

Beatty Secondary School Science Department (Chemistry Unit) Chemistry 6092

Name:

_____()

Date: _____

Class: 4E1

TOPIC: FUELS AND CRUDE OIL (WORKSHEET 1)

Learning Objectives:

- (a) Name natural gas, mainly methane, and petroleum as sources of energy.
- (b) Describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation.
- (c) Name the following fractions and state their uses.
 - (i) petrol (gasoline) as a fuel in cars
 - (ii) naphtha as the feedstock and main source of hydrocarbons used for the production of a wide range of organic compounds in the petrochemical industry
 - (iii) paraffin (kerosene) as a fuel for heating and cooking and for aircraft engines
 - (iv) diesel as a fuel for diesel engines
 - (v) Iubricating oils as lubricants and as a source of polishes and waxes
 - (vi) bitumen for making road surfaces
- (d) Describe the issues relating to the competing uses of oil as an energy source and as a chemical feedstock.

Multiple-Choice Questions

- 1 Petroleum can be separated by fractional distillation because its constituents
 - A are immiscible B have different densities
 - Care highly flammableDhave different boiling points(D

2 Which of the following fractions of petroleum has the highest boiling point?

AdieselBkeroseneCbitumenDpetroleum gas(

3 Which fuel, on combustion, does not form a pollutant?

Α	petrol	В	natural gas			
С	hydrogen	D	diesel	(С)

- 4 Which of the following are arranged in order of increasing boiling points?
 - **A** kerosene, petrol, diesel, bitumen
 - **B** bitumen, diesel, kerosene, petrol
 - **C** petrol, diesel, kerosene, bitumen
 - **D** petrol, kerosene, diesel, bitumen

1

)

(**D**

)

5 Which of these fractions has the most number of carbon atoms per molecule?

A C	naphtha petrol	B D	diesel lubricating oil	(D)
The	main constituent of natural g	as is _				
A C	butane methane	B D	ethane petroleum gas	(С)

7 The fractions obtained by fractional distillation of petroleum have different uses. Which fraction and use are correct?

	fraction	use
Α	bitumen	fuel for lorries and buses
В	kerosene	aircraft fuel
С	petrol	making waxes
D	lubricating oil	surfaces of roads

At which outlet of the fractionating column below is the fuel used in gas cookers 8 collected?



(Α)

В)

(

9 Which statement about petroleum is true?

6

- Α Petroleum can be separated by simple distillation.
- В Natural gas is a renewable source of energy.
- Biodiesel is an alternative fuel to petroleum. С
- Biogas is produced when organic matter decays in air. D (С)
- 10 Petroleum can be separated into fractions using fractional distillation. Which statements about petroleum are correct?

- 1 Alkanes used in polishes and waxes have a higher boiling point than those 1 used as diesel fuel.
- 2 Any of the fractions could be used as fuels because their enthalpy changes of combustion are negative.
- The fraction used for petrol is extracted from higher up the fractionating column 3 than the fraction used for paraffin.
- The fraction obtained at a particular point in the fractionating column always 4 contains the same compounds in the same ratio.

Α	1, 2 and 3	В	1 and 4
С	2 only	D	3 and 4

(Α)

2

Structured Questions



use of fraction A: fuel for cooking and heating

use of fraction D: making / paving road surfaces

(c) Propane and butane leave the column in the same fraction labelled A. Explain why.

Both propane and butane have similar low relative molecular masses and boiling points. As such, both fractions condense within the same range of temperatures in the fractionating column, leaving at A.

12 Petroleum (crude oil) is a mixture of hydrocarbons which is separated into useful fractions by fractional distillation. The table shows the percentages of various fractions obtained by fractional distillation (the supply) and the percentages required (the demand) for the petroleum from a Middle East oil field.

fraction	percentage produced (supply)	percentage required (demand)	
petroleum gases	4	4	0
petrol	13	26	13
naphtha	10	5	5
kerosene	14	8	6
diesel	13	20	7
bitumen and other heavy hydrocarbons	46	37	11

(a) What physical property enables petroleum to be separated by fractional distillation?

difference in boiling points

(b) (i) For which fraction does the demand exceed the supply by the greatest amount?

<u>petrol</u>

(ii) For which fraction does the supply exceed the demand by the greatest amount?

bitumen and other heavy hydrocarbons

(c) Describe how the different fractions can be separated by fractional distillation.

As the petroleum is heated, all of the fractions boil and the vaporised crude oil enters the fractionating column as a gas.

The temperature is the highest at the bottom of the fractionating column and the lowest at the top of the column. As the vapour rises up the column, each fraction is cooled down and condenses at different parts of the column through selective condensation.

Fractions with lower boiling point condense and are collected at the upper part of the column while fractions with higher boiling point condense and are collected at the lower part of the column.

(d) Some cars use diesel fuel while some use petrol. A car will travel a greater distance in kilometres using one litre of diesel than one litre of petrol. Suggest why.

Diesel has a greater number of carbon atoms compared to petrol. As such, the enthalpy change of combustion increases with the number of carbon atoms. This leads to more energy released from the combustion of diesel than petrol, leading to a greater distance travelled.

(e) Name two fuels, suitable for cars, which does not come from crude oil.

hydrogen and ethanol and biodiesel

13 Methane is a fuel obtained from natural gas. Methane completely burns in air to form carbon dioxide and water. An equation for this reaction is shown below.

$$H = C = H + 2O = O \longrightarrow O = C = O + 2O ; \Delta H = -890 \text{ kJ/mol}$$

(a) Explain in terms of the bonds broken and made why this reaction is exothermic.

The total amount of thermal energy absorbed to break the (C-H) bonds in methane and the (O=O) bonds in oxygen is lesser than the thermal energy released to form the (C=O) bonds in carbon dioxide and the (O-H) bonds in water.

(b) Calculate the energy released when 0.96 g of methane is completely burnt in air

No of mol of methane	$= \frac{0.96}{16} = 0.06 \text{ mol}$	KJ mo l
Total amount of energy	= 0.06 × 890 = <u>53.4 kJ</u>	890 KJ/ × 0.06

(c) Name all the possible products in the incomplete combustion of methane. Explain how this incomplete combustion can be harmful.

Water vapour, carbon monoxide and soot (carbon). Carbon monoxide is a toxic gas can bind to haemoglobin to form carboxyhaemoglobin which prevents blood from transporting oxygen around the body and may lead to death.

- **14** Natural gas consists mainly of methane (CH₄). Hydrogen sulfide (H₂S) is a common contaminant of natural gas and must be removed before natural gas is used as a fuel.
 - (a) Construct the equation to show the combustion of hydrogen sulfide in air to form sulfur dioxide and water.

 $\underline{2H_2S+3O_2\rightarrow 2SO_2+2H_2O}$

(b) Suggest why it is necessary to remove the hydrogen sulfide before natural gas is used as a fuel.

Sulfur dioxide formed from the combustion of hydrogen sulfide is an air pollutant that may react with oxygen and rainwater to form acid rain. This may lead to the corrosion of limestone and metal buildings and kill aquatic lives.

(c) A 480 dm³ sample of natural gas, containing 10% hydrogen sulfide is completely burnt in air. Calculate the mass of sulfur dioxide produced.

Volume of H ₂ S	$=\frac{10}{100}$	× 480 =	48 dm ³		
Mol of H₂S	$=\frac{48}{24}$	= 2 mol			
Comparing mole ratio:					
	H₂S	:	SO ₂		
	2	:	2		
Mass of SO ₂	=	2 × (32	2+16×2)		
	=	<u>128 g</u>			

(d) State one environmental problem that can be caused by the leakage of methane from natural gas pipelines.

Methane is a greenhouse gas which will lead to an increase in temperatures of the surface of the Earth. Hence, this may result in global warming.

15 Suggest why there may be future difficulties in this use of petroleum.

Petroleum is a non-renewable resource and the world's petroleum reserves are finite and would deplete eventually. Hence, the supply of petroleum may not be sufficient to fulfil the use of the demand in the future.

16 The table below shows the approximate composition of petroleum from various sources expressed in percentage by mass.

source	naphtha	petrol / paraffin	diesel / lubricating oil
Middle East	20	34	46
Nigeria	24	38	38
North Africa	30	38	32
Venezuela	2	18	80

Suggest reasons why the price per barrel of oil is greatest for North African petroleum and least for Venezuela petroleum.

The demand for smaller fractions like naphtha and petrol/paraffin is much higher than diesel/lubricating oil, resulting in the barrel of oil being most expensive for North African petroleum and least expensive for Venezuela petroleum.

This can be observed that North African petroleum has 68% of naphtha and petrol/paraffin whereas Venezuela petroleum has 20% of naphtha and petrol/paraffin.

The high demand of smaller fractions are important because smaller fractions like naphtha are used in the petrochemical industries as a chemical feedstock. On the other hand, petrol and paraffin are used as fuels for transportation vehicles like cars and aeroplanes.