THE OPEN UNIVERSITY OF SRI LANKA

B.Sc. DEGREE PROGRAMME 2014/15

INDUSTRIAL CHEMISTRY – CMU3232

CONTINUOUES ASSESSMENT TEST (CATIII) – No Book Test

Duration: one hour

Date: 23rd August 2015 **Time: 1.00 p.m. – 2.00 p.m.**

Answer all the questions.

Registration No: ..... **Invigilator's signature: .....**

Question No	
1.	
2.	
Total	
Average	
%	

1.a. i. What do you understand by the term "petroleum"?

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ii. Briefly describe, by using chemical equations, the inorganic theory that explains how hydrocarbons are formed in petroleum.

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iii. Why inorganic theory is considered as a failure?

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(30 marks)

b. i. What is meant by the term "Refinery Process" of petroleum?

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ii. What is the major technique used to refine petroleum?

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iii. Briefly describe how petroleum is refined.

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(30 marks)

c. i. Distinguish between cracking and reforming.

	Cracking	Reforming
1.		
2.		

ii. Give **three** the factors affecting the rate and efficiency of catalytic reforming.

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(20 marks)

d. i. Briefly describe what is meant by the term 'octane number'?

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ii. Give **four** techniques that can be used in refining process to increase the octane number of gasoline.

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(20 marks)

2.a. What is the major product of each of the following reactions?

i. $CH_4 + H_2O \underset{\text{Steam reforming}}{\overset{\text{Ni}}{\rightleftharpoons}} ? \ldots\ldots + ? \ldots\ldots$

ii. $CH_3{-}CH{=}CH_2 + H_2O \xrightarrow[\substack{150\text{ -}170\ ^{o}C \\ 100\text{ - }250\ atm}]{H_3O^+ / \text{ Catalist}} ? \ldots\ldots$

iii.  $+ H_2 \xrightarrow[\substack{200\ ^{o}C \\ 25\text{ - }40\ atm}]{\text{Ni}} ? \ldots\ldots$

(24 marks)

b. i. What is meant by the term "value addition?"

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(06 marks)

ii. Give **two** value added products from Eppawala phosphate deposit.

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(06 marks)

iii. Pigment grade TiO_2, a value added product of a mineral sand which can be obtained via chloride process. Briefly describe, using chemical equation(s) the chloride process.

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(22 marks)

iv. Give **two** more uses of TiO_2 other than as a pigment.

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(06 marks)

c. i. What do you understand by the term "heavy mineral"?

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(06 marks)

ii. Complete the Table given below by writing the chemical formulae and physical properties of the following heavy minerals.

	Ilmenite	Monozite	Sillimanite
Chemical formula			
Magnetic property			
Extractable metal			

(18 marks)

d. i. Zirconia is a value added product from zircon sand. What are the **three** forms of zirconia?

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(06 marks)

iv. Write down balanced chemical equation for the conversion of zirconium sand to zirconia (zirconium oxide) during fusion with coke at 2800 °C.

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(06 marks)

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The Open University of Sri Lanka
B.Sc Degree Programme – 2014/15

Industrial Chemistry – Level 5

Answer guide to CAT (III)

1.a i. Petroleum means "Rock oil". It is a heterogeneous mixture of hydrocarbons with deferent boiling point

ii. Formation of metal carbides

$Ca + 2C \xrightarrow[\text{High pressure}]{\text{High temperature}} CaC_2$ / $4\,Al + 3C \longrightarrow Al_4C_3$

Action of water on carbides

$CaC_2 + H_2O \longrightarrow Ca(OH)_2 + C_2H_2$

Hydrogenation $C_2H_2 + H_2 \longrightarrow C_2H_4$

Polymerization $3C_2H_2 \longrightarrow C_3H_6$

iii. It fails to account for the presence of chlorophyll. It does not explain the presence of coal deposits in the vicinity of the oil field.

b. i. Crude petroleum contains thousands of deferent hydrocarbons. The refinery process of petroleum is the separation of crude petroleum into various fractions according to boiling point ranges.

ii. Fractional distillation.

iii. Crude oil is preheated to 400-500 ^{0}C

The heated crude oil is passed to fractionating tower /column. Fractionating tower is provided with a large number of horizontal steel trays.

The tower is hot at the bottom and cooler at the upper end.

The highest boiling fractions condense at the bottom

The lower boiling fraction at the top

c i.

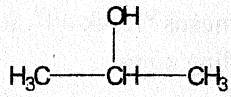
	Cracking	**Reforming**
1	Breaking down of larger molecules to smaller	Changing / rearranging the molecular structure.
2	Quantity / volume of fuel is increased.	Quality /Octane number of fuel increased.

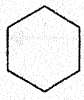
ii. 1.Temperature
2.Pressure
3.Catalyst used
4.Aromatic & naphthalene compound content of feed stock

d.i. It measures fuel's ability to resist knocking as it burns in the combustion chamber of an engine. It is the percentage by volume of iso-octane in the iso-octane - heptane mixture that matches the fuel being tested in a standard test engine

ii

Catalytic reforming	Alkylation	Isomerization
Hydro- forming	Dimerization	Polymerization

2. a. i. $CO + 3H_2$ ii. 

iii. 

b. i. It is a process of changing or transforming a product from its original state to more valuable state.

ii. Single super phosphate

Triple super phosphate

iii. It is a continuous process. It usually requires TiO_2 content > 90% .In the first step conversion of rutile to Ti (IV) chloride

$$TiO_2(s) + 2Cl_2(g) + C(s) \xrightarrow{1000°C} TiCl_4(aq) + CO_2(g)$$

Second step-Oxidation of Ti (iv) chloride

$$TiCl_4(aq) + O_2(g) \longrightarrow TiO_2(s) + 2Cl_2(g)$$

iv.(a) In water treatment (b)In air purification (c) In solar energy

c. i. Those are loose aggregates of unlithified material containing combinations of minerals with high specific gravity above 2.85

ii.

	Ilmenite	**Monozite**	**Sillimanite**
Chemical formula	$FeTiO_3$	$(Ce,La,Th)PO_4$	Al_2SiO_5
Magnetic property	Magnetic	Non-magnetic	Non-magnetic
Extractable metal	Ti	Ce,La,Th	Al

d. i. (1) Monoclinic (2) Tetragonal (3) Cubic

ii. $$2ZrSiO_4 + C \xrightarrow{2800°C} 2ZrO_2 + 2SiO + CO_2$$