ethanol in kJ/mol.

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Question 23 (5 marks)

A student uses ethanol (C_2H_5OH) to heat 300.0 g of water. The water's temperature increases from 22.0°C to 52.0°C. The initial volume of ethanol is 25.0 mL, and the final volume is 22.5 mL. The density of ethanol is 0.789 g/mL.

Calculate the experimental heat of combustion of ethanol in kJ/mol.

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