Neap:

CHEMISTRY VCE UNITS 3&4
DIAGNOSTIC TOPIC TESTS 2017

TEST 1: ENERGY FROM FUELS

TOTAL 35 MARKS (45 MINUTES)

Student's Name: _____ Teacher's Name: _____

Directions to students

Write your name and your teacher's name in the spaces provided above.
Answer all questions in the spaces provided.

SECTION A – MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

For each question in Section A, choose the response that is correct and circle your choice.

Choose the response that is **correct** or **best answers** the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1

What is the advantage of a biochemical fuel compared to the same compound derived from fossil fuels?

A. No energy is used to extract and isolate a biochemical fuel from its source.

B. The amount of energy per mole is greater for the biochemical fuel compound.

C. Only the biochemical fuel is produced naturally in an endothermic reaction.

D. The biochemical fuel can be replenished quickly using natural processes.

Question 2

A bushwalker needs to boil some water using a small canister of butane gas under pressure, which burns in air according to the following thermochemical equation:

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l) \quad \Delta H = -5750 \text{ kJ mol}^{-1}$$

Given that 74.9 kJ of energy is required to heat the saucepan and boil the water, the minimum mass of butane required is

A. 0.0261 g

B. 0.756 g

C. 1.51 g

D. 3.02 g

SECTION B – SHORT-ANSWER QUESTIONS

Instructions for Section B

Answer **all** questions in the spaces provided.

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 working in your answers to numerical questions; no marks 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).

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (14 marks)

a. Solar energy is a promising renewable energy source. One method of capturing solar energy is through its use in producing biomass and subsequent production of biofuels. Biomass refers to organic matter derived from living or recently living organisms.

i. Write a balanced equation to represent the process by which green plants convert solar energy into the chemical energy in biomass using carbon dioxide and water as reactants to produce glucose and oxygen. 2 marks

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ii. The energy stored in biomass can be released by direct combustion, in the burning of wood for example.

Suggest **one** disadvantage of this direct combustion of biomass as an energy source. 1 mark

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iii. Alternatively, the energy stored in biomass can be released through conversion of biomass to bioethanol.

Bioethanol may be produced by the fermentation of a glucose solution using yeast enzymes.

$$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

What volume of gas, measured at standard laboratory conditions (SLC), would be evolved if 9.0 g of glucose undergoes fermentation? 3 marks

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Question 2 (11 marks)

Natural gas is a very important and widely used energy source in society. It consists primarily of methane.

a. The gas is piped to homes to be burnt for heating and cooking purposes.

i. Give a balanced thermochemical equation for the complete combustion of methane. 2 marks

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ii. Calculate the mass of methane (in grams) required to bring to the boil 750 mL of water at an initial temperature of 15 °C. Assume that 65% of the energy produced by the burning methane is used to heat the water. 3 marks

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b. Natural gas is also used for electricity generation in gas-fired power stations. In these stations, hot gases produced in a combustion reaction expand air in a combustion turbine, spinning the blades and the attached generator.

i. List in order the energy conversions that take place in the gas-fired power station during this process. 2 marks

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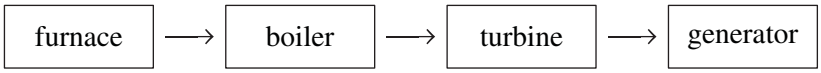
The flowchart below shows the major components of a coal-fired power station.



ii. Give **one** reason why gas-fired power stations achieve a higher energy efficiency in electricity output than coal-fired power stations. 1 mark

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TEST 1: ENERGY FROM FUELS

SUGGESTED SOLUTIONS AND MARKING SCHEME

SECTION A – MULTIPLE-CHOICE QUESTIONS

Question 1 **D**

The compound in a biochemical fuel, or the same compound derived from fossil fuels, would produce the same amount of energy per mole burnt and so **B** is not correct. Similarly, energy is required for the isolation (often distillation) of the compound irrespective of its source. **A** is also incorrect. Both fossil fuel formation and biofuel production occur due to natural processes; for example, the action of microbes on complex compounds. **C** is not correct. However, fossil fuel formation takes millions of years, whereas biofuels can be generated in a matter of months. **D** is the required answer.

Question 2 **C**

From the equation, 2 mol of C_4H_{10} yields 5750 kJ, so x mol of C_4H_{10} yields 74.9 kJ.

$$\frac{x}{2} = \frac{74.9}{5750}$$

$$\therefore x = 2 \times \frac{74.9}{5750}$$

$$= 0.0261 \text{ mol}$$

$$\text{mass of butane} = n \times M$$

$$= 0.0261 \times 58.0$$

$$= 1.51 \text{ g}$$

If the amount of butane is not converted to mass, 0.0261 mol is obtained (so **A** is incorrect). If only 1 mol of butane is used (not 2 as the equation requires), 0.756 g of butane results (so **B** is incorrect). If the ratio from the equation is used to multiply by 2 rather than divide by 2, the result is 3.02 g (so **D** is incorrect).

(In practice more butane may be required to allow for loss of heat from the apparatus.)

SECTION B – SHORT-ANSWER QUESTIONS

Question 1 (14 marks)

a. **i.** $6CO_2(g) + 6H_2O(l) \xrightarrow[\text{light}]{\text{chlorophyll}} C_6H_{12}O_6(aq) + 6O_2(g)$ 2 marks

1 mark for reactants/products.
1 mark for balancing/states.

ii. *For example:*

The fuel is 'wet' and so does not produce large amounts of energy per gram of fuel. 1 mark

iii. $n(C_6H_{12}O_6) = \frac{m}{M}$

$= \frac{9.0}{180.0}$ mol 1 mark

$n(CO_2) = 2 \times n(C_6H_{12}O_6)$

$= 2 \times \frac{9.0}{180.0}$

$= 0.10$ mol 1 mark

$V(CO_2)_{SLC} = n \times 24.8$

$= 0.10 \times 24.8$

$= 2.5$ L 1 mark

b. **i.** Carbon dioxide is used in photosynthesis to make glucose, which is used to make ethanol, which releases the carbon dioxide on combustion. Therefore there is no net addition of carbon dioxide to the atmosphere. 1 mark

ii. *For example:*

Deforestation and land clearing for large-scale production of crops to produce bioethanol is of concern as this will endanger habitats and lead to possible erosion and land degradation. 1 mark

c. **i.** $CH_3(CH_2)_{14}COOCH_3$ *(methyl ester of the fatty acid)* 1 mark