Student Name: _____

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CHEMISTRY 2021

Unit 3
Key Topic Test 1 – Fuels

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: 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.
- A calculator is permitted in this test.

Materials supplied

- Question and answer book of 10 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

100MJ is equivalent to

A. 100 000 J
B. 1 000 kJ
C. 0.100 GJ
D. 100 000 GJ

Question 2

By selecting to fill your car with E10 fuel (10% ethanol) instead of standard 91 fuel you would expect

A. to travel less distance on a tank of fuel
B. improved engine performance
C. to produce 10% less carbon dioxide
D. greater fuel efficiency

Question 3

1.0 mol of ethanol undergoes complete combustion in a car engine. The amount of oxygen, in mol, that reacts with the ethanol would be;

A. 2.0
B. 2.5
C. 3.0
D. 3.5

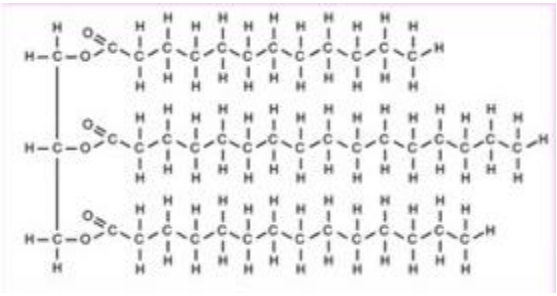
Question 4

Biodiesel is described as being hygroscopic. This means that it;

A. can freeze at low temperatures
B. is quite thick slowing down its movement in fuel lines
C. absorbs water
D. has a decreased flammability

The following information applies to the next 2 questions.

The triglyceride below can be used to produce biodiesel.



Question 5

The molecules produced by the reaction of the triglyceride and methanol would be;

A. Fatty acids and water

B. Fatty acids and glycerol

C. Methyl esters and water

D. Methyl esters and glycerol

Question 6

The triglyceride could be obtained from;

A. Fermentation of plant material

B. Waste cooking oil

C. Recycled engine oil

D. Fractional distillation of crude oil

Question 7

The alternative that correctly lists the fuels in order of energy per gram, from lowest to highest is;

A. Octane, diesel, methane, hydrogen

B. diesel, octane, hydrogen, methane

C. diesel, octane, methane, hydrogen

D. hydrogen, methane, diesel, octane

Question 8

When glucose undergoes fermentation, the following molecules are produced;

A. carbon dioxide and water

B. ethanol and carbon dioxide

C. ethanol and oxygen

D. ethanol and water

Question 9

The combustion of diesel in a truck results in most of the energy released as:

A. heat

B. sound

C. movement

D. light

Question 10

The list of fuels that can all be obtained from a renewable source is;

A. octane, ethanol, methane, biodiesel

B. natural gas, ethanol, methane, biodiesel

C. ethanol, methane, propane, biodiesel

D. methane, biodiesel, ethanol, hydrogen

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

Home heating makes use of a range of fuels including wood, natural gas and LPG.

a. Which of the three fuels could be regarded as renewable?

_____

1 mark

b. Write balanced equations for the;

i. Complete combustion of methane (a major component of natural gas).

_____

ii. Incomplete combustion of butane (a major component of LPG) where carbon monoxide is produced.

_____

1 + 1 = 2 marks

c. The conversion of chemical energy to heat in the above fuels is close to 100%, while the conversion of chemical energy to useful energy in cars is close to 25%. Why?

_____

_____

_____

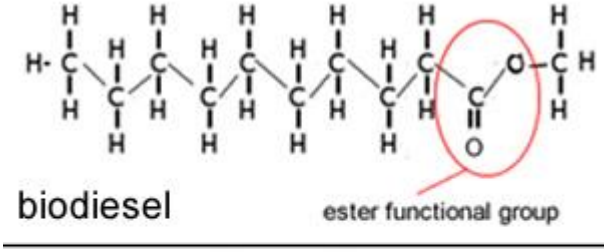
_____

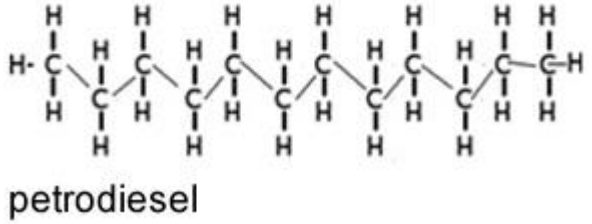
2 marks

Total 5 marks

Question 2

The structures of petrodiesel and biodiesel are shown below;





a. Write the molecular formula for the two reactants that the biodiesel molecule would be produced from.

_____

2 marks

b. Write an equation for the combustion of the biodiesel molecule above.

_____

2 marks

c. Explain why;

i. Biodiesel has a higher viscosity than petrodiesel.

_____

_____

ii. Petrodiesel has a higher energy content than biodiesel

_____

_____

1 + 1 = 2 marks

d. In cold areas of the country, explain by referring to the chemistry involved, which of the 2 fuels would be most suitable.

_____

_____

_____

_____

3 marks

e. Which one of the two fuels would be regarded as renewable? Explain why.

_____

_____

_____

2 marks
Total 11 marks

Question 3

Consider the following list of fuels: C, C_2H_5OH, CH_4, C_8H_{18}, $C_{17}H_{34}O_2$, $C_{19}H_{34}O_2$, $C_{12}H_{26}$.

Which fuel or fuels;

a. Can be produced from fermentation? _____

b. Is mined as a solid? _____

c. Is an unsaturated fatty ester? _____

d. Is the fuel most commonly used in cars? _____

e. Is commonly used to generate mains electricity? _____

f. Can react with methanol to form biodiesel? _____

6 marks

Question 4

Two of the main methods of producing mains electricity are from coal or solar panels. The use of coal is usually between 30% and 40% efficient and solar panels are usually between 15% and 20% efficient. Currently about 70% of Victoria's electricity is generated by coal and about 5% of electricity is generated by solar.

a. Describe the energy transformations that occur when coal is used to produce electricity.

_____

_____

_____

2 marks

b. Why is such a large percentage of Victoria's electricity produced from coal?

_____

_____

_____

2 marks

c. Discuss why the percentage of electricity being produced by solar is increasing while the percentage of electricity being produced by coal is decreasing. In your answer refer to at least two environmental and at least two economic factors.

_____

_____

_____

_____

_____

_____

4 marks

Total 8 marks

Question 5

Methane can be sourced in several ways including fracking, as a bi-product of decomposing waste and crude oil.

a. Describe how fracking is carried out.

_____

_____

_____

2 marks

b. What conditions are required in order to obtain methane from decomposing waste.

_____

_____

_____

2 marks

c. Describe how methane is obtained from petroleum.

_____

_____

_____

2 marks

d. **i.** Which source or sources of methane would be regarded as a biofuel?

_____

ii. Discuss the environmental effects of each process.

_____

_____

_____

1 + 3 = 4 marks
Total 10 marks

END OF KEY TOPIC TEST