

(64) 20-11-23

Code (15) 2004

(21)

Nov-23

ENGINEERING CHEMISTRY -II

Scoring Indicators

QNo	Key	Split score	Total score
I 1.	<u>Polymer</u> - <u>Monomer</u>		
	(a) Polythene - Ethene	1/2	
	(b) PVC - Vinyl Chloride	1/2	
	(c) Buna-S - 1,3 Butadiene styrene	1/2	2
	(d) Nylon-66 - Adipic acid Hexamethylene diamine	1/2	
2.	No two electrons in an atom can have the same set of four quantum numbers	2	2
3.	Electrolytes that dissociate when dissolved in water almost completely into ions even at moderate concentrations Ex: HCl, HNO <sub>3</sub> , H <sub>2</sub> SO <sub>4</sub> (any 2)	1 1	2
4.	1) Optical fibre is immune to electromagnetic interference 2) light can be kept within the fibre by the phenomenon of total internal reflection (any two)	1 1	2

5.	Pesticides, herbicides, Insecticides } fertilisers, chemicals & oil } any two	1 1	2	
<u>PART-B</u>				
II 1a	<u>Saturated Compound</u>			
	⇒ Contains only single covalent bonds between carbon atoms.	}		
	⇒ less reactive & does not decolourise 'Br' water		1½	
	⇒ Does not decolourise Baeyer's reagent			
	<u>Unsaturated Compound</u>		3	
	⇒ Contains at least one covalent double or triple bond between carbon atoms.	}		
	⇒ More reactive		1½	
	⇒ Decolourise 'Br' water			
	⇒ Decolourise Baeyer's reagent.			
	(Any 3 difference)			
1b	<u>Functional group</u> is defined as an atom or group of atoms which determines the properties of an organic compound	1½	3	
	aldehyde = -CHO      Carboxylic acid = -COOH amine = -NH <sub>2</sub>	1½		

2. Heisenberg's Uncertainty Principle

It is impossible to measure simultaneously the position & momentum (or velocity) of a small particle with absolute accuracy or certainty 3

Mathematical Statement

The mathematical statement of Uncertainty principle are 6

$$\Delta x \times \Delta p \geq \frac{h}{4\pi}$$

$$\Delta x \times m\Delta v \geq \frac{h}{4\pi}$$

$$\Delta x \times \Delta v \geq \frac{h}{4\pi m}$$

This implies that the position & velocity (or momentum) of small particle like electron can not be measured simultaneously with the certainty. 3

3a. Electroplating

⇒ Object to be electroplated is made the cathode

⇒ Anode is superior metal to be deposited 1/2

⇒ The electrolyte is the solution of the soluble salt of the metal which is to be deposited on the metal

## ENGINEERING CHEMISTRY -II

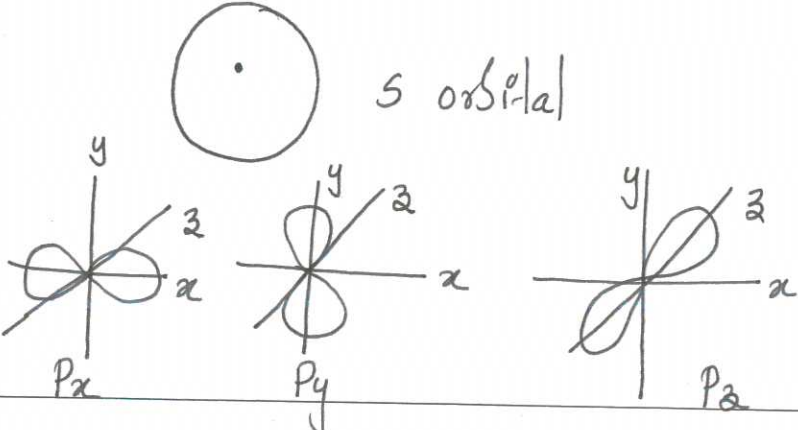
## Scoring Indicators

QNo	Key	Split score	Total score
	<p><u>Anodising</u></p> <p>⇒ Graphite rod or lead sheet acts as Cathode</p> <p>⇒ Object to be anodized is the anode</p> <p>⇒ Electrolyte contains an oxidizing agent like chromic acid, Phosphoric acid or sulphuric acid</p> <p>3b. ① A salt bridge maintains the electrical neutrality of the electrolytes in the two half cells.</p> <p>② It completes the circuit</p> <p>③ It prevents the transference of electrolyte from one half cell to the other i.e. intermixing of the two solutions.</p> <p>④ It avoids liquid junction potential between solutions</p> <p>(any three)</p> <p>4 The word smog is derived from the words smoke &amp; fog. This is the most common example of air pollution that occurs in the major cities. Smog causes</p>	<p>1/2</p> <p>3</p>	<p>6</p>



## ENGINEERING CHEMISTRY - II

## Scoring Indicators

QNo	Key	Split score	Total score
5a	<p>It can be controlled by using catalytic converters in automobiles where oxides of nitrogen &amp; hydrocarbons are converted to harmless products like nitrogen &amp; <math>\text{CO}_2</math></p> <p><u>Industrial Smog</u> or <u>London Smog</u> or <u>Reducing Smog</u> or <u>classical Smog</u></p> <p>This occurs in cool, humid climate. It is mixture of smoke, fog &amp; <math>\text{SO}_2</math>. It is a reducing smog.</p> <p>The orbitals having the same energy are called degenerate orbitals</p> <p>Ex: <math>p_x, p_y, p_z</math></p>	<p>6</p> <p>1/2</p> <p>3</p>	6
5b	 <p>s orbital</p> <p><math>p_x</math> <math>p_y</math> <math>p_z</math></p>	3	6



## ENGINEERING CHEMISTRY - II

## Scoring Indicators

QNo	Key	Split score	Total score
7	<p>① High calorific value which determines the amount of heat produced &amp; temp attained.</p> <p>② Moderate ignition temp</p> <p>③ Moderate velocity of combustion for continuous supply of heat.</p> <p>④ Low moisture content. Velocity of combustion in presence of moisture leads to low temp.</p> <p>⑤ Low non-combustible matter content as their presence leads to formation of ash, decrease in calorific value of fuel, additional cost of storage, handling &amp; disposal of waste products etc.</p> <p>⑥ Combustion of fuel shall not lead to formation of harmful products like <math>SO_2</math>, <math>H_2S</math>, <math>PH_3</math> etc. which endangers human lives.</p> <p>⑦ Low storage cost, easy transportation free from the fire hazards.</p> <p>⑧ Efficient burning air, without smoke.</p> <p>⑨ Controllable combustion, i.e. easy to start &amp; to stop as &amp; when required.</p> <p>⑩ Shall not undergo spontaneous combustion by itself</p>	6	6

(any 6)

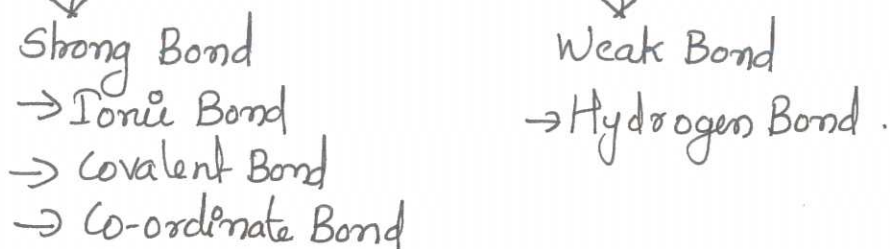
PART - C

UNIT - I

III a. The attractive force which holds various constituents like atoms, ions etc. together in different chemical species is called a chemical bond

Types of chemical bond

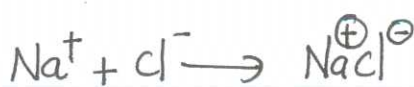
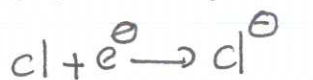
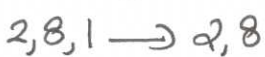
2



Ionic Bond Bond is formed by complete transfer of  $e^-$  from one atom to another atom so as to complete their outermost orbit by acquiring  $8e^-$  or  $2e^-$  in case of Hydrogen.

2

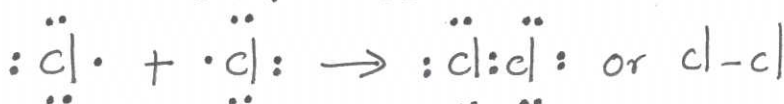
Ex: Formation of NaCl



Covalent Bond The bond formed between the two atoms by mutual sharing of  $e^-$ s between them.

2

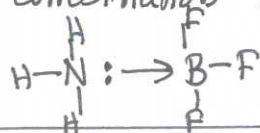
Ex: Formation of  $Cl_2$  molecule



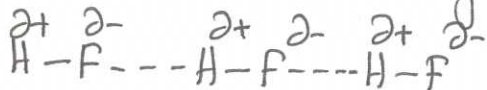
Co-ordinate Bond When, in the formation of a bond, the  $e^-$  pair is donated by one atom but shared by both the atoms so as to complete their octet.

2

Ex: Combination of  $NH_3$  &  $BF_3$



Hydrogen Bond N, O, & F are the highest electronegative element. When they are attached to a hydrogen atom to form covalent bond, the  $e^-$  of the covalent bond are shifted towards the more electronegative atom. As a result, the more electronegative atom become slightly -ve while the hydrogen atom becomes slightly +ve. This partially +ve charged hydrogen atom of one molecule forms a bond with the more electronegative atom of another molecule. This is known as Hydrogen bond.



b

ORBIT	ORBITAL
<p>1) An orbit is a well defined circular path around the nucleus</p> <p>2) It represent planar motion of an <math>e^-</math> around the nucleus</p> <p>3) The concept of an orbit is not accordance with the wave character of <math>e^-</math> of Uncertainty principle.</p> <p>4) Orbits are circular</p> <p>5) do not have any directional characteristics.</p> <p>6) The maximum no of <math>e^-</math>s in any orbit is given by <math>2n^2</math> where 'n' is the no of the orbit</p> <p>(any two difference)</p>	<p>1) An orbital is the three dimensional space around the nucleus within which the probability of finding the <math>e^-</math> is maximum.</p> <p>2) Three dimensional motion of an <math>e^-</math> around the nucleus.</p> <p>3) Accordance with wave character of <math>e^-</math> of Uncertainty principle.</p> <p>4) diff orbits have diff shapes</p> <p>5) All orbitals except s-orbitals have directional characteristics.</p> <p>6) Max no of <math>e^-</math>s present in any orbital is two.</p>

(IV) a) Quantum Number is defined as a set of four numbers with the help of which we can get complete information about all  $e^-$ s in an atom i.e., location, energy, the type of orbital, shape & orientation of orbitals etc.

### Four Quantum Numbers (n)

- ① Principal Quantum No (n)
- ② Azimuthal Quantum No (l)
- ③ Magnetic Quantum No (m)
- ④ Spin Quantum No (s)

### Principal Quantum No

- $\Rightarrow$  Main shell in which  $e^-$  reside
- $\Rightarrow$  It tells about size of the orbital, energy of the orbital
- $\Rightarrow$  Max. no. of  $e^-$  present in the shell  $2n^2$
- $\Rightarrow$  Their values 1, 2, 3, 4, <sup>any integer</sup> other than zero designations K, L, M, N etc.

### Azimuthal Quantum No

- $\Rightarrow$  No. of subshell present in any main shell.
- $\Rightarrow$  It tells about relative energies of subshell & shapes of orbitals present in any sub-shell
- Values 0 to (n-1)

s	p	d	f
0	1	2	3

### Magnetic Quantum No

- $\Rightarrow$  No. of orientation of each subshell in space or No. of orbitals present in any subshell
- Values  $m = -l \dots 0 \dots +l$

### Spin Quantum No

$\Rightarrow$  Direction of  $e^-$  spins clock wise or anti-clock wise

$$s = +\frac{1}{2} \text{ or } -\frac{1}{2}$$

$+\frac{1}{2}$  Spin up,  $-\frac{1}{2}$  Spin down

IV

Aufbau Principle In the ground state of the atoms, the orbitals are filled in order of their increasing energies. In other words,  $e^-$  first occupy the lowest energy orbital available to them & enter into higher energy orbital only when the lower energy orbitals are filled

Hund's Rule Pairing of  $e^-$  in the orbitals belonging to the same sub-shell does not take place until each orbital belonging to that sub-shell has got one  $e^-$  each i.e., it is singly occupied

IV

- (b)
- ① Inability to explain line spectra of multi- $e^-$  atoms
  - ② Inability to explain fine structure of line spectra of Hydrogen atoms.
  - ③ Inability to explain splitting of lines in the M.F (Zeeman effect) & in the E.F (Stark effect)
  - ④ Inability to explain the reasons of chemical bond formation & shapes of molecule.
  - ⑤ Inability to explain de Broglie concept of dual nature of matter & Heisenberg Uncertainty principle.

## UNIT - II

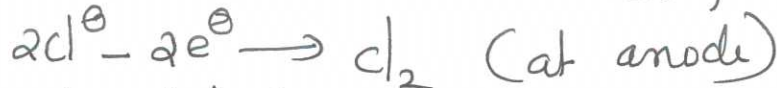
V a The decomposition of electrolyte by the passage of electricity is called electrolysis. The apparatus used for electrolysis is called electrolytic cell or electrolytic tank. The electrolyte either in the fused state or in aqueous solution is taken in the tank. The metal rods, called electrodes are dipped in the electrolyte & are connected to a battery. The electrode connected to -ve pole of the battery is cathode & connected to +ve pole of the battery is anode.

### Electrolysis of Molten NaCl

In molten NaCl undergoes decomposition as  $\text{NaCl} \rightarrow \text{Na}^+ + \text{Cl}^-$ . On passing electric current  $\text{Na}^+$  ions move towards cathode & get discharged.



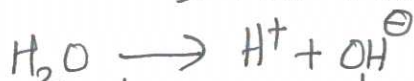
The  $\text{Cl}^-$  ions move towards anode & are discharged.



Na deposited at the cathode & chlorine gas is evolved at the anode.

### Electrolysis of Aqueous NaCl

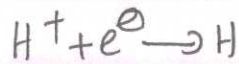
An aqueous NaCl contains besides  $\text{Na}^+$  &  $\text{Cl}^-$  ions,  $\text{H}^+$  &  $\text{OH}^-$  from water.



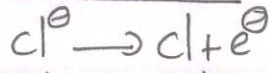
When current is passed through the solution,  $\text{Na}^+$  &  $\text{H}^+$  ions move towards cathode &  $\text{Cl}^-$  &  $\text{OH}^-$  ions move towards anode. At cathode  $\text{H}^+$  ions are discharged in preference to  $\text{Na}^+$  ions, as the discharge potential of  $\text{H}^+$  ions are lower than discharge potential

of  $\text{Na}^+$  ions. Similarly the  $\text{Cl}^-$  ions are discharged in preference to  $\text{OH}^-$  ions at the anode.

At cathode



At anode



3

### (b) Faraday's First Law

The amount of any substance liberated or deposited at an electrode is directly proportional to the quantity of electricity passed through the electrolyte.

$$W \propto Q$$

$$W = ZQ \quad Z = \text{Electrochemical equivalent.}$$

$$Q = I \times t$$

$$W = ZIt$$

3

### Faraday's II<sup>nd</sup> Law

When the same quantity of electricity is passed through solution of diff electrolytes connected in series, the masses of substance deposited at respective electrodes are directly proportional to their equivalent masses.

$$W_A \propto E_A \quad \& \quad W_B \propto E_B$$

$$\frac{W_A}{W_B} = \frac{E_A}{E_B}$$

3

VI  
a

Corrosion is the slow process of decay of the metal, due to the attack of the atmospheric gases on the surface of the metal, resulting in the formation of metallic compounds such as oxides, hydroxides, carbonates, sulphides etc.

### Types of Corrosion

(1) Dry or chemical corrosion (2) wet or Electrochemical Corrosion.

Dry or Chemical Corrosion - direct reaction between environmental atmospheric gases such as  $O_2, H_2S, SO_2$  halogens or anhydrous inorganic liquids with metal surfaces. Ex: Cu, Al, Mg etc are coated with a thin layer of oxides.

1/2

Wet or Electrochemical Corrosion

Occurs due to the existence of separate anodic & cathodic areas in the system between which current flows through the conducting liquid & the anode gets oxidized & wasted.

1/2

Ex: Rusting of iron

(b) Prevention of Corrosion

- ① Maintaining the purity of the metal
- ② Alloying with other elements
- ③ Modification of environment
- ④ Barrier protection or protective coating  
 $\Rightarrow$  Metallic coating  $\Rightarrow$  Nonmetallic coating  
 $\Rightarrow$  Organic coating.
- ⑤ Cathodic protection or electrical protection
- ⑥ Anodic solution

15

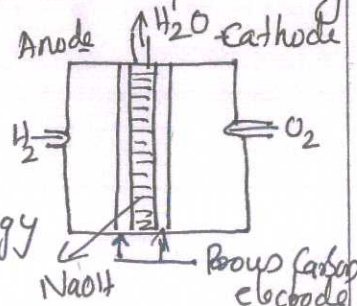
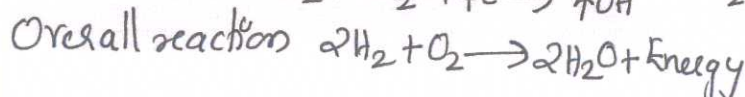
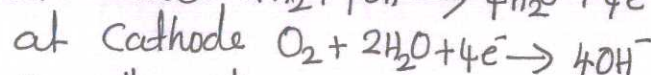
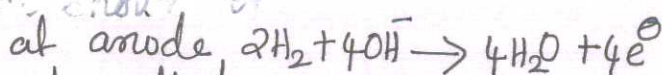
5

[any 5 method with brief explanation]

(c) Hydrogen - Oxygen fuel cell

The cell consists of two electrodes made of porous graphite impregnated with a catalyst Pt, Ag or CuO. They are placed in aqueous concentrated solution of NaOH or KOH.  $H_2$  gas &  $O_2$  gas are continuously bubbled through the porous electrodes at the anode & cathode respectively.

5





VIII  
a

Glass is a mixture of a number of silicates & approximate composition of glass may be represented as  $xM_2O, yMO, 6SiO_2$ , glass is an amorphous hard, brittle transparent super cooled liquid of infinite viscosity obtained by fusing a mixture of Sodium carbonate, calcium carbonate & silica

① Soda Glass It is a mixture of Sodium & Calcium silicates. The raw material required for the production are sand, limestone & Sodium carbonate.

② Borosilicate glass or pyrex glass It is a mixture of sodium aluminum borosilicate. It can withstand high temp. It is resistant to chemicals & has low coefficient of expansion

③ Safety glass It is a type of glass which when breaks does not allow its broken pieces to fly apart. It is obtained by placing thin layers of vinyl plastic with an adhesive b/w two sheets of glass  
[any 3 glasses]

(b) Natural rubber is a linear polymer of Isoprene & is called as 1,4-poly Isoprene.

Properties of natural rubber improved by Vulcanization  
Vulcanization is the process of heating raw rubber with Sulphur at 373-415K. ZnO is used in the reaction it accelerates the rate of Vulcanization.

(c) Thermoplastics

- ⇒ Formed by addition polymerisation
- ⇒ They are soft, weak & less brittle, soluble in organic solvent
- ⇒ Remoulded, recast & reshaped
- ⇒ On heating, they soften & melt & become fluid but on cooling become hard
- ⇒ Ex<sup>o</sup> Cellulose acetate, PVC, etc.

15

2.5

## Thermosetting Plastics

- ⇒ Formed by Condensation polymerisation
- ⇒ hard, strong brittle & insoluble in organic solvents
- ⇒ Cannot be remoulded or reshaped
- ⇒ On heating do not soften
- Ex: Bakelite, Polyester etc

2.5

## UNIT - IV

IX<sub>a</sub>  $O_2 \xrightarrow{\text{u.v light}} O + O$  Ozone thus formed decomposes  
 $O_2 + O \xrightarrow{N_2} O_3$  & there exists a dynamic equilibrium which maintains a constant conc of ozone in the atmosphere

3



### depletion

- ⇒ Excessive use of chemicals like Fluoro & CFC, Freons used in refrigerator, air conditioners & in the production of plastic foams.
- ⇒ Transportation of  $O_3$  from photochemical production region to extratropical region by wind currents.

3

10

### Consequences

Sunburn, Cataract, Brain cancer, Global warming damage to vegetation

2

### Control of $O_3$ depletion

- ⇒  $O_3$  depleting substances are to be replaced by other less harmful substances in refrigerators, air conditioners, aerosol sprays etc.

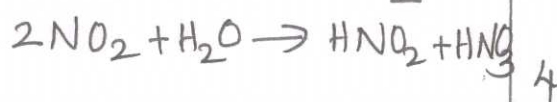
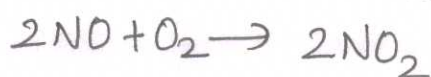
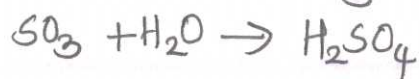
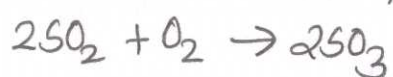
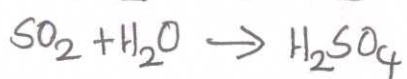
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- ⇒ Injection of gases which react with Cl atoms & immobilise them in polar region

(b) any 5 goal

5

X



The phenomenon of the presence of excessive acid in rain water is called acid rain or acid deposition or acid precipitation. pH of rain water below 5.6 It is called acid rain

(b) Consequences

Way to reduce the production of Acid rain

(b) Cracking - It is the process of breaking up of less volatile bigger molecule of hydrocarbons from petroleum into more volatile lower molecule of hydrocarbons

Two types

(1) Thermal Cracking - Brief explanation.

(2) Catalytic Cracking - Brief explanation.

3

15

3

1

2

2



