Student Name: _____

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CHEMISTRY 2021

Unit 3
Key Topic Test 2 – Combustion

Recommended writing time*: 45 minutes
Total number of marks available: 50 marks

QUESTION BOOK

* The recommended writing time is a guide to the time students should take to complete this test. Teachers may wish to alter this time and can do so at their own discretion.

Conditions and restrictions

- Students are permitted to bring into the room for this test: scientific calculator, pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the room for this test: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 12 pages.

Instructions

- Print your name in the space provided on the top of the front page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the room for this test.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions.
Choose the response that is **correct** for the question.
A correct answer scores 1, an incorrect answer scores 0.
Marks are **not** deducted for incorrect answers.
If more than one answer is completed for any question, no mark will be given.

Question 1

When carbon monoxide is formed in a combustion reaction rather than carbon dioxide;

A. more energy is produced

B. there is probably a lack of oxygen gas available

C. oxygen is not involved in the reaction

D. The ΔH value does not change

Question 2

When 2.50 g of water is heated the temperature rises by 15.0 °C. The amount of energy, in J, required to do this is closest to:

A. 22

B. 38

C. 120

D. 157

Question 3

A 200 ml container of water at 25°C was heated with 12.0 kJ of energy. The final temperature of the beaker of water is closest to:

A. 14 °C

B. 39 °C

C. 85 °C

D. 277 °C

Question 4

The combustion of 10.0 mL of butan-1-ol would give what volume in mL of carbon dioxide?

A. 40

B. 50

C. 60

D. 65

Question 5

The volume occupied by 2.50 g of methane at 10 °C and 2.50 atm in litres is:

- **A.** 0.174
- **B.** 0.690
- **C.** 1.45
- **D.** 23.2

Question 6

When diesel fuel is burnt:

- **A.** Once some energy is supplied and bonds within the reactants break, no further energy needs to be supplied.
- **B.** More energy is absorbed to break covalent bonds than is released when new covalent bonds form
- **C.** Dispersion forces within diesel molecules are broken and reform within carbon dioxide molecules
- **D.** The covalent bonds present in the reactants are stronger than the covalent bonds in the products

Question 7

For the reaction $CO_{(g)} + ½\ O_{2(g)} \rightarrow CO_{2(g)}$, $\Delta H = -283\ kJ\ mol^{-1}$. It can be concluded that;

- **A.** heat energy is converted to 283kJ of chemical energy
- **B.** the heat content of CO_2 is 283kJ more than the heat content of CO and O_2
- **C.** the heat content of CO_2 is equal to the heat content of CO and O_2
- **D.** when the chemical bonds in 1 mol of CO_2 are broken to form CO and O_2, 283kJ of energy needs to be absorbed

Question 8

When determining the heat content of a fuel, a container containing 100mL of water is then replaced with 200mL of water. If the same amount of energy is supplied you would expect;

- **A.** the energy content of the fuel to be approximately doubled
- **B.** the temperature change to be approximately doubled
- **C.** the temperature change to be approximately halved
- **D.** the energy content of the fuel to be approximately halved

Question 9

The volume occupied by 16.0g of oxygen gas in litres at SLC is;

A. 12.4

B. 16.0

C. 24.8

D. 49.6

Question 10

The combustion of petrol can be represented by;

$$C_8H_{18(g)} + 12.5O_{2(g)} \rightarrow 8CO_{2(g)} + 9H_2O_{(g)} \quad \Delta H = -5054\ kJ\ mol^{-1}$$

Given that

$$H_2O_{(l)} \rightarrow H_2O_{(g)} \quad \Delta H = 41\ kJ\ mol^{-1}$$

ΔH for the reaction; $C_8H_{18(g)} + 12.5\ O_{2(g)} \rightarrow 8CO_{2(g)} + 9H_2O_{(l)}$ in $kJmol^{-1}$ is;

A. -4685

B. -5054

C. -5095

D. -5423

SECTION B- Short-answer questions

Instructions for Section B

Questions must be answered in the spaces provided in this book.
To obtain full marks for your responses you should

- Give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- Show all workings in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.

Make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $H_2(g)$; NaCl(s)

Question 1

a. Write a thermochemical equation for the combustion of propane.

_____

2 marks

b. If 15.0 litres of oxygen is required for the complete combustion of propane at SLC, what mass of propane has reacted?

_____

_____

_____

3 marks

c. If 60mL of propane reacts at SLC, determine;

i. What volume of oxygen would react.

_____

ii. What the change in volume of the mixture would be.

_____

2 marks

Total 7 marks

Question 2

a. Write an equation for the combustion of pentanol.

_____

2 marks

b. The Heat of combustion of pentanol is 3331 kJ mol^{-1}. Convert this to units of kJ g^{-1}.

_____

_____

2 marks

c. How much energy is produced when 20.0 g of pentanol is burnt?

_____

_____

2 marks
Total 6 marks

Question 3

When coal is burnt, the reaction can be written as $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$.

a. The Heat of Combustion of coal is 25.5 MJ/kg. What mass of coal (in kg) is needed to produce 100 MJ of energy?

_____

_____

2 marks

b. What volume of CO_2 at 42°C and 110 kPa can be produced when 1.50 tonne of coal is burnt?

_____

_____

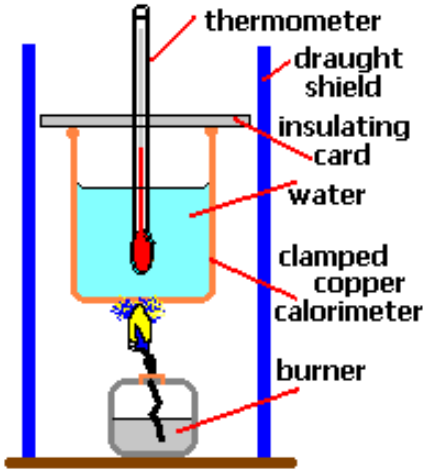
_____

_____

3 marks
Total 5 marks

Question 4

A student aims to determine the heat of combustion of propan-1-ol. An experiment is set up as below;



When propan-1-ol is burnt, the mass of the spirit burner decreases by 0.560g and the temperature of the 100 mL of water in the can increases by 25.3 °C.

a. Determine the heat energy absorbed by the water in the can.

_____

_____

1 mark

b. Determine the Heat of combustion of propan-1-ol in kJ g^{-1}

_____

_____

_____

_____

2 marks

c. Determine the Heat of combustion of propan-1-ol in kJ mol^{-1}

_____

_____

1 mark

d. Why is the value that you calculated for the Heat of Combustion, significantly less than the theoretical value of 2021 kJ mol^{-1}?

_____

_____

_____

_____

2 marks

e. The student decides to then repeat the experiment to determine the Heat of Combustion of butan-1-ol in $kJmol^{-1}$. What value might they expect to obtain? Show your reasoning.

_____

_____

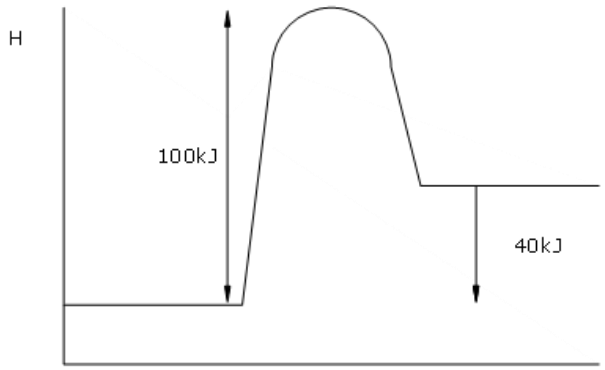
_____

_____

2 marks
Total 8 marks

Question 5

Refer to the diagram below;



a. Does this energy diagram represent an exothermic or endothermic reaction?

_____

1 mark

b. What is the value of the;

i. ΔH_____

ii. Activation Energy _____

1 + 1 = 2 marks

c. The reaction is reversed. Determine the value of the;

i. ΔH_____

ii. Activation energy_____

1 + 1 = 2 marks

Total 5 marks

Question 6

a. Determine the volume of carbon dioxide produced at 10.0 °C and 1.00 atm when 1.00 MJ of energy is produced from the combustion of ethanol.

_____

_____

_____

_____

_____

_____

4 marks

b. The volume of carbon dioxide produced when 1 MJ of energy is produced from the combustion of petroleum is less than the volume of carbon dioxide calculated in part a. Why then is ethanol considered to contribute less to the enhanced greenhouse effect?

_____

_____

_____

_____

2 marks
Total 6 marks

Question 7

H_2 undergoes combustion according to:

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)} \quad \Delta H = -286\ kJ\ mol^{-1}$$

a. If 1.00 mol of H_2 reacts with an excess of oxygen, how much energy is produced?

_____

1 mark

b. Determine the ΔH for the equation; $4H_{2(g)} + 2O_{2(g)} \rightarrow 4H_2O_{(g)}$

_____

1 mark

c. How much energy is absorbed when 1.00 mol of water vapour is split into hydrogen and oxygen gas?

_____

1 mark
Total 3 marks

END OF KEY TOPIC TEST