**Unit 3: Thermochemistry test Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

 **Mark: /50**

**SECTION A – Multiple-choice questions**

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| **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.  |

*Use the following information to answer Questions 1,2 and 3*

The equation for the reaction between aluminium metal and oxygen gas is

4Al(s) + 3O2(g) 🡪 2Al2O3(s) *ΔH* = - 130 kJ

**Question** **1**

The amount of energy released from the complete combustion of 0.200 mol of aluminium is

**A**. 6.5 kJ

**B**. 13 kJ

**C**. 52kJ

**D**. 520 kJ

**Question 2**

The volume of oxygen gas required at SLC to react with 0.200 mol of aluminium is, in L,

**A**. 1.86

**B**. 3.72

**C**. 4.96

**D**. 6.40

**Question 3**

0.36 mol of aluminium is reacted with 0.24 mol of oxygen gas. The amount of reactant remaining after the reaction is

**A**. no reactants remain

**B**. 0.040 mol aluminium

**C**. 0.040 mol oxygen

**D**. 0.12 mol aluminium

**Question** **4**

The specific heat capacity of iron is

**A**. the energy required to raise the temperature of 1.0 mole of iron by 1.00C.

**B**. the energy required to raise the temperature of 1.0 g of iron by 1.00C.

**C**. the energy released by the combustion of 1.0 g of iron.

**D**. the energy required to raise the temperature of water in a iron vessel by 1.00C.

**Question 5**

Methane is burnt under a beaker containing 80 g of water. The initial temperature of the water is 15 0C. If 8000 J of energy is released by the methane, what will the final temperature of the water be, in 0C?

**A**. 20

**B**. 24

**C**. 39

**D**. 48

**Question 6**

The volume of CO2 at SLC produced, in litres, from the complete combustion of 4.60 g of ethanol will be closest to

**A**. 0.62

**B**. 1.28

**C**. 2.48

**D**. 4.96

**Question 7**

Which of the following will release the greatest amount of energy?

**A**. 10.0 L of hydrogen gas at SLC

**B**. 10.0 L of methane gas at SLC

**C**. 15 g of octane

**D**. 16 g of ethanol

**Question 8**

1 mol of methane is completely combusted in one reactor and 1 mol of methanol in another. (Assume SLC)

**A**. The amount of energy released and CO2 formed will be the same in both reactors.

**B**. Methane releases more energy but the same volume of CO2 gas.

**C**. Methanol releases more energy and a greater volume of CO2 gas.

**D**. Methane releases more energy and a lower volume of CO2 gas.

**Question 9**

A 2.5 g sample of bread is burnt under a container holding 600 g of water. The temperature of the water increases by 6.0 ºC. The energy value of the bread, in kJ g-1, is

**A**. 6020

**B**. 8440

**C**. 12100

**D**. 15050

**Question 10**

The mass of plant oil required to release the same amount of energy as 1.0 g of carbohydrate is, in g,

**A**. 0.33

**B**. 0.35

**C**. 0.43

**D**. 1.0

**SECTION B- Short-answer questions**

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| **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, H2(g); NaCl(s) |

**Question 1** (7 marks)

**a. i**. Write a balanced chemical equation for the complete combustion of methanol, CH3OH.

 1 mark

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  **ii**. Add the value of ∆*H* to your equation. 2 marks

**b**. **i**. Write a balanced equation for the incomplete combustion of methanol to form CO and

 water. 1 mark

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 **ii**. Determine the volume of CO that will be produced from the incomplete combustion of

 250.0 g of methanol at SLC. 3 marks

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**Question 2** (8 marks)

The thermochemical equation for the complete combustion of octane is given below.

2C8H18(g) + 25O2(g) 🡪 16CO2(g) + 18H2O(l) Δ*H* = --10920 kJ mol-1

**a**. 80.8 g of octane undergoes combustion.

 **i.** Calculate the energy released. 1 mark

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 **ii**. Calculate the mass of CO2 released. 3 marks

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 **iii**. Calculate the volume of this CO2 released at SLC. 2 marks

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**b**. Calculate the mass of octane required to produce 1.00 MJ of energy. 2 marks

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**Question 3** (6 marks)

The following questions refer to the reaction between ethane and oxygen shown below:

 2C2H6(g) + 7O2(g) 🡪 4CO2(g) + 6H2O(g)

**a**. 40 L of ethane is reacted with 84 L of oxygen gas. (Conditions are held constant)

 **i**. Calculate the volume of CO2 formed. 1 mark

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 **ii**. Calculate the volume of steam formed. 1 mark

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 **iii**. Calculate the volume of reactant remaining. 1 mark

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**b**. Calculate the volume of ethane at SLC needed to react with 0.28 mol of oxygen gas. 2 marks

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**c**. Write a balanced equation for the incomplete combustion of ethane to form carbon monoxide

 and water. 1 mark

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**Question 4** (12 marks)

Ethanol is added to a burner and the burner is placed under a beaker containing 200.0 g of water. The temperature of the water is recorded as 15.6 0C.

**a**. Write a balanced equation for the complete combustion of ethanol.

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 1 mark

**b**. The mass of the burner and ethanol is recorded before and after combustion.

 Mass before 186.2 g

 Mass after 184.5 g

 **i**. Determine the amount of energy that will released from the combustion of the ethanol.

 2 marks

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 **ii**. What will the final temperature of the water be? (Assume full heat transfer to the water)

 2 marks

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 **iii**. How do you think the actual temperature change will compare to the theoretical? 1 mark

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**c**. The water in the beaker is replaced with 200 g of olive oil, also at 15.6 0C. Explain the impact

 of this change on

 **i**. the energy released by the ethanol if the same mass is burnt 1 mark

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 **ii**. the final temperature of the oil. 1 mark

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**d**. The ethanol in the burner is replaced with methanol. Calculate the energy released from the

 combustion of the same mass of methanol. 2 marks

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**e**. Calculate the volume of CO2 produced at SLC from the combustion of

 **i**. 1.00 mole of methanol 1 mark

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 **ii**. 1.00 mole of ethanol 1 mark

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**Question 5** (8 marks)

The enthalpy of solution of ammonium nitrate is +54 kJ mol-1. A solution calorimeter is calibrated by adding 5.00 g of ammonium nitrate to a calorimeter at 16.4 ºC. The temperature falls to 12.2 ºC.

**a**. Determine the calibration factor of the calorimeter. 3 marks

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**b**. A 1.00 g piece of sodium is now added to the calorimeter and the temperature increases by

 5.4 ºC. Calculate the enthalpy for the reaction between sodium and water. 2 marks

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**c**. The heat of combustion of a particular biscuit is 6.22 kJ g-1. A sample of this biscuit is to be

 burnt under a steel can containing 100 g of water. Explain how you could experimentally use

 this set-up to determine the efficiency of the energy transfer into the can of water. 3 marks

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 **END OF TOPIC TEST**