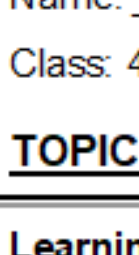
8.2 Alkenes
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ANSWERS

Beatty Secondary School
Science Department (Chemistry Unit)
Chemistry 6092

Name: _____ () Date: _____

Class: 4E _____

TOPIC: ALKENES (WORKSHEET 1)

Learning Objectives:

- Describe the alkenes as an homologous series of unsaturated hydrocarbons with the general formula C_nH_{2n} .
- Draw the structures of unbranched alkenes, C2 to C4, and name the unbranched alkenes, ethene to butene.
- Describe the manufacture of alkenes and hydrogen by cracking hydrocarbons and recognise that cracking is essential to match the demand for fractions containing smaller molecules from the refinery process.
- Describe the difference between saturated and unsaturated hydrocarbons from their molecular structures and by using aqueous bromine.
- Describe the properties of alkenes (exemplified by ethene) in terms of combustion, polymerisation and the addition reactions with bromine, steam and hydrogen.
- State the meaning of polyunsaturated when applied to food products.
- Describe the manufacture of margarine by the addition of hydrogen to unsaturated vegetable oils to form a solid product.

Multiple-Choice Questions

- What feature would show that a compound **must** be an alkene?
 A if it only contains carbon and hydrogen
 B if it reacts with bromine
 C if it is a hydrocarbon with a C=C bond
 D if it burns in air with a smoky flame (C)

- Which structural formula represents an unsaturated hydrocarbon?
 A B C D (A)

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- Compounds X and Y are two different alkenes. Which statement about X and Y is **not** correct?
 A They both undergo addition reactions.
 B They have the same empirical formula.
 C They both contain carbon and hydrogen only.
 D They have the same boiling point. (D)

- Which of the following would be a likely product on cracking the hydrocarbon octadecane, $C_{18}H_{38}$?
 A C_8H_{18}
 B C_9H_{18}
 C $C_{18}H_{40}$
 D $C_{36}H_{74}$ (A)

- Which compound undergoes an addition reaction with bromine?
 A C_2H_4
 B C_2H_6
 C C_2H_5OH
 D CH_3CO_2H (A)

- Which one of these equations does **not** show an addition reaction?
 A $CH_3Cl + Cl_2 \rightarrow CH_2Cl_2 + HCl$
 B $C_2H_6 + Br_2 \rightarrow C_2H_5Br$
 C $C_4H_8 + H_2 \rightarrow C_4H_{10}$
 D $nC_2H_4 \rightarrow [-CH_2-CH_2-]_n$ (A)

- A student investigated the reaction of vegetable oils with hydrogen. 100 cm³ of hydrogen was bubbled through 1 g samples of four different vegetable oils containing a suitable catalyst. The volume of hydrogen remaining after each experiment was recorded.

vegetable oil	volume of hydrogen remaining / cm ³
P	100
Q	87
R	63
S	0

 Which vegetable oils are unsaturated?
 A P, Q and R
 B Q and R only
 C Q, R and S
 D S only (C)

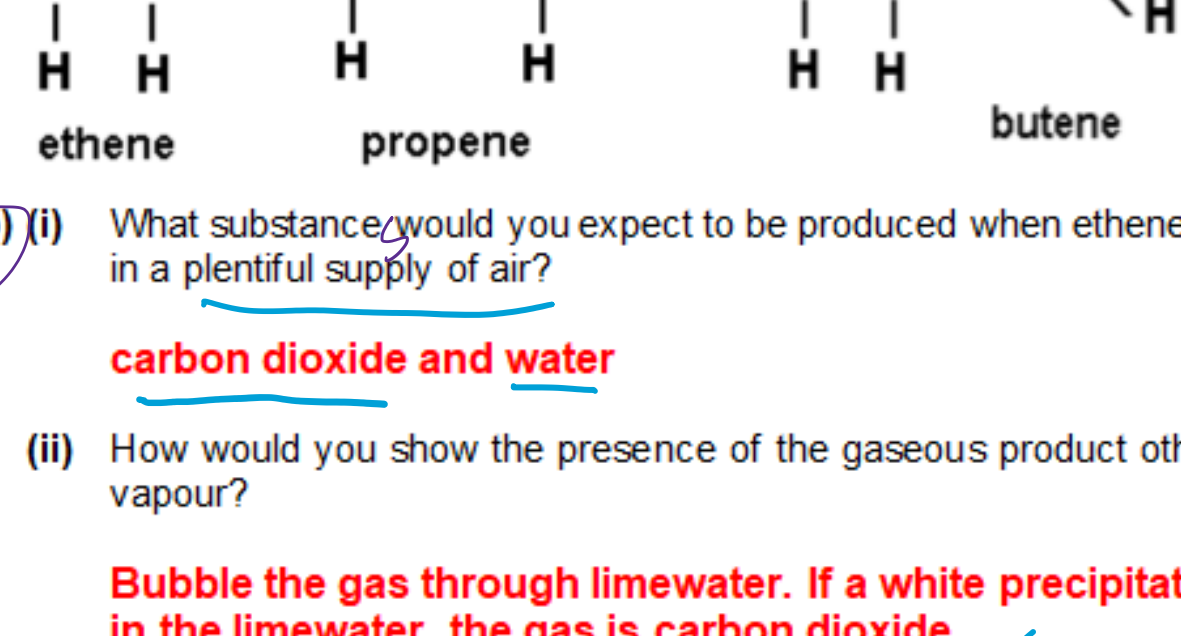
- How can margarine be made from vegetable oils?
 A by the addition of hydrogen to a saturated oil
 B by the addition of hydrogen to an unsaturated oil
 C by the addition of steam to a saturated oil
 D by the addition of steam to an unsaturated oil (B)

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Structured Questions

- The hydrocarbon ethene (C_2H_4) is the first member of the series of compounds called alkenes.

- Draw diagrams to show the structural formula of the first three members of the alkene series.



- What substance would you expect to be produced when ethene is burned in a plentiful supply of air?
 carbon dioxide and water

- How would you show the presence of the gaseous product other than water vapour?
 Bubble the gas through limewater. If a white precipitate is formed in the limewater, the gas is carbon dioxide.

- Alkenes burn in air like alkanes but they produce more soot (unburnt carbon) than alkanes. Write an equation for the complete combustion of
 (a) ethene,
 $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

- butene
 $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$

- Write the balanced chemical equation when propene undergoes each of the following reactions.

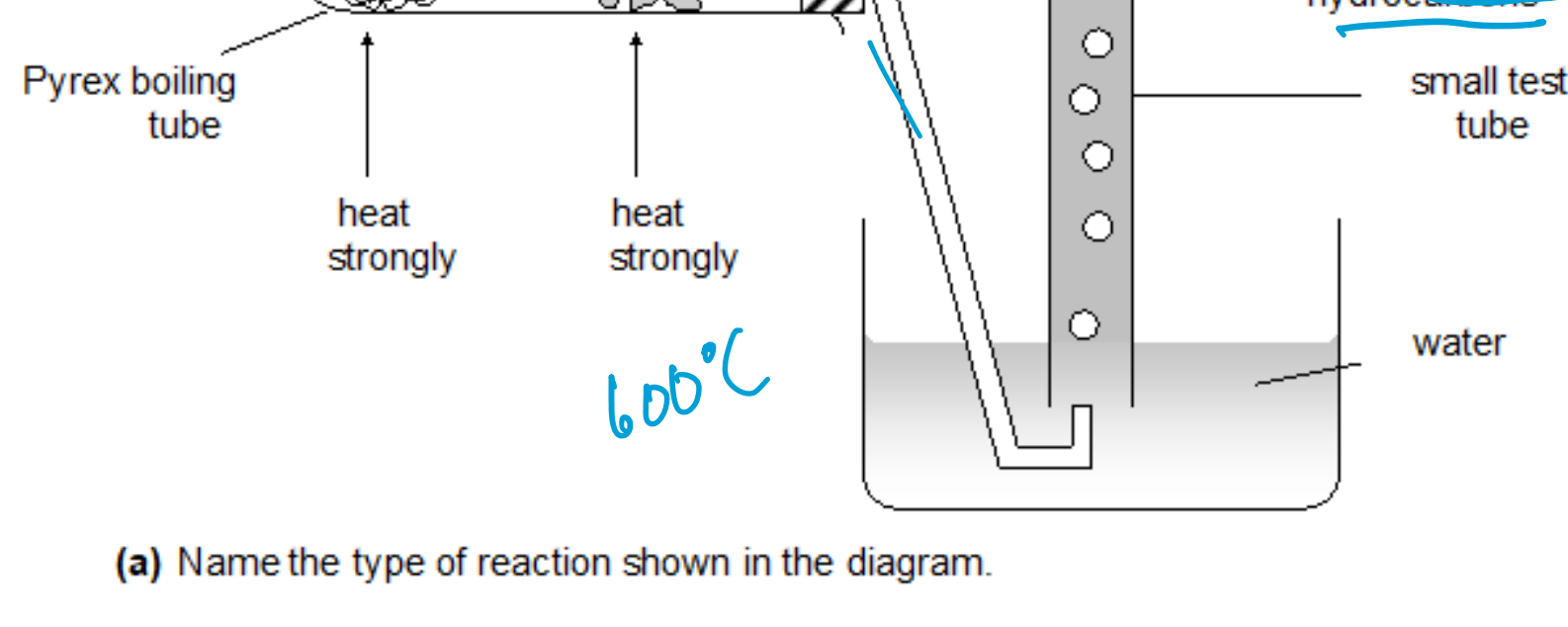
- addition of hydrogen,
 $C_3H_6 + H_2 \rightarrow C_3H_8$

- addition of bromine,
 $C_3H_6 + Br_2 \rightarrow C_3H_5Br_2$

- addition of steam.
 $C_3H_6 + H_2O \rightarrow C_3H_7OH$

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- Kerosene is a mixture of alkanes. The diagram below shows how a mixture of propene and other hydrocarbons can be produced from kerosene in the laboratory.



- Name the type of reaction shown in the diagram.
 Cracking

- What is the purpose of the pieces of broken pot?
 It acts as a catalyst to speed up the rate of reaction.

- A typical alkane found in kerosene has the formula $C_{14}H_{30}$. Construct the equation for one reaction that takes place in the apparatus producing propane from $C_{14}H_{30}$.
 $C_{14}H_{30} \rightarrow C_3H_8 + C_{11}H_{22}$

- Describe a chemical test to show that the other product formed is unsaturated.
 Test: Add bromine solution/aqueous bromine to the other product formed.
 observation: The reddish-brown bromine solution/aqueous bromine decolourises.

- Cracking is used to break big hydrocarbon molecules into smaller ones.

- State the conditions for cracking.
 High temperatures of about 600 °C and either aluminium oxide or silicon(IV) oxide catalyst.

- State and explain one advantage to motor vehicles of cracking.
 Through cracking, long-chain molecules which are less in demand such as diesel and lubricating oils can be converted to short-chain alkanes, such as petrol, which is high in demand to be used in motor vehicles.

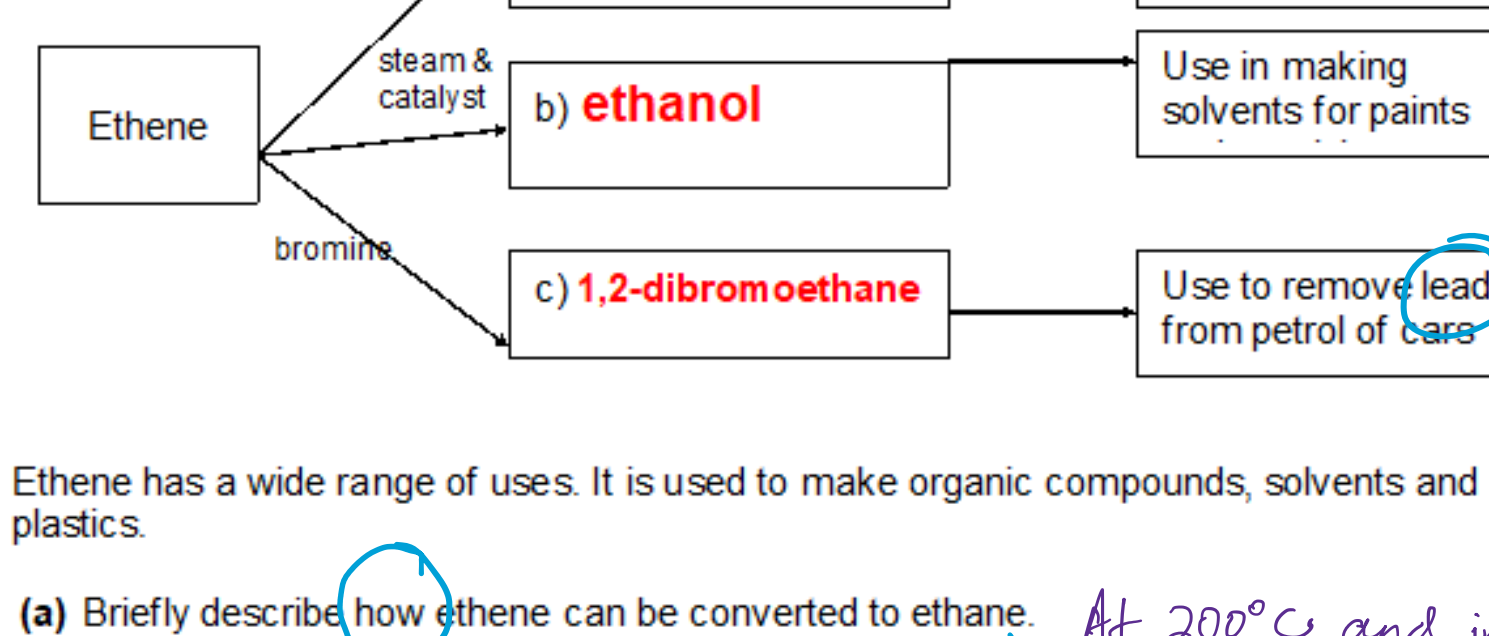
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- Explain the meanings of substitution and addition reactions.

Substitution reactions are reactions in which alkanes react with halogens, such as chlorine and bromine, in the presence of ultraviolet light to form two new compounds.

Addition reactions are reactions in which an unsaturated organic compound combines with another substance to form a single new compound.

- Complete the following boxes with the name of the compounds formed from ethene.



- Ethene has a wide range of uses. It is used to make organic compounds, solvents and plastics.

- Briefly describe how ethene can be converted to ethane.
 Ethene contain C=C double bonds. The double bond is broken with the addition of hydrogen molecule to form ethane.

- This type of reaction is known as hydrogenation. Name one industrial use of hydrogenation.
 Manufacture of margarine from vegetable oil.

- Calculate the volume of hydrogen (measured at r.t.p) needed to convert 5.6 g of ethene to ethane.
 Mr of $C_2H_4 = 12 \times 2 + 4 = 28$
 No. of moles of $C_2H_4 = 5.6 / 28 = 0.200 \text{ mol}$
 No. of moles of $H_2 = 0.200 \text{ mol}$
 Volume of $H_2 = 0.200 \times 24 \text{ dm}^3 = 4.8 \text{ dm}^3$

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- A student collects some data about the fat content of some margarines. The margarines tested are all mixtures of saturated fat A, unsaturated fat B, and water. He also does an experiment to count how many drops of bromine water react with 10g of each type of margarine. The table shows his results.

margarine	% by mass of saturated fat	% by mass of unsaturated fat	number of drops of bromine water per 10 g
1	10	80	12
2	20	70	11
3	40	20	3

- What colour change happens when bromine reacts with a margarine?
 Reddish-brown bromine turns colourless.

- What is seen when the bromine is in excess?
 Reddish-brown remains.

- The margarines are sold in 500 g packs. Which margarine contains most water per 500 g? Explain your reasoning.
 Margarine 3. By calculating the % mass of saturated and unsaturated fat, the total % mass totals to 60%. So the remaining 40% will be water. This value is higher compared to margarine 1 and 2 which consists of 10% water.

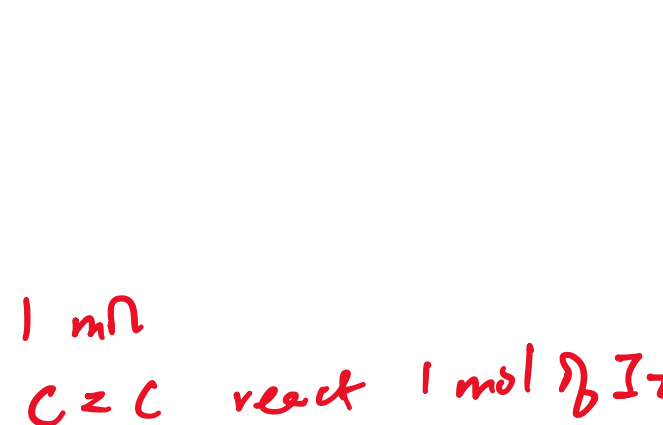
- Another margarine contains 50 g of saturated fat A, and 20 g of unsaturated fat B, per 100 g. Estimate the number of drops of bromine water that react with 10 g of this margarine.
 About 3 drops.

- Some cooking oils contain a mixture of water with molecules of saturated and unsaturated fats. Iodine and bromine both react in a similar way with fat molecules. The mass of iodine that reacts with three different types of oil are shown below.

oil	mass of iodine that reacts with 100 g of the oil / g
C	175
D	124
E	163

- A student says 'oil C contains a larger mass of fat than oil D'. Do you agree with the student? Explain your reasoning.
 No. The mass of fat can be saturated and unsaturated fats. Iodine only reacts with only unsaturated fats. Hence the student is not able to conclude that the mass of fat in oil C is larger.

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- A pure fat has a molecular mass of 400. 100 g of the fat reacts with 127 g of iodine. How many double bonds are there in each molecule of the fat? Show your working.
 Number of moles in pure fat = $100 \div 400 = 0.25 \text{ mol}$
 Number of moles in iodine = $127 \div (127 \times 2) = 0.5 \text{ mol}$
 0.25 mol of fat reacts with 0.5 mol of iodine.
 1 mol of fat reacts with 2 mol of iodine.
 Hence there are 2 double bonds in each molecule.

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