COVENANT UNIVERSITY
NIGERIA

TUTORIAL KIT
OMEGA SEMESTER

PROGRAMME: CHEMISTRY

COURSE: CHM 225

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1. Crude oil can be classified in several ways dependent on its composition. State the classification types and their compositions.

   Ans. paraffinic – more than 75% aliphatic compounds✓✓

   Naphthenic - more than 70% naphthenic rings✓✓

   Asphaltic – more than 60% aromatic rings✓✓

   Light crude – higher proportion of light hydrocarbons✓✓

   Heavy crude – higher proportion of heavy hydrocarbons✓✓

2.a. Soap is made by the action of hot caustic solution on fatty oil with the simultaneous formation of glycerin. Write chemical equation to represent this.

   b. Ordinary toilet soaps and laundry soaps may be made by the boiled or hot process. Describe the hot process.

3. The first major treatment crude oil receives at a refinery is fractional distillation, to separate it into fractions.

   a. What is a fraction?

   b. On what physical property is the separation based?

   Ans. What is a fraction? Mixture of compounds with similar boiling point✓

   On what physical property is the separation based? Boiling point✓

4. State the function and give one example of the following constituents in paint manufacturing.

   i. Resins ii. Pigments and extenders iii. The binders

5. Give a rough sketch of a fractionating column. Label your diagram to show:

   i. The temperature gradient

   ii. At least four major fractions

iii. Name the material drawn off from the bottom of the fractionating column and give its major use.

Ans.

c. Give a rough sketch of a fractionating column. A good attempt at sketching the column✓

Label your diagram to show:

iv. The temperature gradient temperature increasing from bottom to top (400°C at bottom to 20°C at the top)✓

v. At least four major fractions gas, petrol, kerosene, naphtha, diesel✓✓

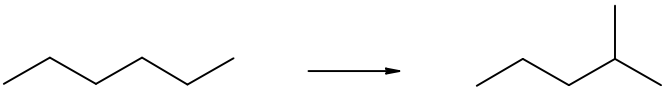
vi. Name the material drawn off from the bottom of the fractionating column and give its major use. Bitumen for roofing and road tarring✓✓

6. What is the structure of natural rubber? Draw a flow chart of rubber production.

7. The demand for lower boiling fractions obtained from fractional distillation is more than supply. In order to meet the demand, the higher boiling fractions are treated in some ways to convert them to more useful fractions. Name and describe as fully as you can the three processes for achieving this conversion. In your description, state the catalyst used, the conditions, reaction equation, type of bond breaking, if any, involved in the process.

Ans.

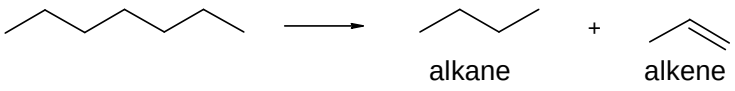
Isomerisation✓ – alumina✓, straight chain converted to branched chain✓



or any other correct reaction

✓✓

Cracking✓ –



or any combination of products, but must be alkane and alkene; or a different higher molecular alkane to give smaller alkane and alkene

✓✓

Catalytic – silica/alumina or zeolite✓, 400°C/pressure✓, carbocation/heterolysis✓

Thermal – 400 – 900°C/70 atm.✓, free radical/homolysis✓

Reforming✓ – alumina/platinum✓, 500°C/21 atm.✓

✓✓

8. (a) what are industrial feedstocks?

(b) Give ten raw materials available locally in Nigeria with their industrial applications

9. Write a balanced equation for the combustion of ethene in excess oxygen.

Ans. $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$✓✓

10. Draw a flowchart describing the production of bio ethanol from cassava using the SSF and the SLSF methods.

11. During combustion, energy is given off and this energy is called enthalpy of combustion.

a. Give the definition of standard enthalpy of combustion.

a. Calculate the enthalpy change of combustion for ethene from the standard enthalpies of formation; $\Delta H_f (C_2H_{4(g)}) = +52.5$ kJ mol^{-1}; $\Delta H_f (CO_{2(g)}) = -393.5$ kJ mol^{-1}; $\Delta H_f (H_2O_{(l)}) = -285.8$ kJ mol^{-1}

Ans.

The standard enthalpy change of combustion is the enthalpy change when 1 mole✓ of substance is burned completely✓ in oxygen at 298K and 1 atm pressure✓

b. Calculate the enthalpy change of combustion for ethene from the standard enthalpies of formation; $\Delta H_f (C_2H_{4(g)}) = +52.5$ kJ mol^{-1}; $\Delta H_f (CO_{2(g)}) = -393.5$ kJ mol^{-1}; $\Delta H_f (H_2O_{(l)}) = -285.8$ kJ mol^{-1} (6 marks)

$\Delta H_c = \Delta H_{f(products)} - \Delta H_{f(reactants)}$✓

$2\Delta H_f(CO_2) + 2\Delta H_f(H_2O) - \Delta H_f(C_2H_4)$✓✓

$2 \times -393.5 - 2 \times -285.8 - 52.5$

$-787 - 571.6 - 52.5$✓

-1411.1 kJ mol^{-1}✓✓

12. Explain the following terms in regard to sugar cane processing

(i) Milling (ii) Clarification (iii) Evaporation (iv) Crystallization

13. In industry, the ΔH_c is used as enthalpy change per mass of compound, and this variation is called energy density, with units of kJ/g or MJ/kg. Energy density is a measure of the efficiency of fuels.

a. Calculate the energy density of the following fuels (5 marks)

Resource type	Molecular formula	DH_c, kJ/mol	Energy density, kJ/g
Petrol	C_8H_{18}	-5470	
Diesel	$C_{20}H_{42}$	-8090	
Natural gas	CH_4	-890	
Hydrogen	H_2	-286	
Ethanol	C_2H_5OH	-1367	

b. Which fuel from the list is the most efficient and which is the least efficient?

Ans.

Resource type	Molecular formula	DH_c, kJ/mol	Energy density, kJ/g
Petrol	C_8H_{18}	-5470	-47.9825
Diesel	$C_{20}H_{42}$	-8090	-28.6879
Natural gas	CH_4	-890	-55.625
Hydrogen	H_2	-286	-143
Ethanol	C_2H_5OH	-1367	-29.717

b. Most efficient is hydrogen and least efficient is diesel✓✓

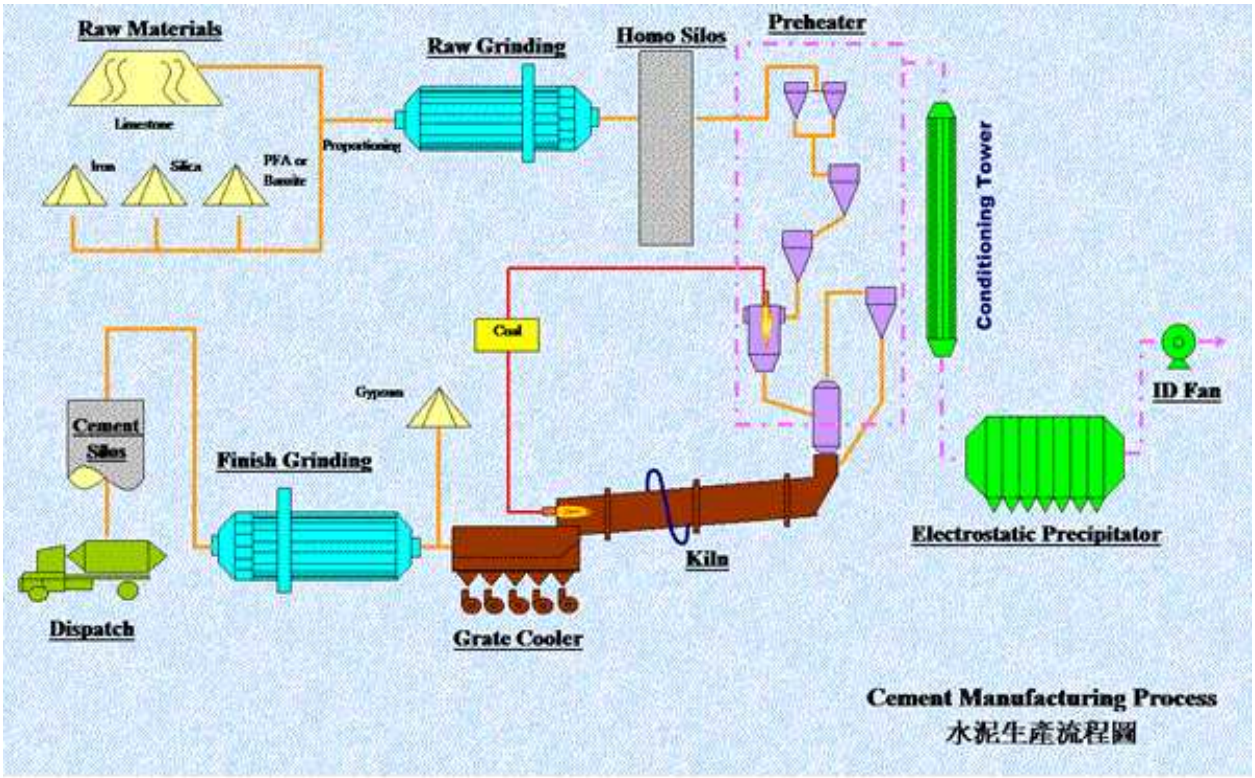
14. Highlight the steps involve in production of sugar from sugar cane.

15 i. State the composition of Portland cement.

ii. Draw a flow chart for the manufacturing of cement.

Ans.

Portland cement are mainly calcium silicates and calcium aluminates. It has this composition, 65% CaO, 20% SiO2, 5% Al2O3.



16. Explain the chemistry of rubber vulcanization using relevant equations where necessary.

17 Soap is made by the action of hot caustic solution on fatty oil with the simultaneous formation of glycerin. Write chemical equation to represent the reaction

$3NaOH + (C_{17}H_{35}COO)_3 \rightarrow 3C_{17}H_{35}COONa + C_3H_5(OH)_3$

Caustic soda Glyeryl stearate Sodium stearate soap Glycerin

ii. Toilet and laundry soaps may be made by boiled or hot process, simply describe the hot process.

Hot Process

A solution of caustic soda testing 18 - 200 (12.6 – 14.4% NaOH) is run into a kettle tank and the melted fats, grease or oils are then pumped in. The amount of caustic is regulated so that there is just enough to combine with all the fatty acids liberated. Heat is supplied. There is no stirrer but agitation is supplied. The kettle is kept boiling until saponification is essentially complete; this requiresabout4hours. Salt (NaCl) is then shoveled in and allowed to dissolve and the boiling is continued until the soap has separated forming the upper layer. The lower layer contains glycerin (4%) and salt and this is drawn off.

The whole operation which was just described is termed the saponificatiob change, and requires about8 hours.

What are the major constraints of local raw material sourcing in Nigeria.

18 Briefly explain the production and recovery of Natural Rubber.

19 i. List Six raw material for manufacturing of glasses

ii. Write short note of the any four classes of commercial glass.

Ans.

marks)

SAND

SODA

BORAX

SALT CAKE

CULLET 3mks for any three

ii. Write short notes on any four classes of commercial glasses (4 marks)

Classes of Commercial Glass

1. Fused silica – Sometimes referred to as quartz glass. It is characterized with low expansion and high softening points, is also extraordinarily transparent to UV radiation.

2. Alkali silicates – Are the only two-component glasses of commercial importance. They arewatersoluble. Sand and soda ash are simply melted together and the products designated sodium silicates. Silicates of soda solution, also known as water glass are widely consumed as an adhesive for paper in themanufacture of corrugated paper boxes.

3. Soda Lime Glass – Represent by far the largest tonnage of glass made today and serves for the manufacture of containers of all kinds, flat glass, windows, plates, tumblers and table wares.

4. Lead Glasses – Are of great importance in optical works because of their high index of refraction and dispersion.

Boron silicates – Usually contain about 13 to 28% B_2O_3 and 80% silicates and have low expansion coefficients, excellent chemical stability. Among the diversified application of these glassesarelaboratory glass wares.

5. Special Glasses – These includes the (1) colour of glass (2) Opal or translucent glass. Colours are produced by the absorption of certain high frequencies by agents in solution in the glass. The colouring agents of this group are the oxides of the transition elements e.g. T, V, Cr, Mn, Fe, Co and Cu.

20. Differentiate between emulsion paint and gloss paint.