



- c. large heat waste  
d. low cost of production
10. Which of the following does not belong to manufactured gases  
a. water gas  
b. nitrogen gas  
c. blast furnace gas  
d. coal gas
11. The principal hydrocarbon compounds in crude oil include all except  
a. paraffins  
b. olefins  
c. naphthenes  
d. aromatics
12. The most important non-hydrocarbon compounds in crude oil include all except  
a. nickel  
b. oxygen  
c. organic sulphur  
d. nitrogen
13. Organosulphur compounds in crude oil may generally be classified as  
a. simple and complex  
b. thiols and thiophenes  
c. sulphides and disulphides  
d. acidic and non-acidic
14. The most important inorganic sulphur compound present in crude oil is  
a. dimethyldisulphide  
b. dimethyl sulphide  
c. mercaptan  
d. hydrogen sulphide
15. Which of the following is not an acid gas treatment method for natural gas  
a. physical adsorption  
b. physical absorption  
c. chemical trisorption  
d. chemisorption
16. Which of the following is not an important test for determining the property of crude oil  
a. pour point  
b. flame test  
c. sulphur content  
d. specific gravity
17. Which of the following is a chemical manufactured from methane  
a. urea  
b. methane gas  
c. LPG  
d. ethanol
18. A refinery that is able to handle multiple types from heavy to light crude is termed as having  
a. large swing  
b. medium swing  
c. low swing  
d. expanded swing
19. What is the basis for classifying refineries as either “sweet” or “sour”?  
a. sulphur content of products  
b. pour point  
c. sulphur content of feedstock  
d. API gravity
20. Which fraction is typically 15–30% crude oil by weight after fractional distillation

- a. gasoline
  - b. kerosene
  - c. full range naphtha
  - d. diesel oil
21. Bitumen and other residues like coke and tar are termed as problematic fuels because of
- a. high production cost
  - b. high viscosity
  - c. high sulfur content
  - d. high environmental discharge
22. What is the percentage of bitumen composition in asphalt concrete pavement material
- a. 75%
  - b. 50%
  - c. 95%
  - d. 5%
23. Typical feedstocks to petrochemical processes include the following except
- a. C<sub>8</sub> compounds
  - b. C<sub>1</sub> compounds
  - c. Aromatic compounds
  - d. C<sub>2</sub> compounds
24. Petrochemicals can be broadly classified as the following categories except
- a. Extra-Heavy Petrochemicals
  - b. Light Petrochemicals
  - c. Heavy Petrochemicals
  - d. Medium Petrochemicals
25. The following processes are termed as the pillars of refinery except
- a. Alkylation
  - b. Reforming
  - c. Blending
  - d. Catalytic Cracking
26. In FCC configuration, the Orthoflow type has its regenerator mounted on top of the reactor.
- a. True
  - b. False
27. The three types of substances that constitute the matrix added to zeolites catalyst include: metal additive, filler and binder.
- a. True
  - b. False
28. To achieve minimum fluidisation velocity, the balance of pressure drop times the cross-sectional area must equal the gravitational forces on the particles' mass.
- a. True
  - b. False
29. Alkylation is catalysed by a strong acid, either sulphuric (H<sub>2</sub>SO<sub>4</sub>) or hydrochloric acid (HCl).
- a. True
  - b. False
30. The research octane number of iso-paraffins and naphthenes increase as the carbon number of the molecule increases.
- a. True
  - b. False
31. Which of the following cannot be classified as chemical conversion process?
- a. Solvent dewaxing
  - b. Delayed coking
  - c. Isomerization
  - d. Visbreaking
32. Crude oils are first desalted and then introduced with steam to which column?

- a. FCC
  - b. Atmospheric Distillation
  - c. Vacuum Distillation
  - d. Catalytic Fractionation
33. The \_\_\_\_\_ is the only physical process where carbon is rejected from heavy petroleum fraction such as vacuum residue.
- a. Solvent Extraction
  - b. Solvent Dewaxing
  - c. Physical Adsorption
  - d. Solvent Deasphalting
34. \_\_\_\_\_ is one of the major processes for the cleaning of petroleum fractions from impurities such as sulphur, nitrogen etc. using hydrogen.
- a. Hydroprocessing
  - b. Hydrogenation
  - c. Hydrotreating
  - d. Hydrocracking
35. Which of the following is the major unit for gasoline production
- a. Fluid catalytic cracking
  - b. Polymerization
  - c. Alkylation
  - d. Crude Distillation
36. The following are thermal and upgrading processes in the refinery except
- a. Delayed Coking
  - b. Hydrocracking
  - c. Flexicoking
  - d. Visbreaking
37. The following are factors which might influence refinery configuration except
- a. feedstock availability
  - b. product conversion
  - c. product markets
  - d. company's strategic objectives
38. Refineries rely on four major processing steps to alter the ratios of the different fractions and these include the following except.
- a. Catalytic Reforming
  - b. Crude Distillation
  - c. Alkylation
  - d. Catalytic Cracking
39. Which unit is termed topping unit and also known as the front-end of the refinery
- a. Crude Distillation
  - b. RFCC
  - c. Polymerization
  - d. Coking
40. The following are effect of poor desalting in crude oil except
- a. Catalysts poisoning
  - b. Fouling in heat exchangers
  - c. Formation of emulsion
  - d. Corrosion of overhead equipment
41. Salt in crude oil exist in the following form
- a. acidic salt
  - b. inorganic salt
  - c. organic salt
  - d. dissolved salt

42. Which of the following is not a step in the salt removal process in crude oil
- Heating
  - Water washing
  - Coalescence
  - Mixing
43. Among the salts present in crude oil which one does not hydrolyze at high temperature to hydrogen chloride
- NaCl
  - MgCl<sub>2</sub>
  - AlCl<sub>3</sub>
  - CaCl<sub>2</sub>
44. Among the salts present in crude oil which is the most abundant
- NaCl
  - MgCl<sub>2</sub>
  - AlCl<sub>3</sub>
  - CaCl<sub>2</sub>
45. For an efficient desalter operation, the following variables are controlled except
- Water level
  - Desalting temperature
  - Water purity
  - Washing water ratio
46. \_\_\_\_\_ is the process of transforming C<sub>7</sub>–C<sub>10</sub> hydrocarbons with low octane numbers to aromatics and iso-paraffins which have high octane numbers.
- Polymerization
  - Catalytic Reforming
  - Isomerization
  - Gasoline Upgrading
47. The main catalyst which is used in an FCC reactor is the
- Zeolite/Platinum type
  - Zeolite type
  - Platinum type
  - Cobalt type
48. The benchmarking indicators for accident reporting are the following except
- lost time accident (LTA) rate
  - LTA severity rate
  - recordable accident rate
  - accident frequency rates
49. Refinery processes include potential hazard risks due to the following except
- excessive operating conditions such as temperature
  - process hazardous material
  - excessive operating conditions such as pressure
  - varied crude oil API handling
50. The following questions are raised in both FTA and HAZOP techniques except

- a. What can happen?
- b. How often can it happen?
- c. How bad will it be?
- d. When can it happen?

**SECTION B (35 MARKS)**  
**ANSWER QUESTION 1 AND 2**

**Q1.** 100,000 BPD of AGO (650–850 °F) produced from the TEN Fields of Ghana, having an API of 22.02 and a sulphur content of 0.305 wt%, is used as a feed to the FCC unit in the refinery. If the cycle stock, that is the unconverted portion below gasoline is 20,000 BPD. Calculate the yield for the FCC Unit: **[20 marks]**

- i. Coke wt%
- ii. LCO LV%
- iii. Gases wt%
- iv. Gasoline LV%
- v. iC<sub>4</sub> LV%
- vi. nC<sub>4</sub> LV%
- vii. C<sub>4</sub><sup>=</sup> LV%
- viii. C<sub>3</sub> LV%
- ix. C<sub>3</sub><sup>=</sup> LV%
- x. HCO
- xi. Wt% S in Gases
- xii. Wt% S in LCO
- xiii. Wt% S in HCO
- xiv. S in Coke
- xv. Gasoline API
- xvi. LCO API

**Q2A.** Calculate the pour point of the following blend? **[8 marks]**

<b>Component</b>	<b>BPD</b>	<b>Pour Point (°C)</b>
Catalytic cracked gas oil	2500	-15
Straight run gas oil	3500	-4
Light vacuum gas oil	5500	44
Heavy vacuum gas oil	1500	46

**B.** What is the aniline point of the following blend? **[7 marks]**

<b>Component</b>	<b>BPD</b>	<b>Aniline point (°C)</b>
Light diesel	4500	73.0
Kerosene	3500	62.5
Light cycle gas oil	3500	35.4

**SECTION C (15 MARKS)**

**ANSWER ONLY ONE QUESTION**

**Q3A.** Explain the operations of crude oil distillation unit in a refinery with the aid of an appropriate diagram. **[12 marks]**

**B.** Explain bi-functional catalyst, using the standard Pt/chlorinated alumina with high chlorine content as an example. **[3 marks]**

**Q4A.** Discuss the role and objective of hydrotreating in refining of crude oil. **[12 marks]**

**B.** State six (6) major products from the crude oil distillation unit. **[3 marks]**

**Table 1 Fluidised Catalytic Cracking Yield Correlations**

Products	Correlation
Coke wt%	$0.05356 \times \text{CONV} - 0.18598 \times \text{API} + 5.966975$
LCO LV%	$0.0047 \times \text{CONV}^2 - 0.8564 \times \text{CONV} + 53.576$
Gases wt%	$0.0552 \times \text{CONV} + 0.597$
Gasoline LV%	$0.7754 \times \text{CONV} - 0.7778$
iC <sub>4</sub> LV%	$0.0007 \times \text{CONV}^2 + 0.0047 \times \text{CONV} + 1.40524$
nC <sub>4</sub> LV%	$0.0002 \times \text{CONV}^2 + 0.019 \times \text{CONV} + 0.0476$
C <sub>4</sub> <sup>=</sup> LV%	$0.0993 \times \text{CONV} - 0.1556$
C <sub>3</sub> LV%	$0.0436 \times \text{CONV} - 0.8714$
C <sub>3</sub> <sup>=</sup> LV%	$0.0003 \times \text{CONV}^2 + 0.0633 \times \text{CONV} + 0.0143$
HCO	$100 - \text{CONV} - (\text{LCO LV}\%)$
Wt% S in Gases	$3.9678 \times (\text{wt}\% \text{ S in feed}) + 0.2238$
Wt% S in LCO	$1.04994 \times (\text{wt}\% \text{ S in feed}) + 0.00013$
Wt% S in HCO	$1.88525 \times (\text{wt}\% \text{ S in feed}) + 0.0135$
S in Coke <sup>a</sup>	$\text{wt}\% \text{ S in feed} - \text{wt}\% \text{ S in gases} - \text{wt}\% \text{ S LCO} - \text{wt}\% \text{ S HCO}$
Gasoline API	$-0.19028 \times \text{CONV} + 0.02772 \times (\text{Gasoline LV}\%) + 64.08$
LCO API	$-0.34661 \times \text{CONV} + 1.725715 \times (\text{Feed API})$

<sup>a</sup> Assuming no sulphur in gasoline

**Blending Correlations:**

- Flash Point Blending

$$\text{BI}_{\text{FP,Blend}} = \sum_{i=1}^n x_{vi} \text{BI}_{\text{FP}i}$$

$$\text{BI}_{\text{FP}i} = \text{FP}_i^{1/\infty}$$

$$\text{BI}_{\text{FP}i} = 51708 \times \exp[(\ln(\text{FP}_i) - 2.6287)^2 / (-0.91725)]$$

- Pour Point Blending

$$\text{BI}_{\text{PP,Blend}} = \sum_{i=1}^n x_{vi} \text{BI}_{\text{PP}i}$$

$$\text{BI}_{\text{PP}i} = 3,262,000 \times (\text{PP}_i/1000)^{12.5}$$

$$\text{BI}_{\text{FP}i} = \text{PP}_i^{1/x}$$

- Aniline Point Blending

$$\text{BI}_{\text{AP,Blend}} = \sum_{i=1}^n x_{vi} \text{BI}_{\text{AP}i}$$

$$\text{BI}_{\text{AP}i} = 1.124[\exp(0.00657\text{AP}_i)]$$