CHAPTER CHEMICAL INDUSTRIES

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INTRODUCTION LONG QUESTION (A) What is importance of chemical industries in Palustan? (Knewledge Base, **Q.1** (B) Explain historical background of industries in Pakistan. IMPORTANCE OF CHEMICAL INDUSTRIES Ans: **(A)** Chemical industries are established to meet the needs of modern societies. (i) Metals: Metallurgy 15 the science of extracting metals form ores. Metals have played a major role in progress of societies. Since ages metals are used for making tools, machines and other items. In the modern age, although polymers have taken the place of metals, yet the importance of metals cannot be ignored. (ii) Polymers: In a number of cases polymers have taken the place of metals. (iii) Baking and Washing Soda: Baking soda (NaHCO₃) and washing soda (Na₂CO₃) are used in daily life for different purposes. (iv) Fertilizers: Fertilizers are vital for the growth and development of plants and crops. One of the important fertilizers urea, is used to enhance the productivity of crops. (v) Petroleum Industry: In the modern age of communication, petroleum industry has a great significance. **Use of Petroleum proudcts:** Petroleum products are used as fuel, solvent and lubricants. Use of petrochemicals: Petrochemicals are used to manufacture a variety of household items, plastics, detergents, rubber etc. HISTORICAL BACKGROUND OF INDUSTRIES Pakistan Industrial Base: Pakistan industrial base was very weak at the time of independence. **Total Industries in India:** At the time of partition, there were 921 big industrial units in India. Pakistan's Share: Out of these only 34 came to the share of Pakistan. Measures Taken to Develop Industry: After the independence, government made a lot of policies and encouraged the • private sector to establish industrial units. • A lot of steps and measures are taken to set up corporations to facilitate loans and technical know-how for the rapid development of industries. Chen ical industry was rabicly developed because the chemicals are used for the manufacturing of a nmunitions, fertilizers and other substances of daily use. Industrial Freducts of Pakistan: Fakistan is now producing a lot of products like: Chemicals Fertilizers Cement Steel Heavy engineering machines and tools.

INTRODUCTION SHORT QUESTIONS How are chemical industries important to us? (Knewledge Base) 0.1 Answer given on Page # 330 (Industrial Products of Pakistan) Ans: Give chemical formulas of baking and washing soda? (Knowledge Base) **O.2** CHEMICAL FORMULAS Ans: The chemical formulas of baking and washing soda are as follows: Baking socia Na HCO3 Washing scda · Na₂CO₃. 10H₂O What was Pakistan's industrial base at the time of independence? (Knowledge Base) Aka)s: PAKISTAN INDUSTRIAL BASE Pakistan industrial base was very weak at the time of independence. **Total Industries in India:** At the time of partition, there were 921 big industrial units in India. **Pakistan's Share:** Out of these only 34 came to the share of Pakistan. MULTIPLE CHOICE QUESTIONS 1. Fertilizer urea is used to enhance: (K.B) (A) Variety of items (B) Both A and C (C) Productivity of crops (D) None of these 2. These are used as fuel, solvent and lubricants: (K.B) (A) Petrochemicals (B) Fertilizers (C) Petroleum products (D) Ores Big industries in India at the time of partition: (K.B) 3. (A) 989 (B) 924 (C) 926 (D) 921 4. How many industries came in share of Pakistan? (K.B) (B) 33 (A) 36 (C) 34 (D) 30 5. Chemical formula of baking soda is: (K.B)(A) NaHCO₃ (B) Na_2CO_3 (C) CaCO₃ (D) Na₂CO₃.10H₂O 6. Chemical formula of washing soda is: (K.B) (B) Na₂CO₃ (A) NaHCO₃ (C) $CaCO_3$ (D) $Na_2CO_3.2H_2O$ (0) **BASIC METALLURGICAL OPERA** 16.1 LONG QUESTION Define the terms. (Knowledge Base) 0.1 (LHR 2015, RWP 2016 G-IL, MTN 2016 G-I, BWP 2016 G-I) (i) Mineral (ii) Ore (iii) Gangue. DEFINITIONS Ans: MINERALS: (LHR 2015, RWP 2016 G-II, MTN 2016 G-I, BWP 2016 G-I) The solia natival materials found beneath the Earth's surface, which contain corruption of metals in the combined state along with earthly impurities, are called minerals". **Examples:** Rocks salt Gypsum •

Q.2

Ans:

(LHR 2015, SWL 2017, RWP 2017, DGK 2016 G-II) **ORES:** "Those minerals from which the metals are extracted commercially at a comparatively low cost with minimum effort are called ores of the metals". All ores of the metals are minerals, but all minerals are not ores **Examples:** Copper glance (Cu₂S) • Chalcopyrite ($CuFeS_2$) GANGUE: (GRW 2014, SGD 2016 G-I) The ear his and other impurities associated with the minerals are known as gangue. Examples: Con Clay Sand Define metallurgy. Describe different steps involved in the metallurgy. (Knowledge+Understanding+Application Base) (DGK 2017, BWP 2017) **METALLURGY Definition:**

"The process of extraction of a metal in pure state on a large scale from its ore by physical or chemical means is called metallurgy".

STEPS INVOLVED

The processes involved in metallurgy for extraction of a metal in the pure state from its ore are:

- (i) Concentration of the ore
- (ii) Extraction of the metal
- (iii) Refining of the metal

(i) Concentration of the Ore:

"The process of **removal of gangue** from the ore is technically known as concentration and the purified ore is called the concentrate".

Methods to Concentrate an Ore:

Concentration of the crushed ore is carried out by the following methods:

(a) Gravity Separation:

(SGD 2016 G-I, MTN 2016 G-D

Gravity separation is based on the differences in densities of the metallic ore and the gangue particles.

Working:

In the process, the powdered heavy motal bearing ore settles down or agitation in a stream of water, while the lighter gangae particles are carried away by the water.



(MTN 2017) (Ex-Q.1)

(b) Froth Flotation Process:

(GRW 2014, 17, SGD 2016 G-ID

"Froth flotation process is based on the wetting characteristic of the cre and the game is particles with oil and water, respectively.²

Working:

The ore particles are preferentially wetted by oil and the gargue particles by the water. The whole mixture is agitated with compressed air. Hence, oil coated particles being lighter come to the surface in the form of a froth that can be skimmed.



(c) Electromagnetic Separation: (LHR 2014; GRW 2014, SGD 2016 G-II, RWP 2016 G-I) Electromagnetic separation is based on the separation of magnetic ores from the nonmagnetic impurities by means of electro-magnets or magnetic separators. Working:

The **powdered** ore is dropped over a leather belt moving over two rollers, one of which is magnetic. The ore gets attracted and is collected nearer to the magnet while the non-magnetic impurities fall further away.



(ii) Extraction of the Metal From the Concentrated Ore:

The metal is isolated from the concentrated one by chemical reduction or electrolytic processes. Chemical methods of reduction of ore involves following methods:

(a) Rossing:

(LHR 2013, SWL 2017)

It is a process of heating the concentrated ore to a high temperature in excess of air. Example:

Copper pyrite (CuFeS₂) is strongly heated in excess of air to convert it into a mixture of cuprous sulphide and ferrous sulphide ($Cu_2S + FeS$). While impurities react with oxygen to form volatile oxides.

$$2\mathbf{CuFeS}_{2(s)} + \mathbf{O}_{2(g)} \longrightarrow 2 \operatorname{FeS}_{(s)} + \mathbf{Cu}_2 \mathbf{S}_{(s)} + \mathbf{SO}_{2(g)} \uparrow$$

(0)

(b) Smelting:

(GRW 2014, 2015, 2016, BWP 2016 G-II, 17, DGK 2016 G-I & II, RWF 2017) (Ex. Q.7). It is further heating the roasted ore with sand flux and coke in the presence of excess of air in a blast furnace.

Process:

It is **highly exothermic process**, therefore a small amount of coke is required in the process. In the process, **first ferrous supplied oxidizes** to rorm ferrous oxide which reacts with sand to form iron silicate slag (FeSO₃). It being lighter rises to the top and is removed from the upper hole.

$$2FeS_{(s)} + 3O_{2(g)} \longrightarrow 2FeO_{(s)} + 2SO_{2(g)} \xrightarrow{\sim} FeO_{(s)} + SiO_{2(g)} \longrightarrow FeSiO_{3(s)}$$

Cuprous sulphide also **oxidizes** to form **cuprous oxide** which reacts with unreacted ferrous sulphide to form ferrous oxide and cuprous sulphide.

Matte:

Cuprous sulphide and ferrous sulphide form a mixture ($Cu_2S.FeS$). This molten mixture is called matte. It is withdrawn from the lower hole. It contains about 45% of copper.

$$\begin{array}{c} 2\mathbf{C}\mathbf{u}_{2}\mathbf{S}_{(1)}+3\mathbf{O}_{2(g)} \longrightarrow 2\mathbf{C}\mathbf{u}_{2}\mathbf{O}_{(1)}+2\mathbf{S}\mathbf{O}_{2(g)} \\ \\ \mathbf{C}\mathbf{u}_{2}\mathbf{O}_{(1)}+\mathbf{FeS}_{(1)} \longrightarrow \mathbf{C}\mathbf{u}_{2}\mathbf{S}_{(1)}+\mathbf{FeO}_{(1)} \end{array}$$



(c) **Bessemerization:**

(GRW 2014 15/ V/L 201(G-I, DGK 2017, MTN 2016 G-I & II, 17, RWP 2017) "It is the further heating of the molton matte in a pear shaped bessemer converter." Bessen er Convertor:

Bessomer converter is the furnace which is used to performed bessemerizaiton. It is fixed on a pixet, so that it can be tilted in any direction.

Process:

Molten matte is mixed with sand and heated with a hot blast of air through tuyers. Ferrous sulphide is oxidized to form ferrous oxide which reacts with sand to form slag (FeSiO₃) that floats on the top.



Blister Copper:

"The molten metal is shifted from the converter to sand moulds and is allowed to cool. The dissolved gases escape out forming blisters on the surface of the solid copper. Therefore, it is called blister copper. It is about 98% pure copper. It is further refined by electrolysis".

(iii) <u>Refining or Purification of the Metal:</u>

(LHR 2015)

L.C.O

Refining the impure metal by electrolysis is the most widely used process of refining metals. **Example:**

Electrolytic refining of copper is carried out in an electrolytic tank.

Electrolytic Cell:

The concentration and working of electrolytic cell is as follows:

Electrode:

There are two copper electrodes:

- <u>Anode:</u> Impure copper metal acts as anode.
- <u>Cathode:</u> Pure copper metal acts as cathode

Both electrodes are suspended in electrolytic solution.

Electrolyte:

Copper subplate solution is used as an electrolyte.

<u>Working:</u>

On passing the electric current through the solution, anode (impure copper) dissolves to prov de Cu^{2+} ions to the solution. These Cu^{2+} ions are discharged by gaining of electrons from the cathode. Thereby copper atoms deposit on the cathode, making it thick block of pure copper metal.

Impurities Obtained:

The impurities like gold and silver settle down as anode mud.



Net Result:

In this process, impure copper from the anode dissolves and goes into the copper sulphate solution. Side by side, pure copper ions from the solution deposit on the cathode. Thus, cathode becomes a pure copper metal. The impurities like gold and silver settle down as anode mud.



	Q.2	What is metallurgy? (Knowle	dge Base)		adin
			(DGK 20)17, FSD 2016 G-II, 17, BWP 2016, G-I	I RWP 2017)
	Ans:	Answer given on Page # 332	0	$1 \pi \pi \Gamma \alpha N V (2)$	100
	Q.3	Describe froth flotation proce	ess. (Znowled	ge+Application Base) GRW 2014-17, FSD 2016 G-I, SW	'L 2016 G-II)
	Ans:	Answer given on Page # 3.3.3	$\langle \langle \langle \rangle$,
	Q.4	Write the formula of copper	lance and c	halcopyrite. (Knowledge Base)	
				(SG	D 2016 G-II)
0	Ans:	VN/0UUU	<u>FORMUL</u>	AS	
$ \rangle$	The formulas of copper glance and chalcopyrite are as follows:				
U	<u> </u>	• Copper glance :	Cu_2S		
		• Chalcopyrite :	CuFeS	2	
	Q.5	What is gangue? Also write c	hemical form	nula of copper glance. (<i>Knowled</i> (GRW 2014, SGD 2016 G-I, RW	ge Base) /P 2016 G-II)
	Ans:	Answer given on Page # 332			
	Q.6	How concentration of ore is d	lone by grav	ity separation and electromagnet	
	Ana	separation: (Knowledge+Ap	рисаноп Ва Гомсемтр/	SE) (DG	(K 2016 G-1)
	Ans:	$\frac{\underline{\mathbf{v}}}{\underline{\mathbf{v}}}$	the followir	a methods:	
		Gravity Separation:		ig methods.	
		In the process, the powdered her	avv metal bea	ring ore settles down on agitation in	a stream of
		water, while the lighter gangue particles are carried away by the water.			
		Electromagnetic Separation:			
		The powdered ore is dropped of	over a leather	belt moving over two rollers, one	of which is
		magnetic. The ore gets attract	ed and is co	ollected nearer to the magnet whi	le the non-
	~ -	magnetic impurities fall further	away.		
	Q .7	Why hair colour of different people is different? (Knowledge Base)			
	Δns•	на		(Interesting Informa)	aon Pg. # 56)
	Ans.	The colour of hair is cuased by	the presence	of transition metal compounds in t	the hair.
		Brown hair contains in	on or coppe	compounds	
		Blonde hair contains c	ompounds of	titanium	C(0)UUU
		• Redhead hair is becau	se of the pres	ei ce of molybienum ocmpounds	10000
		16.1 BASIC ME	PACLOR	GICAL OPERATIONS	
	1		Stephes	EQUESTIONS	
	1.	Science of extracting metals i	rom ores is ((B) Metallurgy	
~	nR	(C) E essemerization		(D) Calcination	
M	ΨN Γ	Blister copper contains: (K.B)		
U)	0 0	(A) 95% pure copper		(B) 99% pure copper	
		(C) 98% pure copper		(D) 92% pure copper	

Y

	3.	Cuprous sulphide oxidizes to form: (K.B)	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
		(A) Cuprous sulphate	(B) Cupric oxide
		(C) Cuprous oxide	(D) Cupric sulphate
	4.	Matte contains% copper: (K	.B)
		(A) 30	
		(C) 40	
	5.	Molten in xture of Cu_2S . FeS is called: (K.)	
		(A) Ore	(B) Matte
		(C) Soil	(D) Petroleum
	6.	First process in volved in metallurgy is: (K	(. <i>B</i>)
3	NN	(A) Latraction of metals	(B) Smelting
$ \rangle$	UU	(C) Froth flotation	(D) Concentration of ore
1	7.	Process based on wetting characteristics o	f ore is called: (K.B)
		(A) Electrolytic separation	(B) Smelting
		(C) Froth flotation	(D) Gravity separation
	8.	Separation of magnetic ore from non mag	netic is called: (K.B)
		(A) Gravity separation	(B) Electromagnetic separation
		(C) Concentrate	(D) Matte
	9.	Brown hair contains: (K.B)	
		(A) Titanium	(B) Molybdenum
		(C) Iron or copper compounds	(D) Alkali metals
	10.	Blonde hair contains: (K.B)	
		(A) Titanium	(B) Molybdenum
		(C) Iron or copper compounds	(D) Alkali metals
	11.	Red hair contains: (K.B)	
		(A) Titanium	(B) Molybdenum
		(C) Iron or copper compounds	(D) Alkali metals
	12.	Process of extraction of metal in pure stat	e is: (<i>K</i> . <i>B</i>)
		(A) Gangue	(B) Gravity separation
		(C) Metallurgy	(D) Electromagnetic Separation
	13.	Process of removal of gangue from ore is a	called: (<i>K</i> . <i>B</i>)
		(A) Concentrate	(B) Metallurgy
		(C) Concentration	(D) Ores
	14.	Minerals are those solid natural materials	which contain: (K.B)
		(A) Compounds of non-metals	(B) Compounds of met ils
		(C) Both A and B	(D) None of these
	15.	Example of ores is:	
		(A) NaHCO ₃	$(B)Cu_2S$
		(C) NaCi	(D) Both B and C
	16.	Cause of color of hair is due to presence o	f:
		(A) Alkali Meta	(B) Halogens
_	ON	(C) Transition element	(D) Noble Gases
N	16/1/	The chemical formula of chalcopyrite is: ((K.B) (GRW 2016)
	00	(A) Cu_2S	(B) CuFeS ₂
		(C) CuS	(D) FeS

16.1 TEST YOURSELF

Define concentration process used in metallurgy of copper. (Knowledge Base) i. Ans:

Definition:

•

Ans:

CONCENTRATION OF ORE

"The process of removal of gangue from the ore is technically known as concentration and the purified ore is called the concert r tte Methods:

Concentration of crushed ore is carried out by following methods:

Gravity separation

Electromagnetic separation

Freth flotation process

Why a small amount of coke is required in the smelting process? (*Knowledge Base*) **USE OF COKE**

A small amount of coke is required in the smelting process because smelting is further heating the roasted ore with sand flux and coke in the presence of excess of air in a blast furnace. It is highly exothermic process. More over the coke initiates the reaction. **Reaction:**

$$2\text{FeS}_{(s)} + 3\text{O}_{2(g)} \longrightarrow 2 \text{ FeO}_{(s)} + 2\text{SO}_{2(g)} \uparrow$$

$$\text{FeO}_{(s)} + \text{SiO}_{2(g)} \longrightarrow \text{FeSiO}_{3(s)}$$

iii. Why lime is added in the smelting process? (*Knowledge Base*) Ans: **ADDITION OF LIME**

Lime $(CaCO_3)$ is added to remove excess of SiO₂. Lime decomposes to form CaO, which reacts with sand to form slag.

 $CaCO_3 \longrightarrow CaO + CO_2$

 $CaO+SiO_2 \longrightarrow CaSiO_{3(Slag)}$

Slag is removed from the upper hole.

How slag and matte are removed from the blast furnance? (Knowledge Base) iv. **REMOVAL OF SLAG AND MATTE** Ans:

Slag:

Slag (FeSiO₃) being lighter rises to the top and forms upper layer, which is removed from the upper hole.

Matte:

Matte is a mixture of cuprous sulphide along with some unreacted ferrous subplifie (Cu₂S.FeS) forms a lower layer. It is withdrawn from the lower hole

What is difference between slag and matte? (Knowledge Ease+Uncerstanding Base) v.

(SGD 2017)

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Ans:
```

DIFFERENTIATIO The differences between slag and matte are as follows:

	THIN OSAN II VAL	Matte
	Defin	iition
- nM	• When Ju: combines with gangue it	• Blast furnace cuprous sulphide and
TNNIN	Will form slag which being lighter in	ferrous sulphide form a mixture
100	weight and floats on the molten metal.	(Cu_2S, FeS) . This molten mixture is
1 -		called matte.
	Den	sity
	• It is lighter than the metal	• It is heavier than the metal

Mention the chemical reaction for the formation of metallic copper in the vi. bessemerization process. (Knowledge Base) Ans: FORMATION OF METALLIC COPPER The chemical reactions for the formation of metallic coppet in the bessenurization process are given as follows: 30₂₍₁₎ >2FeO_(s) - 250_{z(g)} 2FeS + SiQ₂₍₁₎ - \rightarrow Fe SiO_{3(slag)} FeO/ $\rightarrow 2\mathrm{Cu}_{2}\mathrm{O}_{(1)} + 2\mathrm{SO}_{2(g)}$ 2Cu,S 30_{2(g)} - $2Cu_2O_{(s)} + Cu_2S_{(s)} \rightarrow 6Cu_{(1)} + SO_{2(g)}$ What is blister copper? (*Knowledge Base*) Ans: **BLISTER COPPER**

Definition:

"The molten metal is shifted from the converter to sand moulds and is allowed to cool. The dissolved gases escape out forming blisters on the surface of the solid copper. Therefore, it is called blister copper".

Composition:

It is about 98% pure copper. •

Refining:

- It is further refined by electrolysis.
- Why anode is eaten up in electro-refining process? (Understanding Base)

viii. Ans:

EATING UP OF ANODE

The anode is eaten up in electro-refining process becuase impure copper from the anode dissolves and goes into the copper sulphate solution. Side by side, pure copper ions from the solution deposit on the cathode. Thus, cathode becomes a pure copper metal. The impurities like gold and silver settle down as anode mud.

ix. What do you mean by anode mud? (*Knowledge Base*)

Ans:

ANODE MUD

(MTN 2016 G-II)

In electro-refining process, the impurities like gold and silver settle down under the anode and are called anode mud.

16.2 MANUFACTURE OF SODIUM CARBONATE BY SOLVAY'S PROCESS

LONG QUESTIONS

Explain the industrial preparation of soda ash. **Q.1**

(Knovieage+Understanding+Application Base) OR.

Explain Solvay's Process for the manufacture of sodium carbonate. (GRW 2013, LHR 2015, DGK 2017, MTN 2017, SWL 2017, BWP 2016 G-II RWP 2017) OR Write a detailed note on Ammonia Solvay's process.

SOLVAY'S PROCESS

(Ex-Q.3)

Principle:

Principle of Solvay's process lies in the low solubility of sodium bicarbonate at low temperature i.e. at 15° C. When CO₂ is passed through an ammonical solution of NaCl it.

called ammonical brine, only NaHCO₃ precipitates.

$$Na^{+}_{(aq)} + HCO^{-}_{3(aq)} \longrightarrow NaHCO_{3(s)}$$

Raw Materials:

The raw materials needed for this process are cheap and easily available. They are in abundance such as,

- Sodium chloride (NaCl) or brine
- Linestone (CaCO₃)
- Amrion'a gas (NH3)

Basic Reactions/Steps Involved:

The process consists of the following steps:

(i) <u>Preparation of Ammonical Brine:</u>

First of all **ammonical brine** is prepared by dissolving **ammonia gas in sodium** chloride solution (brine).

(ii) <u>Carbonation of Ammonical Brine:</u>

(MTN 2016 G-I)

Ammonical brine is fed **into carbonating tower** and **carbon dioxide** is passed through Following reactions take place in the carbonating tower.

$$CO_{2(g)} + NH_{3(g)} + H_2O_{(l)} \longrightarrow NH_4HCO_{3(aq)}$$
$$NH_4HCO_{3(s)} + NaCI_{(brine)} \longrightarrow NaHCO_{3(aq)} + NH_4Cl$$

The temperature of the mixture is lowered to 15°C and precipitates of NaHCO₃ are obtained.

(iii) <u>Filtration of Precipitates:</u>

The milky solution from the carbonating tower is filtered to get sodium bicarbonate. It is used as a baking soda.

(iv) Calcination:

Sodium **bicarbonate** is heated to get sodium carbonate.

$$2NaHCO_{3(1)} \xrightarrow{heat} Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(1)}$$

 CO_2 is again used in tower. It is about half of CO_2 needed in the process.

(v) <u>Preparation of Carbon Dioxide and Slaked Lime:</u>

CO2 is prepared by heating limestone in a lime kiln. Then it is carried to carbonating lower

$CaCO_{3(s)} \xrightarrow{heat} CaO_{(s)} \xrightarrow{} CO_{2(g)}$

Quick lime (CaO) formed in lime kilr is slaked with water. Then, it is pumped to the ammoria recovery tower.

(slaked lime)

(vi) <u>Ammonia Recovery Tower:</u>

Ammonia is recovered in this tower from **ammonium chloride** solution produced in the carbonated tower and calcium hydroxide formed in lime kiln.

 $2NH_4Cl_{(s)} + Ca(OH)_{2(l)} \longrightarrow 2NH_{3(g)} + CaCl_{2(s)} + 2H_2O_{(l)}$

In fact, all ammonia is recovered in this tower and is reused in the process. There are minor losses of ammonia in the process which are compensated by using some fresh ammonia. Brine Aminonica Carbonating moniating NH₃ Tov er Brine Tower Ki n Lin e NE SCO3 NH₄CI CECC rco, Na₂CO Ammonia Recovery Tower CaO H₂O Steam (Ca(OH) CaCl Figure: Flow Sheet Diagram of Solvay's Process for the Manufacturing of Sodium Carbonate

Advantages of Solvay's Process: (LHR 2014, GRW 2015, BWP 2017, MTN 2017, RWP 2017) The advantages of Solvay's process are as follows:

(i) It is a **cheap process** as raw materials are available at very low prices.

(ii) Carbon dioxide and ammonia are recovered and reused.

(iii)Process is pollution free, because the only waste is calcium chloride solution.

(iv)Sodium carbonate of very high purity is obtained.

(v) Consumption of **fuel** is very less since no solution is to be evaporated.

Q.2 What are the important industries of soda ash in Pakistan? (Knowledge Base)

Ans:

IMPORTANT INDUSTRIES OF SODA ASH

The important industries of soda ash in Pakistan are as follows:

(i) Imperial Chemical Industries (ICI) Khewra (Jhelum):

Pakistan is self-sufficient as far as demand of sodium carbonate is concerned. **Imperial Chemical Industries (ICI)** Khewra (**Jhelum**) is producing enough **sodium carbonate.** This unit was established in 1944 in Khewra because abundant raw material sodium chloride is available here.

(ii) Sindh Alkali Limited:

A Sindh Alkali Limited was established near Karachi in 1966. Sodium carbonate and sodium bicarbonate are important industrial chemicals and are used by many industries.

16.2 MANUFACTURE OF SODIUM CARBONATEBO

Q.1 What de you mean by valcination? (Knowledge Base)

(LHR 2015, MTN 2017, SGD 2016 G-I)

Ans:

CALCINATION

Calcination is a process of thermal decomposition by heating a substance at high temperature below its melting point.

Example:

Sodium bicarbonate is heated to get sodium carbonate in the sovlay's process.

$$2\text{NaHCO}_{3(1)} \xrightarrow{\text{heat}} \text{Na}_2\text{CO}_{3(s)} + \text{CO}_{2(g)} + \text{H}_2O_{(1)}$$

Q.2 Write down two important compounds with their formulae which are used in the manufacture of sodium carbonate. (*Knowledge Base*) (RWP 2016 C-19)

Ans:

Ans:

COMPOUNDS AND THEIR FORMULAS

The two important compounds with their formulae which are used in the manufacture of sodium carbonate are as follows:

- (i) Sodium chloride NaCl
- (ii) Lime tone CaCO₃
- Q.3 What is role of technology in the production of common chemcials? (*Knowledge Bare*) (Science, Technology and Society Pg. # 163)

ROLE OF TECHNOLOGY

"Technology is considered a consequence of science and engineering".

Role:

- Technology began to influence human efforts to produce common chemicals since people began using different tools and machineries.
- Now it is because of use of technology that needs of people are being fulfilled.
- Use of technology has increased the production with improved quality of proudcts.

Examples:

Common chemcials are being produced on commercial scale by chemists or chemical engineers since centrules. Important example are:

- Alkalies
- Salts
- Soaps
- Detergents etc.

16.2 MANUFACTURE OF SODIUM CARBONATE BY SOLVAY'S PROCESS

MULTIPLE CHOICE QUESTIONS

1. Pakistan is self-sufficient for the demand of: (*K*.*B*)

- (A) Sodium carbonate(B) Sodium bicarbonate(C) Sodium chloride(D) Sodium hydroxide
- In Solvay's process, CaCl₂ solution is a material: (K.B)
 - (A) Need
 - (C) Raw Material
- 3. Solvay's process involves recovery and reuse of CO₂ and: (K.B)
 - (A) Amneria

(C) Sodium

(B) Aluminium

(B) Waste Froduct

D) Reactant

(D) NaCl

Sodium hydrogen carbonate decomposes to liberate gas. (K.B)

- $(A) H_2 (B) SO_2$
- $(C) CO_2 (D) N_2$

CON



Give the advantages of Solvay's process. (Knowledge Base) v. (LHR 2014, GRW 2015, SWL 2017 Answer given on Page # 342 Ans: 16.3 MANUEA 0.1 How urea is manufactured on industrial scale? (Enowledge Base) (SWL 2017, SGD 2017, FSD 2017, GWP 2016 G-I) **OR** How urea is manufactured? (SGD 2017, FSD 2016 G-I) **MANUFACTURE OF UREA** Provencies of Urea: Urea is nitrogenous fertilizer. It consists of 46.6% nitrogen. It is white crystalline compound • Highly soluble in water. It is used for the manufacturing of important chemicals, but its major (about 90%) • use is as a fertilizer. **Raw Materials:** (GRW 2015, 17) The raw materials for the manufacturing of urea are: Ammonia (NH₃) Carbon dioxide (CO₂) • Haber's Process: (SWL 2017) Ammonia is prepared by the "Haber's process". One volume of nitrogen (from air) and three volumes of hydrogen (obtained by passing methane and steam over heated nickel catalyst) is passed over iron catalyst at 450°C and 200 atm pressure. $N_{2(g)} + 3H_{2(g)} = 450\% 2NH_{3(g)}$ Nitrogen is taken from air. • Hydrogen is obtained by passing methane and steam over heated nickel catalyst. **Process / Steps Involved:** Manufacturing of urea involves three stages: (i) Reaction of Ammonia and Carbondioxide: Carbon dioxide is passed through liquid ammonia under high pressure to form ammonium carbamate. NHLCOONY $2NH_{2}$ +COAmmonium Carbamate (ii) Urea Formation: (SGD 2017) When ammonium carbamate is evaporated with the help of steam, it dehydrates to form urea. $NH_2COONH_4 \longrightarrow NH_2CONH_2 + H_2O^{\uparrow}$ Ammonium Carbamate (Urea)

(iii)Granulation of Urea:

At this stage, liquid urea is evaporated to form granules. When liquid urea is sprayed from top of a tower under pressure and a hot current of air is introduced from the base it evaporates to form granules.



0.2 What is the importance of urea? Explain its industries in Pakistan. (Knowledge Base) (SGD 2014, LHR 2015, GRW 2017, RWP 2017, SWL 206 G-II, BWP 2016 G-I) Ans:

IMPORTANCE AND STATUS OF UREA

It is white crystalline organic compound. Its importance is because of following usage.

(i) Agriculture Sector:

Urea is widely used world over in the **agriculture sector** both as a **fertilizer** and **animal** feed additive. About 90% of urea is used as fertilizer. It has the highest nitrogen percentage, i.e. much higher than other **nitrogenous fertilizers**. It is harmless and is useful for all types of crops and soils.

(ii) Safe Storage:

It is **non-toxic**, **non-explosive**, therefore, can be stored safely but it is **very soluble** in water and hygroscopic, therefore, storage requires better packing.

(iii) As a Raw Material:

It is used as a **raw material** for the **manufacture** of many important **compounds**.

(iv) To Make Explosives:

It is used to make **explosives**.

(v) Reduction of NO_x Pollutants:

It is used in automobile systems to reduce the NO_x polletants in exhaust gases

INDUSTRIAL UN TS OF UREA

There are about six urea man ifactiving units in Pakistan. The major four are

- Fagi Fertilizer company
- Engro Chemicals
- Fauj fertilizer
- Bin Cesim, Dawood Hercules company

Eu; Fertilizer is the biggest fertilizer manufacturer with 59% market shares.

Subsidy to Promote Urea Manufacturing:

Government provides an indirect subsidy to manufacturers but this industry is still facing supply shortfall problems. The price of urea has grown since the last years.

16.3 MANUFACTURE OF UREA SHORT QUESTIONS What is the importance and status of urea in agricultural sector? (Knowledge Base) 0.1 **Ans:** Answer given on Page # 346 What are industrial units of urea in Pakistan? (I'nowledge Base) **Q.2** Answer given on Page # 345 Ans: Write formula of grea and amonium carbamate. (Knowledge Base) (BWP 2016 G-I) Q.3 FORMULAS Ans: The formulas of urva and ammonium carbamate are as follows: Olica NH₂CONH₂ Ammonium carbamate H₂NCOONH₄ Why fertilizers are added to the soil for crops? (*Knowledge Base*) 0.4 (Interesting Formation Pg. # 165) **ROLE OF FERTILIZERS** Ans: Crops need phosphorus and nitrogen to grow well. Athough, there is 78% nitrogen in air yet it can not be assimilated directly by plants. Therefore, fertilizers are used to provide these essential elements to soil and ultimately plants. MULTIPLE CHOICE QUESTIONS Urea is a fertilizer: (*K*.*B*) 1. (A) Phosphate (B) Nitrogenous (C) Pottasium (D) Sulphar Percentage of nitrogen in urea: (K.B) 2. (A) 46.2 % (B) 48% (C) 41% (D) 46.6% 3. Urea is a compound: (K.B) (A) White-crystalline (B) Transparent (C) Blue crystalline (D) Non crystalline Urea is highly soluble in: (K.B) 4. (A) Toulene (B) Water (C) Benzene (D) CCl_4 5. Urea is used for manufacturing of: (K.B) (A) Crude oil (B) Slaked lime CON (C) Important chemicals (D) None of these Which of the following % age of urea is used as fertilizers? (K.R) 6. (B) 93% (A) 90% (D) 94% (C) 90.4% 7. Ammonia is prepared by: (K,B)(A) Scivay's process (B) Electromagnetic separation (C) Hal et's process (D) Electrolysis Volume of nitrogen in Haber's process is obtained from: (K.B) 8. (A) Water (B) Air (C) Carbon dioxide (D) None of these Nitrogen reacts with hydrogen to form ammonia at: (K.B) (B) 235 atm (A) 250 atm (C) 300 atm (D) 200 atm

10.	Temperature required for the production	of ammonia is: (K.B)	~
	(A) 400°C	(B) 450 °C	
	(C) 425 °C	(D) 500 °C	SIGON
11.	Urea is used to make: (K.B)		
	(A) Fire extinguisher	(E) Explosives	
	(C)Auto nobiles	(D) None of these	
12.	There are no v many mea manufacturing	g units in Pakistan? (K.B)	
5	(A) Six	(B) Nine	
M	(C) Tvelve	(D) Seven	
AN A	The biggest fertilizer manufacturer in Pa	kistan is: (K.B)	
	(A) Engro Chemicals		
	(B) Dawood Hercules compony		
	(C) Bin Qasim		
	(D) Fauji Fertilizers compony		
14.	Fauji fertilizer contributes with market s	hares: (<i>K</i> . <i>B</i>)	
	(A) 55%	(B) 61%	
	(C) 56%	(D) 59%	
15.	The gas prepared by Haber's process is:	(K . B)	(SWL 2017)
	(A) CO ₂	(B) SO ₂	
	(C) HI	(D) NH ₃	
	16.3 TEST Y	OURSELF	
i.	What happens when ammonium carbama	ate is heated with steam? (Ki	nowledge Base)
	(SGD 2017)		
Ans:	HEATING OF AMMONI	<u>UM CARBAMATE</u>	
	When ammonium carbamate is evaporated with	th the help of steam, it dehydrate	es to form urea.
	$NH_2COONH_4 \longrightarrow N$	$H_2CONH_2+H_2O\uparrow$	- 60
	Ammonium carbamate	(Urea)	
ii.	How many stages are involved in the form	nation of ures? (Knowledge I	Base
Ans:	STAGES INV	<u>OLVED</u>	
	Three stages are involved in the manufactur	e of tree	
	• Reaction of ammonia and carbon did	oxide.	
	Urea formation		
The second se	Cranulation of urea.		
	What is the percentage of nitrogen in ure	a? (Knowledge Base)	
Ans:	PERCENTAGE OF NITRO	<u>DGEN IN UREA</u>	
	The percentage of nitrogen in urea is 46.6%).	

ATURAL FERTILIZERS ARE BETTER THAN SYNTHETIC FERTILIZERS

Following are two major types of fertilizers:

- (i) Natural Fertilizers
- (ii) Chemical fertilizers
- (i) Natural Fertilizers:

"Natural fertilizers contain all natural, biodegradable materials from livestock and human waste and foliage of plants".

These materials are decomposed by bacteria. Decomposed materials contain useful nutrient for plants. Organic matter is essential part of fertile soil. Uses of natural fertilizers return the nutrients and organic matter of soil.

Advantages:

The advantages of natural fertilizers are as follows:

- They improve the soil condition to support plant growth.
- They improve the porosity of the soil to make it capable of absorbing water, thus improve crops production.
- They improve the structure of soil which in turn allows more air to get to plant roots.
- The chance of water shortage because of the moisture holding capacity of soil increases.
- Natural fertilizers practically do not contain toxic chemicals. Thus, they do not damage the soil and crops yield increases.

(ii) Chemical Fertilizers:

"Chemical Fertilizers include one or more of the three elements most important for plant nutrition; nitrogen, phosphorus and potastium"

<u>Advantages.</u>

The advantages of chemical feitilizers are as follows:

They release the nutrients very fastly.

<u>Disadvantages:</u>

- Their effects are short lived, so they are required again and again, after short intervals, may be 4 to 6 times in a year.
- Use of synthetic fertilizers may cause over fertilization resulting in burning of plants instead of greening them.

	Ν	ATURAL FERTILIZER: F SHOI	S ARE BETTER THAN SYN ERTILIZERS RT QUESTIONS	
	Q.1	What are natural fertilizers? (1	Knævledge Buse)	(FSD 2017)
	Ans:	Answer given on Page # 349	711(1)[0][0][0][0][0][0][0][0][0][0][0][0][0][
	Q.2	What are disadvantages of cher Answer iver on $Page # 340$	nvical fortnizers? (Knowledge Base)	
	Alls. 0.3	What is fertilizer? (Kno eleage	Base)	
	Ans:	Answer given on Fage # 349		
T	14	MULTIPLE	CHOICE QUESTIONS	
	1.	Natural fertilizers contain natu	ral Bio-degradable from: (K.B)	
		(A) Nitrogen	(B) Phosphorous	
		(C) Livestock	(D) Potassium	
	2.	Chemical fertilizers release ver	ry fastly: (K.B)	
		(A) Minerals	(B) Gases	
		(C) Nutrients	(D) Both A and C	
	3.	Natural fertilizers improve the	structure of: (K.B)	
		(A) Soil	(B) Ores	
		(C) Minerals	(D) Metals	
	4.	Natural fertilizers are decompo	osed by: (K.B)	
		(A) Fungi	(B) Algae	
		(C) Bacteria	(D) Ferns	
	5.	Natural fertilizers practically d	lo not contain: (K.B)	
		(A) Nitrogenous chemicals	(B) Ionic chemicals	
		(C) Non-ionic chemicals	(D) Toxic chemicals	
		16.4 PET	ROLEUM INDUSTRY	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
		LON		a comu
	Q.1	What are the characteristics of	f petroleum? Explain the origin of petroleum? (Wnowlade a	oleurn.
	Ans:	ans: <u>Definition:</u> (Knowledge Base) (GRW 2017)		ng hawing
		water, salis and earth particles w	with it".	ns naving
-	MA	CHARACTE	ERISTICS OF PETROLEUM	
ND	UU	The characteristics of petroleum	are as follows:	1. 1
U	-	 Petroleum 1s a natural pi Detroleum maana nach ai 	roduct found under the Earth's crust trap	pped in rocks.
		 Feuloieum means rock of It is lighter than water and 	a. d is insoluble in it	
		it is ingited than water and		
			CHEMISTRY-10	350

ORIGIN OF PETROLEUM

Petroleum was formed by the decomposition of dead plants and animals burried under earth's crust millions of years ago. It is believed that millions of years ago living plants and animals in the seas died. Their bodies sunk and burried under multiend stand. Then decomposition process took place in the absence of air because of nigh pressure, temperature and bacterial effects This process took millions of years for completion. **Crude Oil:**

Remains of dead plants and animals were converted into dark brownish viscous crude oil. **Trapping of Petroleurn:**

Peticleur was trapped between two layers of impervious rocks.



Being lighter and insoluble in water it floats over the water and forms an oil trap. The gaseous products accumulated over the petroleum are found as natural gas.

Extraction of Petroleum:

(SWL 2016 G-I)

Petroleum is extracted by drilling holes (oil wells) into Earth's crust where the oil is found. When a well is drilled through the rocks, natural gas comes first with a great pressure. For some time crude oil also comes out by itself due to gas pressure. When gas pressure subsides, then crude oil is pumped out.

Refining of Petroleum:

The crude oil is refined in the refineries. Refining process is the separation of crude oil mixture into various useful products (fractions). It is carried out by process called fractional distillation.

Q.2 Write a note on fractional distillation of perroleum. (Knowledge+Understanding+Application Base) OR
(Ex-Q.4) (GRW 2017)

Write a note on refining of crude oil. (GRW 2014, LHR 2013, SGD 2014,13, MTN 2017) <u>FRACTIONAL DISTILLATION</u>

Definition:

"The process of separating a mixture into its fractions by evaporation and condensation on the basis of difference in their boiling points is called fractional distillation".

Principle:

The principle of fractional distillation is based upon separation of substances depending upon their boiling points. The substances having low boiling points boil out first and leave the others behind. There next fraction of slightly higher boiling point boils out. This process remains continue until a residue is left behind. The vapours of each fraction we collected and condensed separately.

<u>Apparatus:</u>

The iraclional distillation of petroleum is carried out in a tall fractionating tower (Oil Refinery).

Steps Involved:

The steps involved in the fractional distillation of petroleum are as follows:

(i) <u>Heating of Crude Oil:</u>

The crude oil is heated in a furnace upto a temperature of 400°C under high pressure.

(ii) <u>Evaporation:</u>

Then vapours are passed through a fractionating column from near its bottom. The hot vapours rise up in the column and gradually cool down and condense.

(iii) <u>Condensation</u>: The vapours of higher boiling point fraction (350-400°C) condense first in the lower part of the tower, while vapours of medium and lower boiling point fractions rise upward in the tower and condense gradually with respect to their boiling points at different levels.



The rule oil is separated into six hydrocarbon fractions.

<u>Deerposition of Single Fraction:</u>

Each fraction is not a single compound. Rather each one is a mixture of hydrocarbons having different number of carbon atoms in it. Each fraction has its specific boiling range, composition and uses.

IMPORTANT FRACTIONS OF PETROLEUM

(GRW 2014, FSD 2016 G-Ta

The important fractions of petroleum, their composition, boiling range ard uses are as follows:

	Name	Composition	Boiling Range	Uses of the literation of the
	Petroleum Gas	C. to S4	up to 25°C	As a fuel, as such in the torm of LPG, used for the production of carbon black (needed in tyre industry) and hydrogen gas (needed to form NH_3 used to manufacture fertilizer).
N	Petroleun Ether	C ₅ to C ₇	30 to 80°C	Used as laboratory solvent and for dry cleaning purpose.
	Gasoline or Petrol	C ₇ to C ₁₀	80 to 170°C	Used as fuel in motor cycles, motor cars and other light vehicles. It is more volatile than kerosene oil. It is also used for dry cleaning.
	Kerosene oil	C ₁₀ to C ₁₂	170 to 250°C	Used as domestic fuel, a special grade of it is used as jet fuel.
	Diesel oil	C ₁₃ to C ₁₅	250°C to 350°C	Fuel for buses, trucks railway engines, tubewell engines and other heavy vehicles.
	Fuel oil	C ₁₅ to C ₁₈	350°C to 400°C	Used in ships and industries to heat boilers and furnaces.

Residual Oil:

Definition:

"The left behind residue obtained after the fractional distillation of crude oil which does not vapourize at 400°C is called residual oil".

Distillation:

The residual oil, which does not vapourize under these conditions is collected and heated above 400° C for further fractional distillation.

Fractions:

The four fractions of residual oil are:

- (i) Lubricants
- (ii) Paraffin wax
- (iii)Asphalt
- (iv)Petroleum coke

16.4 PETROLEUM INDUSTRY

SHORT QUESTIONS

That is connection of diesel fuel sold in summer and winter? (*Knowledge Base*) (Interesting Information Pg. # 170)

COMPOSITION OF DIESEL FUEL

The diesel fuel sold in winter is different mixture of hydrocarbons from the mixture sold in summer. This is because diesel sets rather like Vaseline at a little below 0°C and will not work as a fuel. More of the lighter fractions are added in winter to prevent this.

L(C(O)



(LHR 2015, GRW 2016 G-II, MTN 2016 G-I)

13. Which fraction of petroleum is used in ships and industries as fuel? (K.B) (A) Petroleum gas (C) Diesel oil
(B) Petrol (D) Fuel oil
16.4 TEST YOURSELF

i. Define petroleum (Knowledge Base)

Ans:

<u>Definition.</u>

The a complex mixture of several gaseous, liquid and solid hydrocarbons having water, salts and soil particles with it."

FETROLEUM

Characteristics:

- The petroleum is a natural product found under the Earth's crust trapped in rocks.
- Petroleum means "rock oil".
- It is lighter than water and is insoluble in it.

ii. How petroleum is extracted? (Knowledge Base)

(LHR 2015)

Ans:

EXTRACTION OF PETROLEUM

Petroleum is extracted by drilling holes (oil wells) into Earth's crust where the oil is found. When a well is drilled through the rocks, natural gas comes first with a great pressure.

For some times crude oil also comes out by itself due to gas pressure. When gas pressure subsides, then crude oil is pumped out.

iii. What is principle of fractional distillation? (*Knowledge Base*) (SWL 2016 G-I)

Ans:

PRINCIPLE OF FRACTIONAL DISTILLATION

The principle of fractional distillation is based upon separation of substances depending upon their boiling points. The substances having low boiling points, boil out first and leaving behind other. Then next fraction of slightly higher boiling point boils out. This process remains continue until a residue is left behind.

iv. In how many fractions crude oil is separated? (Knowledge Base)

Ans:

FRACTIONS OF CRUDE OIL

The crude oil is separated into six fractions.

- (i) Extroleum gas
- (ii) Petroleann (ether)
- (iii) Gasoline (petrol)
- (iv) Kerosene oil
- (v) Diesel oil
- (vi) Fuel oil

(FSD 2016 G-I)

Residual oil is another left behind residue of fractional distillation of petroleum.

v. What do you mean by a fraction of petroleum? (*Knowledge Base*)

Ans:

FRACTION OF PETROLEUM

Fraction of petroleum means a par of petroleum. Each fraction is not a single compound rather each one is a mixture of hydrocarbons having different number of carbon atoms in it. Each fraction has its specific boiling range, composition and uses.

DIFFERENT TYPES OF ERE REQUIRE DIFFERENT METHODS

LONG QUESTIONS

What are the things needed to start and sustain fire? Describe methods to put outfire. (Knowledge Base)(Science, Technology and Society Pg. 170)

Ans:

Q.1

THINGS TO START AND SUSTAIN FIRE

The things needed to start and sustain fire are as follws:

(i) <u>Fuel:</u>

The substance that burns in the combustion process, e.g. wood, oil and electricity.

(ii) <u>Heat:</u>

The energy component of the fire when it comes in contact with fuel, it provides the energy necessary for ignition and sustaining combustion process.

(iii)Air (Oxygen):

It is essential component for combustion process.

Self Sustained Chemical Chain Reaction:

"A self sustained chemical chain reaction is a complex reaction that requires fuel, oxygen and heat energy to come together in a very specific way".

METHODS TO PUT OUT FIRE

Fire can be put out by taking away any of the components like fuel, heat and air (oxygen). When fuels are different, they require different techniques to put them out.

(i) <u>Wood Fire:</u>

Wood fire can be extinguished by throwing water on it. Water uses large amount of reat for evaporation process, so it absorbs huge amount of heat and derrive the wood tire of heat and it is not possible for fire to be sustained.

(ii) Oil Fires:

Oil fir s can' be pur cut with water because oil and water do not mix. Oil being lighter than water, fleats and spreace over it. The fire also spreads along with water. To put out oil fire, oxygen needs to be cut off. This can be controlled by throwing sand, table salt or backing socia on the flames.

(iii)<u>Electric Fire:</u>

Electric fire is much stronger than other fires because its source of heat is electrical energy. It requires cut off oxygen supply to put it out. Oxygen supply can be controlled

by using fire extinguishers. DIFFERENT TYPES OF FIRE REQUIRE DIFFEREN TO EXTINGUISH What is self sustained chemical chain reaction? (Kno vledge Base) 0.1 Answer given on Page # 356 Ans: Q.2 Name the things needed to start and sustain fire? (Knowledge Base) Ans: THINGS TO START AND SUSTAIN FIRE he things needed to start and sustanin fire are: Fuel Heat Air (oxygen) **MULTIPLE CHOICE QUESTIONS** Which fire could be extinguished by water? (*K*.*B*) 1. (B) Oil fire (A) Wood fire (D) Fat fire (C) Electric fire 2. Which fire is the strongest of all? (*K*.*B*) (A) Wood fire (B) Oil fire (C) Electric fire (D) Fat fire Which fire can not be extingiushed with water? (*K*.*B*) 3. (A) Wood fire (B) Oil fire (D) Both A and C (C) Electric fire The energy necessary for ignition and sustaining combustion process is provided by: 4. (K.B)(A) Fuel (B) Heat (C) Air (D) Oxygen To put out oil fire needs to be cut off. (K.B) 5. (A) Oxygen (B) Nitrogen (C) Hydrogen (D) Carbondioxide **CHEMISTRY AS A CAREER IN INDUSTRY** LONG QUESTIONS **Q.1** Write a detailed note on chemistry as a career in industry. (Knowledge Base) (Science Technology and Society Pg. 170) CHEMISTRY AS A CAPTER IN INLUSTRY Ans: Chemist: By studying chemistry, one can be a professional chemist. Functions of a Chemist: He studies the composition and properties of available chemicals. He cevelor's methods to manufacture new substances on commercial scale to need the needs of society. He designs and develops instruments and techniques to make the production more and more economical.

Career of a Chemist:

Chemists can have working opportunities in almost all fields of industry depending

upon their areas of specialization.

(i) Organic Chemists:

Organic chemists have career in pharmaceutical, petroleum, petrochemicals, connetics, polymers and plastic industries.

(ii) Inorganic Chemists:

Inorganic chemists work in:

- Metallurgical industries
- Marufacturing industries like textile, cement, sugar
- Chernicals
- Manufacturing plants like fertilizer, acids and caustic soda.

(iii)Physical Chemists:

Physical chemists have working opportunities in energy transformation industries. They develop new and better energy sources. They explore renewable energy fields.

(iv) Analytical Chemists:

Analytical chemists work in almost all fields of industry.

- They identify the materials, measure their quantities and control the quality of the products.
- They evaluate the efficiency and devise techniques to enhance the production.
- They have working scope from food and beverage industry to paints and varnish industry.
- They work even in generating units.

(v) Other Types of Chemists:

The other types of chemists are:

- Biochemists
- Food chemists
- Material chemists etc.

CHEMISTRY AS A CAREER IN INDUSTRY SHORT QUESTIONS

Q.1 Good communication skills promote the sale while poor communication skills often result in inefficiency. (*Knowledge Base*) (Science, Technology and Society Pg. # 171)

Ans:

COMMUNICATION

Definition:

"Communication is the exchange of information to others through audio, video, print or electronic media".

Good Communication Skills:

Good communication skills help to ensure the efficient operation of all levels of an organization, from lowest to highest

Poor Communication Scills:

Poor communication skills often result in inefficiency. Successful business leaders know, arefficiency equals a loss of productivity and consequently, a loss of profits.

Moreover, communication can make the difference between success and failure for a company. Therefore, in the field of chemical industry good communication skills are also vital.

Q.2 What is the work of an inorganic chemist? (*Knowledge Base*)

Ans: Answer given above.







	EXERCI	SE SOLUTION	- 10
	MULTIPLE CI	HOICE QUESTIONS	e) COV
4			0100
1.	Concentration is a: (K.R)	(GI:\W 2014, SGD 2017,	FSD 2016 G-I,II)
	(a) Mixing technique	(b) Separating technique	
2	(c) Bolying technique	(d) Cosing technique (K, B)	(GCD 2017)
Z.	(a) Deputy basis	(h) Concentration basis	(SGD 2017)
	(a) Motting basis	(d) Magnetic basis	
ND	(c) we thig task $M_{\rm D}$ is a mixture of (KB)	(u) Wagnetic Dasis	4 15 SWI 2017)
1NN	(a) FeS and CuS	(b) $Cu_{2}O$ and FeO	4,15, 5 WL 2017)
09	(a) ΓCS and CuS	(d) CuS and FeO	
4	In the bessemerization process: $($	$(\mathbf{K} \mathbf{R})$	
ч.	(a) Roasted ore is heated	(b) Molten matte is removed	
	(c) Molten matte is heated	(d) Molten matte is added	
5	Concentration of the conner ore	is carried out by: (K B)	
	concentration of the copper ore	(LHR 2013, GRW 2	013. RWP 2017)
	(a) Calcinations	(b) Roasting	- , ,
	(c) Froth flotation	(d) Distillation	
6.	When CO ₂ is passed through the a	mmonical brine the only salt that p	recipitates is: (K.B)
	(a) NaHCO ₃	(b) NH_4HCO_3	
	$(c) Na_2 CO_4$	(d) $(NH_4)_2 CO_2$	
7	In Solvay's process slaked lime i	s used to: (KR)	
<i>.</i>	(a) Prepare CO ₂	(b) Prepare quick lime	
	(c) Recover ammonia	(d) Form Na ₂ CO ₃	
8.	When NaHCO ₂ is heated it form	s: (K.B)	(DGK 2017)
	(a) CO ₂	(c) $CaCO_3$	(20112017)
	(b) NH_2COONH_2	(d) CaO	
9.	Formula of urea is: (K.B)	(GRW 2013, LHR 201	3,14, SGD 2017)
	(a) NH ₂ COONH ₄	(b) NH ₂ COONH ₂	
	(c) NH_2CONH_4	(d) NH ₂ CONH ₂	2 200
10.	Crude oil is heated in the fractiona	ating furnace upto: (K.B)	2) (C(U)U
		(MTN 2016 7-1 17, FSD 2016 G-I	C. SWI (2016 G-I)
	(a) 300°C	(b) 3.50°C	
	(c) 400°C	(d) 450°C	
11.	When crude oil is heated in the fra	ctionating tower: (K.B)	
	(a) Vapeurs of higher boiling point f	iaction condense first in the lower par	t of the tower
	(b) Vapours of lower boiling point fi	action condense first in the lower part	of tower
~	(c) Vapcurs of higher boiling point c	condense later in the upper part of towe	er
	(c) Vapours of higher boiling point r	never condense	
UAL)	Which one of the following is used	as jet fuel? (K.B)	
<u></u>	(a) Kerosene oil	(b) Lubricating oil	



 $2\mathrm{CuFeS}_{2(\mathrm{s})} + \mathrm{O}_{2(\mathrm{g})} \longrightarrow 2 \operatorname{FeS}_{(\mathrm{s})} + \mathrm{Cu}_2 \mathrm{S}_{(\mathrm{s})} + \mathrm{SO}_{2(\mathrm{g})} \uparrow$

4. Explain process of electro-refining. (Knowledge+Application Base)

(FSD 2016 G-I, SGD 2016 G-II, MTN 2016 G-II, DCK 2016 G-IM

- Answer given on Page # 335 Ans:
- 5. What are advantages of Solvay's process? (Knowledge Base)

(DGK 2016 G-II, 17, FSD 2016 G-I, LHF 2014 GRW 2015, SWL 2017 MIN 2016 G-II)

Ans.

- ADVANTA CES OF SOLVAY'S PROCESS
- The advantages of Solvay's process are as follows:
- (i) It is a cheep process, as raw materials are available at very low prices.
- (ii) Carbon dickide and an monia are recovered and reused.
- (iii) Socium carbonate of very high purity is obtained.

(iv) It is pollution free because the only waste is calcium chloride solution.

(v) Consumption of fuel is very less since no solution to be evaporated.

What is the principle of Solvay's process? (*Knowledge Base*)

(SWL 2016 G-II)

Ans:

PRINCIPLE OF SOLVAY'S PROCESS

Principle of Solvay's process lies in the low solubility of sodium bicarbonate at low temperature i.e., at 15^{0} C. When CO₂ is passed through an ammonical solution of NaCl called ammonical brine only NaHCO₃ precipitates.

$$Na^{+}_{(aq)} + HCO^{+}_{3(aq)} \longrightarrow NaHCO_{3(s)}$$

7. What happens when ammonical brine is carbonated? (*Knowledge Base*)

Ans:

CARBONATION OF AMMONICAL BRINE

When CO_2 is passed through an ammonical solution of NaCl called ammonical brine only NaHCO₃ precipitates. Following reactions take palce in the carbonating tower.

$$CO_2 + NH_3 + H_2O \longrightarrow NH_4HCO_{3(aq)}$$

 $NH_4 + HCO_3 + NaCl \longrightarrow NaHCO_3 + NH_4Cl_{(au)}$

 $CO_2 + NH_3 + H_2O + NaCl \longrightarrow NaHCO_{3(s)} + NH_4Cl_{(aq)}$

 $Na^{+}_{(aq)} + HCO^{-1}_{3(aq)} \longrightarrow NaHCO_{3(s)}$

The temperature of the mixture is lowered to 15°C and precipitates of NaHCO₃ are obtained.

8. How NaHCO₃ is converted to Na₂CO₃? (*Knowledge Base*)

2NaHCO

(GRW 2014, SGD 2017, DGK 2016 G-II)

Ans:

CONVERSION OF NaHCO₃ TO Na₂CO₃

By heating sodium bicarbonate (NaHCO₃), it can be converted into sodium carbonate (Na_2CO_3) . This process is called calcination.

$$2NaHCO_{(1)} \xrightarrow{\ } Na_2CO_{3(s)} + CO_{(g)} + H_2O_{(1)}$$

9. How amnonia is recovered in the Solvay's process: (*Knowledge Base*)

(LHR 2014, 2015)

Ans:

MMONIA RECOVERY

Ann onia is recovered in ammonia recovery tower from ammonium chloride soul or produced in the carbonated tower and calcium hydroxide formed in lime kiln.

$$2NH_4Cl_{(s)} + Ca(OH)_2 \longrightarrow 2NH_{3(g)} + CaCl_2 + 2H_2O$$

In fact, all ammonia is recovered in this tower and is reused in the process.

(GRW 2014, SWL 2016 G I

10. How ammonia is prepared for the synthesis of urea? (Knowledge Base)

+3N

Ans.

PREPARATION OF AMMONIA

Ammonia is prepared by the "Haber's process" One volume of mirogen (from air) and three volumes of hydrogen (obtained by passing methane and steam over heated nickel catalyst) is passed over iron cut ityst at 450°C and 200 and pressure $450^{\circ}C \rightarrow 2NH_{3(g)}$

200 atm

Describe the form a ion of petroleum. (Knowledge Base) 11. FORMATION OF PETROLEUM Ans:

(LHR 2015, MTN 2017)

(FSD 2016 G-I)

Organic Theory:

According to the organic theory, millions of years ago living plants and animals in the seas died. Their bodies sank and burried under mud and sand. Then decomposition process took place in the absence of air because of high pressure, temperature and bacterial effects. This process took millions of years for completion. Thus, remains of dead plants and animals were converted into a dark brownish viscous crude oil.

What is refining of petroleum and how it is carried out? (Knowledge Base) 12.

Ans:

REFINING OF PETROLEUM

"Refining process is the separation of crude oil mixture into various useful products (fractions)."

Method:

It is carried out by a process called "fractional distillation". Fractional distillation is the process of separating a mixture into its fractions on the basis of differences in their boiling points by evaporation and condensation.

13. Give a use of kerosene oil. (Knowledge Base)

(MTN 2016 G-II, 17, GRW 2017, BWP 2016 G-I, 17, SGD 2017)

Ans.

USE OF KEROSENE OIL

Kerosene oil is used as domestic fuel, a special grade of it is used as jet fuel.

Describe the difference between diesel oil and fuel oil. (Knowledge Base) (LHR 2013) 14. DIFFERENTIATION

Ans:

The differences between diesel oil and fuel oil are as follows:

	Diesel Oil	Fuel Oil	- 100
	Number of C	arbons Atoms	0)[[[[
	• The number of carbon atoms in diesel oil ranges from C ₁₃ to C ₁₅	• The number of carbon alons in the off ranges from C_{15} to C_{18} .	
	Its boiling range is 250°C to 350°C	 Kange Its boiling range is 350°C to 400°C. 	
	U.	Ses	
1 A	• It is used as fuel for buses, trucks, railway engines, ships etc.	• It is used in industries to heat boilers and furnace.	
			i

15.	Write down the names of four fractions obtained by the fractional distillation of	
	residual oil. (<i>Knowledge Base</i>)	(SWL 2016 G 13)
Ans	ns: <u>FRACTIONS OF RESIDUAL OIL</u>	
	The four fractions obtained by the fraction	al distillation of residual all are:
	• Petroleum gas	
	• Petroleum ether	
	 Dicsel oil Fuel oil 	
16.	What is the difference between crude of	l and residual oil? (Knowledge Base)
0	NALIUU	(BWP 2017, SGD 2016 G-II, 17)
	DIFFERENT	<u>CIATION</u>
101	The difference between crude oil and resid	lual oil are as follows:
0	Crude Oil	Residual Oil
	Defini	tion
	• It is dark brownish viscous liquid which	The left behind residue of crude oil
	is formed by decomposition of dead	when it is heated at 400°C under high
-	plants and animals in absence of air	pressure.
_	Products of	Distillation
	• It gives residual oil on fractional	• On heating at 400°C it gives further
	Distillation.	four fractions:
		(i) Lubricants (ii) Parrafin wax
		(iii) Asphalt (iv) Petroleum coke
17.	Which petroleum fraction is used in dry	cleaning?
	(LH	R 2013, SGD 2016 G-I, II, FSD 2017 MTN 2016 G-II)

Ans:

PETROLEUM FRACTION USED IN DRY CLEANING

Gasoline or petrol and petroleum ether is used in dry cleaning.

EXTENSIVE LONG QUESTIONS

- Q.1 Describe in detail the various processes involved in the concentration of ore. Explain your answer with the help of diagrams.
- **Ans:** See LQ. 2 (Topic 16.1)
- Q.2 Explain the process of roasting with reference to copper.
- **Ans:** See LQ.2 (Topic 6.1)
- Q.3 Write a detailed note on Ammonia Solvay's process.
- **Ans:** See LQ.1 (Topic 16.2)
- Q.4 Write a note on fractional distillation of petroleum.
- Ans: See LQ.2 (Topic 16.4)
- Q.5 How user is manufactured? Explain showing the flow sheet diagram.
- Ans: See LQ.1 (Topic 15.3)
- Q.6 How crude oil is refined? Explain two important fractions of petroleum along with their usage.
- **Ans:** See LQ.2 (Topic 16.4)
- Q.7 Write a note in detail on smelting and bessemerization, giving a specific example.
- **Ans:** See LQ.2 (Topic 16.1)

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ADDITIONAL CONCEPTUAL QUESTIONS

Q.1 What is meant by flux?

- Ans: A substance introduced in smelting process to promote flaidity and to remove impurities in form of slag.
- Q.2 What is difference between mineral and ore? (K.P) (SGD 2016 G-II)

Ans:

DIFFE RENTLATION

The differences between mineral and ore are as follows:

~ A	1 \ \\\Muerse	Ore
<u>NVIN</u>	Defi	nition
U Th ben con con imp	he solid natural materials found neath the Earth's surface, which ntain compounds of metals in the nbined state along with earthly purities, are called minerals".	• "Those minerals from which the metals are extracted commercially at a comparatively low cost with minimum effort are called ores of the metals".
	Na	ture
• All	minerals are not ores.	• All ores of the metals are minerals.
	Exa	mples
• Ro	cks salt, hematite, gypsum etc.	• Ores of copper are; copper glance (Cu ₂ S) and chalcopyrite (CuFeS ₂).

 Q.3
 Describe the difference between gasoline and kerosene oil. (Knowledge Base)

 Ans:
 <u>DIFFERENTIATION</u>

Gasoline	Kerosene
Number of Ca	arbons Atoms
• The number of carbon atoms in diesel	• The number of carbon atoms in fuel oil
oil ranges from C_7 to C_{10} .	ranges from C_{10} to C_{12} .
Boiling	Range
• Its boiling range is 80° C to 170° C	• Its boiling range is 170° C to 250° C
• Used as fuel in motor cycles, motor	• Used as domestic fuel, a special grade
cars and other light vehicles. It is more	of it is used as jet fuel.
volatile than keresene oil. It is also	
used for try cleaning.	
9.0	·

	Terms	Definitions	יחחומ				
		The solid natural materials found beneath the Earth's surface which	5				
	Minerals	contain compounds of metals in the combined state (long with earthly					
		impurities, are called minerals.					
	21	Those runerals from which the metals are extracted commercially at a					
	Ores	comparatively low cost with minimum effort are called ores of the					
		metals.					
N	Gangue	The earthly and other impurities associated with the minerals are known					
		as gangue.					
	Metalluray	The process of extraction of a metal in pure state on a large scale from its					
	wietanurgy	ore by physical or chemical means is called metallurgy.					
	Concentrate	The process of removal of gangue from the ore is technically known as					
		concentration and the purified ore is called the concentrate.					
	Gravity	Gravity separation is based on the differences in densities of the metallic					
	Separation	ore and the gangue particles.					
	Froth Flotation	Froth flotation process is based on the wetting characteristic of the ore					
	Process	and the gangue particles with oil and water, respectively.					
	Electromagnetic Separation	Electromagnetic separation is based on the separation of magnetic ores					
		from the non-magnetic impurities by means of electro-magnets or					
		magnetic separators.					
	Roasting	It is a process of heating the concentrated ore to a high temperature in					
		excess of air.					
	Smelting	It is further heating the roasted ore with sand flux and coke in the					
		presence of excess of air in a blast furnace.	_ran				
2	Bessemerization	It is the further heating of the molten matte in a pear shaped bessering))[[[[[
		converter.					
	Blister Copper	The molten metal is shifted from the converter to said moulds and is					
		allowed to cool. The discolved gases escape out forming blisters on the					
		surface of the solid copper. Therefore, it is called blister copper. It is					
		about 98% pure copper. It is further refined by electrolysis.					
	Ekotrolytic	Refining the impure metal by electrolysis is the most widely used process of					
	Nethrung of	refining metals.					
	Metal						
	Matte	During smelting of copper ore cuprous sulphide and ferrous sulpide form					

Concentration The process of removal of gangue from the ore is technically known so concentration and the purified are is called the concentrate. Slag When flux combine with generation is all form that which being lighter in weight and foots or the noteen metal. Principle of solvary freeses in the low solubility of sodium becathoring to weight and more solvary process rises in the low solubility of sodium becathoring is owned as a mamonical solution of NaCl called animonical brine, only NaHCOs precipitates. Technology Technology is considered a consequence of science and engineering. Fertilizer Fertilizer is a substance added to soil to improve plants growth and yield. Natural Natural fertilizers contain all natural, biodegradable materials from Fertilizers Inportant for plant nutrition; nitrogen, phosphorus and potassium. It is a complex mixture of several gaseous, liquid and solid hydrocarbons having water, salts and earth particles with it. Fractional The process of separating a mixture into its fractions by evaporation and condensation on the basis of difference in their boiling points is called fractional distillation Self Sustained A self sustained chemical chain reaction is a complex reaction that requires fuel, oxygen and heat energy to come together in a very specific way. Communication Communication is the exchange of information to others through acadive video, print or electronic media. Diesal Oil The number of carbon utoms in preselfoil langes from C ₁₃ to C ₁₅ . <th>-</th> <th></th> <th>a mixture (Cu₂ S .FeS). This molten mixture is called matte.</th>	-		a mixture (Cu ₂ S .FeS). This molten mixture is called matte.			
Concentration concentration and the purified are is called the concentrate. Slag When flux combine with gasgie if will form that which being lighter in weight and floats or the upoten metal. Principle of solvaix process fies in the low solubility of sodium bear brince is an ammonical solution of NaCl called ammonical brine, only NaHCOs precipitates. Technology Technology is considered a consequence of science and engineering. Fertilizer Fertilizer is a substance added to soil to improve plants growth and yield. Natural Natural fertilizers contain all natural, biodegradable materials from fertilizers Ivestock and human waste and foliage of plants. Chemical Fertilizers include one or more of the three elements most fertilizers important for plant nutrition: nitrogen, phosphorus and potassium. Ptroleum It is a complex mixture of several gaseous, liquid and solid hydrocarbons having water, salts and earth particles with it. Fractional The process of separating a mixture into its fractions by evaporation and condensation on the basis of difference in their boiling points is called fractional distillation. Residual Oil Oil which does not vapourize at 400°C is called residual oil. Self Sustained A self sustained chemical chain reaction is a complex reaction that requires fuel, oxygen and heat energy to come together in a very specific way. Communication Communication is the exchange of information to others drough acdio video, print or electron		Concentration	The process of removal of gangue from the ore is technically known as			
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Image: Self Sustained Residual Oil The left behind residue obtained after the fractional distillation of crude oil which does not vapourize at 400°C is called residual oil. Self Sustained Chain Reaction A self sustained chemical chain reaction is a complex reaction that requires fuel, oxygen and heat energy to come together in a very specific way. Communication Communication is the exchange of information to others shrough acade, video, print or electronic media. Diesal Oil The number of carbon stops in creation is a receptor C ₁₃ co C ₁₅ .			condensation on the basis of difference in their boiling points is called			
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Self Sustained A self sustained chemical chain reaction is a complex reaction that requires fuel, oxygen and heat energy to come together in a very specific way. Communication Communication is the exchange of information to others through audio. video, print or electronic media. Diesal Oil The number of carbon utoms in desel oil ranges from C ₁₃ to C ₁₅ .		Residual Oil	The left behind residue obtained after the fractional distillation of crude			
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Diesal Oil The number of carbon atoms in d esel oil ranges from C ₁₃ to C ₁₅ .			video, print or electronic media.			
WWW. SILMARKICOLOGICO		Diesal Oil	The number of carbon stoms in a casel of ranges from $C_{13} \approx C_{15}$.			

st	Chapter-16		Chemical Industry			
CUT HERE	 SELF TEST Time: 35 Minutes Q.1 Four possible answers (A), (B), (C) and (D) to each question are given, mark the correct answer. (o×1=6) 1. Red hair contains: (A) Titepian compounds (B) Molyodenum compounds (D) Alkali metals 					
W	2.	Exist :r copper contains pure copper: (A) 95% (C) 98%	(B) 99% (D) 92%			
	3.	Formula of urea is:				
		(A) NH ₂ COONH ₄	(B) NH ₂ COONH ₂			
I.		(C) NH ₄ CONH ₂	(D) NH ₂ CONH ₂			
	4.	Temperature required for the production	of ammonia is:			
i		(A) 400°C	(B) 450°C			
I.		(C) 425°C	(D) 500°C			
	5.	Fauji fertilizers contributes market shares:				
i		(A) 55%	(B) 61%			
I.		(C) 56%	(D) 59%			
	6.	Composition of petroleum ether is:				
		(A) C_2 to C_{10}	(B) C_5 to C_7			
I.		(C) C ₁₃ to C ₁₅	(D) C to C_4			
	Q.2 Give short answers to the following questions. (5×2=10)					
i	(i)	What do you mean by gangue?				
I.	(ii)	What is the difference between slag and matte?				
	(iii)	Give reaction for the formation of amonia?				
i	(iv)	What do you mean by calcination?				
I.	(v)	What is the phinciple of solvity's process?				
	Q.3	Answer the following questions in detail.		(5+4=9)		
NAR	MAN	Write a note on a superfraction along with diagram	m?	(5)		
99	VI) ~	write a note on manufacture of urea.	thain annomiaian in and-sta	(4)		
I	NUIE	of students.	in ment supervision in order to	check the Skill		