ECET

CHEMISTRY

ATOMIC STRUCTURE

- **Dalton's Concept**
- Atom is a smallest indevisable particle of matter.
- Atom can neither be created nor be destroyed.
- Atoms of same element will exhibit same properties and different elements will exhibit different properties
- Atoms of different elements combined to form compound atoms.
- Even though atom is a smallest particle, there are subatomic particles in the atom like electrons, protons, neutrons, neutrinos, positrons, antineutrinos and mesons etc.
- Fundamental particles or elementary particles of atom are electrons, protons, and neutrons.
- Protons and neutrons together called nucleons
- **ELECTRON**
- Electron was discovered by J.J. Thomson
- It was discovered in discharge tube experiments.
- Electron was named by John Stoney.
- These are discovered in Cathode rays.
- Cathode rays are a group of negatively charged particles that are electrons.
- Charge of electron was determined by Millikan oil drop experimental.
- $\frac{e}{m}$ of electron, called specific charge was determined by J.J. Thomson
- Specific charge of electron increases by increasing velocity of electron.
- Charge of electron is

  a) 1 unit negative charge b) -1.602×10^{-19} coulombs

  c) $-4.8\times10^{-10}\ e.s.u$ (e.s.u is electro static unit) d) Its mass is 9.1×10^{-28}gms or 9.1×10^{-31}kg
- For all practical purposes its mass can be neglected.
- Its mass is $\frac{1}{1837}$ times of hydrogen atom.
- **PROTON**
- Proton was discovered by Rutherford.
- These are discovered in Anode rays, in discharge tube experiments.
- Anode rays are called Canal rays
- Anode rays were discovered by Goldstein

⇨ The magnitude of charge of an electron and a proton is equal but opposite in sign.

⇨ Charge of proton is equal to

a) charge of electron but positive b) 1 unit positive charge

c) 1.602×10^{-19} coulombs d) 4.8×10^{-10} *esu*

⇨ Mass of proton is

a) a unit b) 1 atom of H c) 1.672×10^{-24} gm d) 1.672×10^{-27} kg

e) 1.00728 *a.m.u*

⇨ Specific charge of proton is $\frac{e}{m}$ coulombs/gram

⇨ **NEUTRON**

⇨ Presence of neutron was predicted by Rutherford.

⇨ Neutron was discovered by Chadwick

⇨ Chadwick bombarded the element Beryllium nucleus with fast moving α – particles.

⇨ α – particle will have 2 units positive charge and 4 units mass. It is equal to $_2He^4$ nucleus.

⇨ Be atom changes to carbon atom forming a neutral particle with one unit mass.

$_4Be^9 + _2He^4 \rightarrow _6C^{12} + _0n^1$

⇨ Mass of neutron is slightly more than mass of proton

a) 1.674×10^{-24} *gm.* b) 1.674×10^{-27} *k.g* c) 1.008665 *a.m.u*

⇨ Charge of neutron is zero.

⇨ Neutron was not discovered in discharge tube experiment because of its zero charge

Fundamental Particle	Discover	Charge	Mass
Electron	J.J. Thomson	1 unit-ve ; -1.602×10^{-19} coulombs -4.8×10^{-10} *e.s.u*	$\frac{1}{1837}$ of 'H' atom 9.11×10^{-28} gms 9.11×10^{-31} *kg*; 0.000548 *amu*
Proton	Rutherford	1 unit +ve $+1.602\times10^{-19}$ coulombs : $+4.8\times10^{-10}$ *e.s.u.*	1 atom of 'H' (1 unit) ; 1.672×10^{-24} gms 1.672×10^{-27} *kg* 1.00728 a.m.u
Neutron	Chadwick	Zero	1.674×10^{-24} *gms* 1.674×10^{-27} *kgs*; 1.008665 a.m.u

⇨ Element without neutron is hydrogen.

⇨ isotope without neutron is protium.

JJ THOMSON'S ATOMIC MODEL

- Entire atom is filled with mass and positive charge.
- Electrons are embedded at different places in the mass
- It can be compared with watermelon
- It is proved to be wrong by Rutherford with α-rays scattering experiment.

α – Rays scattering Experiment

- Rutherford bombarded thin gold foil with fast moving α – particles.
- α – particle has 4 units mass and 2 units positive charge
- Observation 1 : Most of the α – rays pass straight through the atom.
  Conclusion : Most of the space in the atom is empty
- Observation 2 : Few α – rays are deflected away from the centre at large angles.
  Observation 3 : One in about a lakh of rays comes back from the centre.
  Conclusion : All the positive charge and mass of the atom is concentrated at the centre.
  Based on this experiment Rutherford proposed his atomic model.

Rutherford's Atomic Model

- Most of the atom is empty
- The centre of the atom where all the positive charge and mass is concentrated is called **Nucleus.**
- Nucleus was discovered by Rutherford.
- Protons and neutrons are present inside the nucleus and are called nucleons.
- Radius of the nucleus is measured in Fermi units and radius of atom is measured in Armstrong units.
  $1A^{\circ} = 10^{-8}$ cm , 1 Fermi unit = 10^{-13} cm .
- Electrons will revolve around the nucleus in the circular paths.
- It is compared with planetary system.
- Rutherford's model can not explain the stability of atom.
- It can not explain the atomic spectra.

ATOMIC NUMBER

- Atomic number was introduced by Mosley with X-ray diffraction studies.
- Atomic number is equal to
  a) number of positive charges on the nucleus
  b) number of protons in the atom
  c) number of electrons in the atom.
- Atomic number is a whole number.
- Atomic number is characteristic of an element.
- It is shown with "Z"
- **MASS NUMBER** : Mass of an atom (in amu) corrected to nearest whole number is called mass number.
- It is shown with "A"
- Atomic mass (or) mass number = number of protons + number of neutrons.
  A = Z + number of neutrons

Number of neutrons = A - Z

- Mass of an atom is determined comparing with ${}_6C^{12}$
- $\frac{1}{12}$th of carbon atom is taken as 1 amu.
- **ISOTOPES :** Atoms of the same element having same atomic number but different mass numbers are called isotopes.
- Isotopes of an element have same
  a) atomic number b) number of protons c) number of electrons
  d) electron configuration
  e) chemical properties
- Isotopes differ in
  a) mass number b) number of neutrons c) physical properties
- As mass number of isotopes increases reactivity decreases.
- Term isotope was introduced by Soddy.
- **Examples of isotopes :** Protium $\left({}_1H^1\right)$, Deuterium $\left({}_1H^2\right)$, Tritium $\left({}_1H^3\right)$.
- Tritium is the smallest atom showing radioactive property.
- ${}_6C^{12}$ and ${}_6C^{4}$, ${}_8O^{16}$ and ${}_8O^{18}$, ${}_{17}Cl^{35}$ and ${}_{17}Cl^{37}$ etc.
- Some atoms will have mass in fractions due to the existence of isotopes.
- **ISOBARS :** Atoms of different elements having same mass number but different atomic numbers are called isobars. eg : ${}_{18}Ar^{40}$ and ${}_{20}Ca^{40}$
- Isobars will have different number of protons, electrons and neutrons.
- They have same number of nucleons i.e., sum of protons and neutrons.
- **ISOTONES :** Atoms of different elements having same number of neutrons are called isotones.
  e.g : ${}_{14}Si^{30}$, ${}_{15}P^{31}$ & ${}_{16}S^{32}$
- Isotones have different atomic number and different mass number.
- They have different number of electrons and protons but same number of neutrons.
- **ISOELECTRONIC SPECIES :** The species with same number of electrons are called Isoelectronic species.
  Eg 1: $H, He^+, Li^{2+}, Be^{3+}$ (all have 1 electron)
  Eg 2 : $C^{-4}, N^{-3}, O^{-2}, F^-, Ne, Na^+, Mg^{2+}, Al^{3+}$
  (all have 10 electrons)
  Eg 3: Ar, K^+, Ca^{2+} (all have 18 electrons).
  Eg 4 : $NH_3, H_2O, H_3O^+, NH_4^+, HF$ (all have 10 electrons).
- **BOHR'S MODEL**
- Bohr's model of atom is based on Rutherford's model, Planck's Quantum theory and Hydrogen spectrum.

- Every atom consists concentric circular orbits around the nucleus in which electrons revolve. These orbits are shown with the numbers 1,2,3,4 ..etc. or K, L, M, N , O, P etc.
- As long as the electron revolves in an orbit it neither lose nor gain energy, so these are called stationary orbits.
- As the distance from nucleus increases, the size of orbit increases, radius increases and energy of electron in the orbit increases.
- The angular momentum of electron in a circular orbit is equal to integral multiple of the factor $\frac{h}{2\pi}$

$$mvr = \frac{nh}{2\pi}$$

m = mass of electron
v = velocity of electron
r = radius of the orbit
n = number of the orbit

h = Planck's constant = 6.62×10^{-27} erg. sec.

- When an electron jumps from lower orbit to higher orbit it gains energy and when it jumps from higher orbit to lower orbit it loses energy in the form of light radiation.

Energy gained or lost = $E_2 - E_1 = \Delta E = h.v$

v = frequency of light radiation emitted.

The electron keep revolving around the nucleus in the stationary orbits as the centrifugal force of e^- is balanced by the electrostatic attraction between nucleus and electron.

- Bohr's model explains spectrum of species having one electron atom (or) ion. $H, He^+, Li^{2+}, Be^{3+}$
- Bohr's model can be used to caliculate radius of orbit. eg : Radius of any orbit in Hydrogen atom is equal to $0.529\ n^2\ A^o$.
- It can be used to calculate the energy of electron.
- It can explain the stability of atom.
- Bohr's model fails to explain

a) Fine division of spectral lines (fine structure of the spectrum)
b) Zeeman effect : Fine division of spectral lines magnetic field is called Zeeman effect.
c) Stark effect : Fine division of spectral lines in electric field is called stark effect.
d) The spectra of species having more than one electrons.
e) The wave nature of electron

- **QUANTUM NUMBERS :** Quantum numbers define state of electron i.e. position and energy of electron.
- The minimum quantum numbers used to locate the electron are Principal Quantum number and Azimuthal Quantum number
- Quantum numbers are

a) Principal Quantum number
b) Azimuthal Quantum number
c) Magnetic Quantum number
d) Spin Quantum number

- **PRINCIPAL QUANTUM NUMBER (n)**
- 'n' was introduced by Bohr.

- 'n' indicates the number of the orbit in which the electron is present.
- 'n' has integral values from 1 to n.
- Orbit is also known as shell (or) Energy level.
- n = 1,2,3,4 etc. or K,L,M,N etc.
- As the value of n increases
  a) size of orbit increases b) energy of orbit increases.
- n is used to calculate the radius of orbit and energy of electron.
- Maximum number of electrons in an orbit is equal to $2n^2$
- **AZIMUTHAL QUANTUM NUMBER**
- Azimuthal (or) Angular (or) Orbital Quantum number 'l' was introduced by Sommerfield to explain fine structure of the spectrum.
- 'l' indicates the sublevel of the energy level in which electron is present or it indicates the orbital in which electron is present. "l" values will be depending on 'n'.
- 'l' has integral values from 0 to (n-1) and total values equal to n.

If n = 1 $l = 1-1 = 0$

If n = 2 $l = 2-2 = 0$

$2-1 = 1$

If n = 3 $l = 3-3 = 0$

$3-2 = 1$

$3-1 = 2$

If n = 4 $l = 4-4 = 0$

$4-3 = 1$

$4-2 = 2$

$4-1 = 3$

- Number of sublevels in an energy level are equal to its principal quantum number.
- 'l' = 0,1,2,3 sublevels respectively are known as s,p,d,f sublevels.
- Sublevels of an energy level have different energies.
- Energy of sublevels in an energy level increases with increase in 'l' level.
- Maximum number of electrons in a subshell is equal to $2(2l+1)$
- **MAGNETIC QUANTUM NUMBER :** Magnetic (or) Orientation Quantum number (or) 'm' was introduced by Lande to explain Zeeman effect and Stark effect.
- 'm' indicates the number of orbitals in a given subshell.
- 'm' has integral values from '$-\ell$' to '$+\ell$' including '0' and total values equal to $(2l+1)$
- Number of values of 'm' for a given value of 'l' = (2l+1).
- m values will be depending on ℓ

If $l = 0$ $m = 0$

$l = 1$ $m = -1, 0, +1$

$l = 2$ $m = -2, -1, 0, +1, +2$

$l = 3$ $m = -3, -2, -1, 0, +1, +2, +3$

- Number of values of 'm' for 's' sublevel = 1
- Number of values of 'm' for 'p' sublevel = 3
- Number of values of 'm' for 'd' sublevel = 5
- Number of values of 'm' for 'l' sublevel = 7
- Number of orbitals in s,p,d,f sublevels respectively are 1,3,5,7
- Orbitals of the same sublevel have the same energy and called degenerate orbitals.
- 'm' indicates the orientation of the orbital.
- **SPIN QUANTUM NUMBER :** Spin Quantum number 's' (or) 'ms' was introduced by Uhlenbeck and Goudschmidt.
- 's' indicates the direction of the spin of electrons.
- Electron revolving around its own self is called spinning of electron.
- 's' has two values $+\frac{1}{2}$ and $-\frac{1}{2}$.
- $s = +\frac{1}{2}$ indicates clockwise spin of electron and it is represented as '↑'
- 's' $= -\frac{1}{2}$ indicates anticlockwise spin of electron and it is represented as. '↓'
- **Shapes of Orbitals :** The region in space around the nucleus where the probability of finding the electron is maximum (95%) is called orbital.
- ψ^2 or radial probability represent the probability of finding the electron around the nucleus.
- The region in space around the nucleus where ψ^2 is maximum is called orbital
- Space within the orbital where there is no probability of finding the electron is called nodal plane.
- The four types of orbitals are 's' orbital, 'p' orbital, 'd' orbital and 'f' orbital.
- Shape of 's' orbital ($\ell = 0$) is spherical.
- The nodal planes in S orbitals is zero.
- The orbital which does not have any direction is 's' orbital.
- Shape of 'p' orbital ($\ell = 1$) is dumb - bell,
- 'p' sublevel has three orbitals P_x, P_y and P_z oriented along X, Y and Z axes respectively.
- Each p orbital has two lobes and one nodal plane.
- The three orbitals of the 'p' sublevel have the same size, shape and energy but differ in orientation.

- The angle between two 'p' orbitals is 90°
- 'd' sublevel has five orbitals
- Shape of 'd' orbital ($\ell = 2$) is double dumb -bell except d_{z^2}
- Double dumb-bell shaped orbital has four lobes and two nodal planes.
- d_{xy}, d_{yz}, d_{zx} orbitals are oriented in between xy, yz and zx access respectively.
- $d_{x^2-y^2}$ orbital is oriented along xy axis.
- d_{z^2} orbital has only two lobes oriented along z -axis and there is a probability of finding the electron at the centre spherically. This is called tyre shaped orbital.
- Between any two d orbitals, the angle is 45°.
- The five orbitals of the 'd' sublevel have the same energy but differ in shape, size and direction.
- f- orbitals ($\ell = 3$) are 7 in number and each f-orbital has 8 lobes and 3 nodal planes.
- f-orbital shape has not been determined.
- The plane in which ψ^2 zero is nodal plane.
- Number of nodal regions for '1s' orbital = 0.
- Number of nodal planes for 's' orbital = 0.
- Number of nodal planes for 'p' orbital = 1.
- Number of nodal planes for 'd' orbitals = 2.
- Number of nodal planes for 'f orbitals = 3.
- **Electronic Configuration** : The distribution (or) arrangement of electrons in various orbitals of an atom is called electronic configuration.
- Various properties of element and arrangement of elements in modern periodic table is based on electronic configuration.
- It is represented by 2 methods

  1) $n\ell^x$ method 2) Box method
- $n\ell^x$ method : In this method n represents main energy level, ℓ represents sub-level & X-represents number of electrons in that sub energy level
- Box Method : In this method each orbital is represented with square (or) box towards left of the box principal Quantum number & above it the sub energy level to which it belongs

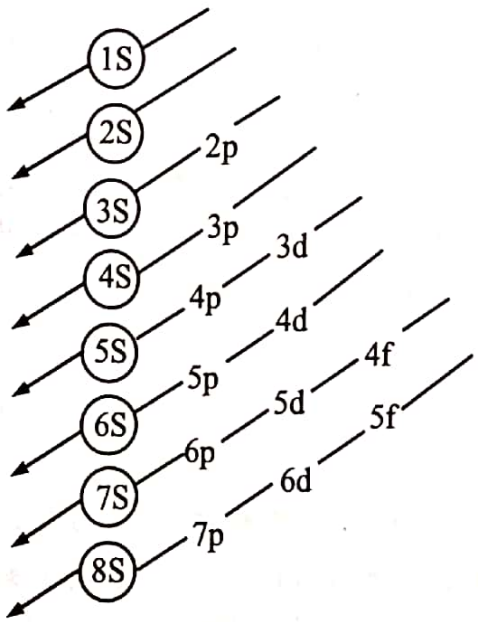
  Ex : E.C of helium

  (a) $n\ell^x$ method : $1S^2$ (b) Box method : 1 | S: ↑↓ |
- **Stability of Atoms & Ions** : Atoms and ions with completely filled sub-shells (or) half-filled sub shells are stable

- Ne, Ar, Kr, Xn & Rn are chemically stable.
- Fe^{+3} (Ferric ion) configuration is (Ar) $3d^5$ & Ferrous ion $\left(Fe^{+2}\right)$ is $[Ar]3d^6$. The 3d sub shell of ferric ion is exactly half-filled. Hence it is more stable than ferrous ion but Cr & Cu show anamolous configuration to get stability.

  Cr : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$

  Cu : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^{10}$
- Modern Periodic Law (or)
- **Mosley's Periodic Law**
- "The physical & chemical properties of element are periodic function of their atomic numbers'
  (or)
  "The physical & chemical properties of elements are periodic function of their electron configuration"
- To understand the electronic configuration, three rules are required.
- **AUFBAU PRINCIPLE :**
- Electron enters into sublevel which has lowest energy.
- Orbitals will be filled with electrons from lower energy to higher energy levels.
- If many orbitals are available for a differentiating electron (newly coming electron) to occupy, then it enters into orbital of lowest energy among them.
- Relative energies of various orbitals can be known with Moeller's diagram or $(n + l)$ value.
- Orbital with less $n + l$ value will have lower energy and vice versa.
- If two different orbitals have the same $(n+l)$ value then the orbital with lower principal quantum number will have less energy.
- The sublevels in the increasing order of energy are given by Moellor's diagram.
- **MOELLOR'S DIAGRAM :**



- The sublevels in the increasing order of energy are
  1s<2s<sp<3s<3p<4s<3d<4p<5s<4d<5p<

PAULI'S EXCLUSION PRINCIPLE

- No two electrons in an atom can have all the four Quantum numbers the same.
- It says in an orbital, more than two electrons can not be accommodated.

HUND'S RULE OF MAXIMUM MULTIPLICITY

- Unless all the orbitals of a sublevel are atleast filled with one electron each, pairing does not take place in any of the orbitals of the sublevel.
- The degenerated orbitals (orbitals with same energy) after being filled with one electron each pairing starts in them.
- The pairing of electrons in s, p, d and f sublevels respectively start with 2nd, 4th, 6th and 8th electron.
- There are 3 unpaired electrons in Nitrogen atom following this rule.

Element	At No.	Electronic Configuration
H	1	$1s^1$
He	2	$1s^2$
Li	3	$1s^2\ 2s^1$
Be	4	$1s^2\ 2s^2$
B	5	$1s^2\ 2s^2\ 2p^1$
C	6	$1s^2\ 2s^2\ 2p^2$
N	7	$1s^2\ 2s^2\ 2p^3$
O	8	$1s^2\ 2s^2\ 2p^4$
F	9	$1s^2\ 2s^2\ 2p^5$
Ne	10	$1s^2\ 2s^2\ 2p^6$
Na	11	$1s^2\ 2s^2\ 2p^6\ 3s^1$
Mg	12	$1s^2\ 2s^2\ 2p^6\ 3s^2$
Al	13	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
Si	14	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$
P	15	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$
S	16	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$
Cl	17	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
Ar	18	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
K	19	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$
Ca	20	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$
Sc	21	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^1\ 4s^2$
Ti	22	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$
V	23	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3 4s^2$
Cr	24	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6.\ 3d^5\ 4s^1.$
Mn	25	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$
Fe	26	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6 4s^2$
Co	27	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7 4s^2$

Ni	28	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ 4s^2$
Cu	29	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}4s^1$
Zn	30	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}4s^2$

ion	No. of Electrons	Electronic Configuration
Na^+	10	$1s^2\ 2s^2\ 2p^6$
Al^{+3}	10	$1s^2\ 2s^2\ 2p^6$
Ca^{+2}	18	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
N^{-3}	10	$1s^2\ 2s^2\ 2p^6$
O^{-2}	10	$1s^2\ 2s^2\ 2p^6$
Zn^+	28	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$
Fe^{+2}	24	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$
Fe^{+3}	23	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$
Ni^{+2}	26	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8$

POINTS TO BE REMEMBERED

- The property of an atom which is a whole number is Atomic number.
- Fractional atomic weights are due to presence of isotopes.
- The two electrons in an orbital must possess opposite spin.
- An orbital can have a maximum of two electrons with opposite spin.
- The maximum number orbitals in an orbit = n^2
- The maximum number of electrons in an orbit = $2n^2$.
- The maximum number of electrons in a sublevel = $2(2l+1)$

BOHR - BURY SCHEME

- The maximum number of electrons that can be present in the outermost orbit is 8.
- The maximum number of electrons than can be present in the penultimate shell is 18.
- The maximum number of electrons than can be present in the antepenultimate shell is 32.
- The maximum number of electrons that can be present in s, p, d and f sublevels respectively are 2, 6, 10 and 14.

PRACTICE SET - I

01. Mass of proton is
1) 1/1837 of H atom 2) 9.1×10^{-28} gm
3) $6\ 7\ 2 \times 10^{-24}$ gm 4) 1.674×10^{-27} kg

02. Charge of electron is
1) 1 unit + ve charge
2) -4.8×10^{-10} coulombs
3) -1.6×10^{-20} coulombs
4) 1.602×10^{-19} coulombs

03. Neutron was discovered by
1) Chadwick 2) Rutherford
3) J.J Thomson 4) Mosley

04. Atomic number was introduced by
1) Fajan 2) Mosley
3) Rontgen 4) Soddy

05. Nucleus was discovered by
1) Division 2) Bohr
3) Rutherford 4) Goldstein

06. The quantum number which indicates size of orbit is
1) Principal Quantum number
2) Azimuthal Quantum number
3) Magnetic Quantum number
4) Spin Quantum number

07. The total number of protons and neutrons in the nucleus of atom is equal to
1) atomic weight 2) atomic number
3) Isotopic.number 4) mass number

08. Magnetic Quantum number was proposed by
1) Bohr 2) Lande
3) Sommerfeld 4) Unlenbeck

09. Atomic number of an element is equal to
1) number of electrons
2) number of .protons
3) number of neutrons
4) number of protons (or) number of electrons

10. Millikan's Oil drop experiment was used to find
1) e/m ratio of an electron
2) electronic charge
3) mass of an electron
4) velocity of an electron

11. Of the following the one that is not a fundamental particle is
1) proton 2) electron
3) position 4) neutron

12. The fundamental particles which are present in equal numbers in neutral atoms are
1) neutrons and electrons
2) neutrons and protons
3) electrons and protons
4) none

13. Plank's constant is expressed in
1) joule/sec 2) sec^{-1}
3) joule-Sec 4) joules

14. The number ol neutrons present in $_9F^{19}$ is
1) 19 2) 9 3) 10 4) 28

15. Rutherford's scattering experiment is related to size of the
1) nucleus 2) atom
3) electron 4) neutron

16. Positive ions are formed form the neutral atom by the loss of
1) positrons 2) protons
3) electrons 4) neutrons

17. The principal Quantum number represents
1) Size of orbit
2) Spin angular momentum
3) Orbital angular momentum
4) Space orientation of the orbital

18. For a given value of quantum number ℓ, the no of magnetic quantum number is
1) $(\ell+1)$ 2) $(2\ell+1)$
3) $(2\ell+1)$ 4) (n-1)

19. Configuration n of ' N ' atom is $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$ instead of $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^0$ according to
1) Aufbau principle 2) Pauli's principle
3) Hund's rule 4) Stability rule

20. The maximum number of electrons which can be present in ' p' and 'f' sublevels respectively are
1) 2 & 6 2) 6 & 10
3) 10 & 14 4) 6 & 14

21. Bohr's model of atom explains
1) Zeeman effect 2) Hydrogen spectrum
3) Stark effect
4) Fine division of spectral lines

22. Particles having same number of electrons but different atomic numbers are
1) isotopes 2) isoelectric species
3) Isotones 4) isosters

23. Unit of Planck's constant is
1) cm 2) cm^{-1}
3) erg/sec 4) erg. sec

24. The atomic number and mass number of an element are 15 and 31. The number of protons, neutrons and electrons in an atom respectively are
1) 15, 15, 16 2) 16, 15, 15
3) 15, 16, 15 4) 16, 15, 16

25. The experiment used to determine charge of an electron is
1) Thomson's discharge tube experiment
2) Miilikan's oil drop experiment
3) Rutherford's α - ray scattering experiment
4) Hydrogen spectrum experiment

26. The number of orbitals present in 'M's hell is
1) 2 2) 4 3) 9 4) 16

27. "The two electrons in an orbital must have opposite spin". This is in accordance with
1) Pauli's principle 2) Hund's rule
3) Aufbau principle 4) DeBroglie's principle

28. As the value of principle Quantum number increases
1) energy of orbit increases
2) energy of orbit decreases
3) radius of orbit decreases
4) velocity of e in the orbit increases

29. The element bombarded with a α – particle in the discovery of nucleus is
1) B 2) Be 3) C 4) N

30. $\frac{e}{m}$ of proton with a change in the nature of the gas
1) increases 2) decreases
3) remains same 4) cannot be predicated

31. The experiment carried out to determine the nucleus is
1) Gold leaf exponent
2) Discharge phr.nomana experiment
3) α - ray scattering experiment
4) Oil drop experiment

32. Number of nodal planes of a 'd' orbital can be
1) 2 2) 1 3) 0 4) 3

33. $(n+l)$ value of 5f is
1) 5 2) 3 3) 8 4) 7

34. The electronic configuration of 'Cr' is (Atomic number = 24)
1) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^2$
2) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$
3) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$
4} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^1\ 4p^1$

35. In an atom no two electrons have all the 4 quantum numbers identical. It is known as
1) Aufbau principle 2) Hund's rule
3) Pauli's rule 4) Einstein's law

36. Atomic mass of an element is
1) No. of neutrons 2) No. of protons
3) No. of neutrons and protons
4) Number of electrons

37. Neutron was discovered by
1) Rutherford 2) Chadwick
3) Thomson 4) Stoney

38. In the discharge tube experiment for the discovery of cathode rays e/m is constant this is due to
1) Electrons are negatively charged
2) Electron is the lightest particle
3) e/m is universal constant
4) Electrons mass is 1/1837 times to hydrogen

39. Rutherford's experiment first proved that atom has
1) Protons 2) Nucleus
3) Neutrons 4) Atom is stable

40. Hund's rule is
1) No two electrons can have the same set values for all the four quantum numbers
2) Electrons do not pair in an orbital until the orbitals of that sub-shell are filled with one electron each.
3) It is impossible to determine position an momentum of an electron simultaneous & accurately.
4) None of the above.

41. Which of the following is not directed along the axis
1) P_x 2) $d_{x^2-y^2}$ 3) d_{xy} 4) d_{z^2}

42. Rutherford's scattering experiment is related to size of the
1) nucleus 2) atom
3) electron 4) neutron

43. The electron is
1) an α- particle 2) a β – particle
3) hydrogen ion 4) positive ion

44. Neutrons are present in the nucleus of all elements except
1) Oxygen 2) Hydrogen
3) Chlorine 4) Dueterium

45. Bohr's model can explain
1) the spectrum of Hydrogen atom only
2) the spectrum of Hydrogen molecule only
3) the spectrum of atom are ion containing one electron only 4) the solar spectrum

46. The number of orbitals in 3d sublevel is
1) 1 2) 3 3) 5 4) 7

PRACTICE SET - I KEY

01) 1	**02)** 4	**03)** 1	**04)** 2	**05)** 3
06) 1	**07)** 4	**08)** 2	**09)** 4	**10)** 2
11) 3	**12)** 3	**13)** 3	**14)** 3	**15)** 1
16) 3	**17)** 1	**18)** 2	**19)** 3	**20)** 4
21) 2	**22)** 2	**23)** 4	**24)** 3	**25)** 2
26) 3	**27)** 1	**28)** 1	**29)** 2	**30)** 3
31) 3	**32)** 1	**33)** 3	**34)** 3	**35)** 3
36) 3	**37)** 2	**38)** 3	**39)** 2	**40)** 2
41) 3	**42)** 1	**43)** 2	**44)** 2	**45)** 3
46) 3				

PRACTICE SET - II

01. As the velocity of electron increases specific charge of electron
1) increases 2) decreases
3) remains same 4) varies irregularly

02. isotopes are formed due to a difference in number of
1) electrons 2) protons 3) neutrons
4) positive charges on the nucleus

03. planetary model of atom was proposed by
1) Thomson 2) Rutherford
3) Bohr 4) Solemnified

04. The theory which proves Rutherford model wrong is
1) Electromagnetic radiation theory.
2) Planck's quantum theory
3) Einstein's quantum theory
4) None

05. Model of stationary states was proposed by
1) J.J.Thomson 2) Rutherford
3) Bohr 4) Sommerfeld

06. Shape of 'p' orbital is
1) spherical 2) dumbell
3) double dumbell 4) tetrahedral

07. The energy of a sublevel depends on the values of
1) n 2) l
3) n & l 4) n, l & m

08. The sublevel into which the electron enters after the completion of '4s' sublevel is
1) 4p 2) 3d
3) 4d 4) 4f

09. The angular momentum of electron in 'M' shell is
(1) $n/2r\pi$ 2) $3h/\pi$
(3) $1.5\,h/\pi$ 4) $h/6\pi$

10. The number of nodal planes for a p- orbital is
1) 0 2) 1 3) 2 4) 3

11. $_{14}Si^{30}$ and $_{15}P^{31}$ are examples of
1) isotopes 2) isobars 3) Isotones 4) isosters

12. The formula for number of neutrons in an atom is
1) A+Z 2) Z-A 3) A-Z 4) A/Z

13. The maximum number of electrons in an energy level is
1) n 2) 2n 3) n^2 4) $2n^2$

14. The maximum number of orbitals in an energy level is
1) V 2) 2n 3) n^2 4) $2n^2$

15. The maximum number of electrons that can be present in the outermost orbit is
1) 2 2) 8 3) 18 4) 32

16. Alpha particle is —— times heavier than neutron
1) 2 2) 3 3) 4 4) 2 1/2

17. Which atomic particle would be undeflected in an electric field ?
1) neutron 2) proton
3) alpha particle 4) beta particle

18. The number of electrons in the atom which has 20 protons in its nucleus is
1) 20 2) 10 3) 30 4) 40

19. Which characteristic is different for neutral at oms of the isotopes of an element ?
1) atomic number 2) atomic weight
3) number of protons 4) number of electrons

20. Elements having different nuclear charge to the same mass number are called
1) isotopes 2) isobars
3) isomers 4) isosters

21. Sodium atom differs from sodium ion in the number of
1) protons 2) neutrons
3) electrons 4) protons and electrons

22. Which pair of particles have identical electronic configuration ?
1) Na^+, K^+ 2) He, Li^+
3) Al^{3+}, Ar 4) Cl^-, F^-

23. The electrons of Rutherford's model of the atom are expected to lose energy because they
1) are attracted by the nucleus
2) strike each other 3) are accelerated
4) are in motion

24. The two main parts of an atom are
1) the shell and energy levels
2) nucleus and kernel
3) nucleus and energy levels
4) planetary electrons and energy levels

25. Which of the following atom contains least number of neutrons
1) ${}_{92}U^{230}$ 2) ${}_{92}U^{236}$
3) ${}_{93}Np^{230}$ 4) ${}_{94}Pu^{239}$

26. In the nth quantum level, the number of electronic sub shell are
1) n 2) 2n 3) $2n^2$ 4) n+1

27. Hydrogen molecule ion H_2^+ contains
1) 1 electron 2) 2 electrons
3) 3 electrons 4) no electron

28. Given that the electronic configuration of an element is $1s^2\ 2s^2\ 2p^3$. Then the number of unpaired electrons in this atom is
1) 0 2) 1 3) 3 4) 7

29. An atom has three protons and four neutrons in its nucleus. The number of planetary electrons in the atom is
1) 4 2) 3 3) 7 4) 1

30. The maximum no. of electrons in an orbital is
1) 2 2) 32 (3) 8 4) 18

31. For a dumbell shaped orbital the I value is
1) 3 2) 0 3) 1 4) 2

32. The electronic configuration 2,8,8,2 represent the element
1) Ar 2) K 3) Ca 4) Cl

33. The two electrons occupying an orbital are distinguished by the following quantum No.
1) principal 2) Azimuthal
3) Magnetic 4) Spin

34. The shape of an orbital is governed by
1) Spin quantum number
2) Principal quantum number
3) Azimuthal quantum number
4) Magnetic quantum number

35. The atomic weight of an element is 52 and its atomic number is 24. The number of electrons, protons, and neutrons in. an atom of this element will be respectively?
1) 24,24,28 2) 24,28,24
3) 28, 24, 24 4) 52, 24, 28

36. The valency electron of an element is represented by 3s The element is
1) Na 2) K 3) Ca 4) Li

37. The number of neutrons present in protium is?
1) 3 2) 2 3) 1 4) 0

38. When 3s orbits is complete, the newly entering electron goes into ?
1) 4f 2) 4s 3) 3p 4) 4d

39. The electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$ corresponds to?
1) Sulphur 2) Phosphorous
3) Silicon 4) Sodium

40. Maximum number of electrons present in "N" shell is?
1) 18 2) 32 3) 2 4) 8

41. Total number of orbitals associated with orbit number 'L' are ?
1) 2n 2) 4 3) 3 4) 1

42. Helium and Tritium are
1) Isotopes 2) Isobars
3) Isotones 4) iso electronic

43. Which of the following are iso electronic
1) Isotopes 2) Isobars
3) Isotones 4) None

44. The number of unpaired electrons is $Is^2\ 2s^2\ 2p^4$ is
1) 4 2) 2 3) 0 4) 1

45. The number of unpaired electrons is Fe^{3+} (Z = 26) is
1) 5 2) 4 3) 3 4) 2

46. Two atoms have same no of nucleons but differ in the no of protons, they are
1) Isotopes 2) Isobars
3) Isotones 4) None

47. Total nos. of electrons, protons and neutron in NH_4^+ ion are.
1) 5,1,7 2) 10,11,7
3) 10,10,11 4) 11,10,7

48. Total no of electrons that can be present in clockwise spin is Mth shell of an atom is
1) 4 2) 8 3) 9 4) 16

49. Two atoms have same atomic number but differ In the number of neutrons. They are
1) Isobars 2) Isotopes
3) Isotones 4) None

50. The particle having 18 electrons in valency shell
1) Ar 2) K+ 3) Cu^+ 4) Cu^{2+}

51. Number of electrons in 'M" shell of an atom with atomic number 12 is
1) 2 2) 4 3) 6 4) 8

52. The number of protons, electrons and neutrons respectively in Na^+ ion are
1) 10,11,12 2) 11,12,12
3) 11,10,12 4) 11,11,12

53. The electronic, configuration of outermost orbit of inert gases is
1) ns^2 2) $ns^2\ np^2$ 3) $ns^2\ np^4$ 4) $ns^2\ np^6$

54. The mass number of an element is 56 and its atomic number is 26. The number of nucleons is equal to
1) 26 2) 30 3) 56 4) None

55. The value of 'ℓ' for 'd' orbital is
1) O 2) 1 3) 2 4) 3

56. The Penultimate shell of an atom can not exceed
1) 2 2) 8 3) 18 4) 32

57. Shape of an orbital present in the subenergy level 'P'
1) spherical 2) dumbell
3) double dumbell 4) spherical dumbell

58. Non - directional orbital is
1) s 2) p 3) d 4) f

59. After 5p is filled, next electron enters the level
1) 5d 2) 4d 3) 6s 4) 4f

60. Magnetic quantum number for '4p' orbital cannot be
1) 4 2) -1 3) +1 4) 0

61. The following is not an isoelectronic pair
1) Na^+, N^{3-} 2) Ca^{2+}, Cl^-
3) Na^+, K^+ 4) Mg^{2+}, O^{2-}

62. An isotone of $_{15}P^{31}$ is
1) $_{17}Cl^{35}$ 2) $_{16}S^{33}$ 3) $_{14}Si^{29}$ 4) $_{17}Cl^{33}$

63. When electron jumps from 4s to 3d energy is
1) absorbed 2) released
3) unchanged 4) none

64. (h/π) is the angular momentum of electron in following shell
1) K 2) L 3) M 4) N

65. Electronic configuration of copper in its +1 oxidation state is
1) [Ar] $4s^1\ 3d^{10}$ 2) [Ar] $4s^1\ 3d^9$
3) [Ar] $4s^0\ 3d^{10}$ 4) [Ar] $4s^1\ 3d^8$

66. The correct ground stale electronic configuration of copper atom (atomic number = 29) is
1) (Ar) $3d^{10}\ 4s^1$ 2) (Ar) $3d^{10}\ 4s^2$
3) (Ar) $3d^0\ 4s^2\ 4p^1$ 4) (Ar) $3d^0\ 4s^1\ 4p^1$

67. Nitrogen is having three unpaired electrons is in according to
1) Hund's rule 2) Aufbau's rule
3) Paul-'s exclusion principle
4) Heisen Berg's uncertainty principle

68. Which of the following is an isoelectronic pair
1) K^+, Cl^- 2) Na^+, Cl^-
3) Na^+, He 4) K^+, xe

69. One atom of $_{19}K^{39}$ contain
1) 19 protons. 20 neutrons and 19 electrons.
2) 19 protons, 20 neutrons and 20 electrons
3) 20 protons. 19 neutrons and 20 electrons
4) 20 protons, 19 neutrons and 19 electrons

70. When '4p' orbitals in any atom are filled completely the next electron goes in
1) 5s 2) 3d 3) 4d 4) 4s

71. Inert gas configuration is
1) $2s^2\ 2p^5$ 2) $2s^2\ 2p^6$
3) $2s^1$ 4) $2s^2\ 2p^6\ 3s^1$

72. The isoelectronic species with CO is
1) CN^- 2) OH^- 3) N_2^+ 4) O_2^-

73. Which of the following has more unpaired d-electrons ?
1) Zn 2) Fe^{+2} 3) Ni^{+3} 4) Cu^+

74. No. of neutrons in ${}_6C^{14}$ are :
1) 6 2)7 3) 8 4) 14

75. Which of the following pairs contain same number of unpaired electrons
1) Ni^{2+}, Co^{2+} 2) Mn^{2+}, Fe^{3+}
3) Mn^{2+}, Ni^{2+} 4) Ti^{3+}, Co^{2+}

76. The total number of neutrons in Zinc atom with mass number 70 and atomic number 30 is
1) 34 2) 40 3) 36 4) 38

77. Two electrons occupying an orbital distinguished by
1) spin quantum number
2) azimuthal quantum number
3) principal quantum number
4) Bohr's theory of configuration of electrons in atoms.

PRACTICE SET - II KEY

01) 1	02) 3	03) 2	04) 1	05) 2
06) 2	07) 3	08) 2	09) 3	10) 2
11) 3	12) 3	13) 4	14) 3	15) 2
16) 3	17) 1	18) 1	19) 2	20) 2
21) 3	22) 2	23) 1	24) 3	25) 3
26) 1	27) 1	28) 3	29) 2	30) 1
31) 3	32) 3	33) 4	34) 3	35) 1
36) 1	37) 4	38) 3	39) 3	40) 2
41) 2	42) 3	43) 1	44) 2	45) 1
46) 2	47) 2	48) 3	49) 2	50) 3
51) 1	52) 3	53) 4	54) 3	55) 3
56) 3	57) 2	58) 1	59) 3	60) 1
61) 3	62) 4	63) 1	64) 2	65) 3
66) 1	67) 1	68) 1	69) 1	70) 1
71) 2	72) 1	73) 2	74) 3	75) 2
76) 2	77) 1			

PRACTICE SET - III

01. Radius of the atom is of the order of
1) 10^{-12} cm 2) 10^{-13} cm
3) 10^{-8} cm 4) 10^{-4} A

02. ${}_{14}Si^{30}$ and ${}_{15}P^{31}$ are examples of
1) isotopes 2) isobars
3) isotones 4) isosters

03. The total number of electrons in one molecule of carbon dioxide is
1) 44 2) 22 3) 66 4) 88

04. Number of orbitals in N shell is
1) 2 2) 8 3) 16 4) 32

05. An atom X has 6 protons and 5 neutrons. Another atom Z has 6 neutrons and 5 protons these atoms are
1) isotopes 2) isomers
3) atoms of different elements
4) identical in all physical properties

06. A species with two electrons , three proton and four neutrons is
1) N 2) N3+ 3) Li 4) Li+

07. An atom of Cr has one 4s electron and five 3d electrons. How many unpaired electrons would there be in Cr^{3+}
1) 1 2) 2 3) 3 4) 4

08. The maximum number of electrons which can occupy sub level with. $\ell = 1$ is
1) 1 2) 2 3) 4 4) 6

09. The atoms which differ in number of neutrons present in the nucleus are
1) Isotones 2) Isotopes
3) Isotones or Isotopes 4) none

10. The maximum number of electrons that present in M shell of an atom is
1) 8 2) 10 3) 18 4) 32

11. Which one of the following has the same electrons with the Argon atom
1) Na^+ 2) Na 3) S^- 4) Cl^-

12. A neutral atom of an element has 2K ,8L, 8M and 2N electrons. Total number of electrons present in P- sub shell is
1) 12 2) 14 3)10 4) 8

13. When electrons revolve in stationary orbit?
1) There is no change in energy
2) They becomes stationary
3) They gain K.E.
4) There is increase in energy

14. The quantum number for the electrons of an atom are n = 2, ℓ = 0, m = 0, s = + 1 / 2 . The atom is
1) Lithium 2) Boron
3) Beryllium 4) Hydrogen

15. The values of magnetic quantum numbers corresponding to ℓ = 2 are?
1) 0,1,2 2) -2, -1, 0,- 1, +2
3) -2 ,-1,0 4) 0,+1,-1

16. When a neutral atom is converted into cation .there is?
1) Decrease in atomic number
2) An increase in atomic number
3) A decrease in size 4) An increase in size

17. The number of neutrons in the radioactive isotope of Hydrogen is
1) 2 2) 0 3) 1 4) 3

18. The number of unpaired electrons in Carbon In ground state is?
1) 2 2) 4 3) 3 4) 1

19. An isotone of $_{76}Ge^{32}$ is
1) $_{77}Ge^{42}$ 2) $_{77}As^{33}$
3) $_{77}Se^{34}$ 4) $_{78}Se^{34}$

20. The ion that is iso electronic with N_2 molecule
1) CN^- 2) O_2^+ 3) O_2^- 4) N_2^+

21. Which of the following has the minimum no of unpaired at electrons
1) Fe^{3+} 2) Co^{3+} 3) Co^{2+} 4) Mn^{2+}

22. The following set of quantum number is correct
1) 4, 2, -1 , -1/2 2) 4,1, 2 , + 1 /2
3) 4, 0,1,+1/2 4) 4,1,3,-1/2

23. Total no of 'P' electrons in Iron atom (Z=26)
1) 6 2) 12 3) 10 4) 8

24. Maximum no. of electrons present in an energy level n = 5 & l =3 is
1) 15 2) 6 3) 10 4) 14

25. An electron with n = 4, l =0, M = 0, S = $+\frac{1}{2}$ is present is the following atom
1) Na 2) At 3) p 4) Ca

26. Number of p - electrons in an atom with atomic number 16 is
1) 2 2) 6 3) 8 4) 10

27. The values of n, l, m ends for the last electron of 'p' atom respectively are
1) 3, 0, 0 + $\frac{1}{2}$ 2) 3,0,1, $-\frac{1}{2}$
3) 3,1,+1, $-\frac{1}{2}$ 4) 3,1,+1, $+\frac{1}{2}$

28. Which one of the following has the configuration $1s^2\ 2s^1\ 2p^3$?
1) 'C'atom 2) excited'c'atom 3) 'N' atom
4) 'C' atom which has lost one electron

29. K^+ is iso electronic with X^{2-}. Then the atom X is
1) Cl 2) P 3) S 4) O

30. dz^2 orbital can accommodate the following number of electrons
1) 2 2) 4 3) 10 4) 1

31. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^0$ is the electronic configuration of
1) Sc 2) v^{2+} 3) Fe^{3+} 4) Co^{2+}

32. Total no. of electrons present in anti clockwise spin in the energy level $n = 4; l = 3; m = -2$ is
1) 5 2) 7 3) 1 4) 3

33. When l = 2, the possible 'm' values are
1) -1, 0, + 1 2) -2, -1, 0, + 1
3) -3, -2, 0, .+1, +2, +3 4)'0'only

34. Which one of the following set of quantum numbers is not possible for 4p electron
1) 4, 1, +1, +1/2 2) 4,1,0, + 1/2
3) 4, 1, 2, +1/2 4) 4, 1, 1, -1/2

35. The four quantum numbers of the valency electron of potassium are
1) 4, 0, 1, 1, 1/2 2) 4, 1, 0, 1/2
3) 4, 0, 0, 1/2 4) 4, 1, 1, 1/2

36. The ion that is isoelectronic with carbon monoxide is
1) CN^- 2) O_2^+ 3) O_2^- 4) N^{+2}

37. Which of the following statements is correct with respect to 'p' orbitals
1) They are spherical in shape
2) They have a strong directional nature
3) They are fivefold degenerate
4) They have no directional nature

38. The azimuthal quantum number 'l' is related
1) The size of orbital
2) The orientation of orbital in space
3) The shape of the orbital
4) The spin angular momentum

39. Which of the following in the correct set of four quantum numbers for valence electrons of Rubidium (Z = 37)?
1) $5,0,0,+\frac{1}{2}$ 2) $5,1,0,+\frac{1}{2}$
3) $5,1,1,+\frac{1}{2}$ 4) $6,0,0,+\frac{1}{2}$

40. The total number of electrons in one molecule of Carbondioxide is
1) 44 2) 22 3) 66 4) 88

41. Which of the element having the following atomic number has the maximum number of electrons in the outer most shell
1) 2 2) 7 3) 9 4) 19

42. The number of orbitals in the main energy level of quantum number n = 2
1) 1 2) 2 3) 4 4) 6

43. Atomic size is in the order of
1) 10^{-8} cm 2) 10^{-13} cm
3) 10^{-10} cm 4) 10^{-15} cm

Fill in the blanks

44. The orbital ol electron with n = 2 and $l = 0$ called.....

45. Number of neutrons present in $_{92}U^{239}$ is ...

46. The mass of an atom is concentrated in.....

47. The pair of $_{16}X^{32}$ and is $_{15}Y^{32}$ are called...

48. The maximum no. of electrons that can present in a sub-level with 'n' value 3 and value of 2 is..

49. The radii of atoms will be in the order ...cm

50. The element having the electronic configuration [Ar] $4s^2$ is.....

51. The no. of neutrons in radioactive isotope hydrogen is.....

52. In an atom when electrons makes transition from .....energy is emitted in the form of radiation

53. The unit charge of proton is equal to ...coulombs

54. Isotopes have similar chemical properties because they have the same

55. The mass of electron is .....gm

56. Where there are two electrons in the same orbital they must have .....spin

57. The maximum number of electrons in a shell with principal quantum number 4 is .....

58. The ground state electronic configuration of carbon is .....

Araise ! Awake ! And stop not till the goal is reached

PRACTICE SET - III KEY

01) 3	02) 3	03) 2	04) 3	05) 3
06) 4	07) 3	08) 4	09) 2	10) 3
11) 4	12) 1	13) 1	14) 1	15) 2
16) 3	17) 1	18) 1	19) 2	20) 1
21) 3	22) 1	23) 2	24) 4	25) 4
26) 4	27) 4	28) 2	29) 3	30) 1
31) 2	32) 2	33) 2	34) 3	35) 3
36) 1	37) 2	38) 3	39) 1	40) 2
41) 3	42) 3	43) 1	44) 2s	45) 147

46) Nucleus 47) Isobars

48) 10 electrons 49) 10^{-8} cm

50) Calcium 51) 2

52) Higher energy level to lower energy level

53) $+1.602 \times 10^{-19}$ c. 54) atomic number

55) 9.1×10^{-28} 56) opposite

57) 32 58) $1s^2 2s^2 2p^2$

PREVIOUS ECET BITS

ECET - 2012

01. The valency electronic configuration of Phosphorous atom (At. No. 15) is

1) $3s^2\ 3p^3$ 2) $3s^1\ 3p^3\ 3d^1$

3) $3s^2\ 3p^2\ 3d^1$ 4) $3s^1\ 3p^2\ 3d^2$

02. An element 'A' of At. No. 12 combines with an element 'B' of At No. 17. The compound formed is

1) covalent AB 2) ionic AB_2

3) covalent AB_2 4) ionic AB

03. The number of neutrons present in the atom of $_{56}Be^{137}$ is

1) 56 2) 137 3) 193 4) 81

ECET - 2013

04. The theory that no two electrons in an atom can have identical values of the four quantum numbers is known as

1) Hund's rule 2) Bohr's theory

3) Aufbau's principle 4) Pauli's principle

05. The angular momentum of an electron revolving round the nucleus in K shell is given by

1) $h / 2\pi$ 2) $h^2 / 2\pi$

3) $\pi / 2h$ 4) $h / 2\pi^2$

06. The valency electronic configuration of chlorine atom (At. No. 17) is

1) $3s^2 3p^3 4s^2$ 2) $3s^2 3p^5$

3) $3s^1 3p^6$ 4) $3s^1 3p^3 3d^3$

ECET - 2014

07. The lightest particle is

1) Positron 2) Neutron

3) Proton 4) α – particle

08. If an electron has spin quantum number of 1/2 and magnetic quantum number of -1, it cannot be present in

1) *d* orbital 2) *f* orbital

3) *p* orbital 4) *s* orbital

09. The ion that is iso electronic with CO is

1) NO^+ 2) O_2^+

3) O_2^- 4) N_2^+

T.S - ECET-2015

10. Which one of the follwoing set of quantum numbers is not possibele for 'p' electron

1) $n = 4, l = 1, m = +1 and\ m_s = +1/2$

2) $n = 4, l = 1, m = 0 and\ m_s = +1/2$

3) $n = 4, l = 1, m = +2 and\ m_s = +1/2$

4) $n = 4, l = 1, m = -1 and\ m_s = -1/2$

11. The first emission line of hydrogen atomic specturum in balamer series appears at (R=rydberg constant)

1) $5R/36cm^{-1}$ 2) $3R/4cm^{-1}$

3) $7R/144cm^{-1}$ 4) $9R/400cm^{-1}$

12. Which ion is iso electornic with '*CO*'

1) N_2^+ 2) O_2^+ 3) O_2^- 4) CN^-

AP - ECET-2015

13. The atomic orbital are progressively filled in order of increasing energy. This principle is called
1) de-Broglie rule 2) Aufbau principle
3) Hund's rule 4) pauli's exclusion principle

14. The specific chagre of electorn is
1) $1.60\times10^{-19}c/electron$
2) $1.67\times10^{-27}kg$
3) $9.58\times10^{7}c/kg$
4) $1.76\times10^{11}c/kg$

15. How many quantum numbers are needed to designate an orbital
1) 3 2) 2 3) 1 4) 4

T.S - ECET-2016

16. Which one of the following pairs of atoms or ions will have same configuration
1) F^{+} and Ne 2) Li^{+} and He^{-}
3) Cl^{-} and Ar 4) Na and K

17. The oxidation number of 'S' in H_2SO_5 is
1) 5 2) 6 3) 7 4) 8

A.P - ECET-2016

18. The maximum number of electrons which can occupy 2s orbital is
1) 1 2) 2 3) 3 4) 4

19. The electronic configuration of carbon is
1) $1s^2 2s^2 2p^1$ 2) $1s^2 2s^2 2p^2$
3) $1s^2 2s^2 2p^3$ 4) $1s^2 2s^2 2p^4$

20. The shape of s orbital is
1) dumb-bells 2) triangle
3) spherical 4) double dumbbell

T.S - ECET-2017

21. For an- f-orbital, the values of 'm' are
1) -1, 0, +1
2) -3, -2, -1, 0, +1, + 2, 3
3) 0, +1, +2, +3 4) -2, -1, 0, +1, +2

A.P - ECET-2017

22. The pauli exclusion principle is concerned with
1) energy of orbital 2) spin of electron
3) energy of electron
4) angular momentum of electron

23. According to Bhor's model of hydrogen atom, the following is quantized
1) linear momentum 2) linear velocity
3) angular momentum 4) angular velocity

24. How many 'd' -orbitals have two perpendicular nodal planes
1) two 2) three 3) four 4) five

T.S - ECET-2018

25. The set of quantum number for the 19^{th} electron in chromium is
1) n=4, l=0, m=0, s=+1/2 or -1/2
2) n=3, l=2, m=1, s=+1/2 or -1/2
3) n=3, l=2, m=-1, s=+1/2 or -1/2
4) n=4, l=1, m=0, s=+1/2 or -1/2

A.P - ECET-2018

26. Pauli's Exclusion principle states that two electrons in same orbital have
1) same spins 2) different spins
3) opposite spins 4) vertical spins

27. Phosphorus has an stomic number of 15. A stable phosphorus atom has an electronic configuration of
1) $1s^2 2s^2 2p^6 3p^5$
2) $1s^2 2s^2 2p^6 3s^2 3p^3$
3) $1s^2 2s^2 2p^6 3s^2 3p^1 4s^2$
4) $1s^2 1p^6 1d^7$

28. Orbits in which electons move according to bohu are
1) elliptical 2) cylindircal
3) circular 4) oval

PREVIOUS ECET BITS KEY

01) 1	02) 3	03) 4	04) 4	05) 1
06) 2	07) 1	08) 4	09) 1	10) 3
11) 1	12) 4	13) 2	14) 4	15) 1
16) 3	17) 4	18) 2	19) 2	20) 3
21) 2	22) 2	23) 3	24) 3	25) 1
26) 3	27) 2	28) 3		

CHEMICAL BOND

- Force of attraction that binds atoms together in a molecule is called chemical bond.
- Atoms combined to form molecule to get more stability
- Molecule that consists of same atoms is called homo atomic molecule
- Molecule that consists of different atoms is called hetero atomic molecule
- When atoms combine their potential energy decreases and so stability increases.
- To explain the formation of chemical bond between two atoms, electronic theory of valency has been proposed by Lewis and Kossel.

ELECTRONIC THEORY OF VALENCY

- It depends on outer most electrons i.e., valency electrons and inert gas electronic configuration.
- Inert gases have 8 electrons with $ns^2 np^6$ electronic configuration in their outer most shell (valence shell), Except He and Helium has ns^2 electronic configuration.
- Because of 8 electrons in the valence shell, these are inert and stable.
- Other atoms that are not having 8 electrons in the outer most shell are not stable and they have the tendency of combining with other atoms.
- Every atom tends to get 8 electrons in its outer most shell to get stability like inert gases. This is called octate rule
- Atoms will get 8 electrons in the valency shell either by loosing, or by gaining or by sharing electrons
- The valency exhibited by loosing or gaining electrons is called electro valency and the valency exhibited by sharing electrons is called covalency.
- Electrovalency was explained by Kossel and covalency was explained by Lewis.

IONIC BOND or ELECTROVALENT BOND

- Examples of Ionic Compounds

  NaCl, KCl, Na_2O, NaF, K_2O, $MgCl_2$, MgF_2, AlF_3, CaF_2, KBr, Na_2S, etc
- Ionic bond (or) electrovalent bond was proposed by Kossel and it depends on electro valency
- The bond formed between two atoms by the complete transfer of electrons is called ionic bond
- Ionic bond is formed between two atoms which have a difference of electronegativity 1.7 between them
- It is formed between the atoms of electropositive metalic elements and electronegative non metalic elements.
- In the formation of ionic compound metal atom loses electrons and forms positive ion and non metal atom gains electrons and forms negative ions.
- Atom and ion differ in number of electrons and in size.

Eg : 1 Formation of NaCl

⇨ In the formation of NaCl, Na atom loses an electron and forms Na^+ ion getting Ne electronic configuration. i.e., $1S^2\ 2S^2\ 2P^6$

$$Na - e^- \rightarrow Na^+$$

Cl atom gains an electron and forms Cl^- ion getting Ar configuration i.e., $1S^2\ 2S^2\ 2P^6\ 3S^2\ 3P^6$

$$Cl + e^- \rightarrow Cl^-$$

⇨ Na^+ and Cl^- ions are held by strong Electrostatic attraction forces forming solid ionic compound NaCl.

$$Na^+ + Cl^- \rightarrow NaCl(s)$$

Eg : 2 Formation of MgO

In the formation of MgO, Mg atom loses $2e^-$ and forms Mg^{+2} ions getting Ne configuration

$$Mg - 2e^- \rightarrow Mg^{+2}$$

'O' atom gains $2e^-$ and forms O^{-2} ion getting 'Ne' configuration.

$$O + 2e^- \rightarrow O^{-2}$$

The Mg^{+2} and O^{-2} ions are held by strong electrostatic attraction forces forming solid MgO.

$$Mg^{+2} + O^{-2} \rightarrow MgO(s).$$

⇨ In the formation of $CaBr_2$, Ca atom loses $2e^-$ and forms Ca^{+2} ion getting 'Ar' configuration.

$$Ca - 2e^- \rightarrow Ca^{+2}.$$

Each Br atom gains $1e^-$ Each Br^- ions getting Kr configuration.

$$2Br + 2e^- \rightarrow 2Br^-$$

The Ca^{+2} and the two Br^- ions are held by strong electrostatic attraction forces forming solid $CaBr_2$.

$$Br^- + Ca^{+2} + Br^- \rightarrow CaBr_2(s)$$

⇨ In the formation of K_2S, each K atom loses one e^- and forms K^+ ion getting Ar configuration.

$$2K - 2e^- \rightarrow 2K^+$$

S atom gains two $e-$ and forms S^{-2} ion getting Ar configuration.

$$S + 2e^- \rightarrow S^{-2}$$

The two K^+ ions and S^{-2} ions are held by strong electrostatic attraction forces forming solid K_2S

$$K^+ + S^{-2} + K^+ \rightarrow K_2S.$$

⇨ In the formation of AlF_3 : Al atom loses $3e^-$ and forms Al^{+3} ion getting Ne configuration.

$$Al - 3e^- \rightarrow Al^{+3}.$$

Each F atom gains one e^- and forms F^- getting Ne configuration.

$$3F + 3e^- \rightarrow 3F^-$$

Al^{+3} ion and three F^- ions are held by strong electrostatic attraction forces forming solid AlF_3.

⇨ **FACTORS AFFECTING IONIC BOND FORMATION**

⇨ All the factors favourable for cation formation and favourable for anion formation are the favourable factors for ionic bond formation.

⇨ **Factors favourable for cation formation**

⇨ large atomic size

⇨ Less ionization potential

⇨ Cation with less charge

- less atomic size
- more electronic affinity
- Anion with less charge
- Anion with inert gas electronic configuration.

PROPERTIES OF IONIC COMPOUNDS

- Ionic compounds are solids.
- Ionic bond is non directional. So ionic compounds do not exhibit isomerism.
- Ionic compounds contain positive and negative ions held by strong electrostatic forces.
- Melting and Boiling points of ionic compounds are high.
- Ionic compounds are soluble in polar solvents like water.
- Ionic compounds conduct electric current either in molten state (or) in aqueous solution.
- Ionic compounds do not conduct electric current in solid state as the ions are not free to move.
- Conduction of electric current in aqueous solution is more than in molten state.
- Reaction between ionic compounds in aqueous solution is very fast

COVALENT BOND

- Covalent bond is formed between the atoms having electronegativity difference less than 1.7

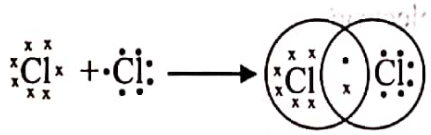
  Eg : for homoatomic molecules : H_2, Cl_2, Br_3, I_2, O_2, N_2, O_3 etc

  Eg : for heteroatomic molecules : H_2O, HCl, NH_3, HBr, CH_4, C_2H_6, H_2SO_4 etc
- When a bond is formed between two atoms potential energy decreases.
- The molecule is more stable than the atoms.
- Covalent bond was introduced as electron pair bond by Lewis.
- It was named as covalent bond by Langmuir.
- Bond formed due to mutual sharing of electron pair donated by both the bonded atoms is called covalent bond.
- Bond formed due to sharing of one electron pair is single covalent bond.
- Bond formed due to sharing of two electron pairs is double covalent bond.
- Bond formed due to sharing of three electron pairs is triple covalent bond.
- **Example : 1**

  In H_2 molecule, when two H atoms combine, each atom donates one electron forming an electron pair. The electron pair is shared by both the atoms forming single covalent bond.
- Number of electron pairs shared in H_2 molecule is 1.

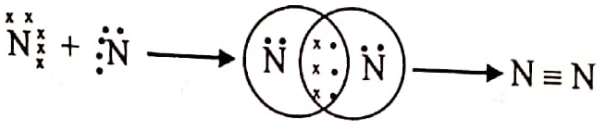
Lewis dot structure $H^{\bullet} + {\times}H \longrightarrow$ 

- In H_2 molecule both hydrogen have got stable [He] H - H electronic configuration
  Number of bonds present in H_2 molecule is 1.
- 'Shape of H_2 molecule is linear.
- **Example : 2**
  In Cl_2 molecule, when two 'Cl' atoms combine, each atom donates one electron forming an electron pair. The electron pair is shared by both the atoms forming a single covalent bond.
  Cl, Atomic no. 17, electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$



- both chlorine atoms have got Ar electronic Cl - Cl configuration
- Number of electron pairs shared in Cl_2 molecule is 1.
- Number of bonds formed in Cl_2 molecule is 1.
- Shape of Cl_2 molecule is linear.
- **Example : 3**
  In O_2 molecule, when two O atoms combine, each atom donates two electrons forming two electron Pairs. The two pairs are shared by both the atoms forming a double covalent bond.
  Oxygen Al. No. 8, electronic configuration $1s^2\ 2s^2\ 2p^4$

- Number of electron pairs shared in O_2 molecule is 2.
- Number of bonds in O_2 molecule is 2 (one - Sigma bond and one π pie bond)
- A multiple bond contains one σ bond and others are π bonds.
- Shape of O_2 molecule is linear.
- **Example : 4**
  In N_2 molecule, when two N atoms combine, each atom donates three electrons forming three electron pairs. The 3 electron pairs are shared by both the atoms forming triple covalent bond (1 σ bond and 2 π bonds)
  N. electronic configuration $1s^2\ 2s^2\ 2p^3$

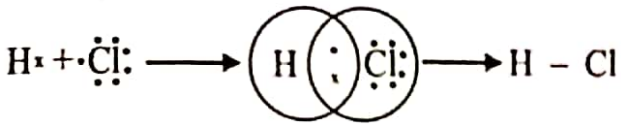


- both nitrogen atoms have got Ne electronic configuration
- Number of electron pairs shared in N_2 molecule is 3.
- Number of bonds in N_2 molecule is 3 .
- Shape of N_2 molecule is linear.

⇨ **Example : 5**

In HCl molecule. When H & Cl atoms combine,
each atom donates one electron forming an electron pair. The electron pair is shared by both the atoms forming a single covalent bond.

$H \rightarrow 1s^1$ $Cl \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$



⇨ Hydrogen gets Helium electronic configuration and Cl gets Ar electronic configuration.

⇨ Number of electron pairs shared in HCl molecule is 1.

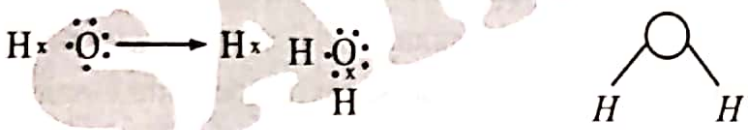
⇨ Number of bond sin HCl molecule is 1.

⇨ Shape of HCl molecule is linear.

⇨ **Example : 6**

In H_2O water molecule, when O atom and two H atoms combine 'O' atom donates one electron each towards two H atoms and each H atom donates one electron towards O atom forming two electron pairs. The electron pairs are shared by the atoms forming two single covalent bonds.

$H \rightarrow 1s^1$ $O \rightarrow 1s^2\ 2s^2\ 2p^4$



⇨ Hydrogen gets Helium electronic configuration and Oxygen atoms get Ne electronic configuration.

⇨ Number of electron pairs shared in H_2O molecule is 2.

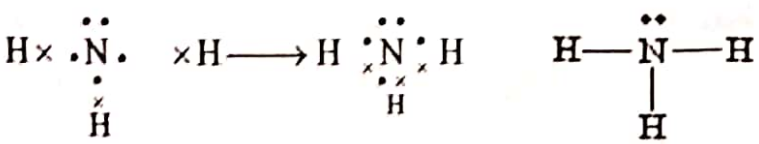
⇨ Number of bonds in H_2O molecule is 2.

⇨ Shape of H_2O molecule is Bent or Angular

⇨ angle in H_2O molecule is 104.5°.

⇨ In Ammonia molecule, when N and three H atoms combine, N atom donates one electron each towards three H atom and each H atom donates one electron towards N atom forming three electron pairs. The electron pairs are shared by the atoms forming three single covalent bonds.

H(1)1 , N (7) 2 , 5



⇨ Hydrogen gets Helium electronic configuration and Nitrogen atoms get Ne electronic configuration.

⇨ Shape of ammonia molecule is pyramidal.

⇨ Angle in ammonia molecule is 107.3°.

⇨ Carbon ground state electronic configuration is $1S^2\ 2S^2\ 2P^2$.

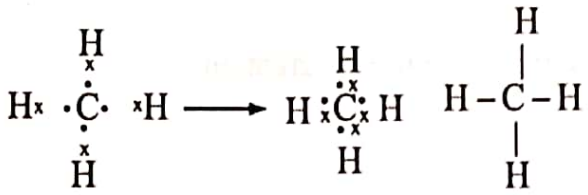
⇨ Carbon excited state electronic configuration is $1S^2\ 2S^1\ 2P^3$.

⇨ Carbon with its excited state electronic configuration, it forms 4 bonds exhibiting 4 valency.

⇨ **Example : 7**

In methane molecule, when C and four H atoms combine, each C atom donates one electron towards each of four H atom and each H atom donates one electron towards ' C atoms forming four electron pairs. The electron pairs are shared by the atoms forming fours single covalent bonds.

H (1) 1, C(6) 2, 4 $H \rightarrow 1s^1$ C, esec : $1s^2\ 2s^1\ 2p^3$



⇨ Number of electron pairs shared in Methane molecule is 4.

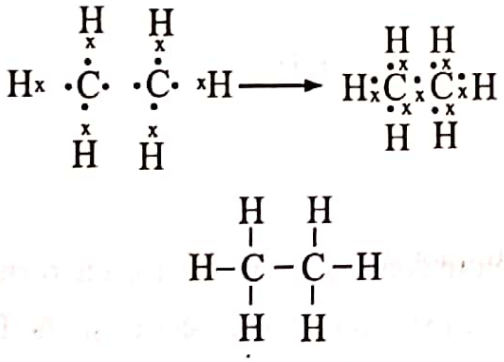
⇨ Number of bonds in Methane molecule is 4

⇨ Shape' of Methane molecule is Tetrahedral.

⇨ Angle in Methane molecule is 109°28" called Tetrahedral angle.

⇨ **Example : 8**

In C_2H_6 i.e., ethane molecule, when two C atoms and six H atoms combine, each C atom donates three electrons towards H atoms and one electron towards the second C atom. Each H atom donates one electron towards C forming a total of seven electron pairs. The electron pairs are shared by the atoms forming seven covalent bonds.



⇨ Number of electron pairs shared in Ethane molecule is 7.

⇨ Number of bonds formed in ethane molecules is 7.

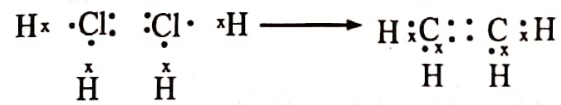
⇨ Shape of ethane molecule is Tetrahedral.

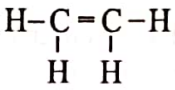
⇨ Angle in Ethane molecule is 109° 28'.

⇨ In C_2H_4 i.e., ethylene (or) ethene molecule when two C atoms and four H atoms combine, two C atoms donate four electrons to four H atoms and two electrons towards the other C atoms hydrogens donate one electron towards C atom forming a total of six electron pairs. The electron pairs are shared by the atoms forming one double bond and four single covalent bonds.

⇨ Number of electron pairs shared in ethylene molecule are 6.

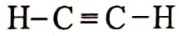
- Number of electron pairs shared between two C atoms are 2.
- Number of bonds in ethene molecule are 6.
- Number of bonds between two C atoms are 2. (1 σ bond and 1 π bond).





- Shape of ethylene molecule is planar triangle (or) trigonal
- The bond angle in ethylene molecule is 120°.
- **Example : 10**

  In C_2H_2 i.e., acetylene (or) ethyne molecule, when two C atoms and tow H atoms combine, two C atoms donates two electron towards two H atom and three electrons towards the other C atom, Each H atom donates one electron towards C atoms forming a total of five pairs of electrons. The electron pairs are shared by atoms forming one triple bond and two single bonds.
- Number of electron pairs shared in acetylene molecule are 5.
- Number of bonds in acetylene molecule are 5.



- Number of electron pairs shared between two C atoms are 3.
- Number of bonds between two carbon atoms are 3 (1 σ bond and 2 π bonds)
- Shape of acetylene molecule is linear.
- The bond angle in acetylene molecules is 180°.
- In all the above three examples C gets [Ne] electronic configuration and hydrogen gets [He] electronic configuration.
- For covalent bond formation, the atoms have

  i) Less atomic size

  ii) less electronegativity difference between the bonded atoms
- **<u>Properties of covalent compounds :</u>**
- Covalent compounds are present in all the three physical states, (eg ; Methane is a gas, Benzene is a liquid and sugar is a solid)
- Covalent bond is directional. So covalent compounds can exhibit isomerism.
- Covalent compounds contain molecules attracted by weak Vanderwaal's attraction forces.
- Melting and Boiling points of covalent compounds are less.
- Covalent element with highest melting point is diamond.

- Covalent compounds are soluble in non polar solvent like benzene, carbon tetrachloride, carbon disulphide, chloroform.
- Polar covalent compounds like HCl, NH_3 are soluble in water due to polarity.
- Compounds like alcohols and carboxylic acids are soluble in water due to formation of H- bond.
- Covalent compounds do not conduct electric current.
- Covalent element which conducts electric current is graphite due to free π - electrons.
- Polar compounds like HCl, NH_3, carboxylic acids conduct electricity In aqueous solution.
- Reaction between covalent compounds is slow
- **Hydrogen Bond :**
- It was proposed by Moore and Winmill.
- The attractive force which binds hydrogen atom with negative (or) electron rich another atom is H - bond (or) Proton bridge bond
- The weak electrostatic attraction force between partial positively charged H atom and negatively charged F (or) O (or) N atom is H-bond.
- For an atom to form H - bond
  a) it should have high electro negativity.
  b) its atomic size should be less. .
- Na and Cl have same electro negativity value but Cl dose not form H - bond predominantly because of its large atomic size.
- The H - bond present between the molecules is called intermolecular H - bond.
  Eg : HF, H_2O, NH_3. ROH, RCOOH, RNH_2.
  P - Nitrophenol, para hydroxy benzaldehyde phenol, O-chlorophenol
- The H - bond present with in a molecule is called intra molecular H - bond.
  Eg : O – Nitrophenol, salicylaldehyde, O-hydroxy benzaldehyde
- Type of H - bond present in p - nitrophenol is intermolecular H - bond.
- Type of H - bond present in O - hydroxy Benzoic acid is intramolecular H - bond.
- Hydroxy benzoic acid which forms H - bond with H_2O molecule is p - hydroxy benzoic acid.
- Strength of H - bond is 2 - 10 K. Cal/ mole.
- The greater the electro negativity & less the atomic size of atom held to H atom, the stronger is the H - bond
  eg ; H - F..... H > H - O .....H > H - N .....H
  10 KCal/mole 7KCal/mole
  2 K.Cal / mole
- Molecule with strongest H - bonds is HF
- F can form HF_2^- (KHF_2) while other halogens do not form such ions as they do not form H - bond.
- The strongest H - bond (27 K.Cal/ mole) is present in HF_2^- ion.

- Molecules of a substance which are held together through H - bond are called associated molecules. Eg : HF, H_2O, NH_3. .
- Molecules of different substances held by H -bond are called co-associated molecules.
- H_2S with greater Vanderwaals attraction force in it is a gas while H_2O with less Vandenwaals attraction forces is a liquid due to formation of H - bond.
- Abnormal high boiling point of water is due to presence of H - bonding.
- Tetrahedral structure of ice is due to formation of H - bonds.
- The low density of ice compared to water is due to formation of H - bonds.
- In crystal of ice every water molecule is tetrahedrally attached to four water molecules through hydrogen bonds with large space between the molecules.
- The anomalous expansion of water is due to the presence of H - bond.
- The increase in density of water from O°C to 4°C is called anomalous expansion of water.
- The density of water is maximum at 4°C (277° A) due to presence of H - bond.
- The boiling point of HF with stronger H - bond is less than that of water because number of H - bonds formed by water molecule are two and formed by HF molecule is one
- The abnormal high boiling point of HF is due to the presence of H - bond.
- The abnormal high boiling point of NH_3 is due to the presence of H - bond.
- The abnormal high boiling point of Alcohols is due to the presence of H - bond.
- The solubility of alcohols and glucose in water is due to the formation o H - bond.
- The solubility of carboxylic acids in water is due to the formation of H - bond.
- The dimerisation of acetic acid in benzene is due to formation of H - bond and so its density is higher
- **Polar and non polar covalent bond :**
- Non polar covalent bond is formed between two similar atoms, or between two atoms with less electronegativity difference.
- A molecule with no charge separation is called non-polar molecule and the bond formed is non-polar covalent bond eg : H_2, Cl_2, N_2, O_2, HCl, HBr, etc.
- If partial positive and partial negative charges are separated within the molecule, it is called polar molecule the bond formed is polar covalent bond.
  Eg : HF, H_2O, NH_3, ROH etc. (Atoms with more electronegativity difference).
- If electronegativity difference in more, the polarity is more HF is more polar than H_2O
- As the electronegativity difference between the bonded atoms increases, ionic character increases and covalent character decreases
- Cs is the least electronegativity atom and fluorine is highest, So ionic character is highest in CsCl
- If valency of atom 'A' is x and an atom 'B' is y. When A and B are combined, the formula of the compound is A_yB_x.

⇨ Between nonmetallic atoms, the electronegativity difference is less so covalent bond is formed.

⇨ Between I and II group elements (i.e., alkali and alkaline earth metals and halogen, N,S etc. Ionic bond can be formed due to more electronegativity difference.

⇨ **Metallic Bond**

Most of metals exist in one of three common structures

1. Hexagonal close packed : Each atom is surrounded by 12 atoms
2. Cubic Close Packet : Each atom is surrounded by 12 atoms
3. Body Centred Cubic : Each atom is surrounded by 8 atoms

⇨ The special type of bonding which holds the atoms together in metal crystal is called the metallic bonding.

⇨ A chemical bond of the type holding together the atoms in a solid metal or alloy is called a metallic bond.

⇨ Metallic bond may be defined as the bond formed as a result of simultaneous attraction of an electron by two or more than two positive ions of the metal.

⇨ Metallic bond may be defined as the electrostatic force of attraction that the neighbour positive metallic ions (kernels) have for the delocalised electrons.

⇨ Lorantz proposed a simple theory known as electron gas model or electron sea model to explain the nature of metallic bond

⇨ **According to electron sea model :** The special type of bonding in metals can be explained based on the following two features of metals.

⇨ Low ionisation energy

⇨ Lesser number of valence electrons than the number of vacant valency orbitals. The valency electrons of metallic atoms are very loosely bound to the nucleus.

⇨ Thus, it is possible for an electron to be delocalized and move freely in the valency orbitals of adjacent atoms.

⇨ The result of the delocalization of valence electrons leads to the production of positive metal ions known as kernels.

A metal atoms is supposed to consist of two parts namely (i) valence electrons and (ii) The remaining part (the nucleus and the inner shells) called Kernel.

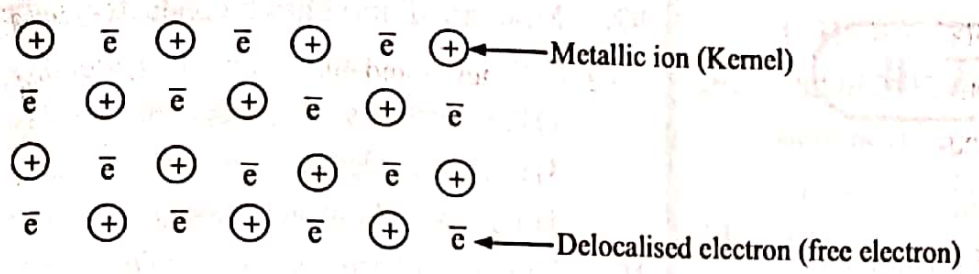
⇨ The kernels of metal atoms occupy the lattice sites while the space between kernel is occupied by valence electrons.

⇨ Metals, in general, have low ionisation energies, because their valence electrons can be removed easily which means that the valence electrons in metals are weakly bound to the kernel.

⇨ The electrons leave the field of influence of one kernel and come under the influence of another kernel.

⇨ The electrons are not localised but are mobile.

⇨ The simultaneous attraction between the kernels and mobile electrons which hold the kernel together is known as metallic bond.



The electron Sea Model of Metallic Bonding

- Strength of the metallic bond increases with
  1. number of valence electrons
  2. decrease in size of the atom
- Electrical and thermal conductivity of metals is due to the movement of delocalised electrons
- Metallic bond can explain the properties of metals like
  1. high conductivity 2. malleability 3. ductibility etc.
- **Coordinate covalent bond (or) Dative bond**
- A bond formed by sharing of electrons but shared pair of electrons is supplied by any one of the bonded atoms is called coordiante covalent bond.
- In this electron pair is shared between donar and acceptor.
- Donar must have
  i) Lone pair of electrons like H_2O, NH_3, ROH, PH_3 etc.
  ii) a negative charge like Cl^-, OH^-, Br^- etc.
  iii) Multiple bonds between carbon like C = C, C ≡ C etc.
- **Acceptor must have**
  i) Electron deficiency with vacant orbitals like BF_3, BCl_3, $AlCl_3$, $FeCl_3$ etc.
  ii) Positive charge like H+
  iii) Multiple bonded compounds other than carbon-carbon multiple bonds, like CO_2, SO_2, SO_3 NO_2 etc.

Eg :

1) Hydronium ion :

$$H_2\ddot{O}: + H^+ \longrightarrow [H_2O \rightarrow H]^+ \text{ or } H_3O^+$$

2) NH_4^- ion :

$$H_3\ddot{N} + H^+ \longrightarrow [H_3N \rightarrow H]^+ \text{ or } NH_4^+$$

3) Ammonia - Boron trifluoride :

$$H_3\ddot{N} + \square\, BF_3 \longrightarrow H_3N \longrightarrow BF_3$$

PRACTICE SET - II

01. NaCl crystal is formed from
1) Na Cl units 2) Na, Cl atoms
3) Na^+, Cl^- ions 4) None

02. To form an Ionic bond between two elements- they should differ much in the following factor.
1) atomic number 2) electro negativity
3) atomic radius 4) electron affinity

03. The bond formed when electrons are shared between two atoms is
1) ionic bond 2) Covalent bond
3) dative bond 4) hydrogen bond

04. The bond that can be formed between a metal atom and a non - metal atom is
1) electrovalent bond
2) covalent bond 3) metallic bond
4) electron deficient bond

05. An atom becomes a negative ion by
1) gaining electrons
2) losing electrons 3) sharing electrons
4) transfer of electrons

06. The boiling point of water is higher than that of hydrogen sulphide. This is due to
1) ionic bonds 2) covalent bonds
3) hydrogen bonds
4) vander waals forces

07. Which of the following possess high strength
1) a Sigma bond 2) a pi bond
3) an ionic bond 4) a coordinate bond

08. When the bond pair of electrons are shared unequally between two atoms, the bond formed will be
1) ionic bond
2) non polar covalent bond
3) polar covalent bond
4) hydrogen bond

09. Molten sodium chloride conducts electricity due to the presence of
1) free electrons 2) free ions
3) free molecules
4) atom of sodium and chlorine

10. The shape of Ammonia molecule
1) pyramidal 2) linear
3) regular tetrahedron
4) distorted tetrahedron

11. The shape of Beryllium chloride molecule
1) pyramid 2) tetrahedral
3) trigonal planar 4) linear

12. In acetylene in Its triple bond the following bonds are present
1) 1 Sigma + 2 pi bonds
2) 2 Sigma + 1 pi bonds
3) 3 Sigma + 2 pi bonds 4) 3 pi

13. The type of bonds in N_2 molecule
1) 2 Sigma + 1 pi bond
2) 2 Sigma + 2 pi bond
3) 1 Sigma + 2 pi bond
4) 1 Sigma + 1 pi bond

14. The melting and boiling points of covalent compounds when compared to that of ionic compounds
1) greater 2) lesser 3) equal 4) none

15. The bond between the most electro positive and electronegative elements
1) Covalent bond 2) Ionic bond
3) Dative bond 4) Hydrogen bond

16. Hydrogen bonding is stronger in the following substance
1) H_2O 2) HF 3) NH_3 4) C_6H_6

17. O - Nitro phenol has
1) Inter molecular hydrogen bonding
2) Intra molecular hydrogen bonding
3) no hydrogen bonding
4) vander wall's forces of attraction

18. Non-directional chemical bond is
1) Ionic bond 2) covalent bond
3) co-ordinate covalent bond
4) none

19. The high boiling point of water is due to
1) Its high specific heat
2) Hydrogen bonding between water molecule
3) Weak dissociation of H_2O molecules
4) Its high dielectric constant

20. Which of the following is a good conductor of electricity
1) Diamond 2) Solid Sodium Chloride
3) Molten Sodium Chloride
4) Solid Potassium Chloride

21. For the formation of covalent bonds the difference in the values of electro negativity between the atoms should be
1) > 1.70 2) < 1.70 3) > 1
4) No relation with soluble salts

22. Which of the following contains bonds that are non-directional in character?
1) BCl_3 2) CsCl 3) NCl_3 4) $BeCl_2$

23. For an ionic bond to form between two atoms, their electro negativities should be
1) equal 2) as different as possible
3) as close as possible 4) in 1 : 4 ratio

24. Which one of the following bonds is directional in character
1) ionic bond 2) Hydrogen bond
3) metallic bond 4) covalent bond

25. H_2O is liquid and H_2S is a gas at room temperature because
1) the size of 'sulphur" is greater than "oxygen" atom
2) there exists hydrogen bonding in H_2O
3) there exists hydrogen bonding in H_2S
4) H_2S is more ionic than H_2O

26. Water has higher Boiling point than the corresponding hydrides H_2S, This is because in water three exists
1) Strong covalent bonds 2) Hydrogen Bonds
3) Ionic Bonds 4) Coordinate bonds

27 H-bond formed between two molecules is called
1) Intermolecular 2) Intra molecular
3) Polar 4) Ionic

28. The molecule with strongest hydrogen bond Is
1) H - F 2) NH_3 3) PH_3 4) H_2O

29. Out of CO_2, NH_3, O_2 and PCl_5 the molecule that does not obey octet rule is
1) CO_2 2) NH_3 3) PCl_5 4) O_2

30. The hydrogen bond is strongest in
1) F - H..... F 2) O - H ..... O
3) H-Cl..... H 4) N - H ..... N

31. Which of the following is exceptional to octet value
1) $BeCl_2$ 2) CO_2 3) H_2O 4) CH_4

32. Ionic bond exists in a molecule of
1) $MgCl_2$ 2) SO_2 3) NO 4) NH_3

33. Ionic compounds
1) have bonds which are directional
2) conduct electricity in solid state
3) don't conduct electricity in molten state
4) are general more soluble in polar solvents than in non polar solvents

PRACTICE SET - I KEY

01) 3	02) 2	03) 2	04) 1	05) 1
06) 3	07) 3	08) 3	09) 2	10) 1
11) 4	12) 1	13) 3	14) 2	15) 2
16) 2	17) 2	18) 1	19) 2	20) 3
21) 2	22) 2	23) 2	24) 4	25) 2
26) 2	27) 1	28) 1	29) 3	30) 1
31) 1	32) 1	33) 4		

You are the creator of your own destiny

PRACTICE SET - II

01. Electrovalent substance is a collection of
1) cations 2) anions
3) cations and anions
4) equal number of cations and anions

02. When two atoms come closure to form a bond their potential energy
1) increases 2) decreases
3) does not change 4) None

03. The type of bond formed between the atoms of alkali metals and halogens
1) covalent bond 2) Ionic bond
3) dative bond 4) hydrogen bond

04. Multiple bond is present in
1) C_2H_4 2) H_2 3) C_2H_6 4) CH_4

05. Which of the following is the weakest bond
1) ionic 2) metallic
3) hydrogen 4) covalent

06. In the formation of a bond between a metal and a non-metal atom, the metallic atoms tend to
1) lose electrons 2) gain electrons
3) cannot be predicted
4) remain unchanged

07. The two electrons Involved in a covalent bond will have
1) opposite spin 2) similar spin
3) similar or opposite spin
4) no spin

08. A covalent substance in the following
1) NaCl 2) Gold
3) Diamond 4) NaOH

09. The number of electrons participate in bonding in N_2 molecule
1) 2 2) 4 3) 6 4) 8

10. The nature of compounds formed by Beryllium
1) ionic 2) covalent
3) coordinate 4) none

11. Which of the following compounds has an electrovalent linkage
1) CH_4 2) $MgCl_2$ 3) $SiCl_4$ 4) Br_2

12. A stronger hydrogen bond is present in
1) H_2O 2) HCl 3) NH_3 4) HF

13. A molecule containing intermolecular hydrogen bond
1) Para nitro phenol
2) Ortho nitro phenol
3) Benzoic acid 4) All the above

14. Which of the following compounds is covalent
1) H_2O 2) CaO 3) KCl 4) Na_2S

15. The valency of an element with electronic configuration $1s^2\,2s^2\,2p^6\,3s^2$ is
1) 0 2) 9 3) 2 4) 8

16. Ionic bond and covalent bands are present in
1) KCl 2) NaCl
3) NaOH 4) NH_4^+

17. Two lone pairs and two bond pairs of electrons are in the following molecule
1) NH_3 2) BF_3 3) CH_4 4) H_2O

18. 5 σ and 1π bonds are present in the molecule
1) C_2H_6 2) C_2H_4
3) C_2H_5Cl 4) C_2H_2

19. In which of the following hydrogen bond does not exist
1) C_2H_5OH 2) $C_6H_5CH_3$
3) CH_3COOH 4) CH_3COOH

20. Which of the following is not ionic compound
1) $BeCl_2$ 2) $MgCl_2$
3) $CaCl_2$ 4) None

21. The number of lone pair of electrons on the central atom of CH_4, NH_3 and H_2O are respectively
1) 2,0,1 2) 0,2,2 3) 0,1,2 4) 2,1,0

22. In 'NaCl' formation
1) 'Na' is oxdised 2) Na^+ is reduced
3) Cl - is reduced 4) Cl^- is reduced

23. The electro negativity of cesium is 0.7 and that of fluorine is 4.0. The bond formed between the two is
1) Covalent bond 2) ionic bond
3) Metallic bond 4) Hydrogen bond

24. Molten CsCl conducts electricity due to the presence of
1) Free electrons
2) Free Cs^+ and Cl^- ions
3) Free molecules
4) Free atoms of Cs and *Cl*

25. An element of atomic number 11 will form a strongly ionic compound with an element of atomic number
1) 10 2) 34 3) 35 4) 37

26. In N_2 molecule the atoms are bonded by
1) $1\sigma, 2\pi$ 2) $1\sigma, 1\pi$
(3) $2\sigma, 1\pi$ 4) $3\sigma, 2\pi$

27. The boiling points of CS_2, H_2O and CCl_4 are 41.3° C. 100°C and 77° C respectively. The liquid in which the inter molecule forces are weakest is
1) CS_2 2) CCl_4
3) H_2O
4) All the above have equally weak forces

28. The charge carried by an electron is
1) $-1.6\times10^{-19}C$ 2) $1.6\times10^{-6}C$
3) $1.6\times10^{-23}C$ 4) $1.5\times10^{-16}C$

PRACTICE SET - II KEY

01) 3	02) 2	03) 2	04) 1	05) 3
06) 1	07) 1	08) 3	09) 3	10) 2
11) 2	12) 4	13) 1	14) 1	15) 3
16) 3	17) 4	18) 2	19) 2	20) 1
21) 3	22) 1	23) 2	24) 2	25) 3
26) 1	27) 1	28) 1		

Araise ! Awake ! And stop not till the goal is reached

PRACTICE SET - III

01. The type of bond formed between two highly electro positive elements
1) ionic bond 2) covalent bond
3) metallic bond 4) dative bond

02. The force responsible for the union of two ice blocks as a single block is
1) vandenwaals force
2) hydrogen bonds
3) dipole inter action
4) vanderwaals force

03. An atom of an element 'A' has three electrons in the outermost orbit and that of B' has 6 electrons in its outermost shell. The formula of the compound formed, when these two one combined
1) A_3B_2 2) A_2B 3) AB_2 4) A_2B_3

04. Ortho Nitro phenol is more volatile than P - Nitro phenol because of
1) resonance in the molecule
2) hyper conjugation
3) inter molecular hydrogen bond
4) intra molecular hydrogen bond

05. Ammonia is soluble in Water - since it is
1) Polar molecule
2) non-polar molecule
3) ionic compound
4) with high dielectric constant

06. The molecule with large C - C bond distance is
1) Ethane 2) Ethene
3) Ethyne 4) Benzene

07. The formula of a compound formed by elements X (2, 8, 6) and Y(2,8,8,2).is
1)XY 2) YX 3) X_2Y_3 4) Y_3X_3

08. The boiling point of H_2O is more than that of HF because
1) Water forms associated molecules
2) HF forms associated molecules
3) The hydrogen bond in H_2O is stronger that of HF
4) H_2O contains two hydrogen bonds on average and hydrogen bond is not present in vapour state of H_2O

09. Which of the following has the highest melting point
1) NaCl 2) NaBr 3) Nal 4) NaF

10. Which of the following compounds contain both electrovalent and covalent bonds
1) H_2 2) CH_4 3) NaCl 4) KOH

11. Which of the following has the highest melting point
1) NaCl 2) NaBr 3) Nal 4) NaF

12. Which of the following compounds contain both electrovalent and covalent bonds
1) H_2 2) CH_4 3) KCN 4) KCl

13. The compound with out lone pairs on the central atom is
1) H_2O 2) CCl_4 3) NH_3 4) CH_3-O-CH_3

14. The most ionic compounds are formed between the groups
1) IA and VI A 2) II A and VII A
3) IIA and VI A 4) IA and VIIA

15. Hydrogen bonding is absent in the following
1) Water 2) Ice 3) Steam 4) None

16. No. of hydrogen bonds formed by a water molecule is
1) 1 2) 2 3) 3 4) 5

17. The compound which contains both ionic and covalent bonds is
1) CH_4 2) H_2 3) KCN 4) KCL.

18. The strength of hydrogen bond is about
1) 20 kJ mol^{-1} 2) 100 kJ mol^{-1}
3) 150 kJ mol^{-1} 4) 200 kJ mol^{-1}

19. Graphite is an example of
1) ionic crystal 2) covalent crystal
3) molecular crystal 4) metallic crystal

20. Among the compounds NaCI. KCl, and CsCl, the one with the greatest ionic character is
1) NaCl 2) KCl 3) CSCl 4) All

21. The electronegativity value of C. H, O. N, and S are 2.5, 2.1, 3.5, 3.0 and 2.5 respectively. Which of the following bonds is most polar
1) C - H 2) N - O 3) C - S 4) O - H

22. The number of 'σ' bonds in ethylene are
1) 3 2) 7 3) 5 4) 1

23. Among PCl_3, NCl_3 and PCl_3 violation of octale rule is observed in ....

24. Inert elements have ___ electrons in the outermost orbit.

25. The bond angle in water is.....

PRACTICE SET -III KEY

01) 3	**02)** 2	**03)** 4	**04)** 4	**05)** 1
06) 1	**07)** 2	**08)** 4	**09)** 4	**10)** 4
11) 4	**12)** 3	**13)** 2	**14)** 4	**15)** 3
16) 2	**17)** 3	**18)** 1	**19)** 2	**20)** 3

21) 4 **22)** 3 **23)** PCl_5

24) 8 electrons

25) 104°30'

PREVIOUS ECET BITS

ECET - 2013

01. Sodium metal and sodium ions have
1) the same number of electrons
2) the same reactivity with water
3) the same number of neutrons
4) different number of protons

ECET -2014

02. The hyddrogen bond is strongest in
1) O-H-- --S 2) S-H---O
3) F-H---F 4) F-H---O

03. The molecule having pyramidal shape
1) PCl_3 2) SO_3
3) CO_3^{2-} 4) NO_3^-

04. Crystals of a sodium chloride belong to the system
1) Orthorhombic 2) Cubic
3) Trigonal 4) Monoclinic

TS-ECET-2015

05. Why sodium chloride is more soluble in water
1) sodium chloride is a covalent compound and water is a polar solvent
2) sodium chloride is a ionic compound and water is a polar solvent
3) sodium chloride is covalent compound and water is a non- polar solvent
4) sodium chloride is ionic compound and water is a non- polar solvent

AP-ECET-2015

06. Which of the following is a non-direction bond
1) metallic 2) coordinate
3) cobalent 4) ionic

07. The bond formed by sidewise overlap of atomic orbitals is
1) ionic bond 2) sigma bond
3) Pi bond 4) coordinate bond

TS-ECET-2016

08. Which one of the following is most covalent in nature
1) NaC1 2) $MgCl_2$ 3) $CaCl_2$ 4) $AlCl_3$

AP-ECET-2016

09. The type of chemical bond present in sodium chloride is
1) covalent bond 2) polar covalent bond
3) polar bond 4) ionic bond

10. Which of the follwing compound has covalent bond
1) NaCl 2) HCl 3) H_2O 4) H_2

11. Which solvent is also called universal solvent
1) ethylacetate 2) methanol
3) water 4) dichloromethane

TS-ECET-2017

12. Among LiCI, $BeCl_2$, BCl_3 and CCl_4, the covalent character follows the order
1) LiCl>$BeCl_2$>BCl_3>CCl_4
2) LiCl<$BeCl_2$<BCl_3<CCl_4
3) LiCl>$BeCl_2$<BCl_3>CCl_4
4) LiCl<$BeCl_2$<BCl_3>CCl_4

13. Which of the following contains ionic, covalent and coordinate covalent bonds
1) NH_4Cl 2) $K_3[Fe(CN)_6]$
3) $CuSO_4$
4) $NH_4Cl, CuSO_4$ and $K_3[Fe(CN)_6]$

14. Which one of the following type of forces are present in Nylon
1) electrostatic forces of attraction
2) hydrogen bonding
3) three dimensional network of bonds
4) metallic bonding

AP-ECET-2017

15. In sodium chloride crystal, each Na^+ ion is surrounded by
1) two Cl^- ions 2) Four Cl^- ions
3) six Cl^- ions 4) Eight Cl^- ions

16. Which among the following molecule contains an π - bond
1) H_2 2) O_2 3) F_2 4) HCl

17. Which among the following is insoluble in water
1) alcohol 2) ammonia 3) benzene 4) acetone

TS-ECET-2018

18. In which of the following compounds, is coordinate covalent bond present
1) PH_3 2) H_2O 3) NH_4OH 4) HB_r

19. Variable valency is shown by_____
1) N and O 2) P and S
3) F and C1 4) N and S

20. In the following balanced equation
$H_2SO_4 + \times HI \rightarrow H_2S + YI_2 + ZH_2O$
The values of x, Y,Z would be_____
1) x=4, Y=8, Z=5 2) x=6, Y=3, Z=4
3) x=8, Y=4, Z=4 4) x=3, Y=5, Z=4

AP-ECET-2018

21. NaCI is classified as having what kind of bonds in the solid phase
1) covalent 2) ionic
3) plar 4) vander waals

22. The Bond formed due to sharing of electrons is

1) ionic bond 2) metallic bond

3) polar bond 4) covalent bond

PREVIOUS ECET BITS KEY

01) 3	02) 3	03) 1	04) 2	05) 2
06) 1	07) 3	08) 4	09) 4	10) 4
11) 3	12) 2	13) 4	14) 2	15) 3
16) 2	17) 3	18) 3	19) 2	20) 3
21) 2	22) 4			

ALL POWER IS WITHIN YOU
YOU CAN DO ANYTHING AND EVERYTHING

SPACE FOR IMPORTANT NOTES

SOLUTIONS

1. A solution is a homogeneous mixture of two or more substances, whose composition can be varied within limits.
2. Homogeneous means the composition is uniform throughout and the substances will be completely miscible.
3. The substance that changes it's physical state in the solution is called solute and which retains its physical state is called solvent.

   The component present in greater amount in a solution is called solvent.
4. The component present in less quantity in a binary solution is referred to as solute.
5. A solution containing only two components is called binary solution.
6. Formation of a solution is a physical process.
7. If water is solvent, the solution is called aqueous solution. If alcohol is used as solvent the solution is called alcoholic solution.
8. A solution in which the amount of the solute is very low is called as Dilute solution.
9. A solution whose concentration is definitely known is referred to as a standard solution.
10. Solid solutions : Are those in which solvent is solid and solute may be gas or liquid or solid : Examples :

    a) Gas in solid : Occlusion of hydrogen over palladium, Pt, Ni etc.

    b) Liquid in solid : Amalgums (liquid Hg in Zn), Hygroscopic salts like, $K_2SO_4.Al_2(SO_4)_3.24H_2O$

    $CuSO_4, 5H_2O$. $CaSO_4.2H_2O$ etc.

    c) Solid in solid : Alloys like Brass (Cu + Zn), Bronze (Cu + Sn), German Silver (Cu + Zn + Ni)

    stainless steel : $Fe + Cr + Ni$
11. Liquid solutions : Are those in which solvent is liquid white solute may be gas or liquid or solid. Examples :

    a) Gas in liquid : Aerated water, Soda water, carborated drinks

    b) Liquid in liquid : Alcohol in water, milk & water, Kerosene & petrol, Benzene + CCl_4 etc.

    c) Solid in liquid : Salt in water, Sugar in water
12. Gaseous solutions : Are those in which solvent is gas, solute may be gas or liquid or solid. Examples :

    a) Gas in gas : Air, Mixture of O_2 and N_2

    b) Liquid in gas : Vapour in air, Moisture in air.

c) Solid in gas : Camphor in air, Naphthalene or Iodine in air (sublimation compounds)

13. Solubility is the amount of solute in grams that saturates 100gm of a solvent at a given temperature.

14. Depending upon the relative amounts of the dissolved solute, there are three types of solutions :

a) Saturated solution

b) Unsaturated solution

c) Supersaturated solution

15. Solution containing maximum amount of the dissolved solute at a given temperature is called saturated solution. This solution can not dissolve any more of solute.

16. A solution in which the amount of dissolved solute is less than that required for saturation is called unsaturated solution. It can dissolve some more solute.

17. A solution containing more the amount of solute than required for saturation at a given temperature is called super saturated solution. This solution is metastable (highly unstable). These are prepared by heating and cooling.

18. MOLE : The amount of a substance containing the same number of elementary units as the number of atoms in exactly 12 grams of C - 12 atom is called mole.

19. The amount of the substance containing Avogadro number of elementary chemical units (atoms or molecules or ions) is also called mole. Ex : The mass of one mole of oxygen atms = 16g (1 GAW).

The mass of one mole of oxygen molecules = 32 g (1GMV)

20. Charge of one mole of electrons is equal to 96500 coulombs. It is equal to one FARADAY

21. Number of moles (m) = $\frac{\text{Weight of substance in gms(w)}}{\text{Gram atomic wt.of the substance(GMW)}}$

22. Gram atom : One gram atomic weight of a substance is called gram atom. It is equal to the weight of Avogadro number of atoms. Ex : Atomic weight of nitrogen = 14 amu (or) :gram atomic weight of N=14gm

Number of gram atoms = $\frac{\text{Weight of substance in gms}}{\text{Gram atomic wt. of the substance}}$

Number of gram atoms in 140 gm of N = $\frac{140}{14} = 10$

23. Gram molecule : One gram molecular weight of a substance is called gram molecule. It is equal to the weight of Avogadro number of molecules.

Ex : Molecular weight of CO_2 = 44 amu

$\therefore$ Gram Mol. wt of CO_2 = 44 grams.

$$\text{Number of gram molecules} = \frac{\text{wt. of substance}}{\text{gram mol.wt (GMW)}}$$

$$\text{No. of gram molecules in 90 gm of water} = \frac{90}{18} = 5$$

24. Avogadro number (N) : The number of atoms in one gram atomic weight of a substance or the number of molecules in one gram molecular weight of a substance is called Avogadro number (N). It is equal to 6.023×10^{23}.

25. Reciprocal of Avogadro number is known as Avogram.

$$\text{Avogram} = \frac{1}{N} = \frac{1}{6.023 \times 10^{23}} = 1.67 \times 10^{-24}$$

26. Weight of a substance (w) = no. of moles (n) X GMV

$$\text{But No. of moles (n)} = \frac{\text{no.of molecules}}{\text{Avogadro number (N)}}$$

$\therefore$ No. of molecules = No. of moles (n) X Avagadro no. (N)

27. No. of moles (for a gas at STP)

$$(n) = \frac{\text{Volume of the gas}}{\text{GMV}}$$

$$(\text{or}) \; n = \frac{V}{22.4}$$

$\therefore$ Volume of the gas (v) = $n \times 22.4$ lit at STP.

(GMV = Gram molar Volume)

28. In case of elements, the weight of one mole of atoms is equal to its gram atomic weight (GAW).

$$\text{No. of moles of atom (n)} = \frac{\text{weight of the element}}{\text{GAW}}$$

But no. of atoms = No. of moles of atoms X Avogadro no. (N)

$$\therefore \text{No. of atoms in a given quantity of element} = \frac{\text{weight of element}}{\text{GAW}} \times N$$

29. Molarity (M) = The number of moles of solute present in one litre (1000ml) of solution at a given temp is known as molarity.

$$\text{Molarity (M)} = \frac{\text{no.of moles of solute (n)}}{\text{Volume of solution in lit } (V_{lit})} \text{ (or) } M = \frac{n}{V}$$

$$\text{No. of moles of solute (n)} = M \times V$$

$$\text{But no. of moles of solute (n)} = \frac{\text{wt.of solute}}{\text{GMV of solute}} = \frac{w}{GMV}$$

$$\therefore \frac{w}{GMV} = M \times V \text{ (or) } w = M \times V \times GMW$$

wt. of solute (w) = Molarity (M) × vol. of solution in lit (V_{lit}) x GMW

$$M = \frac{w}{GMW} \times \frac{1}{V_{lit}}$$

$$\text{Also } M = \frac{w}{GMW} \times \frac{1000}{V_{ml}}$$

30. Units of molarity (M) are moles/ lit.

31. Molarity depends on temperature

As temperature increases, Molarity decreases

32. For dilute solutions, (dilution, formula)

$$M_1V_1 = M_2V_2$$

Where,

M_1 = Molarity of concentrated solution

V_1 = Volume of concentrated solution

M_2 = Molarity of Diluted solution

V_2 = Volume of Diluted solution.

33. For volumetric titrations

(When two different substances react)

$$\frac{M_1V_1}{n_1} = \frac{M_2V_2}{n_2}$$

where,

M_1 = Molarity of 1st solution

M_2 = Molarity of 2nd solution

V_1 = Volume of 1st solution

V_2 = Volume of 2nd solution

n_1 = no of moles of 1st solution

n_2 = no. of moles of 2nd solution

34. The solution whose concentration is exactly known is called standard solution. Standard solutions are prepared in volumetric flasks or standard flasks.

35. If one gram molecular weight (1 GMV) of a solute is present in one litre (1000ml or 1000 CC) of the solution it is said to be 1 Molar or 1M (one mole)

36. If 0.1 gram molecular weight of a solute is present in one litre of the solution, it is said to be 0.1M or decimolar or M/10 solution.

37. Weight of the solute present in one litre = Molarity x Molecular weight.

38. If the solution of molarity, M_1 and volume, V_1 is diluted to volume V_2 its molarity changes to M_2. ($V_1M_1 = V_2M_2$ or $M_2 = V_1M_1 / V_2$)

39. The volume of water to be added = $V_2 - V_1$ or volume after dilution (V_2) - volume before dilution (V_1)

40. If density (d) and percent by weight (w%) of a substance in a solution are known, then its molarity (M) is calculated by, $M = d \times w\% \times \frac{10}{Mol.wt}$

41. Number of moles of solute in a solution (n) = Molarity (M) X vol. in lit (V_{lit})

42. No. of millimoles present in a solution = Molarity (M) X Vol in cc

43. Molarity of a mixture of solutions of different concentrations of same substance can be calculated by

$$M = \frac{V_1M_1 + V_2M_2 + ... V_nM_n}{\text{Total Volume}}$$

44. Normality (N) : The number of gram equivalents of a solute present in one litre (1000ml) of the solution is called as normality (N).

45. $$\text{Normality (N)} = \frac{\text{No. of gram equivalents of solute}}{\text{Volume of solute in lit}}$$

$$\text{(or) } N = \frac{\text{wt. of solute (w)}}{\text{Equivalent wt of solute}} \times \frac{1}{\text{Volume in lit}}$$

$$N = \frac{w}{GEW} \times \frac{1}{V_{lit}} \text{ (or) } N = \frac{w}{GEW} \times \frac{1000}{V_{ml}}$$

46. If one gram equivalent weight of a solute is present in one litre of the solution, it is said to be one normal (or 1N)

47. If 0.1 gram equivalent weight of a solute is present in one litre of the solution, it is said to be 0.1 N or decinormal or N/10 solution.

48. Weight of the solute present in one litre = Normality (N) X Equivalent weight (GEW).

49. Weight of the solute present in a given solution = volume

of solution in lit (V_{lit}) × Normality (N) × GEW i.e. $w = V_{lit} \times N \times GEW$

50. If a solution of normality N_1 of volume V_1 is diluted to a volume V_2 then its normality changes to N_2. This N_2 can be calculated by $V_1N_1 = V_2N_2$.

51. The volume of water to be added to dilute a solution of volume V_1 of normality N_1 to a concentration of N_2 is given by, volume of water to be added = volume after dilution - volume before dilution (or) $V_2 - V_1$

$$\text{Volume of water to be added} = \frac{V_1N_1}{N_2} - V_1$$

52. When the solutions of two different substances react with each other, then $V_1N_1 = V_2N_2$ where V_1 and N_1 are volume and normality of one substance, while, V_2 and N_2 are volume and normality of other substance.

53. If density (d) and percent by weight (w%) of a substance in a solution are known, then its normality is calculated by $N = d \times w\% \times \frac{10}{EW}$

54. No. of gram equivalents present in a solution = Normality (N) X volume in cc

55. Normality of a mixture of solutions of different concentrations of same substance,

$$N = \frac{V_1N_1 + V_2N_2 + ... V_nN_n}{\text{Total Volume}}$$

56. In the acid base neutralisation reactions, the molarity of excess substance is given by, the resultant solution in acidic, if $V_AN_A > V_BN_B$, then

$$N = \frac{V_AN_A - V_BN_B}{\text{Total Volume}}$$

The resultant solution is basic, if $V_BN_B > V_AN_A$ then $\frac{V_BN_B - V_AN_A}{Total\ volume}$

57. Relationship between molarity (M) and normality (N) of any solution is given by,

Molarity X mol. wt = Normality X Eq. wt.

$$\text{Molarity} = \frac{\text{Normality} \times \text{Eq. wt}}{\text{Mol. wt}}$$

$$\text{Normality} = \frac{\text{Molarity} \times \text{Mol. wt}}{\text{Equivalent weight}}$$

58. Equivalent weight is defined as the number of parts by weights of a substance that can react with or displace 1.008 parts by weight of hydrogen or 8 parts by weight of oxygen or 35.5 parts by weight of chlorine.

59. $$\text{Eq. wt of an Acid} = \frac{\text{Mol.wt or Formula wt of the acid}}{\text{Basicity of the acid}}$$

60. Basicity of an acid is the number of replaceable hydrogens in a molecule of the acid.

61. Equivalent weights of common acids are :

$$\text{Eq. wt of HCl } (E_{HCl}) = \frac{\text{Mol. wt of HCl}}{1} = \frac{36.5}{1} = 36.5$$

$$\text{Eq.wt of } HNO_3 \ (E_{HNO_3}) = \frac{\text{Mol.wt of } HNO_3}{1} = \frac{63}{1} = 63$$

$$\text{Eq. wt of } H_2SO_4 \left(E_{H_2SO_4}\right) = \frac{\text{Mol.wt of } H_2SO_4}{2} = \frac{98}{2} = 49$$

$$\text{Eq. wt of Acetic acid } (E_{CH_3COO_H}) = \frac{\text{Mol. wt of } CH_3COO_H}{1} = \frac{60}{1} = 60$$

$$\text{Eq. wt of phosphoric acid } \left(E_{H_3PO_4}\right) = \frac{\text{Mol. wt of } H_3PO_4}{3} = \frac{98}{3} = 32.66$$

$$\text{Eq. wt of oxalic acid } \left(E_{H_2C_2O_4}\right) = \frac{\text{Mol. wt of } H_2C_2O_4}{2} = \frac{126}{2} = 63$$

62. $$\text{Equivalent wt. of Base} = \frac{\text{Mol.wt or Formula weight of the base}}{\text{Acidity}}$$

63. Acidity of a base is the number of replaceable hydroxyl ions (OH^-) in a molecule of the base.

64. Equivalent weights of common bases are :

Eq. wt of NaOH $(E_{NaOH}) = \frac{\text{Formula wt of NaOH}}{1} = \frac{40}{1} = 40$

Eq. wt of KOH $(E_{KOH}) = \frac{\text{Formula wt of KOH}}{1} = \frac{56}{1} = 56$

Eq. wt of $Ba(OH_2)$ $(E_{Ba(OH)_2}) = \frac{\text{Formula wt of } Ba(OH)_2}{2} = \frac{171.3}{2} = 86.65$

$E_{NH_4OH} = \frac{35}{1} = 35$ $\quad E_{Mg(OH)_2} = \frac{58}{2} = 29$

$E_{Ca(OH)_2} = \frac{74}{2} = 37$ $\quad E_{Fe(OH)_3} = \frac{107.1}{3} = 35.7$

65. Equivalent wt. of a salt $= \frac{\text{Formula wt. of the salt}}{\text{Total charge either on cation or on anion of the salt}}$

66. Eq : wts of some salts are :

$E_{NaCl} = \frac{58.5}{1} = 58.5$ $\quad E_{Na_2CO_3} = \frac{106}{2} = 53$

$E_{MgCl2} = \frac{95}{2} = 47.5$ $\quad E_{MgSO_4} = \frac{120}{2} = 60$

$E_{CaCO_3} = \frac{100}{2} = 50$ $\quad E_{AgNO_3} = \frac{170}{1} = 170$

$E_{CuSO_4} = \frac{159.5}{2} = 79.75$

67. Eq. wt of Oxidising agent or Reducing agent

$$= \frac{\text{Formula wt.of OA or RA}}{\text{Number of electrons transferred in the reaction per mole}}$$

68. Eq. wt of $KMnO_4$ in acid medium $= \frac{158}{5} = 31.6$

Eq. wt of $K_2Cr_2O_7$ in acid medium $= \frac{294}{6} = 49$

69. Mole fraction is defined as the ratio of number of moles of a component to the total number of moles of all the components present in a solution.

Mole fraction of solute $X_A = \frac{n_A}{n_A + n_B}$ n_A is number of moles of solution

n_B is number of moles of solvent

number of moles $= \frac{W}{M.W}$. Hence, $X_A = \frac{\frac{W_A}{M.W_A}}{\frac{W_A}{MW_A} + \frac{W_B}{MW_B}}$

70. In a solution, the sum of mole fractions of all components = 1

71. Temperature has no effect on mole fraction since the quantities of solute and solvent are expressed by weights.

72. Molarity and Normality change with temperature since the volume of solution changes with temperature.

73. A solution containing A,B,C,D.....i components, then mole fraction of i i.e. $X_i = \frac{n_i}{n_A + n_B + n_C + n_D + ...n_i}$

PUT YOUR FULL EFFORTS

DONOT WORRY ABOUT THE RESULT

THEY ARE BOUND TO COME TO YOU

PRACTICE SET - I

01. The concentration of a solution is defined as

1) The amount of solvent present in a given amount of solution

2) The amount of solute present in a given amount of solution

3) The amount of solute present in a given amount of solute

4) The amount of solvent present in a given amount of solute.

02. If n represents the number of moles of a solute and N represents the number of moles of a solvent, the mole fraction of the solvent is given by

1) $\frac{n}{n+N}$ 2) $\frac{N}{n+N}$ 3) $\frac{n+N}{n}$ 4) $\frac{n+N}{N}$

03. The molarity is defined as the number of moles of solute present in

1) one litre of the solvent

2) one litre of the solution

3) one kilogram of the solvent

4) one kilogram of the solution

04. The molality of a solution is defined as the number of moles of solute present in

1) one litre of the solvent

2) one litre of the solution

3) one kilogram of the solvent

4) one kilogram of the solution

05. Normality of a solution is the number of ...of solute per litre of the solution

1) moles 2) equivalents

3) formula weight 4) mole fraction

06. The weight percentage of a solute is given by

1) $\frac{\text{wt of the solvent}}{\text{wt of the solute}} \times 100$

2) $\frac{\text{wt of the solute}}{\text{wt of the solvent}} \times 100$

3) $\frac{\text{wt of the solute}}{\text{wt of the solution}} \times 100$

4) $\frac{\text{wt of the solution}}{\text{wt of the solute}} \times 100$

07. A saturated solution is defined as one which is .....with the excess of solid at a particular temperature

1) in contact 2) in equilibrium

3) contains impurities 4) none of these

08. In a super saturated solution, the amount of solute is.....in comparision to saturated solution

1) more 2) less 3) equal to 4) none of these

09. The solubility generally rises with

1) increase in temperature

2) evaporation

3) heterogeneous mixture 4) none of these

10. The completely miscible solution can be separated by

1) a separating funnel

2) decrease in temperature

3) increase in volume of the solvent

4) none of these

11. Sugar dissolves in water due to the formation of

1) covalent bond 2) ionic bonds

3) coefficient-ordinate bonds

4) hydrogen bonding

12. When a saturated solution prepared at a higher temperature is cooled, we get

1) super cooled mixture

2) super saturated solution

3) an equilibrium mixture 4) on molar solution

13. An alloy is a homogenous mixture of

1) two solids 2) two liquids

3) two metals 4) two non-metals

14. In a saturated solution there exists an equilibrium between

1) solvent and excess of solid

2) solution and excess of solid

3) solid and excess of solvent

4) solid and excess of solution

15. In one molal solution that contains 0.5 mole of solute there is

1) 1000 g of solvent 2) 1000 ml of solvent
3) 500 ml of solvent 4) 500 g of solvent

16. Which of the following does not depend upon the temperature

1) molarity 2) molality 3) formality 4) normality

17. 36 g of glucose (molecule mass 180) is present in 500 g of water, the molality of the solution is

1) 0.01 2) 0.4 3) 0.05 4) 0.1

18. The number of moles of a solute per kilogram of the solvent is called

1) formality 2) normality
3) molarity 4) molality

19. The mole fraction of ethyl alcohol in a solution containing 36 g of H_2O and 46 g of ethyl alcohol is

1) 1/3 2) 1/2 3) 2/3 4) 3/4

20. The molarities of 0.1N solution of HCl, 1 M H_2SO_4 are respectively

1) 0.1 M and 0.1 M 2) 0.1 M and 0.05 M
3) 0.05 M and 0.1M 4) 0.1 M and 0.2 M

21. For the preparations of 100 ml of 0.1N solution of sulphuric acid, the amount of H_2SO_4 needed is

1) 4.9 g 2) 9.8 g 3) 14.7 g 4) 19.7 g

22. How many grams of glucose are present in 100ml of 0.1 M solution

1) 180 g 2) 18.0 g 3) 1.8 g 4) 3.6 g

23. The normality of a solution of sulphuric acid is N/10. Its molarity will be

1) $\frac{M}{5}$ 2) $\frac{M}{10}$ 3) $\frac{M}{20}$ 4) $\frac{M}{40}$

24. A solution of KCl contains 74.5 g of it in 90 g of water. The mole fraction of KCl will be

1) 1/6 2) 1/5 3) 1/4 4) 74.5 / 90

25. 49 g of H_2SO_4 are dissolved in 250ml of the solution. Its molarity will be

1) 0.5 M 2) 1.0 M 3) 1.5 M 4) 2.0M

26. The amount of Na^+ in 0.1 M Na_2SO_4 is

1) 2.3 g 2) 4.6 g 3) 23 g 4) 46 g

27. 45 g of glucose is dissolved in 500 g water, The molality of the solution is

1) 0.25 2) 0.5 3) 0.75 4) 1.0

28. How many grams of water are present in 100 ml of 0.1 m solution of sulphuric acid ?

1) 10 g 2) 20 g 3) 50 g 4) 100 g

29. A solution contains 180 g of glucose in 180 g of water. The total number of moles of both solute and solvent in the solution will be

1) 1 2) 10 3) 11 4) 21

30. A sample of H_2O_2 used for bleaching of hair contains 5.1 of H_2O_2 in 90 g of water. The mole fraction of H_2O_2 is

1) $\frac{0.15}{5}$ 2) $\frac{0.15}{5.15}$ 3) $\frac{5}{5.15}$ 4) $\frac{5}{0.15}$

31. Which of the following has molality equal to one ?

1) 36.5 g of HCl in 500 ml of water
2) 36.5 g of HCl in 1000 ml of water
3) 36.5 g of HCl in 1000 g of water
4) 36.5 g of HCl in 500 g of water

32. The weight of urea required to prepare 200 ml of 2 M solution will be

1) 12 g 2) 24 g 3) 20 g 4) 60 g

33. What is the molality of a solution prepared by dissolving 9.2 g toluene (C_7H_8) in 500 g of Benzene

1) 1/2 2) 1/4 3) 1/5 4) 1/10

34. A solution of urea is prepared by dissolving 180g of it in one Kg of water. The mole fraction of urea in the solution

1) $\frac{1}{55.5}$ 2) $\frac{1}{56.5}$ 3) $\frac{1}{100}$ 4) 1.8

35. The molarity of 0.1 H_2SO_4 is

1) 0.1 M 2) 0.05 M 3) 0.2 M 4) 0.02 M

PRACTICE SET - I KEY

01) 2	02) 2	03) 2	04) 3	05) 2
06) 3	07) 2	08) 1	09) 1	10) 3
11) 4	12) 2	13) 3	14) 2	15) 4
16) 2	17) 2	18) 4	19) 1	20) 2
21) 1	22) 3	23) 3	24) 1	25) 4
26) 2	27) 2	28) 4	29) 3	30) 2
31) 3	32) 2	33) 3	34) 2	35) 2

PRACTICE SET - II

01. The number of atoms present in 32gm of oxygen

1) 3.2×10^{10} 2) $6.02\times10^{23}\times2$

3) 3.2×10^{23} 4) 6.02×10^{10}

02. How many moles of CO_2 are present in 88gm of CO_2

1) 1 2) 2 3) 44 4) 6.02×10^{23}

03. Decimolar solution contains

1) 0.1 moles of solute 2) 2 gm of solute

3) 1 mole of solute 4) 0.01 moles of solute

04. 90gm of water is equal to

1) 2 moles 2) 3 moles 3) 4 moles 4) 5 moles

05. Alloy is example of

1) Solid in gas 2) Solid in solid

3) Liquid in liquid 4) Gas in solid

06. Molarity of 0.2N sodium carbonate solution is

1) 0.05M 2) 0.2 M 3) 0.1 M 4) 0.4 M

07. A saturated solution on heating becomes

1) Unsaturated 2) Dilute

3) Supersaturated 4) Concentrated

08. Which of the following has same molarity and normality?

1) H_2SO_4 2) Na_2CO_3

3) $NaCl$ 4) $KMnO_4$

09. Normality of 0.1M phosphoric acid solution is

1) 0.1 N 2) 0.2 N 3) 0.3 N 4) 0.5 N

10. Which of the following is used in preparation of aerated soda water ?

1) CO 2) CO_2 3) SO_2 4) NO_2

11. What is the volume (in litres) of 0.1 M H_2SO_4 required to completely neutralize 1 litre of 0.5M NaOH

1) 5 2) 2.5 3) 0.55 4) 10

12. The weight of $AgNO_3$ (mol. wt = 170) present in 100ml of its 0.25M solution is

1) 4.25 g 2) 42.5 g 3) 17 g 4) 1.7 g

13. The molarity of pure water is

1) 18.0 2) 55.55 3) 10.00 4) 5.55

14. Equivalent weight of Na_2CO_3 is

1) 106 2) 53 3) 49 4) 63

15. Which concentration method has no units ?

1) Normality 2) Molarity

3) Mole fraction 4) Molality

16. Weight of Na_2CO_3 required to prepare 250ml of 0.1N solution is

1) 1.32 gm 2) 1.98 gm

3) 2.04 gm 4) 3.96 gm

17. Molarity of 0.5 N H_2SO_4 solution is

1) 0.5 M 2) 1M

3) 2M 4) 0.25M

18. 4.9 gm of H_2SO_4 is present in 1 litre of a solution. The molarity of the solution is

1) 0.5 2) 0.2 3) 0.01 4) 0.05

19. In a binary solution, sum of mole fraction of the two components is always equal to

1) One 2) Less than 1

3) More than 1 4) Zero

20. The molarity of a solution obtained by dissolving 0.01 moles of NaCl in 500ml of solution is

1) 0.01 M 2) 0.05 M

3) 0.02 M 4) 0.03

21. 5.85 gm of NaCl is dissolved in 500ml of water. solution The molarity is

1) 0.1 2) 0.2 3) 0.3 4) 0.4

22. The weight of $H_2C_2O_4\ 2H_2O$ (oxalic acid, MW = 126) required to prepare 500ml of 0.2N solution is

1) 1.26 g 2) 6.3 g
3) 4.5 g 4) 2.25 g

23. 9.8 gms of H_2SO_4 is present in 2 litres of solution. The molarity of the solution is

1) 0.1 M 2) 0.05 M
3) 0.2 4) 0.03

24. The molarity of solution containing 1 gm of NaOH in 250ml of the solution is

1) 1M 2) 0.5 M 3) 0.1 M 4) 0.2 M

25. Weight of 2.5 moles of Na_2CO_3 is

1) 265 gm 2) 260 gm
3) 200 gm 4) 150 gm

26. Normality of 0.05M Na_2Co_3 solution is

1) 0.1 N 2) 0.01N 3) 0.05 N 4) 0.025 N

27. A binary solution contains equal number of moles of solute and solvent. Then mole fraction of solute and solvent are

1) $X_1 = X_2 = 1$ 2) $X_1 = 0, X_2 = 1$
3) $X_1 = 10, X_2 = 90$ 4) $X_1 = X_2 = 0.5$

28. Acidity means

1) No. of replaceable H atoms
2) No. of replaceable OH^- groups
3) No. of oxygen atoms to be added
4) No. of hydrogen atoms to be added

29. Basicity means

1) No. of replaceable OH^- groups
2) No. of replaceable H^- ions
3) No. of oxygen atoms to be added
4) No. of hydrogen atoms to be added

30. Basicity of oxalic acid is

1) 1 2) 2 3) 3 4) 0

31. Mole fraction is independent of

1) Pressure 2) Temperature
3) Catalyst 4) Concentration

32. Volume of 0.1 M H_2SO_4 solution required to neutralize 50ml of 0.2 M NaOH solution is

1) 25 ml 2) 50 ml 3) 100 ml 4) 75 ml

33. The number of grams of anlhydrous Na_2CO_3 present in 250ml of 0.25M solution is

1) 13.35 2) 1.335 3) 6.625 4) 0.6625

34. 3gm of a salt of mol. wt. 30 is dissolved in 250 ml of water. The molarity of this solution is

1) 4 2) 0.5 3) 0.4 4) 0.3

35. An aqueous solution contains 0.53gm of Na_2CO_3 (M.W = 106) dissolved in 100ml of solution. The molarity of the solution is

1) 0.05 M 2) 0.04 3) 0.10 4) 0.01

36. The weight of H_2SO_4 (F.W = 98) present in 400ml of 0.1 M solution is

1) 2.5 gm 2) 3 .92 gm
3) 4 .9gm 4) 9. 80 gm

37. The molarity of 4% NaOH solution is

1) 0.1 M 2) 0.5 M 3) 0.01 M 4) 1.0M

38. Formation of a solution is

1) Physial Change 2) Chemical Change
3) Permanent Change 4) Redox Change

39. Amalgum is

1) Gaseous solution 2) Liquid solution
3) Solid solution 4) Amphorsonic solution

40. One mole of any gas contains

1) 6.625×10^{-27} molecules
2) 6.023×10^{23} atoms
3) 6.023×10^{23} molecules 4) 22. 4 molecules

41. The number of moles is high in

1) 32 g of O_2 2) 14 g of N_2
3) 64g of SO_2 4) 4g of H_2

42. The solution of known concentration is known as

1) Isomeric solution 2) Molar solution

3) Normal solution 4) Standard solution

43. The relation between Mol. wt and Eq. wt for H_3PO_3 is

1) M /1 2) M/2 3) M/3 4) M/4

44. In which of the following Molarity and Normality is same for 1 litre of solution

1) 4g NaOH and 36.5g of HCl

2) 4g of NaOH and 4.9 g of H_2SO_4

3) 98g of H_2SO_4 and 3.65gm of HCl

4) All of the above

45. One molar solution contains

1) One gram mole of solute

2) Avagadro number of solute molecules

3) One mole of solute 4) All the above

46. In which of the following the quantity of solute is more than solubility

1) Unsaturated solution 2) Saturated solution

3) Supersaturated solution

4) Concentrated solution

47. The following solution has same molarity and normality

1) H_2SO_4 2) Na_2CO_3 3) $NaCl$ 4) $KMnO_4$

48. Soda-water is an example of solution

1) Liquid in gas 2) Gas in liquid

3) Solid in liquid 4) Gas in gas

49. Which of the following is true for a solution of sugar in water.

1) Sugar is the solute 2) Water is the solvent

3) It is an aqueous solution 4) All

50. Which of the following method of concentration is independent of temperature

1) Molarity 2) Normality

3) Molality 4) All the above

PRACTICE SET-II KEY

01) 2	02) 2	03) 1	04) 4	05) 2
06) 3	07) 1	08) 3	09) 3	10) 2
11) 2	12) 1	13) 2	14) 2	15) 3
16) 1	17) 4	18) 4	19) 1	20) 3
21) 2	22) 2	23) 2	24) 3	25) 1
26) 1	27) 4	28) 2	29) 2	30) 2
31) 2	32) 2	33) 3	34) 3	35) 1
36) 2	37) 4	38) 1	39) 3	40) 2
41) 4	42) 4	43) 3	44) 1	45) 4
46) 3	47) 3	48) 2	49) 4	50) 3

PRACTICE SET - III

01. What is the type of solution in which equation exists between undissolved solute and dissolved solute?

Ans. Saturated solution .

02. What happens when a saturated solution is heated ?

Ans. The solution becomes unsaturated.

03. When a solution is disturbed, a solid solute separated from the solution. What is the type of solution?

Ans. Supersaturated solution.

04. What type of solution is formed when a saturated solution is cooled slowly?

Ans. Super saturated solution

05. A litre solution contains certain number of moles of solute. What is the suitable method of expressing the concentration

Ans. Molarity

06. 0.1 gram molecular weight of substance is dissolved in one litre of solution. What will be the concentration of the solution ?

Ans. 0.1 M

07. What happens to the molarity of the slution, if the solution is just heated ?

Ans. Molarity decreases.

08. 10.6 g. of Na_2CO_3 is present in 1 litre of the solution. What is the molarity of the solution ?

Ans. 0.1 M

09. If the volume of 0.1M solution is 100 ml. How many milli moles are present in the solution ?

Ans. 10 millionoles.

10. The volume 0.01 M solution is 200 ml. How many moles are present in the solution ?

Ans. 0.002 moles.

11. What are the units of molarity ?

Ans. gm moles / lit.

12. The molarity of solution is M. Molecular weight of the substance is W. What is the amount of substance in 1000 ml of the solution ?

Ans. w = M x mol. wt. x vol. in litre = M x W x 1

13. 0.1 gm equivalent weight of a substance is dissolved in one litre of the solution. What is the concentration of the solution ?

Ans. 0.1 N

14. What happens to the normality of the solution if the solution is just heated ?

Ans. Normality decreases.

15. 4.9 g of H_2SO_4 is prsent in 1 lit. of the solution. What is the normality of the solution ?

Ans. 0.1 N

16. What are the units of normality ?

Ans. equivalents / lit.

17. Give the relation between normally and molarity for a tribasic acid ?

Ans. Normally = Molarity x 3

18. 2 moles of solute is dissolved in 6 moles of solvent. The mole fraction of solute is

Ans. 2 / 8 = 0.25

19. What are the units of mole fractions ?

Ans. No units

20. Give the relation between normally and molarity ?

Ans. Normally x equivalent weight = molarity x molecular weight.

21. The molarity of solution containing 1.0 g NaOH in 250 ml of water is _____

22. The number of moles of water present in 90.0 grams of water is _____

23. A solution of P^H 9.0 is one thousand times as basic as a slution of P^H _____

24. The number of grams of anhydrous Na_2CO_3 Present in 250 ml of 0.25 M solution is _____

25. _____ ml of 0.1 M H_2SO_4 solution is required to neutralise 50 ml of 0.2 M sodium hydroxide solution.

26. If the formula weight of H_2SO_4 is 98, the amount of the acid present in 400 ml of a 0.1 M solution of the acid will be

A) 2.45 g. 2) 3.92 g.
C) 4.90 g 4) 9.8 g

27. The normally of a solution containing 2.5 g. of NaOH in 100 ml is

1) 0.1 N 2) 0.2 N
3) 0.625 N 4) 0.25 N

28. The molarity of 2% solution of NaOH is

1) 0.1 2) 0.02 3) 0.5 4) 0.05

29. 10 ml of 2M NaOH would require ____ of 2M sulphuric acid for complete neutralisation.

30. The weight of solute (in grams) present in 5 litres of 0.1 M NaOH solution is

1) 20 2) 40 3) 10. 4) 50

31. The mole fraction of oxygen in a mixture of 7g. of nitrogen and 8 g. of oxygen is

1) 8/15 2) 0.5 3) 0.25 4) 1.0

32. Molarity of pure water

1) 100 2) 75 3) 55.5 4) 85.5

33. 10g. of H_2SO_4 is dissolved 100 ml of solution. The normality of that solution is

1) 4.04 2) 3.04 3) 2.04 4) 1.04

34. How much water is to be added to dilute 10 ml of 10 N HCl to make it exactly decinormal ?

1) 1000 ml 2) 990 ml 3) 1010 ml 4) 100 ml

35. The molarity of 0.1N sulphuric acid is

1) 0.1 M 2) 0.05 M
3) 0.2 M 4) 0.02 M

36. To neutralise 20 ml of M/10 NaOH the volume of M/20 HCl required is
1) 40 ml 2) 10 ml 3) 15 ml 4) 25 ml

37. Molarity is expressed as
1) grams / litre 2) litre / mole
3) moles / litre 4) moles / 100 g

38. The volume of 0.1 M H_2SO_4 that is needed to completely neutralise 40 ml of 0.2 M NaOH is
1) 10 ml 2) 20 ml 3) 30 ml 4) 40 ml

39. The molarity of a solution 4g. of NaOH in 250 ml of solution is
1) 0.5 2) 1.0 3) 2.0 4) 0.4

40. The volume of 0.1 M H_2SO_4 that is needed to completely neutralise 30 ml of 0.2m NaOH solution is
1) 30 ml 2) 15 ml 3) 40 ml 4) 60 ml

41. Density of water is 1 g / cc the concentration of water in moles / litre in pure water.
1) 1000 2) 18 3) 0.018 4) 55.5

42. 10 ml of concentrated H_2SO_4 (19 molar) is dilute to 1 litre. The approximately strength of dilute acid could be
1) 0.19 N 2) 0.36 N
3) 0.09 N 4) 1800 N

43. For preparing one litre m/10 solution of H_2SO_4 we need
1) 9.8 g. 2) 10 g. 3) 100 g. 4) 4.9 g

44. If 250 ml of solution contains 24.5 g of H_2SO_4. The molarity and normality respectively are
1) 2M, 1N. 2) 1M, 2N.
3) 1M, 0.5N. 4) 0.5 M, 1N

45. By adding water to the solution, its
1) concentration does not change
2) concentration increases
3) concentration decreases .
4) ionisation decreases

46. The weight of solute present in 200 ml of 0.1 M H_2SO_4
1) 3.92 g. 2) 2.45 g 3) 4.9 g 4) 1.96 g

47. If the volume of 2M H_2SO_4 solution is increased from 1 litre to 10 litres, then the normality of the solution is
2) 0.2 2) 0.1 3) 4 4) 0.4

48. The units of mole fraction of a component of solution.
1) Mole / litres 2) Moles / Kg
3) No units 4) Grams / litre

49. How much water is to be added to 10 ml of 10 N HNO_3 to make its concentration 0.1 N
1) 1000 ml 2) 990 ml
3) 1010 ml 4) 100 ml

50. The number of moles present in 2.0 litres of 0.5 M NaOH is
1) 2 2) 1 3) 4 4) 0.1

51. The molarity of 0.1 N H_2SO_4
1) 0.1 2) 0.05
3) 0.2 4) 0.02

52. 2N – HCl will have the same molar concentration as
1) 0.5 N – H_2SO_4 2) 0 N – H_2SO_4
3) 2N – H_2SO_4 4) 4 N–H_2SO_4

53. When 7g of phosphoric acid (mol. wt. 98) is dissolved in 500 ml of solution of water the resulting solution is
1) 0.16 molar 2) 0.14 molar
3) 0.14 normal 4) 0.28 normal

54. What will be the mole fractions of water and ethanol in a solution containing 1 mole of water and 4 moles of ethanol ?
1) 0.2 mole water + 0.8 mole ethanol
2) 0.4 mole water + 0.6 mole ethanol
3) 0.6 mole water + 0.4 mole ethanol
4) 0.5 mole water + 0.5 mole ethanol

55. 5.3 gm of Na_2CO_3 are dissolved 3 litre of water. What is the molarity of the solution ?
1) 0.0165M 2) 0.0266 M
3) 0.0166M 4) 0.0162 M

PRACTICE SET - III KEY

21) 0.1m	22) 5 mol	23) 6	24) 0.6625m	25) 50
26) 2	27) 3	28) 2	29) 5ml	30) 1
31) 2	32) 3	33) 3	34) 2	35) 2
36) 1	37) 3	38) 4	39) 4	40) 1
41) 4	42) 1	43) 1	44) 2	45) 3
46) 4	47) 4	48) 3	49) 2	50) 2
51) 2	52) 4	53) 2	54) 1	55) 3

PRACTICE SET - IV

01. For neutralising exactly 60 ml of 2N base 120 ml of an acid is required. The normality of the acid is
1) 6 N 2) 0.33 N 3) 1 N 4) 10.5 N

02. Morecular weight of a base is W. The acidity is 2. The equivalent weight is
1) $\sqrt{W}$ 2) $\sqrt{2W}$ 3) 2W 4) $\frac{W}{2}$

03. The number of moles of water present in 90 g of water is
1) 1 2) 5 3) 10 4) 18

04. 9.8g of H_2SO_4 is present in two litres of its solution. The molarity of the solution is
1) 0.1 M 2) 0.05 M 3) 0.2 M 4) 0.01 M

05. The molarity of 4% NaOH (w/v) is
1) 0.1 M 2) 0.5 M 3) 0.01 M 4) 1 M

06. The molecular weight of H_2SO_4 is 98. The amount of the acid present in 400ml of 0.1 M solution
1) 2.45 g 2) 3.92 g 3) 4.9 g 4) 9.8 g

07. 20 ml of 0.1 M H_2SO_4 is neutralised by 40 ml of NaOH the molarity of NaOH is
1) 0.05 2) 0.1 3) 0.2 4) 0.02

08. The molarity of solution of glucose ($C_6H_{12}O_6$) containing 36 gms of glucose per 400 ml of the solution is
1) 0.05 2) 0.5 3) 1.0 4) 2.0

09. 0.585 g NaCl is present in 500 ml of solution. Its molarity is
1) 0.2 M 2) 0.1 M 3) 0.01 M 4) 0.02 M

10. One mole of H_2SO_4 present in a solution is exactly neutralised by
1) one mole of NaOH 2) two moles of $Ca(OH)_2$ 3) one mole of $Ba(OH)_2$
4) one mole of NH_3

11. The volume of 0.01 M NaOH solution required to neutralise 20 ml of 0.5 M dibsic acid is
1) 2000 ml 2) 20 ml 3) 200 ml 4) 100 ml

12. 3g of a solute with molecular weight 30 is dissolved in 500 ml of solution of water. Molarity of the solution is
1) 0.4 m 2) 0.2 m 3) 3 m 4) 0.3 m

13. Molarity of 12% NaOH (w/v) is
1) 3 M 2) 1 M 3) 1.2 M 4) 1 M

14. Molarity of 10.6% (w/v) Na_2CO_3 solution
1) 2 M 2) 0.5 M 3) 1.5 M 4) 1 M

15. Number of moles of solute present in 500 ml of 0.5 M solution of it is
1) 0.25 2) 2 3) 1.5 4) 0.5

16. Weight of oxalic acid in 10 litres of 0.05 N axalic acid solution is (formula weight = 126 g)
1) 126 g 2) 31.5 g 3) 3.15 g 4) 315 g

17. The molarity of HCl is 12M. Volume of water that is to be added to 200 ml of the acid to get 0.5 M solution of HCl is
1) 4 lit 2) 12 lit 3) 10 lit 4) 4.8 lit

18. Volume of 0.2 M NaOH, required to neutralise completely 100 ml of 0.2 M H_2SO_4 is
1) 100 ml 2) 200 ml
3) 400 ml 4) 150 ml

19. The molarity of 1.5 N H_3PO_4 solution is
1) 3 M 2) 0.75 M
3) 0.5 M 4) 4.5 M

20. How many grams of dibasic acid (mol. wt. 200) should be present in 100 ml. of aqueous solution to give decinormal strength ?
1) 1 gm. 2) 2 gm 3) 10 gm 4) 20 gm.

21. The weight of oxalic acid cyrstals $H_2C_2O_4\,2H_2O$ required to prepare 500 ml. of 0.2 N solution is
1) 63 g. 2) 3.15 g 3) 126g 4) 6.3 g

22. How much water is to be used to dilute 10 ml. of 10 N HCl to make exactly decinormal (0.1 N) solution

1) 990 ml. 2) 1000 ml.
3) 1010 ml. 4) 100 ml

23. Molarity of 0.1 N sulphuric acid is

1) 0.1 M 2) 0.05 M 3) 0.2 M. 4) 0.5 M

24. To neutralise completely 20 ml. of M/10 NaOH, the volume of M/20 HCl required is

1) 40 ml 2) 10 ml 3) 15 ml 4) 25 ml

25. Molarity is expressed as

1) grams / litre 2) mole. lit
3) moles / litre 4) moles / 1000 gms.

26. 0.4 moles of Na_2CO_3 is present 500 ml. of its solution. Normality is

1) 0.32 2) 1.6 3) 0.2 4) 2

27. The volume of water to be added to dilute 500 ml. of 0.25 N HCl to deci normal HCl solution, is

1) 750 ml 2) 500 ml
3) 1000 ml 4) 1.25 lit.

28. The normality of 20% (weight / volume) acetic acid solutin is (molecular weight = 60g.)

1) 1 N 2) 1.7 N 3) 3.33 N 4) 6.8 N

29. How many grams of oxalic acid is required to prepare 500 ml of N/10 solution (molecular weight 126 g.)

1) 3.15 gms 2) 0.15 gm
3) 6.4 gm 4) 1.157 gm

30. E and N are the equivalent weight and the normality of an acid respectively. The number of grams of the acid present in I litre of its solution is

1) E / N 2) N / E
3) EN 4) (E + N)

31. 3.16 grams of $KMnO_4$ (mol. wt. 158) are dissolved in 1 litre of the solutin. The normality of the solution (5 electrons are transferred per mole of $KMnO_4$ in the reaction)

1) 0.1 N 2) 1N 3) 0.01 N 4) 0.316 N

32. 4.9 gms. of H_2SO_4 is present in 500 ml of the solution, the normality and the molarity of the solution respectively.

1) 0.2 N, 0.1 M 2) 0.1 N, 0.2 M
3) 1N, 2M 4) 2N, 1M

33. 100 ml of 0.6 N solution is diluted to 2000 ml. The normality of the resulting solution is

1) 0.2 N 2) 0.03 N 3) 3 N 4) 0.3 N

34. 200 ml of 0.2 M H_2SO_4 is completely neutralised by 0.4 N NaOH. Volume of NaOH consumed is

1) 200 ml 2) 100 ml 3) 50 ml 4) 150 ml

35. 200 ml of 0.20 M H_2SO_4 solution is diluted with water to get 0.2 N solution. Volume of water to be added is

1) 300 ml 2) 400 ml 3) 200 ml 4) 150 ml

36. The mole fraction of water in 20 % aqueous H_2O_2 solution (w/v) approximately is

1) 1.0 2) 0.88 3) 0.6 4) 1.2

37. 138 gms. of ethyl alcohol is mixed with 72 gms. of water. ratio of the mole fractions of alcohol to water is

1) 3 : 4 2) 1 : 2 3) 1 : 4 4) 1.1

38. The mole fraction of glucose in 10% (wt/wt) equeous solution is approximately

1) 0.18 2) 0.01 3) 0.1 4) 0.017

39. 5.85 of NaCl is dissolved in 500 ml. of water. The molarity is

1) 0.1 2) 0.2 3) 0.3 4) 0.4

40. A gaseous mixture containing 4.4 grams of CO_2 and 4 grams of methane (CH_4). the mole fraction of CO_2 is

1) 0.1 2) 0.2 3) 0.3 4) 0.4

LOOK AT WHAT YOU HAVE LEFT, NEVER LOOK AT WHAT YOU HAVE LOST

PRACTICE SET - IV KEY

01) 3	02) 4	03) 2	04) 2	05) 4
06) 2	07) 2	08) 2	09) 4	10) 3
11) 1	12) 2	13) 1	14) 4	15) 1
16) 2	17) 4	18) 2	19) 3	20) 2
21) 4	22) 1	23) 2	24) 1	25) 3
26) 2	27) 1	28) 3	29) 1	30) 3
31) 1	32) 1	33) 2	34) 1	35) 2
36) 2	37) 1	38)	39) 2	40) 4

SELF TEST

01. The molarity of pure water is
1) 18 M 2) 55.5 M 3) 1000 M 4) 5.65 M

02. The volume of $KMnO_4$ solution of 0.1 M required to completely oxidise 50ml of 0.25 M Ferrous sulphate solution is acid medium is
1) 125 2) 25 3) 50 4) 250

03. When 0.01 mole of KCL is dissolved is 500ml of solution the concentration is
1) 0.02 M 2) 0.01 M 3) 0.05 M 4) 0.2 M

04. The molarity of 4% solution of NaOH is
1) 1 2) 0.5 3) 0.05 4) 0.02

05. How many grams of NaOH will be needed to prepare 250 ml of 0.1 M solution.
1) 1 gm 2) 10 gms 3) 4 gms 4) 6 gms

06. The molarity is expressed as
1) grams / litre 2) mole. Lit
3) moles / lit 4) moles / 1000 gms

07. When 100ml of 1 N NaOH solution is mixed with 10ml of 10 NH_2SO_4 solution, the resulting solution will be
1) Acidic 2) Alkaline
3) Neutral 4) Slightly alkaline

08. Solubility of a solute depends on
1) Pressure 2) concentration
3) temperature 4) crystalline structure

09. The best indicator used in the titration of weak acid with strong base is
1) Methyl orange 2) Orange red
3) Phenophthalein 4) Litmus solution

10. A solution of 2 gm can only dissolve in 20 gm of water of 25^0C. What is its solubility
1) 0.4 gm 2) 10 gm 3) 100 gm 4) 1000 gm

11. 10gm of NaOH is dissolved in 90 gms of water. What is the mole percentage of NaOH in solution
1) 0.47 % 2) 4. 7 % 3) 47 % 4) None

12. 5.85 gm of NaCl is dissolved in 500ml of water. The molarity is
1) 0.1 2) 0.2 3) 0.3 4) 0.4

13. When 0.1 ml of 0.1 N HCl is added to 100 ml of pure water the p^H of the solution will be
1) 0.1 2) 1.0 3) 4.0 4) 7.0

14. The mole fraction of O_2 in a mixture of CH_4 and O_2 containing equal masses is
1) $\frac{1}{2}$ 2) $\frac{1}{3}$ 3) $\frac{2}{3}$ 4) $\frac{1}{4}$

15. The weight of NaOH present in 250ml of 0.2M NaOH solution
1) 2gm 2) 4 gm 3) 1 gm 4) 3 gm

SELF TEST KEY

01) 2	02) 2	03) 1	04) 1	05) 1
06) 1	07) 3	08) 3	09) 3	10) 2
11) 2	12) 2	13) 3	14) 2	15) 1

ALL POWER IS WITHIN YOU YOU CAN DO ANYTHING AND EVERYTHING

PREVIOUS ECET BITS

ECET-2010

01. Solutions containing relatively very low concentration of solute is called

1) Concentrated solutions 2) Dilute solutions

3) Homogeneous solutions

4) Heterogeneous solutions

02. The strength of a solution expressed in gram equivalents per litre of the solution is

1) Molar solution 2) Molal solution

3) Normal solution 4) Mole fraction.

03. The normality of a given solution containing 49 grams per litre of sulphuric acid is

1) 1.0 M 2) 2.0M 3) 0.25M 4) 0.5M

04. The amount of NaOH required to prepare $\frac{N}{100}$ solution in 250 ml of water is

1) 10 grams 2) 1.0 grams

3) 0.1 grams 4) 0.01 grams

05. The solvent which can denote photons is called

1) Protophilic 2) Amphiprotic

3) Aprotic 4) Protogenic

ECET-2011

06. How many grams of NaOH will be needed to prepare 250ml of 0.1 M solution ?

1) 1 g 2) 10g 3) 4g 4) 6g

07. The normality of solution containing 60g of CH3COOH per litre is

1) 1N 2) 2N 3)0.5 N 4) 1.5N

08. Molarity is expressed in

1) moles kg^{-1} 2) g lit^{-1}

3) moles lit^{-1} 4) lit $mole^{-1}$

09. The normality of 4% (W/V) NaOH is

1) 0.1 2) 1.0 3) 0.05 4) 0.01

ECET-2012

10. 5.85 gms of sodium chloride were dissolved in water and the solution made upto 100 ml in a standard flask. 10ml of this solution were pipetted out into another flask and made up with distilled water into 100 ml of solution. The concentration of the sodium chloride solution now is

1) 0.1 M 2) 1.0 M

3) 0.5 M 4) 0.25 M

11. Concentration of a 1.1 M solution of phosphoric acid in water is

1) 0.33 N 2) 1.0 N 3) 2.0 N 4) 3.0N

ECET - 2013

12. The concentration of a 1.0×10^{-3} M solution of calcium nitrate in water is

1) 1.64 ppm 2) 164 ppm

3) 32.8 ppm 4) 100 ppm

13. 1.43 gms of crystalline sodium carbonate (M.w 286) were dissolved in water and made up to 100 ml in a standard flask. 10ml of this solution were pipetted out into another flask and made up to 100ml with distilled water. The normality of the final solution is

1) 0.01N 2) 0.1N

3) 0.05 N 4) 0.005N

TS-ECET-2015

14. What happened to a solution when a non- voltatile solute is added to a solbent

1) vapour pressure decreases

2) vapour pressure inceases

3) boiling point decreases

4) no change in vapour pressure

15. How much volume of 0.1 MH_2SO_4 solution is required to neutralized completely 50 ml of 0.2 N NaOH solution

1) 25 ml 2) 50 ml 3) 75 ml 4) 100 ml

AP-ECET-2015

16. Molarity of 0.1 N oxalic acid is

1) 0.1 M 2) 0.05 M 3) 0.3 M 4) 0.2 M

17. What is the normality of molar sodium carbonate solution

1) 1 N 2) 0.5 N 3) 2N 4) 1.5 N

18. Number of moles of solute dissolved in 1000 gm. of solbent is called

1) molarity 2) formaltity
3) normality 4) molality

TS- ECET - 2016

19. The number of moles of hydroxide (OH^-) ions in 0.3 liter of 0.005 M solution of $Ba(OH)_2$ is

1) 0.0050 2) 0.0030 3) 0.0015 4) 0.0075

20. The normality of 0.3 M of H_3PO_3 is

1) 0.1 2) 0.9 3) 0.6 4) 0.3

AP- ECET- 2016

21. One molar solution of sodium hydroxide is prepared by adding

1) 4g/L 2) 0.4g/L 3) 0.04g/L 4) 40g/L

22. A solution is a mixture of

1) two solutes 2) two solids
3) single solvent 4) solute & solvent

TS- ECET - 2017

23. Molarity of 4% (W/V) solution fo NaOH is

1) 0.1 2) 0.5 3) 0.001 4) 1

24. The weigth of $H_2C_2O_4.2H_2O$ required to prepare 500 mL of 0.2 N solution is

1) 1.26 g 2) 6.3g 3) 1.575g 4) 3.15g

AP- ECET- 2017

25. The normality of 2.3 M H_2SO_4 solution is

1) 0.46 N 2) 0.23 N 3) 2.3N 4) 4.6N

26. 8 grams of substance of molecular weight 40 is dissolved in 250 g of water. Then the molality of the solution is

1) 0.4 2) 0.8 3) 0.2 4) 0.6

TS- ECET - 2018

27. 50 cc pf decinormal NaOH solution will be completely neutralised by 'x' ml of decimolar H_2SO_4 solution. The value of 'x' is_____

1) 10 2) 25 3) 50 4) 1

28. The nomality of solution obtained by dissoving 5.3 grams of Na_2CO_3 in 1 litre solution is

1) 1N 2) 0.1N 3) 0.05N 4) 0.5N

AP- ECET- 2018

29. 5 moles of a solute is dissolved in 10 litres of solution. What is its molarity?

1) 5 M 2) 2M 3) 0.5 M 4) 0.2M

30. The following solution has same molarity and normality

1) Na_2CO_3 2) NaCl
3) H_2SO_4 4) $K_2Cr_2O_7$

31. The nomality of solution obtained by dissoving 5.3 grams of Na_2CO_3 in 1 litre solution is

1) 1N 2) 0.1N 3) 0.05N 4) 0.5N

PREVIOUS ECET BITS KEY

01) 2	02) 3	03) 4	04) 3	05) 1
06) 2	07) 1	08) 3	09) 2	10) 1
11) 4	12) 4	13) 2	14) 1	15) 2
16) 2	17) 3	18) 4	19) 2	20) 3
21) 4	22) 4	23) 4	24) 2	25) 4
26) 2	27) 2	28) 2	29) 3	30) 2
31) 2				

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SPACE FOR IMPORTANT NOTES

ACIDS & BASES

1. Acids are substances which (1) are sour to taste and corrosive. (2) turn blue litmus red.(3) contain hydrogen which can be replaced by active metals (Zn, Mg), (4) react with bases to form salts. (5) react with carbonates and bicarbonates liberating CO_2 (6) conduct electricity in aqueous state.

   Some common acids are HCl, HNO_3, H_2SO_4

2. Bases are substances which (1) are bitter in taste, (2)soapy to touch (3) turn red litmus blue. (4) react with acids to form salts. (5) electrolytic conductors in aqueous statesome common bases are NaOH, KOH, $Ca(OH)_2$

3. According to Lavoiser all acids contain oxygen and it is responsible for acidic nature.

4. According to H. Davy all acids must contain hydrogen as its constituent.

5. Modern theories of acids and bases are :

   1) Arhenius theory of acids and bases

   2) Bronsted - Lowry theory of acids and bases

   3) Lewis theory of acids and bases

6. Arrhenius theory of acids and bases is based on Arrhenius theory of electrolytic dissociation.

7. According to Arrhenius, Acid is a substance, which produces H^+ ions in aqueous solution.(or) Acid is a substance that increases the concentration of H^+ ions in aqueous solution.

   Ex : HCl, HNO_3, H_2SO_4, H_3PO_4, CH_3COOH

   $\boxed{HCl \rightleftarrows H^+ + Cl^-}$

8. According to Arrhenius, base is a substance which produces $OH^{(-)}$ ions (hydroxyl ions) in aqueous solution. (or) Base is a substance that increases the concentration of OH^- ions in aqueous solution :

   $\boxed{MOH \rightleftarrows M^+ + OH^-}$ ex : NaOH,KOH,$Ba(OH)_2$,NH_4OH

9. Strength of acids and bases can be explained on the basis of ionisation constant (Extent of ionisation)

   Ex : $HA \underset{\text{acid}}{\rightleftarrows} H^+ + A^{(-)}$, $Ka = \dfrac{[H^+][A^-]}{[HA]}$ where K_a = acid dissociation constant and

$\underset{\text{base}}{MOH} \rightleftarrows M^+ + OH^{(-)}$; $Kb = \dfrac{[M^+][OH^-]}{[MOH]}$ K_b = base dissociation constant

10. Strong acid ionises completely (high Ka value) to give more H^+ ions.

Ex : HCl, HNO_3, H_2SO_4, H_2CrO_4, HI

11. Strong base ionises completely (high K_b value) to give more $^{(-)}OH$ ions.

Ex : NaOH, KOH

12. Weak acid does not ionise completely (low K_a value) to give less H^+ ions

Ex : CH_3COOH, oxalic acid $(H_2C_2O_4)$, HCN, HCOOH, H_2CO_3, H_3BO_3, H_3PO_4 etc.

13. Weak base does not ionise completely (low K_b value) to give less $OH^{(-)}$ ions

Ex : NH_4OH, $Be(OH)_2$, $Ca(OH)_2$, $Al(OH)_3$, $Fe(OH)_3$

14. Acid reacts with base to form salt and water (Neutralisation)

Ex : $HCl + NaOH \rightarrow NaCl + H_2O$
acid base salt water

15. Limitations of Arrhenius theory of acids and bases :

1) It is applicable only to aqueous solution

2) It failed to explain acidic nature of carbondioxide (CO_2)

3) It failed to explain basic nature of NH_3, Na_2CO_3, CaO, Na_2O, BaO etc and M_gO

4) It failed to explain nonprotic acids like SO_2, NO_2, P_2O_5 and SO_3 etc.

5) The hydration of hydrogen ion in aqueous state was not explained. $(H^+ + H_2O \rightarrow H_3O^+)$
hydronium ion

6) The reactions between metal oxide and non-metal oxide are also neutalisations were not explained by Arrhenius.

16. According to Bronsted - Lowry, a substance which can donate a proton to other substance is an acid (or) proton donor is an acid. Ex : HCl, HNO_3, H_2SO_4, CH_3COOH

17. According to Bronsted - Lowry, a substance which can accept a proton from other substance in called a base (or) proton acceptor is a base. Ex : NH_3, H_2O, HSO_4^-, HCO_3^-, Cl^-

18. According to Bronsted - Lowry theory acid and base are interrelated by the equation

Acid $\rightleftarrows$ Base + H^+ (proton)

19. In the reaction, $HCl + H_2O \rightleftarrows H_3^+O + Cl^-$ HCl is an acid since it donates a proton and H_2O is a base since it accepts a proton.

20. In the reaction, $NH_3 + H_2O \rightleftarrows NH_4^+ + OH^-$; NH_3 is a base since it accepts a proton and H_2O is an acid since it donates a proton.

21. According to Bronsted- Lowry theory each acid - base involves two acids and two bases or acid - base pairs.

For example, $\underset{\text{acid}}{HCl} + \underset{\text{base}}{H_2O} \rightleftarrows \underset{\text{acid}}{H_3O^+} + \underset{\text{base}}{Cl^-}$

HCl and Cl^- are one acid - base pair

H_3O+ and H_2O are another acid base pair

22. The acid - base pair which differ by a proton is called conjugate acid-base pair.

Ex : HCl, Cl^- and H_2O, H_3O^+

23. An acid by donating a proton is converted into its conjugate base and a base by accepting a proton is converted into its conjugate acid

Acid - Proton (H^+) = conjugate base

Base + Proton (H^+) = conjugate acid

24. Some conjugate acid - base pairs are :

Acid	Base (conjugate)	Acid	Base (conjugate)
HCl	Cl^-	$HClO_4$	$ClO_4^{(-)}$
H_3O^+	H_2O	HNO_3	$NO_3^{(-)}$
NH_4^+	NH_3	H_2SO_4	$HSO_4^{(-)}$
H_2O	$OH^{(-)}$	$HSO_4^{(-)}$	SO_4^{2-}
CH_3COOH	$CH_3COO^{(-)}$	H_2S	$HS^{(-)}$
H_2CO_3	$HCO_3^{(-)}$	$HS^{(-)}$	S^{2-}
HCO_3^-	CO_3^{2-}		

25. In a conjugate acid - base pair, if the acid is strong, its conjugate base is weak. Similarly if the base is strong, its conjugate acid is weak.

Ex : HCl is strong acid and hence its conjugate base Cl^- is weak base.

26. According to Bronsted - Lowry theory, the transfer of a proton from an acid to a base is called neutralisation.

27. An acid which has greater tendency to donate a proton is called strong acid.

Ex : HCl, H_2SO_4, HNO_3, H_2CrO_4

28. An acid which has lesser tendency to donate a proton is called weak acid.

Ex : HCN, CH_3COOH, H_2CO_3, HCOOH, H_2CO_3, H_3PO_4, H_3BO_3 etc.

29. A base which has greater tendency to accept a proton is called strong base.

Ex : $OH^{(-)}$, $CN^{(-)}$, $CH_3COO^{(-)}$, $HCOO^-$

30. A base which has lesser tendency to accept a proton is called weak base.

Ex : $Cl^{(-)}$, $HSO_4^{(-)}$, $NO_3^{(-)}$

31. Bronsted - Lowry classified solvents into four types :

1) Protophillic solvents

2) Protogenic solvents

3) Amphiprotic solvents and

4) Aprotic solvents

32. Solvents that have greater tendency to accept protons (i.e., bases) are called protophillic solvents.

Ex : Liquids ammonia, water, alcohol.

33. Solvents that have tendency to produce protons (i.e., acids) are called protogenic solvents.

Ex : HCl (liquid), acetic acid, water. H_2SO_4, HNO_3, etc.

34. Amphiprotic solvents act either as protophilic or protogenic solvents. They donate or accept proton depending upon the nature of other substance. Ex : H_2O, ROH

35. Solvents which neither donate nor accept protons are called aprotic solvents.

Ex : Benzene, carbon tetrachloride, carbondisulphide (CS_2), Toluene etc.

36. H_3O^+ is the strongest acid that can exist in water.

37. $OH^{(-)}$ is the strongest base that can exist in water.

38. The levelling of the strength of all strong acids in water to the same level as that of H_3O^+ (or) the levelling of the strengths of all strong bases in water to the same level as that of $OH^{(-)}$ is known as levelling effect of water.

39. Bronsted - Lowry theory can explain the acid - base character of substances in non aqueous solutions. It can explain the basic nature of ammonia (NH_3)

40. Bronsted-Lowry theory is useful only when proton donor and proton acceptor are available together.

41. Bronsted - Lowry theory can not to explain the acidic character of electron deficient compounds like BF_3,BCl_3, $AlCl_3$, $FeCl_3$, CO_2,SO_2,SO_3, P_2O_5, NO_2 etc.

    It can not explain basic character of substances like CaO, Na_2O, K_2O, BaO etc.

42. B.L. theory can not explain neutralisation reaction between CaO and CO_2 with does not involve a proton transfer.

    $CaO + CO_2 \rightarrow CaCO_3$, $Na_2O + CO_2 \rightarrow Na_2CO_3$, $BaO + CO_2 \rightarrow BaCO_3$

43. According to Lewis theory, a substance which accepts an electron pair and forms a co-ordinate covalent bond is known as an acid. (or) Electron pair acceptor is an acid.

    Ex : H^+, $FeCl_3$, BF_3, $AlCl_3$, PF_3, $SiCl_4$, SF_4

44. **Types of Lewis acids :**

    1) Cations with vacant orbitals. Ex : H^+, Na^+, Mg^{2+}, Fe^{3+}, Fe^{2+}, Zn^{2+}, Ag^+

    2) Electron deficient compounds (compounds in which the central atom does not possess eight electrons in valence shell) Ex : BF_3, BCl_3, $AlCl_3$, $FeCl_3$, SO_3

    3) Inorganic molecules containing double bonds between dissimilar atoms :

    Ex : CO_2, SO_2,NO_2

45. According to Lewis theory, a substance which donates an electron pair and forms a co-ordinate covalent bond is called a base (or) Electron pair donor is a base.

    Ex : NH_3, H_2O, $OH^{(-)}$, $Cl^{(-)}$

46. **Types of Lewis bases :**

    1) All anions are negatively charged ions.

    Ex : Cl^-, $F^{(-)}$, $OH^{(-)}$, $CN^{(-)}$

2) Molecules containing lone pair of electrons.

Ex : $NH_3, H_2O, R-OH$ (alcohol), PH_3, ASH_3

3) Molecules having multiple bonds between carbon atoms (organic compounds)

Ex : C_2H_4 (ethylene), C_2H_2 (acetylene) : $H_2C=CH_2, HC\equiv CH$

47. Neutralisation according to Lewis theory is the formation of co-ordinate covalent bond between an acid and a base with transfer of electron pair.

Ex : 1) Formation of Ammonia Boran trifloride

H_3N	+	BF_3	$\longrightarrow$	$H_3N \rightarrow BF_3$
(Donor)		(Acceptor)		(Adduct)
Ammonia		Borantriflouride		Ammonia borantriflouride

Ex : 2) Formation of Ammonium ion

$$H_3N + H^+ \longrightarrow [NH_4]^+ \text{ or } \left[\begin{array}{c} H \\ | \\ H-N \rightarrow H \\ | \\ H \end{array}\right]^+$$

Ex : 3) Formation of Hydronium ion $\left[H_3O^+\right]$

$$H_2O + H^+ \longrightarrow [H_3O]^+ \text{ or } \left[\begin{array}{c} H-O \rightarrow H^+ \\ | \\ H \end{array}\right]^+$$

48. Limitations of Lewis theory of acids and bases.

1) Lewis theory can not explain the strengths of acids and bases

2) Acids like HCl, H_2SO_4 can not form co-ordinate covalent bonds and can not accept electron pair.

3) Acid-base reactions are fast but Lewis acid - base reactions are slow.

4) Neutralisation of normal acids like HCl, H_2SO_4 and bases like NaOH, KOH where dative bonds are not formed cannot be explained by Lewis theory.

5) The catalytic activity of H^+ ion cannot be explained by Lewis theory.

6) It can not explain the basic nature of substances like $Ca(OH)_2$, NaOH, KOH etc which can not donate electrons.

49. The product of molar concentrations of H^+ and $OH^{(-)}$ ions in pure water or in aqueous solution at a given temperature is known as ionic product of water (K_w)

$K_w = [H^+][^-OH]$

At 25^0C the value of $K_w = 1.0\times10^{-14}$ moles^2 / lit^2

units of K_w = moles^2 / lit^2

50. In pure water, $[H^+] = [OH^{(-)}] = 1.0\times10^{-7}$ moles / lit

51. $[H^+] = \frac{Kw}{[OH^{(-)}]}$ and $[OH^{(-)}] = \frac{Kw}{[H^+]}$

52. In neutral solutions, $[H^+] = |OH^{(-)}| = 1.0\times10^{-7}$ moles / lit at 25^0C

In acidic solutions. $[H^+] > |OH^{(-)}|$

i.e. $[H^+] > 1.0\times10^{-7}$ and $|OH^{(-)}| < 1.0\times10^{-7}$

In basic solutions. $|OH^{(-)}| > [H^+]$

i.e., $[OH^{(-)}] > 1.0\times10^{-7}$ and $[H^+] < 10\times10^{-7}$

53. As the temperature increases $[H^+]$ and $[OH^-]$ increases and K_w increases.

54. In pure water and neutral solutions, the concentrations of $[H^+]$ and $|OH^{(-)}|$ ions are equal

$\therefore [H^+] = [OH^{(-)}] = \sqrt{1.0\times10^{-14}} = 1.0\times10^{-7}$ mole/lit

55. Soren sen introduced concept of pH

pH : The negative logarithm (base - 10) of the hydrogen ion concentration is known as pH of the solution.

Thus, $pH = -\log_{10}\left[H^+\right] = \log_{10}\frac{1}{\left[H^+\right]}$

56. Similarly $P^{OH} = -\log_{10}\left[OH^-\right] = \log_{10}\frac{1}{\left[OH^-\right]}$

57. In pure water at 25^0C $\left[H^+\right] = \left[OH^-\right] = 1.0\times10^{-7}$ mole/lit

Thus in pure water.

$P^H = -\log_{10}\left(1\times10^{-7}\right) = -(-7) = +7$

and $P^{OH} = -\log\left(1\times10^{-7}\right) = -(-7) = +7$

$\therefore\ P^H + P^{OH} = 7+7 = 14$

58. For pure water and neutral solutions :

$P^H = P^{OH} = 7$ and $P^H = 14 - P^{OH}$

59. For acidic solution P^H is less than 7

For basic solution P^H is greater than 7

$$P^H = \underset{\text{Acidic}}{\overset{0\ \longleftarrow}{}} \quad \underset{\text{(neutral)}}{7} \quad \underset{\text{basic}}{\overset{\longrightarrow\ 14}{}}$$

60. The lower the P^H, more acidic is the solution, conversely the higher the P^H, the more basic is the solution.

61. If $\left[H^+\right]$ concentration increases by 10 times, the P^H decreases by one unit and if the $\left[H^+\right]$ can decreases by

10 times, the P^H increases by one unit.

62. $\left[H^+\right] = 10^{-P^H}$

63. Human blood has specific P^H 7.4 (Slightly alkaline)

64. Buffer : A solution which resists change in its P^H value by the addition of a small amount of an acid or a base is called Buffer solution.

65. The property of resisting the change in P^H value is known as Buffer action or Buffer capacity.

66. Examples of buffers are : Mixtures of

$CH_3COOH + CH_3COONa$ and $NH_4OH + NH_4Cl$

(Acetic acid) + (Sodium acetate) (Amm hydroxide + Amm. Chloride)

67. **Buffer solution are of two types :**

1) Acidic buffers and 2) Basic buffers

68. Acidic Buffer : A mixture of weak acid and salt of its conjugate base is called Acidic buffer. The p^H of this buffer will be less than 7.

Ex : $CH_3COOH + CH_3COONa$, $H_2CO_3 + NaHCO_3$, $HCN + NaCN$, $HCOOH + HCOONa$

$H_3PO_4 + NaH_2PO_4$

69. Basic buffer : A mixture of weak base and salt with its conjugate acid is called Basic buffer. Its p^H will be more than 7.

Ex : $NH_4OH + NH_4Cl$

70. **Applications of buffer solutions are :**

1) Buffer solutions are used in chemical analysis, in industrial synthetic processes and in enzyme catalysed reactions to control p^H

2) Buffers play an important role in biochemical reactions which occur at definite p^H.

For example : Carbonate buffer keeps p^H of blood at a constant value of 7.4.

3) Ammonia buffer (mixture of $[NH_4OH + NH_4Cl]$ is used in the estimation of hardness of water by E.D.T.A method

4) Buffers should be added to tonics and syrups

Araise ! Awake ! And stop not till the goal is reached

PRACTICE SET - I

01. Which of the following is a Lewis acid

1) $HCOOH$ 2) H_2SO_4 3) SiF_4 4) H_2S

02. The conjugate acid of $N_3^{(-)}$ (azide) ion is

1) NH_3 2) HN_3 3) $NH_2^{(-)}$ 4) $N_2^{(-)}$

03. In a neutral solution

1) $\left[H^+\right] > \left[OH^{(-)}\right]$ 2) $\left[OH^{(-)}\right] > \left[H^+\right]$

3) $\left[H^+\right] = \left[OH^{(-)}\right]$ 4) $\left[H^+\right] = 8$

04. The Buffer which keeps the pH of blood constant (7.4) is

1) Borate 2) Phosphate
3) Acetate 4) Carbonate

05. The pH of a solution is increased from 3 to 6. Its $\left[H^+\right]$ ion concentration will be

1) Reduced to half 2) Doubled
3) Reduced by 1000 times
4) increases by 1000 times

06. The conjugate base of NH_2^- is

1) NH_3 2) NH^{2-} 3) NH_4^+ 4) N^{3-}

07. The conjugate acid of $NH_2^{(-)}$ ion is

1) NH_3 2) $NH_4^{(-)}$ 3) N_2H_4 4) NH_2OH

08. BF_3 is a/ an

1) Arrhenius acid 2) Lewis acid
3) Bronsted acid 4) Lowry acid

09. Which one of the following is a Lewis acid

1) PCl_3 2) BCl_3 3) NCl_3 4) $CHCl_3$

10. The pH of N/10 Sodium hydroxide solution is

1) 12.0 2) 2.0 3) 10.0 4) 13.0

11. The conjugate base of HCl is

1) Cl^- 2) Cl 3) Cl_2 4) H_2Cl^+

12. $K_w = 1.0\times10^{-12}$ moles^2 / lit^2. Then pH of water is

1) 12 2) 6 3) 7 4) 14

13. pH of 10^{-6} M HCl is

1) 8 2) 6 3) 6.96 4) 8.69

14. pH of 0.005 M H_2SO_4 Solution is

1) 2.5 2) 4.5 3) 1 4) 2

15. Conjugate base of HCO_3^- is

1) CO_3^{2-} 2) HCO_3^{2-} 3) H_2CO_3 4) $H_2C_2O_3$

16. 10ml of 0.1 M HCl is diluted to 1 litre. The pH of the new solution is

1) 13 2) 3 3) 1 4) 5

17. Which is not a Lewis acid?

1) $AlCl_3$ 2) PH_3 3) BF_3 4) $SnCl_2$

18. The ionic product of water is 10^{-14}. The $\left[H^+\right]$ ion concentration in 0.1 M NaOH solution is

1) 10^{-11} moles/ lit 2) 10^{-13} moles/lit
3) 10^{-1} moles/lit 4) 10^{-4} moles/lit

19. The pH of 0.05M H_2SO_4 solution is

1) 5 2) 1.3010 3) 2.0 4) 1.0

20. Buffer solution is prepared by mixing

1) Weak acid and its salt with its conjugate base
2) Strong acid + its salt with strong base
3) Weak acid + its salt of a weak base
4) Strong base + its salt with strong acid

21. The ionic product of water at 25^0C is

1) 10^{-7} 2) 10^{-12} 3) 10^{-14} 4) 10^{-13}

22. The pH of 0.001 M aqueous solution of sodium hydroxide will be

1) 5.0 2) 7.5 3) 9.0 4) 11.0

23. The conjugate acid-base pair for the following reaction is $HCl + H_2O \rightleftarrows H_3O^+ + Cl^-$

1) HCl, H_2O 2) H_3O^+, HCl
3) HCl, Cl^- 4) Cl^-, H_2O_2

24. Conjugate acid of $CN^{(-)}$ is

1) CN_2 2) $CN_3^{(-)}$ 3) HCN 4) H_2CN

25. For acidic solutions

1) $P^H > 7$ 2) $P^H < 7$ 3) $P^H = 14$ 4) $P^H = 0$

26. The buffer used in the estimation of hardness of water (in E.D.T.A. method)

1) Ammonia buffer 2) Adidate buffer
3) NaOH buffer 4) Carbonate buffer

27. If $\left[H^+\right]$ increases by 10 times, then P^H

1) Decreases by 10 Units 2) Decreases by 1 Unit
3) Increases by 1 Unit 4) Increases by 10 Units

28. If $\left[H^+\right]$ increases by 100 times, then P^H

1) Increases by 2 Units 2) increases by 4 Units
3) Decreases by 2 Units 4) Decreases by 1 Unit

29. The solution that is made by mixing appropriate amounts of a weak acid and its salt with strong base is called

1) Acid buffer 2) Basic buffer
3) Neutral buffer 4) Universal buffer

30. The P^H of 10^{-2} M NaOH solution is

1) 2.0 2) 10.0 3) 12.0 4) 1.0

31. The conjugate acid of HPO_4^{2-} is

1) H_3PO_3 2) PO_3^{3-} 3) $H_2PO_4^{(-)}$ 4) H_3PO_4

32. The P^H of a solution is 5 at 25^0C. The $OH^{(-)}$ ion concentration of the solution is

1) 10^{-5}M 2) 10^{-7}M 3) 10^{-9}M 4) 10^{-3}M

33. The greater the P^H the more

1) Basic is the solution 2) Neutral is the solution
3) Acidic is the solution 4) Bitter is the solution

34. C_2H_4 (Ethylene) is an example for

1) Lewis acid 2) Lewis base
3) Arrhenius acid 4) Bronsted base

35. The less the P^H the more

1) Basic is the solution 2) Neutral is the solution
3) Acidic is the solution 4) Alkaline is the solution

36. Which of the following is Lewis acid

1) CO_2 2) H_2SO_4 3) H_2CO_3 4) NH_3

37. The P^H of 0.001 N HCl solution is

1) 1 2) 2 4) 3 4) 4

38. The hydroxide ion concentration of a solution is 1×10^{-8} ions/ litre. The P^H of the solution is

1) 8 2) 6 3) 2 4) 14

39. $AlCl_3$ is considered as Lewis acid because

1) It accepts a pair of electrons
2) It donates a pair of electrons
3) It releases electrons 4) it gains electrons

40. When small amount of acid or alkali is added, a solution which maintains constant P^H is known as

1) Indicator 2) Buffer
3) Neutral 4) Amphoteric

41. The conjugate acid of O^{-2} is

1) $OH^{(-)}$ 2) H_2O 3) $HO_2^{(-)}$ 4) $HO_2^{(-)}$

42. The following theory could not explain the presence of hydronium ion in water

1) Arrhenius theory 2) Lewis theory
3) Bronsted – Lowry theory 4) Soren sen theory

43. Neutralisation according to Arrhenius theory involves

1) Transfer of proton 2) Formation of dative bond
3) Formation of water 4) Formation of H_3O^+

44. The strongest base is

1) NaOH 2) $Mg(OH)_2$
3) $Ca(OH)_2$ 4) NH_2OH

45. 100ml of 0.1 N HCl is mixed with 100ml of 0.1 N NaOH solution. The P^H of the resulting solution is

1) 0 2) 1 3) 14 4) 7

46. Acid – base which differ by a proton are called

1) Redox pair 2) Conjugate acid base pair
2) Complementary pair 4) Isomeric pair

47. The strongest conjugate base is

1) Cl^- 2) SO_4^{2-} 3) $CH_3COO^{(-)}$ 4) NO_3^-

48. The P^H is highest for

1) CH_3COOH 2) H_2SO_4
3) Na_2CO_3 4) NaOH

49. At a given temperature the K_w of water is 10^{-10}. The p^H value of the solution is

1) 10 2) 8 3) 6 4) 5

PRACTICE SET - I KEY

1) 3	2) 2	3) 3	4) 4	5) 3
6) 2	7) 1	8) 2	9) 2	10) 4
11) 1	12) 2	13) 2	14) 4	15) 1
16) 2	17) 2	18) 2	19) 4	20) 1
21) 3	22) 4	23) 3	24) 3	25) 2
26) 1	27) 2	28) 3	29) 1	30) 3
31) 3	32) 3	33) 1	34) 2	35) 3
36) 1	37) 3	38) 2	39) 1	40) 2
41) 1	42) 1	43) 3	44) 1	45) 4
46) 2	47) 3	48) 4	49) 4	

PRACTICE SET - II

01. At 90^0C, the concentration of H_3O^+ in pure water is 10^{-4} mol. lit^{-1}. What is the value of K_w at this temperature?

1) 10^{-6} 2) 10^{-8} 3) 10^{-14} 4) 10^{-12}

02. The pH of a litre solution is 2. It is diluted with water till its pH became 4. How many litres of water is added?

1) 99 2) 9 3) 999 4) 9.9

03. The pH of one litre NaoH solution is 12. What is the amount in grams of NaOH present in this solution

1) 40 2) 4 3) 0.4 4) 2.0

04. The pH of an aqueous solution is increased from 3 to 6. Its H^+ ion concentration will be (1998)

1) reduced to half 2) doubled
3) reduced by 1000 times
4) increased by 1000 times

05. The conjugate base of NH_2^- is

1) NH_3 2) NH^{2-} 3) NH_4^+ 4) N^{3-}

06. Which of the following solutions cannot act as a buffer?

1) $NaH_2PO_4 + H_3PO_4$

2) $CH_3COOH + CH_3COONa$

3) $HCl + NH_4Cl$ 4) $H_3PO_4 + Na_2HPO_4$

07. The strongest conjugate base results from

1) Formic acid 2) H_3PO_4
3) Acetic acid 4) all

08. The pH of the aqueous solution containing 0.49 g of H_2SO_4 in one litre is

1) 2 2) 1 3) 1.7 4) 0.3

09. BF_3 is a/an

1) Arrhenius acid 2) Lewis acid
3) Bronsted acid 4) none of these

10. Which of the following compounds is a Lewis acid?

1) PCl_3 2) BCl_3 3) NCl_3 4) $CHCl_3$

11. pH of solution is 5.0. Its hydrogen ion concentration is decreased by 100 times. The solution will then be

1) neutral 2) acidic 3) basic 4) more acidic

12. Which of the following acts as both Bronsted acid and Bronsted base?

1) $HCOO^-$ 2) Cl^- 3) O^{-2} 4) HSO_4^-

13. The pH of 0.05M H_2SO_4 solution is

1) 5 2) 1.3010 3) 2.6990 4) 1

14. The correct order of increasing basic strength of ClO_4^-, Cl^- and CH_3COO^- is

1) $ClO_4^- < Cl^- < CH_3COO^-$

2) $ClO_4^- > Cl^- > CH_3COO^-$

3) $Cl^- < ClO_4^- < CH_3COO^-$

4) $CH_3COO^- < Cl^- < ClO_4^-$

15. A mono basic acid has concentration 0.1 M. pH of that solution is

1) 1.0 2) 2.0 3) 3.0 4) 5.0

16. The pH of a 0.001 M aqueous solution fo sodium hydroxide will be

1) 5.0 2) 7.5 3) 9.0 4) 11.0

17. If in a 100 ml of an aqueous HCl of pH 1.0, 900ml. more of distilled water is added. the pH of the resulting solution will become
1) 1.0 2) 2.0 3) 4.0 4) 7.0

18. Which of the following is an example of buffer solution?
1) $NH_4OH + NH_4Cl$ 2) $NaCl + NaOH$
3) $H_2SO_4 + Al_2(SO_4)_3$ 4) $H_3PO_4 + AlPO_4$

19. 0.01 M HCl solutions is diluted by 100 times, the pH of solution so formed is
1) 1.0 2) 2.0 3) 4.0 4) 1.001

20. A solution of pH 12 is one thousand times as basic a solution of pH
1) 6 2) 9 3) 7 4) 11

21. The pH of a solution is 2. If its pH to be changed to 4, then the H^+ concentration of the original solution has to be
1) doubled 2) halved
3) increased 100 times
4) decreased 100 times

22. The hydroxide ion concentration of a solution is 1×10^{-6} ions/litre. The pH of the solution is
1) 8 2) 6 3) -8 4) -6

23. pH of a solution is 4.0. What should be the change in the hydrogen ion concentration of the solution if its pH to be increased to 5.0?
1) halved 2) doubled
3) increased by 10 times
4) decreased to 1/10 of is concentration

24. In the reaction $HCl + H_2O \rightleftharpoons H_2O + Cl^-$
1) H_2O is the conjugate base of HCl
2) Cl^- is the conjugate base of HCl
3) H_3O^+ is the conjugate base of HCl
4) Cl^- is the conjugate acid of H_2O base.

25. CO_2 is a
1) Bronsted acid 2) Lewis acid
3) both Bronsted & Lewis acid
4) Arrhenius acid

26. Arrhenius neutralization involves
1) Formation of dative bond
2) Formation of water by the combination of H^+ with OH^-
3) Transfer of proton 4) Formation of H^3O^+

27. Conjugate base of H_2O is
1) H_3O^+ 2) H^+ 3) OH^- 4) H_2

28. Which of the following cannot act as Bronsted acid?
1) HSO_4^- 2) HCO_3^- 3) $HCOO^-$ 4) $H_2PO_4^-$

29. The strongest hydracid is
1) HF 2) HCl 3) HBr 4) HI

30. pH is much for an aqueous solution of
1) KCl 2) Na_2CO_3
3) NH_4Cl 4) $CuSO_4$

31. The hydroxyl ion concentration in a solution with a pH of 3 is
1) 10^{-11} 2) 10^{-7} 3) 10^{-3} 4) 10^{-10}

32. pH of which of the following is much?
1) Gastric juice 2) Lime
3) Blood 4) Pure water

33. An acid solution with a pH of 4 is diluted by 100 times. The pH of the solution is
1) 2 2) 6 3) 5 4) 3

34. pH of a solution is 4. The $[H^+]$ ion concentration of the solution is
1) 10^{-4} moles lit^{-1} 2) 4 moles lit^{-1}
3) 0.4 moles lit^{-1} 4) 4×10^{-4} moles lit^{-1}

35. 20cc of N/10 HCl is mixed with 30 cc of $\frac{N}{10}$ NaOH solution. pH of the mixture is
1) 4 2) < 7 3) > 7 4) 7

36. Presence of hydronium ion in an aqueous solution cannot be explained by this theory
1) Bronsted - Lowry 2) Lewis
3) Arrhenius 4) All

37. To a solution of acetic acid few drops of NaOH is added, then pH of the solution will
1) increase 2) decrease
3) no change 4) cannot be predicted

38. pH of pure rain water
1) > 7 2) < 7
3) 7 4) < pH of soda water

PRACTICE SET- II KEY

01) 2	02) 1	03) 3	04) 3	05) 2
06) 3	07) 4	08) 1	09) 2	10) 2
11) 1	12) 4	13) 4	14) 1	15) 1
16) 4	17) 2	18) 1	19) 3	20) 2
21) 4	22) 1	23) 4	24) 2	25) 2
26) 2	27) 3	28) 3	29) 4	30) 2
31) 1	32) 3	33) 2	34) 1	35) 3
36) 3	37) 1	38) 3		

PRACTICE SET - III

01. The conjugate base of HSO_4^- ions
1) H_2SO_4 2) SO_4^{-2} 3) O^- 4) SO_3^{-2}

02. $HCl + H_2O \rightarrow H_3O^+ + Cl^-$, pick up the conjugate acid – base pair among the following pairs.
1) $HCl - H_2O$ 2) $HCl - H_3O^+$
3) $HCl - Cl^-$ 4) $Cl^- - H_2O$

03. In the reaction $HCl + H_2O \leftrightarrow H_3O^+ + Cl^-$
1) $(H_3O)^+$ is the conjugate acid of HCl
2) Cl^- is the conjugate base of HCl
3) H_3O^+ is the conjugate acid of H_3O
4) Cl^- is the conjugate acid of H_3O^+

04. The conjugate acid of strong base is
1) strong acid 2) strong base
3) weakacid 4) weakbase

05. BF_3 is an acid according to
1) Lewis 2) Bronsted – Lowery
3) Arrhenuis 4) Boyle

06. The congugate base of a strong acid is
1) strong base 2) strong acid
3) weakacid 4) weakbase

07. The conjugate acid of HPO_4^{2-} is
1) $H_2PO_4^-$ 2) H_3PO_3 3) PO_4^{3-} 4) P_2O_5

08. The conjugate acid of O^{2-} ion is
1) O_2 2) OH^- 3) H_2O 4) H_2O_2

09. The conjugate acid of $S_2O_8^{-2}$ is
1) HSO_4^- 2) H_2SO_4 3) $H_2S_2O_8$ 4) HS_2O_8

10. According to Bronsted the relative strengths of bases is
1) $CH_3COO^- > OH^- > Cl^-$
2) $OH^- > CH_3COO^- > Cl^-$
3) $CH_3COO^- > Cl^- > OH^-$
4) $OH^- > Cl^- > CH_3COO^-$

11. Strength of an Arrhenius acid is indicated by
1) number of hydrogen atoms present in the molecule
2) dissociation constant of the acid
3) degree of ionisation
4) number of oxygen atoms only in the acid

12. Which of the following is a Lewis acid?
1) HCOOH 2) H 3) SiF_4 4) NH_3

13. Which of the following is Lewis acid?
1) NH_3 2) BCl_3 3) NCl_3 4) $CHCl_3$

14. BF_3 is a
1) Lewis acid 2) Bronsted base
3) Bronsted acid 4) Lewis base

15. Which of the following is a Lewis acid?
1) NH_3 2) H_2O 3) H^+ 4) Cl

16. Which is the Lewis acid amongst the following?
1) OH^- 2) NH_3 3) $R-O-R$ 4) $ZnCl_2$

17. According to the concept of Lewis, an acid is a substance which
1) accepts protons 2) donates protons
3) accepts a lone pair of electrons
4) donates a lone pair of electrons

18. $AlCl_3$ is a Lewis acid because
1) it donates a electrons pair
2) it forms ionic bond
3) if forms covalent bond
4) it accepts a lone pair of electrons.

19. Which of the following is considered as conjugate acid – base pair

1) H^+, HCl 2) H_2O, O^{2-}

3) NH_2^-, NH_3 4) H_2SO_4, SO_4^{2-}

20. $SnCl_2 + 2Cl^- \rightarrow SnCl_4$ the Lewis acid in the reaction is

1) Cl^- 2) $SnCl_2$ 3) $SnCl_4$ 4) All

21. 10 ml of 0.1 M HCl solution is diluted to a litre, the P^H of the resulting solution is

1) 2 2) 3 3) 1 4) 1.5

22. A solution of pH 9.0 is one thousand times as basic as solution of pH.

1) 12 2) 4 3) 2 4) 6

23. The pH of a solution is 5.0. The $[OH^-]$ of the solution is

1) 10^{-3} mol – lit^{-1} 2) 10^{-8} mol – lit^{-1}

3) 10^{-9} mol – lit^{-1} 4) 10^{-14} mol – lit^{-1}

24. The concentration of $[OH^-]$ is 10^{-8} moles / litre. pH of the solution is

1) 6 2) 5 3) 4 4) 8

25. The pH of 0.005 molar sulphuric acid solution is

1) 2.0 2) 5.0 3) 10.0 4) 1.0

26. The pH of the solution is 6.0 To this solution, acid is added to get pH = 3.0. The increase in hydrogen ion conc. is

1) 100 times 2) 1000 times

3) 2.5 times 4) 3 times

27. The pH of 10^{-8} M NaOH solution is

1) between 7 and 8 2) equal to 7

3) between 6 and 7 4) equal to 8

28. 100 ml of 0.2 M HCl is diluted with water to 1 litre

1) pH of the solution decreases

2) pH increases by one unit

3) pH remains constant

4) pH increases by 2 units

29. $[OH^-]$ ion contration of 0.5 M aqueous HCl solution is

1) 2×10^{-2} mol / lit 2) 5×10^{-12} mol / lit

3) 2×10^{-14} mol / lit 4) 5×10^{-2} mol / lit

30. When CO_2 dissolves in pure water, then pH of water changes to

1) 7 2) > 7 3) < 7 4) 0

31. pH of a solution is 5, its pH becomes 4

1) By increasing $[H^+]$ by 100 times

2) By decreasing $[H^+]$ by 10 times

3) By decreasing $[OH^-]$ by 10 times

4) By increasing [OH–] by 100 times

32. The pH of 0.001 N solution of acid is

1) 3 2) < 3 3) > 3 4) 0

33. Which of the following acts as buffer solution of good buffer capacity ?

1) $NH_4OH + NH_4Cl$

2) $NH_4OH + CH_3COOH$

3) NaOH + NaCl

4) CH_3COONa + NaCl

34. Which of the following mixtures in aqueous solution acts as a buffer solution ?

1) NHO_3 + NaOH 2) H_2SO_4 + KOH

3) NH_4OH (excess) + HCl

4) $CH_3COOH + CH_3COONA$

35. The pH of a solution is 2. If its pH is to be changed to 4, then the $[H^+]$ of the original solution has to be

1) doubled 2) halved

3) increased by 100 times

4) reduced by 100 times

36. The pH of a solution is 4.0 What is the change in the hydrogen ion concentrations of the solution if its pH is decreased to 3.0 ?

1) halved 2) doubled

3) decreased to 1/2 of its original conc.

4) increased by 10 times

37. The pH of 10^{-8} M NaOH is

1) 8 2) 5 3) 6.98 4) 8.5

38. The pH of an aqueous solution of NaCl is

1) 1 2) 14 3) 7 4) Zero

39. The pH of 0.05 M $Ba(OH)_2$ solution

1) 1 2) 0 3) 12.0 4) 13

40. The pH of 10^{-5} M NaOH solution

1) 6 2) 5 3) 3 4) 9

41. If the temperature of pure water at 25° is increased to 80°C the pH of water

1) increases 2) decreases

3) does not change 4) can not be pridicted

42. The pH of human blood is

1) less than 7 2) less than 4

3) more than 8 4) slightly mor than 7

43. The conjugate acid of N_3^- (azide) ion

1) NH_3 2) HN_3 3) NH_2^- 4) N_2^-

44. The pH of one litre solution is 12. What is the amount in grams of NaOH present in this solution ?
1) 40 2) 4 3) 0.4 4) 20

45. The pH of one litre solutin is 2. It is diluted with water till its pH become 4. How many litres of water is added
1) 99 B) 9 3) 999 4) 9.9

46. The pH of a solution is increased from 3 to 6. Its H^+ ion conc will be
1) reduced to half 2) doubled
3) reduced by 1000 times
4) increased by 1000 times

47. The conjugate base of NH_3 is
1) NH_3 2) NH_2^- 3) NH_4^+ 4) N_2^-

48. Which of the solutions can not act as buffer
1) $NaH_2PO_4 + H_3PO_4$
2) $CH_3COO + CH_3COO\ Na$
3) $HCl + NH_4Cl$
4) $H_3PO_4 + Na_2HPO_4$

49. The pH of a solution containing 0.49 g of H_2SO_4 in one litre is
1) 2 2) 1 3) 1.7 4) 0.3

50. The pH of N/10 NaOH solution
1) 12.0 2) 2.0 3) 1.0 4) 13.0

51. The pH of 0.5 M NaCl solution at 298 K is approximately
1) 3.51 2) 5 3) 7 4) 14

52. The pH of solution is 5.0. Its hydrogen ion conc is decreased by 100 times. The solution will be
1) neutral 2) acidic 3) basic 4) more acidic

53. Which of the following acts both as Bronsted acid Bronsted base
1) $HCOO^-$ 2) NH_3
3) O^{2-} 4) HSO_4^-

54. Which has no tendency to act as Lewis acid
1) I^- 2) I^+ 3) $SnCl_2$ 4) $AlCl_3$

55. The pH of 4 gm / litre solution of NaOH is
1) 13 2) 11 3) 13.5 4) 12

56. The correct order of increasing basic strength of ClO_4^-, Cl^- and CH_3COO^- is
1) $HSO_4^- < Cl^- < CH_3COO^-$
2) $HSO_4^- > Cl^- > CH_3COO^-$
3) $Cl^- < HSO_4^- < CH_3COO^-$
4) $CH_3COO^- < Cl < HSO_4^-$

57. Buffer solution is prepared by mixturing
1) weak acid + its salt of strong base
2) strong acid + its salt of strong base
3) weak acid + its salt of weak base
4) Any of these

58. The pH of 0.05 M H_2SO_4 is
1) 5 2) 13.01 3) 2.6990 4) 1

59. The ionic product of water is 10^{-14}. The hydrogen ion conc present in 0.1 M NaOH solution is
1) 10^{-11} mol / lit 2) 10^{-13} mole / lit
3) 10^{-1} mole / lit 4) 10^{-4} mole / lit

60. If to a 100 ml of an aqueous solutin of HCl of pH 1.0, 900 ml of pure distilled H_2O is added, the pH of the resultant solution would be
1) 1.0 2) 2.0 3) 4.0 4) 7.0

61. Which of the following mixtures in aqueous solution acts as buffer
1) $HNO_3 + KNO_3$ 2) $H_2SO_4 + K_2SO_4$
3) $NH_4OH + NH_4Cl$ 4) $CH_3COOH + NaCl$

PRACTICE SET - III-KEY

1) 2	2) 3	3) 2	4) 3	5) 1
6) 4	7) 1	8) 2	9)	10) 1
11) 3	12) 3	13) 2	14) 1	15) 3
16) 4	17) 3	18) 4	19) 3	20) 2
21) 2	22) 4	23) 3	24) 4	25) 1
26) 2	27) 4	28) 2	29) 3	30) 3
31) 3	32) 1	33) 1	34) 4	35) 4
36) 4	37) 1	38) 3	39) 4	40) 4
41) 2	42) 4	43) 2	44) 3	45) 1
46) 3	47) 2	48) 3	49) 1	50) 4
51) 3	52) 1	53) 2	54) 1	55) 1
56) 1	57) 1	58) 4	59) 2	60) 2
61) 3				

SELF TEST

01. The pH of 0.001 M HCl is
1) 4 2) 2 3) 1 4) 3

02. The conjugate base of NH_3 is
1) NH_3 2) NH_2^- 3) NH_4^+ 4) N_2^-

03. The p^H of a solution is increased from 3 to 6. Its H^+ ion concentration will be

1) reduced to half 2) doubled
3) reduced by 1000 times
4) increased by 1000 times

04. According to the concept of Lewis, an acid is a substance which

1) accepts protons 2) denotes protons
3) accepts a lone pair of electrons
4) denotes a lone pair of electrons

05. The p^H of 0.1 N NaOH is

1) 12 2) 13 3) 10 4) 14

06. The p^H of a solution is 2.0. If its p^H is to be changed to 4 then the concentration of H^+ of the original solution has to be

1) doubled 2) halved
3) increases 100 times 4) decreased 100 times

07. The p^H of $10^{-4}M$ aqueous solution Hydroxide solution is

1) 4 2) 7 3) 9 4) 10

08. The conjugate acid of strong base is

1) strong acid 2) strong base
3) weak acid 4) weak base

09. Ionization constant of water at a given temperature is 1×10^{-13}. The p^H of water at that temperature is

1) 7 2) 13 3) 6.5 4) 1

10. The p^H of an aqueous solution is 6.00. The $(OH)^{-1}$ of the solution is

1) $1.0\times10^{-6}M$ 2) $1.0\times10^{-8}M$
3) $1.0\times10^{-7}M$ 4) $1.0\times10^{8}M$

11. Which of the following is a Lewis acid

1) BF_3 2) H_2O 3) NH_3 4) CaF_2

12. The correct logarithmic expression for p^H value is

1) $\frac{1}{+\log M}$ 2) $\frac{-1}{+\log M}$ 3) $-\log H^+$ 4) $+\log H^+$

13. The relationship between H^+ ion concentration and p^H can be written as

1) $p^H = -\log\left(H^+\right)$ 2) $p^H = -\log_{10}\left(H^+\right)$
3) $p^H = +\log_{10}\left(H^+\right)$) $\left(H^+\right)^2 = 10\,p^H$

SELF TEST KEY

01) 4	02) 2	03) 3	04) 3	05) 2
06) 4	07) 4	08) 3	09) 3	10) 2
11) 1	12) 2	13) 2		

PREVIOUS ECET QUESTIONS

ECET-2010

01. Which of the following salts solution form a buffer?

1) NH_4OH and NH_4Cl
2) HCl and CH_3COCl
3) NH_4OH and CH_3COONa
4) NH_4Cl and CH_3COOH

02. The ionic product of water is expressed as

1) 10^{-14} 2) 10^{-7} 3) 10^{14} 4) 10^{7}

ECET-2011

03. The conjugate acid of $NH_4^{(-)}$ is

1) NH_3 2) NH_2OH 3) $NH_4^{\oplus}$ 4) N_2H_2

04. The p^H of a solution is 2. Its p^H is to be changed to 4. Then H^+ concentration of original solution has to be

1) halved 2) doubled 3) increased by 100 times
4) decreased by 100 times

05. The compound that doesnot acts as lewis acid

1) $AlCl_3$ 2) BF_3 3) NH_3 4) $FeCl_3$

ECET - 2013

06. Which of the following is a non - aprotic & non-polar solvent?

1) Chloroform 2) n-Butanol
3) Dimethyl formamide 4) Diethyl ether

07. The pH of an aqueous solution of KOH was found to be 10.0. Then its pOH ___

1) 10.0 2) 4.0 3) 14.0 4) 3.0

08. Which one of the following is a Lewis base?

1) Aq. $MgCl_2$ 2) Anh. $AlCl_3$
3) Pyridine 4) Lithium hydroxide

ET - 2014

. The pH of 0.05 M acetic acid is ($K_a = 2\times10^{-5}$)
1) 2 2) 11 3) 10^{-3} 4) 3

). The volume in ml. of 0.1 M solution of NaOH required to completely neutralize 100 ml of 0.3 M solution of H_3PO_3 is
1) 60 2) 600 3) 300 4) 30

1. The P^{ka} values of four carboxylic acids are 4.76, 4.19, 0.23 and 3.41 respectively. The strongest carboxylic acid among them is the one having P^{ka} value of
1) 4.19 2) 3.41 3) 0.23 4) 4.76

12. If pH value of a solution is 8, then its pOH value will be
1) 7 2) 1 3) 6 4) 10

TS-ECET-2015

13. 10 ml of 0.05 m H_2SO_4 is diluted to 100 ml with water. What is the pH of the resultant solution
1) 2.0 2) 1.0 3) 2.3 4) 2.7

14. What is the conjugate base of OH^-
1) H_2O 2) H_2O^+ 3) O^- 4) O^{2-}

AP-ECET-2015

15. Which of the following compound is a weak acid
1) H_2SO_4 2) HNO_3
3) CH_3COOH 4) NH_4OH

16. Which of the following compound is not Lewis base
1) BF_3 2) CH_3OH 3) H_2O 4) NH_3

TS-ECET-2016

17. In I_3^- Lewis base is
1) I^- 2) I_2^+ 3) I_2^- 4) I_2

18. One m1 of 0.1N HC1 is added to one liter of sodium chloride solution, the pH of the resulting solution is
1) 7 2) 1 3) 4 4) 2

AP-ECET-2016

19. The pH of neutral solution is
1) 2.0 2) 7.0 3) 3.0 4) 5.0

20. According to Lewis theory, acid species will
1) donate electrons 2) accept electrons
3) accept proton 4) donate proton

TS-ECET-2017

21. The conjugate base of hydrogen molecule is
1) elctron 2) hydride ion
3) proton 4) hydroxide ion

22. p^H of a solutioni is 1. It is diluted by $1X\ 10^3$ times. The p^H of the resulting solution will be
1) 1 2) 3 3) 4 4) 5

AP-ECET-2017

23. THe pH value of 0.05M $Ba(OH)_2$ solution is
1) 10 2) 12 3) 13 4) 11

24. Which of the following molecule is not a Lewis Base
1) H_2O 2) BF_3 3) NH_3 4) CO

TS-ECET-2018

25. Arrange the following in the decreasing order of acidiety:
I) H_2SO_3 II) H_3PO_4
III) $HClO_3$
1) I>II>III 2) II>III>I
3) III>II>I 4) I>III>II

26. Which anion is the weakest conjugate base
1) $C_2H_5O^{\ominus}$ 2) $F^{\ominus}$
3) $CH_3COO^{\ominus}$ 4) $NO_3^{\ominus}$

AP-ECET-2018

27. Process in which acids (H^+) and bases (OH^-) react to form salts and water is called
1) neutralization 2) halogenation
3) hydrogenation 4) hydrolysis

28. A substance that donates a pair of electrons to form coordinate covalent bond is called
1) lewis acid 2) lewis base
3) bronsted-Lowry acid 4) bronsted-lowry base

PREVIOUS ECET KEY

1) 1	2) 1	3) 1	4) 4	5) 3
6) 4	7) 2	8) 3	9) 1	10) 2
11) 3	12) 3	13) 1	14) 1	15) 3
16) 1	17) 1	18) 3	19) 2	20) 2
21) 2	22) 3	23) 3	24) 2	25) 3
26) 4	27) 1	28) 2		

ELECTRO CHEMISTRY

SYNOPSIS :

- The branch of chemistry that deals with the relation between chemical energy and electrical energy is called electrochemistry.
- Electrochemistry deals with electrolytic cells and voltaic or galvanic cells.
- Electrochemistry deals with chemical changes brought about by electricity and vice versa
- Electrolyte cells convert electrical energy into chemical energy.
- Voltaic or galvanic cells convert chemical energy into electrical energy. They are called electro chemical cells.
- A substance which allows an electric current to flow through it is called conductor.
- A substance which does not no electric current to flow through it is called insulator or non-conductor
- Conductors are of two types
  - Metallic or electronic conductors.
  - Electrolytic or ionic conductors.
- Metal wires, graphite rod are examples for electronic conductors.
- In case of electronic conductors :
  - conductivity is due to flow of electrons
  - no chemical change takes place
  - no transfer of matter takes place
  - conductivity decreases with increase in temperature
- Solutions of Acids, bases and salts are examples for electrolytic conductors.
- A substance which conducts electricity either when melted or when dissolved in solvent is called electrolyte.
- Substances which do not conduct electricity either in molten state or in solution are called nonelectrolytes. Ex : Urea, Sugar, Alcohol etc.
- In case of electrolytic conductors :
  - conductivity is due to movement of ions
  - chemical changes take place at the electrodes
  - transfer of matter takes place
  - conductivity increases with increase in temperature
- Of all the metals highest electrical conductivity is shown by silver (Ag).
- **Theory of Electrolytic Dissociation :**
- Theory of electrolytic dissociation or theory of ionisation was proposed by Arrhenius
- When an electrolyte is dissolved or melted it splits into charged particles called ions. Positively charged particles are called cations while negatively charged particles are called anions.
- The total charge of cations is equal to the total charge of the anions.
- In solution there exists an equilibrium between unionised molecules and the ions.

⇨ The fraction of the total number of molecules ionised is known as degree of ionisation (a)

$$\alpha = \frac{\text{No. of ionised molecules}}{\text{Total no. of molecules taken}}$$

⇨ Degree of ionisation increases with dilution and temperature.

⇨ Electrolytes whose degree of ionisation is high (or) undergo ionisation completely are called strong electrolytes.

Ex : strong acids, strong bases, many salts solution

Eg : HCl, H_2SO_4, HNO_3, $HCrO_4$, NaOH, KOH, NaCl, KCl, Na_2SO_4, K_2SO_4 etc

⇨ Electrolytes whose degree of ionisation is low are called weak electrolytes.

Ex : solution of weak acids, weak bases, some of the salts like Barium salts

Eg : H_2CO_3, CH_3, COOH, HCOOH, H_3BO_3, H_3PO_4, NH_4OH, $Al(OH)_3$, $Al(OH)_3$, $Fe(OH)_3$ etc

⇨ Arrhenius theory of ionisation can explain :

✦ electrolysis
✦ electrolytic conduction
✦ variation of electrolytic conduction with dilution
✦ abnormal colligative properties etc.

⇨ **Electrolysis**

⇨ The decomposition of an electrolyte carried out by passing electrical current through it, in fused state or in solution is known as electrolysis.

⇨ Electrolysis is

✦ a redox reaction
✦ a decomposition reaction
✦ an endoergic reaction

⇨ Electrolysis is carried out in electrolytic cells.

⇨ The electrode at which electrons enter the electrolytic cell is called cathode.(Attraction of electrons)

⇨ The electrode through which electrons leave the electrolytic cell is called anode. (Loss of electrons)

⇨ Chemical process that takes place at cathode is reduction ($M^{n+} + ne^- \rightarrow M$)

⇨ Chemical process that takes place at anode is oxidation. $H^{n-} \longrightarrow X + ne^-$

⇨ Transfer of electrons in from anode to cathode.

⇨ Electrodes which do not react with the electrolyte are called inert electrodes examples are platinum, graphite.

⇨ The products obtained at the two electrodes during electrolysis depend on the nature of electrodes as well as nature of the electrolytes.

⇨ When inert electrodes are used for electrolysis, the nature of products depend on the electrolyte only.

⇨ When the anode is same metal that is present in the electrolyte, during electrolysis anode dissolves and gets deposited on the cathode in many cases.

⇨ If two different cations are present in the electrolyte the cation with higher reduction potential value gets discharged first at the cathode.

⇨ If the electrolyte contains two different anions, the anion with less reduction potential value gets discharged first at the anode.

- ⇨ Conductance in directly proportional to degree of dissociation.
- ⇨ For strong electrolytes degree of dissolution is almost equal to one.
- ⇨ For week electrolytes degree of dissolution is less than one.
- ⇨ Degree of dissociation X100 = Percentage of dissociation.
- ⇨ In weak electrolytes, degree of dissociation increases with dilution (i.e., concentration decreasing). Then conductance is increased.

A few electrolysis reactions are listed below

Electrolyte	(Oxidation) Anode Reaction	(Reduction) Cathode Reaction	Product At anode	Product Cathode	By Product
Molten Nacl	$2Cl^- \rightarrow Cl_2 + 2e^-$	$Na^+ + e^- \rightarrow Na$	Chlorine(Cl_2)	Sodium (Na)	–
Overall reaction : $2NaCl \rightarrow 2Na + Cl_2$					
Sodium chloride solution	$2Cl^- \rightarrow Cl_2 + 2e^-$	$2H^+ + e^- \rightarrow H_2$	Chlorine	Hydrogen	Sodium hydroxide (Na^+, OH)
	Overall reaction $2NaCl \rightarrow 2H_2O + 2e^- \rightarrow Cl_2 + H_2 + 2NaOH$				
KCl solution	$2Cl^- \rightarrow Cl_2 + 2e^-$	$2H^+ 2e^- \rightarrow H_2$	Chlorine	Hydrogen	Potassium Hydroxide
Acidulated water (or) Alkalified water	$4OH^- \rightarrow 2H_2O$ $O_2 + 4e$	$H^+ + 2e^- \rightarrow H_2$	Oxygen	Hydrogen	–
Concentrated HCl	$2Cl^- \rightarrow Cl_2 + 2e^-$	$2H^+ + 2e^- H_2$	Chlorine	Hydrogen	–
Molten sodium Hydride (NaH)	$2H^- \rightarrow H_2 + 2e^-$	$Na^+ + e^- \rightarrow Na$	Hydrogen	Sodium	–
$CuSo_4$ solution with Cu electrodes	$Cu \rightarrow Cu^{++} + 2e^-$	$Cu^{++} + 2e^- \rightarrow$ Cu	Cu^{++}	Pure copper	–
$AgNo_3$ solution with "Ag" electrodes	$Ag \rightarrow Ag^+ + e^-$	$Ag^+ + e^- \rightarrow Ag$	Ag^+	Pure Silver	–
KBr	$2Br^- \rightarrow Br_2 + 2e^-$	$K^+ + e^- \rightarrow K$	Br_2	K	–
$CuCl_2$	$2Cl^- \rightarrow Cl_2 + 2e^-$	$Cu^{2+} + 2e^- \rightarrow Cu$	Cl_2	Cu	–

USES OF ELECTROLYSIS : - Electrolysis is used in the preparation of

- ⇨ Gases like H_2, O_2, Cl_2, F_2 etc.
- ⇨ Metals like sodium, Magnesium, Calcium etc.
- ⇨ Compounds like NaoH, KOH, $Ca(OH)_2$ $KmnO_4$, $KClO_3$ etc.
- ⇨ In the electrolytic refining of metals.
- ⇨ In electroplating.
- ⇨ **Faraday I law :-**

The extent of chemical reaction that takes place or the amount of the substance liberated or deposited or dissolved at the electrodes during electrolysis is directly proportional to the quantity of current passing through the solution.

$$W \times Q$$
$$W \times ct$$
$$W = ect$$

When W = wt. Of the substance formed

C = Quantity of current

Q = ct, where c-the strength of current in amperes and t–time of flow in second

e = constant called electrochemical equivalent

- ⇨ **II Law :-** When the same quantity of current is passed through solution of different electrolytes, the weights of the substance formed at the electrodes are proportional to their chemical equivalents or equivalent weights

$$\frac{W_1}{E_1} = \frac{W_2}{E_2}$$

When W_1 and W_2 are the weight of the substances

E_1 and E_2 are equivalent weights

- ✦ The amount of the substance formed at the electrodes when one coulombs of current is passed (a ampere per one second) through the solution is called Electro chemical equivalent .
- ✦ The units of electro chemical equivalent are gm/coulomb or grams amp^{-1}/sec^{-1}
- ✦ The amount of the substance formed due to the passage of Avagadro number of electrons ($N_0 = 6.02 \times 10^{23}$) is called chemical equivalent
- ✦ The charge of Avagadro number of electrons is 96500 coulombs or Faraday (F).
- ✦ The amount of the substance form during electrolysis when 96500 coulombs of current is passed is equal to its gram equivalent weight.

Equivalent weight (E) = 96500 × electro chemical equivalent

$$E = F \times e$$
$$e = E/F$$

- ✦ The relation between atomic weight and equivalent weight is

$$\text{Equivalent weight (E)} = \frac{\text{Atomic weight}}{\text{Valency}} \quad E = \frac{M}{Z}$$

- ✦ The Faraday law expressions are

E = ect

$$W = \frac{E}{F}ct \qquad W = \frac{Mct}{ZF}$$

List of elements with their atomic weight valency and chemical equivalent

Element	Atomic wt(M)	Valency (Z)	ChemicalEquivalent (E)
Hydrogen	1	1	1
Oxygen	16	2	8
Chlorine	35.5	1	35.5
Copper	63.5	2	31.75
Zinc	65.0	2	32.5
Aluminium	27.0	3	9

Electrochemical Cells :

- A device in which electrochemical reactions are performed is called electrochemical cell. In this chemical energy is converted into electrical energy. These are called galvanic cells or voltaic cells.
- The cells in which a substance is decomposed using electricity are called electrolytic cell.
- The quantitative aspects of electrolyte cells are governed by Faraday's laws of electrolysis.
- The cells in which chemical energy is converted into electrical energy are called Galvanic or Voltaic cells.

Galvanic Cells (or) Voltaic Cells :

- Electrical energy is produced at the expense of chemical energy in Galvanic or Voltaic cells.
- Electricity is generated in Galvanic cell by oxidation and reduction reactions.
- In a Galvanic cell oxidation takes place at anode.
- Anode in a Galvanic cell is called negative electrode.
- In a Galvanic cell reduction takes place at cathode.
- Cathode in a Galvanic cell is called positive electrode.
- Electrons flow from the anode to cathode in the external circuit.
- The two half cells in a Galvanic cell are connected by a salt bridge or porous pot.
- A salt bridge prevents accumulation of charges and maintains the electrical neutrality of solutions.
- A salt bridge provides a path for the mobility of charges between half-cells.
- Salt bridge is a U – shaped glass tube filled with a gelly like substance, agar-agar, mixed with an electrolyte.
- The common electrolytes used in the salt bridge are KCl, NH_4NO_3 and KNO_3.
- Daniel cell is common example of Galvanic cell.

Cell Notations

- A cell consists of two electrodes anode and cathode. Each electrode is called half cell.
- Anode is written on the left hand side and cathode on the right hand side.
- The electrode materials, elements and compounds are represented by the usual chemical symbols. Active masses are given in brackets.
- While writing anode, metal or solid phase is written first followed by electrolyte. The contact between solid

phase and fluid is denoted by a verticle line or semicolon.
Ex : Anode of Daniel cell is written as $Zn \mid Zn^{+}$ or $Zn ; Zn^{2+}$ or $Zn ; ZnSO_4$

⇨ While writing cathode, electrolyte is followed by solid phase.
Ex : Cathode of Daniel cell is written as $Cu^{2+} \mid Cu$ or $Cu^{2+} ; Cu$ or $CuSO_4 ; Cu$.

⇨ A salt bridge is denoted with two vertical lines separating the two half–cells, where as a porous pot is denoted by a dotted vertical line.

⇨ Daniel cell is represented as
$Zn \mid Zn^{2+} \| Cu^{2+} \mid Cu$ (or)
$Zn \mid ZnSO_4 \| CuSO_4 \mid Cu.$ (or)
$Zn ; ZnSO_4 \| CuSO_4 ; Cu$

⇨ Cell constructed with a porous pot (or a membrane) is represented as
$Zn, Zn^{2+} ; Cu^{2+}, Cu$ (or)
$Zn, ZnSO_4 ; CuSO_4, Cu$

⇨ **Galvanic Cells and Cell Reactions :**

⇨ In a galvanic cell oxidation occurs at anode and reduction at cathode.

⇨ Cell reaction is obtained as a combination of the two electrode reactions.

⇨ The oxidation – reduction reactions of a Galvanic cell acts as the source of electricity.

⇨ Anode reaction of Daniel cell is given as
$Zn \rightarrow Zn^{2+} + 2e^{-}$ (oxidation)

⇨ Cathode reaction of Daniel cell is given as
$Cu^{2+} + 2e^{-} \rightarrow Cu$ (reduction)

⇨ The cell reaction of Daniel is
$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

⇨ If a cell is constructed with two metals, each dipped in its own ions, them more electropositive metal acts as anode.

⇨ If a cell is constructed with zinc and silver electrodes the cell reaction is given as
$Zn + 2\,Ag^{+} \rightarrow Zn^{2+} + 2\,Ag$

⇨ **Extra Points**

⇨ Galvanic cells are further classified into two types : Primary cells and secondary cells.

⇨ Primary cell : A cell which acts as a source of energy without prior charging by electrical current.

⇨ Secondary Cell : A cell which can be recharged after use and can be used again.

⇨ Dry cell is an example of primary cell, while lead storage battery, example of secondary cell.

⇨ Dry cell contains
a) Zn sheet as anode
b) Carbon rod as cathode
c) A mixture of MnO_2 and NH_4Cl as electrolyte

⇨ At anode of dry cell Zn is oxidised
$Zn \rightarrow Zn^{2+} + 2e^{-}$

⇨ At cathode of dry cell Mn is reduced

$2\,MnO_2 + 2\,NH_4 + 2e^- \rightarrow Mn_2O_3 \cdot H_2O + 2\,NH_3$

- A reversible cell is the one in which cell reactions are reversed by passing electricity in the external circuit.
- Lead storage cell is a reversible cell.
- Daniel cell is also an example of reversible cell.
- Dry cell is an example of irreversible cell.
- When a cell is made up by same element, and differing in the concentrations of the electrolytes in contact with the element then such cell is called concentration cell.
  Ex : $Zn|Zn^{2+}(C_1) \| Zn^{2+}(C_2)|Zn$

Electrode Potentials

- When a metal is dipped in solution containing its own ion, the potential developed on the metal surface is described in terms of electrode potential.
- The tendency of an electrode to gain electrons is called its reduction potential
- The tendency of an electrode to lose electrons is called oxidation potential.
- Reduction potential (R.P) denotes the ability of an electrode to get reduced.
- Oxidation potential (O.P) denotes the ability of an electrode to get oxidised.
- Electrode potential depends on
  a) concentration of electrolyte
  b) nature and purity of electrode
  c) Temperature.
- Electrode potential of pure metal in contact with its own ions of unit activity (concentration is 1 molar) and at $25^\circ C$ is called standard electrode potential. It is denoted with E^0.
- Electrode potential of standard hydrogen electrode (SHE) is fixed as zero volts
- S.H.E. is the one in which hydrogen gas is bubbled at 1 atm pressure through a solution of 1 molar H^+ over a platinised surface. SHE is represented as
  $Pt, H_2\,(1\ atm)/H^+\,(1\ M)$; $E^0 = 0.0$ Volts
- For a given electrode both R.P and O.P have same value, but with opposite signs.
- The standard reduction potential of zinc electrode is –0.77 V $Zn^{2+} + 2e \rightarrow Zn$; $E^0 = -0.77$ V.
- The standard oxidation potential of Zinc electrode is +0.77 V; $Zn \rightarrow Zn^{2+} + 2e^-$; $E^0 = +0.77$ V
- S.R.P. values are useful in calculating E.M.F. value of cells.
- S.R.P values is a direct measure of redox ability of metals.
- Nernst described the effect of concentration of electrolyte on electrode potentials.
- To calculate the electrode potential at any concentration and temperature, Nearest equation is used.

$$\epsilon = \epsilon^\circ = \frac{2.303RT}{nF}\log\frac{1}{[M^{n+}]} \qquad \epsilon = \epsilon^\circ + \frac{2.303RT}{nF}[Mn^+]$$

- At $25^\circ c$, the equation is $\epsilon = \epsilon^\circ + \frac{0.0592}{n}\log[M^{n+}]$ (or) $\epsilon = \epsilon^\circ - \frac{0.0592}{n}\log\frac{1}{[M^{n+}]}$

EMF of Cell

- The extent of the electrochemical reaction can be obtained by the electromotive force (EMF) of the cell.
- EMF of a galvanic cell is its ability to drive the electrons into the circuit.
- EMF of a cell is accurately measured by potentiometre method or by null deflection method. Null deflection method is also known as Poggendorff's compensation method.
- EMF of a cell is also obtained from electrode potential

  In terms of reduction electrode potential

  $$EMF_{cell} = E_{right} - E_{left}$$

  or $$EMF_{cell} = E_{cathode} - E_{anode}$$

  In terms of oxidation electrode potential

  $$EMF = E_{left} - E_{right}$$
  $$EMF = E_{anode} - E_{cathode}$$

- EMF of a cell is the difference between the reduction potentials of reduction half cell and oxidation half cell.
- If the EMF of the cell is +ve, electricity is generated spontaneously.
- If the EMF of the cell is –ve, the reverse reaction takes place.
- Best Galvanic cell is the one with highest +ve EMF value.
- If the EMF of the cell is zero, the cell stops functioning.
- A reversible cell is one which satisfies
  a) when external EMF is less than the EMF of the cell, cell reaction takes place.
  b) when external EMF is more than the EMF of the cell, the cell reaction is reversed.
- A standard cell is one whose EMF values
  a) are constant and reproducible
  b) are not much altered with a variation in temperature
- EMF of a dry cell varies between 1.25 V to 1.50 V.

Electrochemical Series

- The list of standard reduction potential values arranged in the increasing order is commonly called electrochemical series (or) galvanic series.
- Since this series also determines the activity of respective elements, it is also called as activity series.

  $Li < K < Ca < Na < Mg < Al < Zn < Fe < Ni < H_2 < \ldots\ldots$

  Negative reduction potential _____ c ref)

  $Cu < Hg < Pf < Au < F_2$ _____ positive reduction potential
- Element with least S.R.P is lithium (–3.05 V). Lithium electrode tops the table of activity series.
- Element with highest S.R.P is fluorine (+2.87 V). Fluorine electrode is at the bottom of the series.
- The smaller the S.R.P value of an element, the greater is its ability to act as a reducing agent in solution.
- The greater the S.R.P value of an element, the greater is its ability to act as an oxidising agent in solution.
- Metals whose S.R.P values are negative can displace hydrogen from acids.

- Alkali and alkaline earth metals near the top of series and are good reducing agents.
- Metals which passes positive reduction potential do not liberate hydrogen with acids.
- Metals with lower reduction potential act as anode and metals with higher reduction potential act as cathode.
- Metal with negative reduction potential act as anode with normal hydrogen electrode (NHE) and metals with positive reduction metals acts as cathode with normal hydrogen electrode (NHE).
- The EMF of a cell is calculated by using.

$E_{cell} = E_{cathode} - E_{anode}$

$E_{cathode}$ & E_{anode} are only reduction potential.

SOLVED EXAMPLES

01. The reduction potentials of zinc electrode ($Zn^{++}|Zn$) and copper electrode (Cu^{++}/Cu) are $0.76V^2$ –0.34 Volts.

(a) Construct a galvanic cell (b) Calculate the emf otte cell (c) What at is the cell action.

Sol: The given galvanic cell is $Zn\,|\,Zn^{++}\,\|\,Cu^{++}\,|\,Cu$

Emf of the cell is $E_{cell} : E_{cathode} - E_{anode.}$

$0.34 - (-0.76) = 1.10$

The cell reaction $Zn + Cu^{++} \rightarrow Zn^{++} + Cu$

02. The oxidation potentials of Fe/Fe^{++} and Ni/Ni^{++} are 0.44V and 0.25V

a) Construct a galvanic cell b) Calculate the emf of cell c) Cell reaction

Sol: Red, potential of $Fe^{++}/Fe = -0.44V$ –anode

Red, potential of $Ni^{++}/ue = -0.25V$ –Cathode

a) $Fe/Fe^{++}\|Ni^{++}/In$ [cell] b) $E_{cell} = -0.25 + 0.44 = 0.19V$ [e.m.f] c) $Fe + Ni^{++} \rightarrow Fe^{++} + Ni$. [cell reaction]

03. The electrode potentials of $Cd|Cd^{++}$ and $Hg^{++}|Hg$ are 0.4V and 0.79 volts.

a) Construct a galvanic cell b) Find the emf of cell. c) What is the cell reaction.

Sol: Cd electrode $\rightarrow$ oxidation

Mg electrode $\rightarrow$ reduction

Red. Of Cd $\rightarrow$ –0.4V

Red. Of Hg $\rightarrow$ +0.79V

a) $Cd|Cd^{++}\,\|\,Hg^{++}\,|\,Hg$ [cell]

b) $E_{cell} = 0.79 + 0.4 = 1.19V$ [e.m.f]

c) $Cd + Hg^{++}$ ® $Cd^{++} + Hg$ [cell reaction]

04. The electrode potential of Ag^+/Ag and $Cu^{++}|Cu$ are 0.8V and 0.34 volts.

Cal. Emf of the cell $Ag|Ag^+\|Cu^{++}|Cu$

Sol: Red of $Ag^+ = -0.8$

$Cu^{++}|Cu = 0.34$

$E_{cell} = E_{cat} - E_{ano}$

$= 0.34 - 0.8 = -0.46V$

emf = –0.46V

It is not a spontaneous cell

05. Calculate electrode potential of Zinc electrode when its concentration is 10^{-2}m. E^0 for Zinc electrode is 0.76V.

Sol : $E = E^0 + \frac{0.059}{n}\log[Zn^{++}]$

$= 0.76 + \frac{0.059}{2}\log(10^{-2}) = 0.76 - \frac{0.059}{2} = 0.76 - 0.06 = 0.70\ V$

06. Calculate the EMF of the cell $Mg/Mg^{2+}(1m)\|Ca^{+2}(1m)/col.$ given E^0 of $Mg/Mg^{2+} = +2.376$ volts and E^0 of $Cal^{2+}/Cal = 0.0403$ volts

Sol : $E_{cell} = E_{AF}^{SOP} - E_C^{SOP}$

$E_{cell} = 2.37 - 0.0403$

$E_{cell} = 2.3297\ V$

07. The oxidation potential of an iron wire dipped in 1m odution of FeSO4 is 0.44 V and that of copper wire dipped in 1m CuSO4 solution is -0.337V. of the two electrodes are connected to form a cell which will be the +ve terminal when current is drawn what will be the EMF of the cell

Sol : $Ecell = E_A^{SRP} - E_C^{SOP}$

$= 0.44 + 0.337$

$= 0.777\ V$

08. Find the number of electrons that can pass through a copper wire when a current of 9.65 coulombs is passed.

Sol : For the passage of 96500 coulombs $\rightarrow 6.02\times10^{23}$

9.65 coulombs $\rightarrow \frac{9.65}{96500}$

$\times 6.02\times10^{23} \Rightarrow 6.02\times10^{-19}$ electrons

09. Find the electro chemical equivalent of oxygen.

Sol : $e = \frac{M}{ZF}$

$= \frac{16}{2\times96500} = 0.000082$ gms/coulombs

10. Find the number of Faradays of current required for electrode deposition 5.4 gms of Aluminium from aluminium fluoride.

Sol : Chemical Eqt. $= E = \frac{M}{Z} = \frac{27}{3} = 9$ rm

9 grams of aluminium can be deposited with 1 Faraday of current

5.4 gms of A1 can be deposited $\rightarrow \frac{5.4}{9} = 0.6$ Faradays

11. Find the weight of oxygen liberated from acidulated water when it is electrolysed for 1000 sec. With a current of 9.65 amperes.

Sol : Strength of current (C) = 9.65 A

Time of Flow (t) = 1000S

Atomicut of (O_2) = M = 16

Valency of O_2 = Z = 2

F = 96500C

$$W = \frac{Mct}{ZF} = \frac{16 \times 9.65 \times 1000}{2 \times 96500} = 0.8 \text{ gms}$$

12. Find the wt of Cu deposited from $CuSO_4$ solution when it is electrolysed for with a current of 1.934 for 100 sec.

Sol :

C	=	1.93
t	=	100 sec
M_C	=	63.5 gm
Z	=	2
F	=	96500

$$W = \frac{1.93 \times 100 \times 63.5}{2 \times 96500} \quad W = 0.0635 \text{ gms}$$

13. Find the strength of the current used if 1.3 gms of zinc is deposited from $ZnSO_4$ solution when it is electrolises for 200 seconds.

Sol : Wt of Zn deposited

(w)	=	1.3 g
C	=	?
t	=	200
F	=	96500
Zn	=	65
Z	=	2

$$W = \frac{MCt}{ZF} \quad C = \frac{WZF}{Mt} = \frac{1.3 \times 2 \times 96500}{650 \times 200} = 19.3A$$

14. Find the weight of silver deposited under identical conditions 6.35 gms of Cu is deposited from from $CuSO_4$

Sol :

W_{Cu}	=	6.35 gms
E_{Cu}	=	31.75
W_{Ag}	=	?
E_{Ag}	=	108

$$E_{Cu} = \frac{M}{2} = \frac{63.5}{2} = 31.75 \qquad E_{Ag} = \frac{M}{1} = \frac{108}{1} = 108 \qquad \frac{W_{Cu}}{E_{Cu}} = \frac{W_{Ag}}{E_{Ag}}$$

$$\frac{W_{Cu}}{E_{Cu}} = \frac{W_{Ag}}{E_{Ag}} \qquad W_S = \frac{6.35}{31.75}$$

$$\times 108 = \frac{635}{3175} \times 108 = 21.6 \text{ gms}$$

PRACTICE SET - I

01. Arrhenius theory could explain the behaviour of
1) strong electrolytes 2) weak electrolytes
3) both 4) none

02. Arrhenius theory was modified and applied to strong electrolytes by
1) Debye Huckel and Onsegar
2) Berthnoist 3) Heisenberg
4) Guldberg and Wage

03. Which of the following does not conduct current in aqueous solution
1) KNO_3 2) CH_3COOH
3) CH_3OH 4) NaOH

04. Electronic conduction is due to
1) Free electrons 2) Ions
3) Molecules 4) Atoms

05. Electrolytic conduction is due to
1) Free radicals 2) Ions
3) Molecules 4) Atoms

06. During electrolysis a compound undergoes
1) Combination 2) Polymerization
3) decomposition 4) All the above

07. During electrolysis oxidation take place at _____ electrode and reduction at _____ electrode

08. Dielectric constant is maximum in
1) H_2O 2) Benzene 3) CCl_4 4) NH_3

09. Which of the following is a weak electrolyte
1) NaCl 2) H_3BO_3 3) $CaCl_2$ 4) $CuSO_4$

10. One Faraday represents
1) One mole of electrons
2) 96800 coulombs of charge
3) One gram equivalent of a substance
4) All the above

11. The electrolysis of aqueous solution of NaCl produces at cathode and anode respectively
1) H_2 and Cl_2 2) Na and O_2
3) H_2 and O_2 4) Na and Cl_2

12. Electrolysis of salt solution is due to the formation of
1) Electrons 2) Ions
3) Acids 4) Oxides

13. The electrolytic conduction of a solution of an electrolyte is proportional to
1) strength of the current
2) time of flow of current
3) number of ions present in the solution
4) the concentration of the solution

14. Which of the following forms a non-conducting aqueous solution
1) $AgNO_3$ 2) CH_3COOH
3) C_2H_5OH 4) NaCl

15. The quantity of electricity required to liberate one gram equivalent weight of an element is called
1) Faraday 2) Ohm 3) ampere 4) Volt

16. Strong electrolyte is one that
1) ionises partially in water
2) ionises completely in water
3) does not depend on temperature
4) none of the above

17. The conductance of an electrolytic solution
1) increases with temperature
2) decreases with temperature
3) does not depend on temperature
4) none of the above

18. The potential of standard hydrogen electrode is
1) 1 volt 2) 0 volt 3) 10 volts 4) none

19. A galvanic cell converts
1) electrical energy into chemical energy
2) chemical energy into electrical energy
3) electrical energy into heat energy
4) chemical energy into heat energy

20. In electrochemical series, the elements are arranged in the
1) decreasing order of SRP
2) Increasing order of SRP
3) Increasing order of atomic number
4) Decreasing order of atomic weight

21. The potentials of two electrodes used in cell are +0.35V and –0.85V. The emf of the cell formed from is
1) 1.2 volts 2) –0.5 V 3) 0.5 V 4) none

22. When electric current is passed through the fused sodium chloride
1) sodium ions are oxidised
2) chlorides ions are reduced
3) neither oxidation nor reduction
4) oxidation of chloride ion and reduction of sodium ions

23. Which of the following can not displace hydrogen from the dilute acids
1) Al 2) Cu 3) Mg 4) Zn

24. The metal with maximum conductivity
1) Zn 2) Ag 3) As 4) Pb

25. Through salt bridge
1) electrons move 2) ions move
3) neutral particles 4) none

26. An electrochemical cell is based up on
1) redox reaction
2) acid base reaction
3) any reaction 4) none

27. Faradays law of electrolysis are related to
1) atomic number of action
2) atomic number of anion
3) equivalent weight of electrolyte
4) speed of the action

28. When Zn metal is added to $CuSO_4$ solution, Cu is precipitated. This is due to
1) Oxidation of Zn^{2+} 2) Reduction of Cu^{2+}
3) Hydrolysis of $CuSO_4$
4) Ionisation of $CuSO_4$

29. When 9.65 coulombs of electricity is passed through a solution of silver nitrate (atomic weight of Ag=108) silver deposited is
1) 10.8 mg 2) 5.4 mg 3) 16.2 mg 4) 21.2 mg

30. In a cell containing zinc electrode and normal hydrogen electrode, the zinc electrode acts as
1) Anode 2) Cathode 3) Both 4) None

31. Electrolysis of salt solution is due to the formation of
1) Electrons 2) Ions 3) Acids 4) Oxides

32. Galvanic cells are used to convert
1) Chemical energy to electrical energy
2) Electrical energy to chemical energy
3) Kinetic energy to potential energy
4) Potential energy to kinetic energy

33. The unit of electrochemical equivalent of an element is
1) gram 2) gram – amp sec^{-1}
3) coulomb/gram 4) gram/coulomb

34. The amount of current that would produce one gram equivalent of any substance is called
1) Ampere 2) Faraday
3) Chemical equivalent 4) voltage

35. Which of the following is an electrolyte
1) Mercury 2) sugar solution
3) ethyl alcohol 4) silver nitrate solution

36. In an electrolytic cell, the anode and cathode are respectively represented as
1) positive electrode, negative electrode
2) negative electrode, positive electrode
3) negative electrodes both
4) positive electrode both

37. Electrolyte when dissolved in water dissociate into ions because
1) they are unstable
2) the water dissolve it
3) the force of repulsion increase
4) the forces of electrostatic attraction are broken down by water

38. The weight of copper deposited by passing 0.5 faraday of current is
1) 63.5 g 2) 31.25 g 3) 15.875 g 4) 7.94 g

39. Which of the following is a poor conductor of electricity
1) CH_3COONa 2) CH_3OH
3) NaCl 4) KOH

40. When a faraday of electricity is allowed to pass through a salt, the amount of the substance liberated deposited at an electrode is called as its
1) atomic weight 2) equivalent weight
3) chemical equivalent 4) none

41. Formula used for the determination of emf of a galvanic cell is
1) E^0 cathode – E^0 anode
2) E^0 anode + E^0 cathode
3) E^0 anode – E^0 cathode
4) none of these

42. Which of the following has maximum reduction potential
1) Na 2) Fe 3) Al 4) Cu

43. One coulomb of charge represents how many electrons
1) 6.25×10^{18} 2) 3.25×10^{20}
3) 2.187×10^{24} 4) 1.47×10^{18}

44. The units of electrochemical equivalent are
1) gram coulomb 2) gram amp^{-1} sec^{-1}
3) gram amp sec^{-1} 4) gram amp^{-1} sec

45. When Zn metal is added to $CuSO^4$ solution Cu is precipitated. It is due to
1) oxidation of Cu^{2+} 2) reduction of Cu^{2+}
3) hydrolysis of $CuSO_4$
4) ionisation of $CuSO_4$

46. When one Faraday of current is passed, which of the following would deposit one gram atomic weight of the metal ?
1) $BaCl_2$ 2) NaCl 3) $AlCl_3$ 4) $CuCl_2$

47. The chemical reaction taking place at anode is
1) oxidation 2) reduction
3) ionization 4) hydrolysis

48. Copper rod dipped in $AgNO_3$ solution gives blue colour to the solution. In this process
1) Cu is oxidised 2) Cu is reduced
3) Ag is oxidised 4) none

49. The weight of copper deposited when 0.5 F of current is passed through $CuSO_4$ solution is
1) 3.175 g 2) 0.3175 g
3) 15.875 g 4) 6.35 g

50. In a cell containing Zn electrode and normal hydrogen electrode (NHE), Zinc electrode acts as
1) anode 2) cathode
3) either cathode or anode
4) none

51. The reactions taking place at anode and cathode of a cell respectively are
1) reduction, oxidation
2) oxidation, reduction
3) hydrolysis, oxidation
4) reduction, hydrolysis

52. A good electrolyte
1) urea solution 2) acetic acid solution
3) sugar solution 4) dil. HCl solution

53. In electronic conduction
1) no chemical change takes place
2) chemical change takes place
3) ions are responsible for conduction
4) mass will migrate

54. Degree of ionisation is much for this solution
1) CH_3COOH 2) HCN 3) NH_4OH 4) NaOH

55. Electrolytic conduction involves
1) migration of ions 2) chemical change
3) mobility of electrons 4) all

56. With temperature this will decrease
1) electrolytic conduction
2) electronic conduction
3) degree of ionisation 4) mobility of ions

57. In an electrolytic cell
1) oxidiation takes place at cathode
2) reduction takes place at anode
3) redox reaction takes place
4) non-redox reaction takes place

58. An aqueous solution of NaOH on electrolysis liberates
1) Oxygen gas at anode and hydrogen gas at cathode
2) Oxygen gas at cathode and hydrogen gas at anode
3) sodium metal at cathode and oxygen gas at anode 4) None

59. One faraday of current can deposit
1) one mole 2) one gm
3) one gm equivalent wt.
4) one electrochemical equivalent

60. Electrochemical equivalent is given by
1) gm. eq. wt/96500 col
2) gm. eq. wt/Faraday
3) gm. mol. wt/96500 col
4) gm. mol. wt/Faraday

61. Lead storage cell is an example to
1) electrolytic cell 2) voltaic cell
3) dry cell 4) none

62. Faradays laws of electrolysis are related to the
1) atomic number of the cation
2) atomic number of the anion
3) equivalent mass of the electrolyte
4) speed of the cation

63. The electrolytic conductance is a direct measur of
1) resistance 2) potential
3) concentration 4) dissociation

64. Laws of electrolysis were given by
1) Arrhenius 2) Faraday
3) Ostwald 4) Debye-Huckle

65. On passing 3 amperes of current for 50 minute 1.8 g of metal was deposited. The equivalent mas of metal is
1) 20.5 2) 25.8 3) 19.3 4) 30.7

66. In a voltaic cell
1) anode is given –ve sing
2) cathode is given –ve sign
3) anode is given +ve sign
4) electrons flows from cathode to anode

67. Potential of SHE is
1) 1V 2) 0.0V 3) 100 V 4) none

68. Purpose of salt bridge in a voltaic cell is to
1) provide a path for the mobility of electrons
2) prevent accumulation of charge
3) provide a path for the flow of current 4) all

69. At the anode of Daniel cell the half–reaction is
1) $Zn \rightarrow Zn^{2+} + 2e^-$ 2) $Zn^{2+} + 2e^- \rightarrow Zn$
3) $Cu \rightarrow Cu^{2+} + 2e^-$ 4) $Cu^{2+} + 2e^- \rightarrow Cu$

70. Standard emf of Daniel cell is
1) 1.5 V 2) 2.2 V 3) 1.1 V 4) 0.0V

71. In electrochemical series the electrode with lowest reduction potential value is
1) Li 2) F_2 3) Cs 4) Pt

72. EMF of a cell can be determined accurately by using
1) voltmeter 2) ammeter
3) potentiometric method
4) all

73. e.m.f. of a cell can be increased by
1) decreasing the conc. of active species or metal ions at anode
2) increasing the area of anode
3) increasing the conc. of metal ions at cathode
4) all

Araise ! Awake ! And stop not till the goal is reached

PRACTICE SET KEY

01) 2	02) 1	03) 3	04) 1	05) 2
06) 3	07) anode, cathode		08) 1	09) 2
10) 4	11) 1	12) 2	13) 3	14) 3
15) 1	16) 2	17) 1	18) 2	19) 2
20) 2	21) 1	22) 4	23) 2	24) 2
25) 2	26) 1	27) 3	28) 2	29) 1
30) 1	31) 2	32) 1	33) 4	34) 2
35) 4	36) 1	37) 4	38) 3	39) 2
40) 2	41) 1	42) 4	43) 1	44) 2
45) 2	46) 2	47) 1	48) 1	49) 3
50) 1	51) 2	52) 4	53) 1	54) 4
55) 4	56) 2	57) 3	58) 1	59) 3
60) 1	61) 2	62) 3	63) 4	64) 2
65) 3	66) 1	67) 2	68) 2	69) 1
70) 3	71) 1	72) 3	73) 4	

IT IS TRUTH ALONE THAT GIVES STRENGTH

PREVIOUS ECET BITS

ECET - 2012

01. Which of the following is an electrolyte?
1) Acetic acid 2) Glucose
3) Urea 4) Pyridine

02. Calculate the Standard emf of the cell, $Cd/Cd^{+2} // Cu^{+2} / Cu$ given that E^0 $Cd / Cd^{+2} = 0.44V$ and $E^0\ Cu / Cu^{+2} = (-)0.34\ V$.
1) $(-)1.0V$ 2) $1.0V$
3) $(-)0.78\ V$ 4) $0.78\ V$

03. A solution of nickel chloride was electrolysed using Platinum electrodes. After electrolysis
1) nickel will be deposited on the anode
2) Cl_2 gas will be liberated at the cathode
3) H_2 gas will be liberated at the anode
4) nickel will be deposited on the cathode

ECET - 2013

04. A zinc rod half immersed in a beaker containing water
1) Corrodes fastest at the top
2) Does not corrode at all
3) Corrode fastest at the water-metal boundary
4) Corrodes fastest at the bottom

ECET - 2014

05. The standard reduction potential for Li^+/Li, Zn^{+2} / Zn; H^+/H_2 and Ag^+ / Ag are $-3.05, -0.762, 0.000$ and $+0.80$ V respectively. Which is the strongest reducing agent?
1) Ag 2) H_2 3) Zn 4) Li

06. The standard reduction potential for the following half-cell reactions are
$Zn = Zn^{+2} + 2e^- E^o = 0.76V$
$Fe = Fe^{+2} + 2e^- E^o = -0.44V$
The E.M.F. for the cell reaction $Fe^{+2} + Zn \rightarrow Zn^{+2} + Fe$ will be
1) -0.32 V 2) $+0.32$ V
3) $+1.20$ V 4) -1.20 V

07. In salt bridge, KCl is used because
1) KCl is present in calomel electrode
2) K^+ and Cl^- ions are not iso electronic
3) K^+ and Cl^- ions have the same transport number
4) KCl is an electrolyte

08. The metal that cannot be obtained by electrolysis of aqueous solution of its salt is
1) Ag 2) Au 3) Cu 4) Al

TS - ECET - 2015

09. When one faraday of electicity is passed for $CuSO_4$ solution, how much copper is deposited at cathode? (Atomic weight of Cu = 63.54)
1) 63.54g 2) 31.72g
3) 15.86 g 4) 127.08 g

10. Calculate the emf of the following cell at $25^0 C$ of Zn / Zn^{2+} (0.1M) // Cu^{2+} (0.1M) /Cu standard reduction potentials of Zn / Zn^{2+} and Cu^{2+} /Cu are -0.76 and + 0.34 V respectively
1) + 1.1 V 2) - 1.1V
3) + 1.07 V 4) + 1.13 V

AP - ECET - 2015

11. If the solution of the $CuSO_4$ in which copper rod is immersed is diluted to 10 times, the electrode potential is
1) decreases by 0.0295 V
2) Increased by 0.295 V
3) decreases by 0.59 V
4) Increased by 0.059 V

12. The amount of electicity that can deposit 108 gms of silver from $AgNO_3$ solution is
1) 1 Faraday 2) 1 Coulomb
3) 1 Ampere 4) 2 Coulombs

13. The resistance of 0.01 N solution of an electrolyte AB at 328 ^oK is 100 Ohms. The specific conductance of solution is (Cell constant = 1 cm^{-1}
1) 100 Ohms 2) 10^2 Ohms-cm
3) 10^{-2} Ohm 4) $10^{-2} Ohm^{-1} cm^{-1}$

14. Specific conductance of 0.1 M $NaCl$ solution is 1.06×10^{-2} Ohm^{-1} cm^{-1}, its molar conductnace in Ohm^{-1} cm^2 Mol^{-1}

1) 1.06×10^{2} 2) 1.06×10^{4}
3) 1.06×10^{3} 4) 5.3×10^{2}

TS-ECET-2016

15. The units of molar conductance are

1) $\Omega cm\, mol^{-1}$ 2) $\Omega^{-1}cm^2\, mol^{-1}$
3) $\Omega^{-2}cm^{-2}\, mol^{-1}$ 4) $\Omega cm^2\, mol$

16. E^0 of Zn electrode is -0.762 volts. The single electode potential of Zn electrode in deci molar $ZnSO_4$ solution is

1) -0.7915V 2) -0.671 V
3) +0.7915V 4) +0.671V

17. The function of salt bridge is

1) to produce a link between two half cells
2) to allow ions to go from one cell to another cell
3) to keep the EMF of the cell positive
4) to maintain electrical neutrality of the solution in two half cells

AP-ECET-2016

18. Which of the following is a good conductor

1) de-ionized water 2) copper
3) teflon 4) bakelite

19. In galvanic cell chemical energy is converted to

1) electrical energy 2) thermal energy
3) sound energy 4) water

20. According to faraday's first law, the mass of any substance deposited or liberated at electrode is directly proportional to

1) quanitity of electricity passed
2) temperature of electrode
3) electrode potential
4) solution concentration

21. In a given galvanic cell the standard reduction potential of zinc electrode is -0.76 V and that of copper electrode is -0.40V. The emf of the galvanic cell is

1) 0.36V 2) 1.16V
3) -0.40V 4) -0.76V

TS-ECET-2017

22. Three faradays of electricity was appsed through an aqueous solution of ferrous chloride. The weight of iron metal (at Wt=56) deposited at the cathode in grams is

1) 56 2) 84 3) 112 4) 168

23. Which one of the following could not be liberated from a suitable electrolyte by the passage of 0.25 faraday of lectricity through the electrolyte

1) 0.25 mole of Ag 2) 16 gms of Cu
3) 2gms of O_2(g) 4) 2.8 lit of H_2 at STP

24. Given standard electrode potentials

$Fe^{3+} + 3e^- \longrightarrow Fe$ $E^0 = -0.036V$

$Fe^{2+} + 2e^- \longrightarrow Fe$ $E^0 = -0.440V$

The standard electrode potenital E^0 for $Fe^{3+} + e^- \longrightarrow Fe^{2+}$ is

1) 0.476 V 2) -0.404V 3) 0.40 V 4) 0.772 V

AP-ECET-2017

25. During the electrolysis of brine, 710 g of Cl_2 was liberated at anode. The weight of NaOH formed

1) 800 g 2) 400 g 3) 80g 4) 40g

26. In the Danniel cell, which electode acts as anode

1) Cu 2) Hg 3) Zn 4) Pt

27. The molar conductance of HCl is more than that of NaCl because

1) NaCl is more polar than KCl
2) NaCl is ionic while HCl is covalent
3) Ionic mobitlity of H^+ is mote than that of Na^+
4) H^+ get hydrated

28. The units for electrochemical equivalent are

1) grams 2) grams ampere
3) coulomb 4) grams per coulomb

TS-ECET-2018

29. Number of coulombs of current required to convert completely one mole of $MnO_4^{\ominus}$ ions in acid medium to one mole of Mn^{+2} ions electrically_____

1) 96500 2) 96500 x 2
3) 96500 x6 4) 5 x 96500

30. Which of the following elements has the highest value of the electrochemical valent

1) Mg 2) Ca 3) K 4) Na

31. The standard reduction potential for Zn^{+2} / Zn and cu^{+2}/cu electrode are -0.76V and +0.34 V respectively. For the cell reaction $Zn + Cu^{+2} \rightarrow Zn^{+2} Cu$ the standard e.m.fis_____

1) +1.10 V 2) -0.42 V

3) +0.42V 4) -1.10V

AP - ECET - 2018

32. One faraday is equal to

1) 99650 C 2) 93100 C

3) 96500 C 4) 94500 C

33. The cell raction fo a cell is $Mg(s) + 2H^{+}(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$. If the standard reduction potential of Zn is -2.372 V, then the emf ofthe cell is

1) +2.372 V 2) -2.372 V

3) 0.00 V 4) -1.372 V

34. Mass of substance produced at electrode is directly proportional to the quantity of electricity passed. This is known as

1) faraday's second law 2) faraday's first law

3) newton's third law 4) newton's first law

PREVIOUS ECET BITS KEY				
01) 1	**02)** 4	**03)** 4	**04)** 4	**05)** 4
06) 2	**07)** 3	**08)** 4	**09)** 2	**10)** 1
11) 1	**12)** 1	**13)** 4	**14)** 1	**15)** 2
16) 1	**17)** 4	**18)** 2	**19)** 1	**20)** 1
21) 1	**22)** 2	**23)** 2	**24)** 4	**25)** 1
26) 3	**27)** 3	**28)** 4	**29)** 4	**30)** 3
31) 1	**32)** 3	**33)** 1	**34)** 2	

CONCENTRATION IS THE ONE AND ONLY ONE METHOD OF ACQUIRING KNOWLDGE

SPACE FOR IMPORTANT NOTES

WATER TREATMENT

1. **Introduction :** As engineering material, water is used in the steam generation, coolant in power plants, as a cleaning agent and it is used in various chemical plants.
2. Main sources for water

   i) Surface Water ii) Underground water
3. Surface water includes rain water, river water, lake water and sea water.
4. Rain water is purest form of water. After it reaches onto the earth many impurities will be dissolved in it
5. In river water, mostly dissolved salts will be present with less organic matter.
6. In lake water less dissolved salts and more organic matter is present
7. Sea water is most impure water, it contains 3.5% dissolved salts out of which 2.6% is NaCl.
8. In the undergound water more dissolved salts will be present and organic matter will not be present and it has clear appearance. Ground water pH value will be more than seven due to the presence of many dissolved salts.
9. Ground water includes springs and well water-
10. In water the impurities are

    i) Dissolved gases like $CO_2, NO_2, SO_2, H_2S, O_2, NH_3$ etc. ii) Suspended matter and colloidal particles

    iii) Micro organisms

    iv) Dissolved salts

    v) Organic matter.
11. Water with much of suspended matter will have turbidity.
12. If water is having micro organisms it will give various diseases.
13. Dissolved salts will give hardness, corrosion of metals and other harmful effects.
14. Organic matter will give colour and bad smell.
15. Dissolved gases cause corrosion. CO_2, NO_2, SO_2 & H_2S like gases give acidic nature and corrosion. H_2S will give bad smell also. NH_3 gives basic nature.

1. Water can be classified into two categories depending on its reactivity with soap.
2. If water forms lather with soap, it is called soft water.

3. If water does not form lather with soap and if it forms a precipitate, it is called hard water.

4. Soap is Na (or) K salt of higher carboxylic acid (fatty acid) like stearic acid, oleic acid, palmitic acid etc.

5. In hard water Ca. Mg and other heavy metal salts are present in the dissolved condition.

6. When hard water is treated with soap then Ca and Mg salts react with soap to form Ca soap (or) Mg soap which will form a precipitate.

7. Example : $C_{17}H_{35}COOH$ (stearic acid)

$$C_{17}H_{35}COONa + CaCl_2 \longrightarrow (C_{17}H_{35}COO)_2\,Ca \downarrow + NaCl$$

(Na salt of stearic acid) Ca salt of stearic acid

(sodium stearate)

1. Hardness of water can be of two types.

   1. Permanent hardness 2. Temporary hardness

2. Temporary hardness can also be called carbonate hardness and permanent hardness can be called non carbonate hardness.

3. Temporary hardness of water is due to the presence of bicarbonate salts of calcium, Mg and other heavy metals and it is also due to carbonate of iron $CaHCO_3$ & $MgHCO_3$

4. If CO_2 is present i n water it reacts with water to form carbonic acid which will give bicarbonate so due to the presence of CO_2 water will get some amount: of temporary hardness and acidic nature.

5. Bicarbonate salts of Ca & Mg can also give alkaline (basic) nature to water.

6. Temporary hardness can be eliminated by boiling water.

7. When water is boiled $CaHCO_3$ and $MgHCO_3$ will be converted into insoluble $CaCO_3$ and $Mg(OH)_2$ respectively. So temporary hardness can be removed.

8. $Ca(HCO_3) \xrightarrow{\Delta} CaCO_3 \downarrow + H_2O + CO_2$

9. If the hardness is not eliminated by boiling it is, called permanent hardness. Permanent hardness can be removed by adding chemicals.

10. Permanent hardness is due to the presence of chloride and sulphate salts of Ca, Mg, Fe and some other heavy metals.

11. Permanent hardness may also be due to $Ca(NO_3)_2$, $Mg(NO_3)_2$ and their silicates.

⇨ Expression of hardness :

1. Hardness will be expressed interms of $CaCO_3$ equivalents.
2. $CaCO_3$ (calcium carbonate) is taken as standard because $CaCO_3$ molecular weight is 100 and equivalent weight is 50. So calculation will be easy and $CaCO_3$ is most insoluble salt in water.
3. $CaCO_3$ equivalent =

$$\frac{\text{Weight of hardness producing substance} \times \text{molecular weight } CaCO_3}{\text{Molecular weight of hardness producing substance}}$$

(or)

$$\frac{\text{Weight of hardness producing substance} \times \text{Eq.weight of } CaCO_3}{\text{Equivalent weight of hardness producing substance}}$$

$$\text{Equivalent weight of salt} = \frac{\text{Molecular weight}}{\text{charge on cation (or) anion}}$$

⇨ Examples :

1. 81mg of $CaCO_3$ is present in 1 litre of water. What is its hardness.

Sol: $\left[Ca(HCO_3)\right]_2$ molecular weight = 162] $\Rightarrow \frac{81\times100}{162} = 50$ mg/litre

.....

50 mg per litre or 50 PPm

2. If 40 mg $MgSO_4$ is present in 500 milli litres of water then what is its hardness ($MgSO_4$, molecular weight = 120)

Sol : $\frac{40\times100}{120} = 33.3$ mg/ 500ml

per litre = 66.6 mg/litre or 66.6 PPm

3. If 0.11 gm of $CaCl_2$ is present in 500 ml water. Then what is its hardness in milligrams / litre

($CaCl_2$ molecular weight = 111)

Sol: $\frac{0.11\times1000\times100}{111}$

4. If X mg of hardness producing salt is present i n a litre water and its molecular weight is'y' then what is hardness.

Sol: $\frac{X \times 100}{y}$

5. If 81 76 mg/litres of $Ca(HCO_3)_2$, 60mg/lit of $CaSO_{,,,}$ 73 mg/litre of $Mg(HCO_3)_2$ are present in a litre of water then what is the temporary hardness and permanent hardness and total hardness.

Sol: $Ca(HCO_3) \Rightarrow \frac{81 \times 100}{162} = 50$ mg/litre

$Mg(HCO_3) \Rightarrow \frac{73 \times 100}{146} = 50$

$CaSO_4 \Rightarrow \frac{60 \times 100}{120} = 50$ mg/litre

Temporary hardness = 100 mg/litre

Permanent hardness = 50 mg/litre

Hardness (total) = 50 + 50 + 50 = 150 mg / litre

Molecular weight of some salts :

$Ca(HCO_3) = 162$	$Mg(HCO_3)_2 = 162$
$CaSO_4 = 136$	$CaCl_2 = 111$
$MgSo_4 = 120$	$MgCl_2 = 95$
$CO_2 = 120$	$Mg(NO_3)_2 = 148$
$HCO_3 = 61$	$MgCO_3 = 84$

⇨ Units of hardness :

1. Hardness units are ppm (parts per millions).
2. mg/ litre
3. clarks degree (^0Cl)
4. French degree (^0Fr)

5. ppm is the parts of $CaCO_3$ equivalents per 10^6 parts of water.

6. If one part of $CaCO_3$ equivalent hardness is present per 10^6 parts of water, then its hardness is 1 ppm.

7. Mg/litre is number of Mg of $CaCO_3$ equivalent hardness per one litre of water.

8. ppm is equivalent to mg/ litre

9. 1 mg/litre = 1 ppm

10. The parts of $CaCO_3$ equivalent hardness per 70,000 parts of water, it is called clarks degree (^0Cl)

11. Parts of $CaCO_3$ equivalent hardness per 10^5 parts of water is called french degree.

12. 1 ppm = 1 mg / litre = 0.1 ^0Fr = 0.07 ^0Cl

13. 1^0C1= 1.43°F= 14.3 ppm = 14.3 mg/litre.

14. 0 to 70 ppm can be regarded as soft water and 70 to 150 ppm hardness can be taken as moderate hard water (or) moderate soft water.

15. 150 to 300 ppm hardness can be taken as hard water and above 300 ppm is very hard water.

⇨ Disadvantages of hard water :

I) In Domestic use :

1. In washing hard water gives wastage of soap, cloths giving some spots on the cloth.
2. In cooking wastage of fuel takes place, certain food do not cook and cooked food will have bad taste.
3. If hard water is taken for' drinking purpose, it will give bad effect on digestive system and it forms stones in Kidney's (calcium oxalate crystal and Magnisium oxalate crystal)

II) In industrial use :

1. In textile industry hard water does not produce exact shade of odour, it will give much soap wastage, it damages the cloth, certain iron manganese salts will form coloured spots on the cloth.
2. In sugar industry if hard water is used it causes difficulty in the crystallisation of sugar. Especially sulphates, nitrates and carbonates will give more difficulty.
3. Dying Industry : In dying industry if hard water is used which is containing Ca, Mg, iron salts, they react with dyes to form undesirable colour and improper shade and fabric damage.
4. Paper Industry : In paper industry hard water gives bad finishing of paper and certain iron salts may give colour to the paper
5. In laundry soap wastage takes place colour change of clothes take place.

6. In pharamaceutical and chemical industry hard water gives undesirable products.

7. In concrete making hard water containing chloride and sulphate salts will effect hydration of cement and strength of concrete decreases.

⇨ Effect of hard water in the steam generation in boilers :

1. In boilers hard water will give mainly four troubles

   i) Scale and sludge formation

   ii) Priming and foaming

   iii) Boiler corrosion

   iv) Caustic embrittlement

i) Sludge and scale formation : Sludge is a loose and slimmy precipitate formed in the boiler.

Sludge is formed by the substances which have lesser solubilities in hot water than in cold water.

Ex : $MgCO_3, MgCl_2, CaCl_2, MgSO_4$

⇨ Disadvantages:

1. Sludges are poor conductors of heat, so wastage of heat takes place.
2. If sludges are formed along with scales it will be trapped into the scales and a very hard scale is formed.
3. Sludge formation disturbs working of boiler.
4. Because of sludge, chocking (blocking) of pipes takes place.
5. Sludge formation can be prevented using soft water.
6. Sludge can be removed by blowdown operation.
7. Scales are hard deposits which are formed on the inner surface of boiler which are difficult to remove.
8. Scale are the main source of boiler troubles.
9. Scales are formed due to the presence of $Ca(HCO_3)_2, CaSO_4, MgCl_2, Mg(HCO_3)_2, MgSiO_3, CaSiO_3$
10. $Ca(HCO_3)_2$ will give $CaCO_3$ upon heating which form scale mainly this takes place in low pressure boilers $Mg(HCO_3)_2$ will give $Mg(OH)_2$ when form scale.

$$Ca(HCO_3)_2 \longrightarrow CaCO_3 \downarrow + H_2O + CO_2$$

$$Mg(HCO_3)_2 \rightarrow Mg(OH)_2 + 2CO_2$$

11. $CaSO_4$ scales will give many troubles in high pressure boilers.

12. $Ca(HCO_3)_2$ and $Mg(OH)_2$ form soft scales and $CaSO_4$, $MgSiO_3$, $CaSiO_3$ form hard scales.

13. $CaSO_4$ will form very hard scales, as the temperature increases $CaSO_4$ scales will give many troubles in high pressure boilers.

14. $MgCl_2$ react with water to form $Mg(OH)_2$, which is insoluble in water and forms soft scales.

15. Generally silica can be present in water when it is filterer through sand filter.

16. Silica will form $CaSiO_3$, $MgSiO_3$ (Mg silicate) scales

17. Scales formation will give wastage of fuel, lowering of boiler safety and danger of explosion.

18. Efficiency of boiler decreases due to the scales and chocking of pipes takes place.

⇨ **Removal and prevention of scales :**

1. The formed scales can be removed with the help of scrapper if the scales are loosely adherent.
2. Scales can be removed by thermal shocks (heating followed by sudden cooling)
3. Using certain chemicals like HCl for $CaCO_3$, EDTA for Ca, Mg salts scales can be removed.

   (i.e., chemical treatement followed by blow-down operation)
4. Scales formation can be prevented using soft water (or) by adding chemicals.
5. Scales formation can be prevented using certain chemicals is called as internal treatment (or) sequestration.
6. Formation of scales can be prevented in high pressure boilers by adding Na_3PO_4 (sodium phospate) or Na_2HPO_4 (disodium hydrogen phospate) or NaH_2PO_4, (sodium dihydrogen phospate) or $Na_2P_2O_7$ (Sodium hydro phosphate) This process is called as phospate conditioning
7. Scales can also be prevented using Na_2CO_3 which is called as carbonate conditioning. But its use is not suggested as it gives caustic embrittlement which is another boiler trouble
8. Scales can be prevented by adding calgon. Calgon is sodium hexameta phosphate $\left[Na_2\left[Na_4(PO_3)_6\right]\right]$. This is called as calgon conditioning.
9. Scales can be prevented by adding kerosene, tannin, Lignin agar-agar gel. This process is called as colloidal conditioning This is useful in low pressure boilers. (These are organic chemicals)
10. To prevent scales sodium aluminate can also be used.
11. Along with above process to prevent scales there is electrical conditioning and radio active conditioning.

⇨ **Caustic embrittlement:** It is a type of boiler corrosion. In the boiler if Na_2CO_3 is present it reacts with water to form $Na(OH)_2$

$$Na_2CO_3 + H_2O \longrightarrow 2Na(OH)_2 + CO_2$$

→ NaOH enters into the hair cracks, rivets, bends and joints of the boiler where its concentration increases.

→ The area with more concentrated NaOH acts as anode and area with dilute NaOH acts as cathode, i.e. a

concentration cell will be formed.

→ From anodic area iron react with NaOH to form $Na_2\ FeO_2$ (sodium ferroate) which will be converted into ferroso ferric oxide (Fe_3O_4)

anode cathode

Fe/conc. NaOH//Fe / dil NaOH

→ To prevent caustic embrittlement instead cf Na_2CO_3, Na_3PO_4 can be added.

⇨ **Boiler corrosion :** Decay of boiler material by chemical (or) electro chemical attack of various substances of hard water is called as boiler corrosion.

Certain salts present in the water like $MgCl_2$, $MgSO_4$, $CaCl_2$, etc. and salts of iron can react with boiler metal to form corrosion.

→ If oxygen is present i n the boiler water (or) if CO_2 is present they also give corrosion.

→ Dissolved gases and dissolved salts will give corrosion.

→ If oxygen is present in the dissolved state in water, iron undergoes corrosion with absorption of oxygen type electro chemical corrosion to form hydrated ferric oxide.

→ If CO_2 present in water it will produce carbonic acid (H_2CO_3) with which corrosion takes place.

→ If corrosion causing salts are removed, boiler corrosion can be prevented.

→ Corrosion with oxygen can be prevented by removing oxygen from boiler water with mechanical deareation (or) by adding sodium sulphite (Na_2SO_3). Hydrazine $(NH_2 - NH_2)$.

→ Corrosion with CO_2 can be prevented by removing CO_2 with mechanical deareation (or) by adding basic substance NH_4OH

⇨ **Priming & Foaming :** Wet steam production is called priming i.e. along with steam some water drops will come out.

- These water drops will be landed up on the adjacent parts of the boiler which will corrode the metal.
- Foaming is constant foam production (i.e., lather production) in the boiler water.
- With the foam production water level in the boiler can not be determined.
- Due to the presence of dissolved salts, high steam velocity, sudden boiling, improper boiler design and sudden increasing steam production rate will give priming
- Due to the presence of certain substance in the desolved condition foaming can be produced.
- Priming can be avoided using soft water, with the proper boiler design, uniform production of steam velocity etc.
- Priming can be stopped by fitting mech steam purifier.
- Foaming can be avoided by using anti foaming agent like caster oil, sodium aluminate.
- If water consist of N a and K salts it will not give hardness.
- Salt like $Na(HCO_3)_2$, $NaCO_3$, K_2CO_3 cannot give hardness but they give basicity.
- Salts like $Ca(HCO_3)_2$, $Mg(HCO_3)_2$ can give temporary hardness and also basicity.
- If oxygen is present in water it will give corrosion.
- If CO_2 is present in water it will give acidity and corrosion.
- Gas like H_2S is present it will give acidity, corrosion and fowl smell (bad smell)
- Mn, iron (Fe) salts will give colour to water
- Arsinic, lead, antimoney and mercuric salts will give toxic. nature to water (poisioness nature)

⇨ **Estimation of hardness :** To estimate the amount hardness in a given water sample there are three methods.

1. Soap titration
2. EDTA methode
3. O-Hehner's method

⇨ **Soap solution method :**

- Distilled water is water which is free from all the ions and which is equal to rain water.

- Distilled water also needs some amount of soap solution to get a constant lather.
- Constant lather can atleast with stand for two minutes.
- In the soap solution method distilled water, standard hard water and unknown hard water should be titrated with standard soap solution.
- Standard hard water can be prepare by dissolving a known amount of $CaCO_3$ and by adding HCl.
- If 1000 mg of $CaCO_3$ is dissolved for 1 lit its hardness is 1000 ppm. (interms of $CaCO_3$ equivalents).
- If volume of soap solution required for distilled water to get the end point is V_1 ml (end point is constant lather production)
- If volume of soap solution require for standard hard water V_2 ml and volume of soap solution for unknown hard water is V_3 ml, then

  for 1000 ppm hardness the volume of soap solution = $V_2 - V$

  For unknown hardness the volume of soap solution = $V_3 - V_1$

  $V_2 - V_1 = 1000$ ppm

  $V_3 - V_1 = ?$

  $$\text{Total hardness} = \frac{V_3 - V_1}{V_2 - V_1} \times 1000$$

- Temporary hardness can be eliminated by boiling the given water sample.
- After boiling followed by cooling and filtration the water sample is again titrated with soap solution. If the volume of solution require to get end points is V , ml then the volume of soap solution for permanent hardness = $V_4 - V_1$

  $$\text{Permanent hardness} = \frac{V_4 - V_1}{V_2 - V_1} \times 1000$$

  Temporary hardness = total hardness - permanent hardness

  $$\frac{V_3 - V_1}{V_2 - V_1} \times 1000 - \frac{V_4 - V_1}{V_2 - V_1} \times 1000 = \frac{V_3 - V_4}{V_2 - V_1} \times 1000$$

⇨ **EDTA method :** It is more accurate than soap solution method. This are called complexometric method.

EDTA (Ethylene diamine tetra acitic acid)

- The indicator used i n EDTA method is eriochrome black-T.
- The buffer solution used in this method is $NH_4Cl + NH_4OH$ (basic buffer) which keeps the pH at 10.
- The solution which will resist change of pH when small amount of acid (or) base is added is called as buffer solution.
- EDTA reacts with Ca(or) Mg of hard water to form a colourless complex. It is also called as complexo metric titration.
- EB-T is in blue colour. It forms a wine red colour complex by reacting with Ca (or) Mg in hard water.
- If wine red coloured hard water is treated with EDTA it changes into blue colour slowly due to the releasing of free indicator i.e. the end point is conversion of wine red colour into blue colour.

$$Ca^{+2} + EB - T \longrightarrow Ca - EB - T \xrightarrow{EDTA}$$

(Blue) (wine red)

$$Ca - EDTA + EB - T$$

(colourless) (blue)

$$Mg^{+2} + EB - T \longrightarrow Mg - EB \xrightarrow{EDTA} Mg - EDTA + EB - T$$

- In this method a standard hard water and given water sample must be titrated with EDTA.
- If volume of EDTA required for standard hard water (1000 pm) is equal to V_1 ml

Volume of EDTA required for sample water = V_2 ml

Total hardness = $\frac{V_2}{V_1} \times 1000$ ppm

- By boiling water temparory hardness will be expelled and it will be titrated again with EDTA.
- The volume of EDTA required for permanent hardness = V_3 ml, then the permanent hardness = $\frac{V_3}{V_1} \times 1000$ ppm

Another method in EDTA :

- Volume of EDTA for temporary hardness is $V_2 - V_3 = \frac{V_2 - V_3}{V_1} \times 1000$

In this method the given water sample is titrated with standard EDTA (whose concentration is exactly known).

➡ 1ml of 0.01 M EDTA = 1mg $CaCO_3$ Equivalent hardness

➡ For a water sample Vml of xM concentration EDTA is required, then amount of $CaCO_3$ equivalent hardness in that water

➡ 1ml 0.01 M EDTA = 1 mg $CaCO_3$ equivalent hardness

Vml of xM EDTA = ?

$$\frac{V}{1}\times\frac{x}{0.01}xl=\frac{Vx}{0.01}=V_x\times100$$

➡ If a water sample requires 2ml of 1M EDTA. Then what is its hardness

1ml of 0.01 M EDTA = 1 Mg $CaCO_3$

2ml of 1M EDTA = ?

$\Rightarrow 2\times1\times100 \Rightarrow 200$ ppm

➡ If 50 ml of water sample require 2ml of 0.1 M EDTA what is hardness.

Mg / 50 ml = $2 \times 0.1 \times 100 = 20$

$$\text{mg/lit}=\frac{20}{50}\times1000=400 \text{ ppm}$$

➡ If 100 ml of water sample needs Xml of YM concentration EDTA then total hardness

$$\text{mg/lit}=\frac{xy}{100}\times100\times1000=xy\,1000 \text{ ppm}$$

⇨ **Softening methods :** The removal of hardness producing salts form water is known as softening of hard water.

1. Lime soda process : In this method the soluble Ca and Mg salts in water are chemically converted into insoluble compounds by adding calculated amount of lime i.e. CaOH and soda i.e. Na_2CO_3 (soda ash)
2. The insoluble compounds are precipitated and filtered

⇨ **Advantages:**

1. It is very economical.
2. This process increases pH value of treated water.
3. To certain extent iron and Mn are also removed.

4. Any kind of water can be treated

⇨ Disadvantages:

1. Disposal of large amount of sludge is very difficult.
2. Hardness will be removed upto 15 ppm (the residual hardness will be 15 to 30 ppm) in hot lime soda process and 50-60 PPm in cold lime-soda process.
3. More skill is required.
4. It is a time consuming process.
5. Some times accelerators like charcoal is required.
6. To get a coarse precipitate coagulants (or) flocculants are required
7. Coagulants will make loose precipitate coarse and flocculants make colloided particles to settle down.

Ex: Alum $(K_2SO_4\ Al_2(SO_4)_3\ 24H_2O)$

$Al_2(SO_4)_3$

$NaAlO_2$ (or $Na_2Al_2O_4$)

→ This process can be carried out in cold condition which is called cold lime soda process (or) in hot condition which is called hot lime soda process.

→ Lime can react with $CaH(CO_3)_2$, $Mg(HCO_3)_2$ permanent hardness causing salts of Mg and iron, CO_2 acidic ions and sodium aluminate.

→ Soda can react with permanent hardness causing salts of Ca, Mg, Fe and acidic ions of H^+ and HCO_3.

→ With the addition of soda, Ca salts will be precipated as $CaCO_3$

→ With the addition of lime Mg salts will be precipitated as $Mg(OH)_2$

→ Hot lime soda process removes hardness upto 15 ppm

→ Cold lime soda process removes hardness upto 30 ppm

→ In hot lime soda process dissolved gases can be eluminated and reaction will be fast, no accelerator is needed.

→ In lime-soda process the amount of lime and soda required can be calculated using the following equations.

$$\text{Amount of lime required} = \frac{1}{100}\left[\text{temp } Ca^{2+} + 2\left(\text{temp } Mg^{2+}\right) + \text{Perm Mg}\right] \text{ in mg/lt}$$

Amount of soda requirement $= \frac{1}{100}\left[\text{Perm } Ca^{2+} + \text{Perm } Mg^{2+}\right]$ in mg/lit

(All must be substituted in terms of $CaCO_3$ equivalents)

i.e., lime reacts with temp. hardness of Ca and Mg and perm. hardness of Mg.

Soda reacts with perm. hardness of Ca and Mg

⇨ Zeolite (permutit) process :

The chemical structure of sodium zeolite is represented as $Na_2O.Al_2O_3 \times SiO_2.yH_2O$ where x = 2 to 10, y = 2 to 6

zeolite is hidrated sodium alumino silicate and it is denoted as Na_2Ze

When hard water is passed through a zeolite bed various hardness causing ions i.e., Ca^{2+} and Mg^{2+} are exchanged with Na of zeolite. i.e., Ca and Mg salts are converted into Sodium salts.

→ Then hard water will made into soft water.

Eg: $Na_2Ze + CaCl_2 \longrightarrow CaZe + 2NaCl$

$NaZe + MgSO_4 \longrightarrow MgZe + Na_2SO_4$

→ zeolites are of two types

i) Natural zeolites ii) synthetic zeolites

→ Natural zeolite is non porous

ex: $Na_2O.Al_2O_3.4SiO_2\ 2H_2O$(natrolite)

Synthetic zeolites are porous and they are prepared by heating a mixture of chine clay, feld spar and soda ash.

These will have high exchange capacity. Synthetic zeolite is called permutit.

→ After exhausted zeolite. It can be regenerated by washing with 10% briine solution (NaCl solution).

$CaZe + 2Na\ Cl \longrightarrow Na_2Ze + CaCl_2$

$MgZe + 2NaCl \longrightarrow Na_2Ze + MgCl_2$

⇨ Advantages:

1. It removes hardness upto 10 ppm, it requires less time, less skill, less space for the equipment.

2. It is very clean and no sludge formation

⇨ Disadvantages

1. The treated water contains more Na salts.
2. It will not remove acidic radicals (anions)
3. High turbidity water cannot be treated, Acidic water can not be treated.
4. $Na(HCO_3)_2$ decomposes CO_2 to cause corrosion
5. $NaCO_3$ in water can form NaOH which gives caustic embrittlement

⇨ Ion exchange process : (De ionisation process (or) demineralisation)

- Ion exchange process removes all the +ve and -ve ions from water.
- Water will be passed through ion exchange resins where all the ions will be removed.
- In cation exchange resins all the cations will be exchange with H^+ ions. In anion exchange resins all the anions will be exchanged with OH^- ions

ion exchange resins arc long chain organic polymers with cross linked structure.

Cation exchange resins are mainly styrene - divinyl benzene copolymers with functional group SO_3H (or) COOH

- These are generally represented as RH^+
- Anion exchange resins are styrine divynyl benzene (or) amine formaldehyde copolymilers which contain OH ions.
- These are generally represented with ROH^-
- $Na^+ + RH^+ \rightarrow RNa^+ + H^+$ (cation exchange)

$Ca^{2+} + 2RH^+ \rightarrow R_2Ca^{2+} + 2H^+$

$Cl^- + ROH \rightarrow 2OH- + R_2SO_4$ (anion exchange)

$SO_4^{-2} + 2ROH \longrightarrow R_2SO_4^{-2} + 2OH^-$

⇨ Regeneration of cation exchange resins

$RNa^+ + HCl \longrightarrow RH^+ + NaCl$

$$R_2Ca^{2+} + H_2SO_4 \longrightarrow 2RH^+ + CaSO_4$$

⇨ Regeneration of anion exchange resins

$$RCl^- + NaOH \longrightarrow ROH + NaCl$$

$$R_2SO_4^{-2} + 2KOH \longrightarrow 2ROH^- + K_2SO_4$$

→ H^+ ions and OH ions join together to form water

→ The exhausted cation exchange resin can be washed with dilute HCl (or) dil H_2SO_4 for its regeneration.

→ The exhausted anion exchange resin can be washed with dil NaOH (or) dil KOH for its regeneration.

→ The treated water will be nearly equal to distilled water or rain water.

⇨ Advantages:

1. This process can be used for acidic (or) basic water for the softening.
2. It produces highly softened water which is good for high pressure boilers. The residual hardness may be about 2 ppm.

⇨ Disadvantages:

1. It is a costly method. If water contains turbidity the softening decreases and takes much time so turbidity must be below 10 ppm.
2. Along with above mentioned methods distillation process, calgon and clarks process can also be use for water softening.
3. In clarks method CaOH is used for softening.
4. In modified lime soda process $BaCO_3$ is used instead of Na_2CO_3

Drinking water (or) municipal water treatment:

→ ***Requirements in drinking water.***

1. It must be clear and odourless
2. It must have pleasant taste and should be cool.
3. In drinking water turbidity should not exceed 10 ppm.
4. It should be free from objectionable dissolved gases and objectionable minerals such as Pb, As, Chromium, Mn etc.
5. For drinking water pH must be about 8 and it should be reasonably soft.

6. Total dissolved solids should be 500 ppm.

7. It must be free from disease producing micro organisms.

➔ Municipal water treatment consist of removal of suspended particles followed by filtration and removal of micro organisms.

⇨ Removal of suspended particles : It is called Sedmentation.

Sedmentation is a process of allowing water to stand undisturbed in big tanks then most of the suspended particles settle down at the bottom due to gravitational force.

➔ Before sedmentation process water must be passed through high screens having large number of holes which is called as screening, in this process floating matter will be removed.

➔ Sedmentation process can be carried out for 2 to 6 hours. Fine clay particles and colloidal particles can be removed by adding certain chemicals called as coagulants & Flocculants

➔ Common coagulants are alum, sodium aluminate ($NaAlO_2$) and coperas. Coperas is $FeSO_4$

➔ $FeSO_4 . 7H_2O$ is called as green vitriol.

➔ After sedmentation water will be filtered mainly through sand filter.

➔ After sedimentation stage, water becomes clear and transparent.

⇨ Removal of micro organisms (sterilisation) :

The process of killing disease causing bacteria and micro organisms in water is called sterilisation or disinfectation. The chemicals used for this purpose are called disinfectants or Germicides

Sterilisation can be carried *out* by following method :

By boiling : For small amounts of water particularly during the epidamics this process can be useful, but it is not useful for municipal water treatment. It is costly method and future contamination is possible.

➔ Bleaching powder: $(CaOCl_2)$ (Calcium oxichloride) or (Calcium chloro hypochlorite)

When it is added to water it reacts with water to release Cl_2 gas.

➔ The released Cl_2 can again react with water to form hypochlorous acid [HOCl] which is powerful disinfectant (or) germicide.

$$CaOCl_2 + H_2O \longrightarrow Cl_2 + Ca(OH)_2$$

$$Cl_2 + H_2O \longrightarrow HOCl + HCl$$

$HOCl + HCl$ is chlorine water

- For 1000 K lit of water 1kg of bleaching powder can be added (1000 Kilo tiltres = 10^6 litres)
- A good bleaching powder must contain of 35 to 38% of Cl_2

⇨ **Draw backs:**

- It introduces Ca in water making it more hard
- If excess of bleaching powder is added it gives pungent smell and pungent taste
- Upon long standing Cl_2 content will be decreased
- By chlorination : By passing Cl_2 gas (or) Cl_2 concentrated solution, water can be sterilised.
- Cl_2 reacts with water to form HOCl which is powerful germicide.
- The process of sterilisation using Cl_2 can be carried out in chlorinator.
- Liquid state chlorination is more effective than gaseous state.
- Chlorination process is most widely used disinfection ion method thoroughout the world.
- Disinfectation method is more effective at low pH values than at higher pH values.

⇨ **Advantages :** It is economical, it can be vised at low (or) higher temperature, it will not give any salt impurities, it is very stable and require less space for chlorination.

⇨ **Disadvantages :** If excess of Cl_2 is added it gives unpleasant taste and smell, excess Cl may give irritation to Mucous membrane.

- The quantity of free Cl_2 in treated water should not exceed 0.1 to 0.2 ppm
- This is effective for treating water with lower pH value. At higher p^H values HOCl gets neutralised.

⇨ **Break point of chlorination :**

- The addition of Cl_2 involves oxidation of organic matter and reduction of certain inorganic substances.

  Cl_2 acts as bleaching agent (i.e. removes colour)
- The dosage of Cl_2 added to get free Cl_2 in water is called, break point chlorination.
- At break point the disinfectation is highly effective as free Cl_2 is available.

- Break point chlorination oxidises organic matter completely removes the colour of water, removes the smell and taste of water, 100% organisms will be killed and future contamination will be prevented.
- If excess Cl_2 is added to water it can be removed process is called dechlorination.
- Dechlorination can be carried out by adding activated charcoal (or) by adding SO_2, Na_2SO_3 (or) $Na_2S_2O_3$ (Hypo) or NH_3

Chloromine Treatment :

- $(CINH_2)$ is produced in the reaction between NH_3 and Cl_2 $NH_3 + Cl_2 \Rightarrow NH_2Cl + HCl$
- When $CINH_2$ is added to water it forms HOCl $CINH_2 + H_2O \rightarrow HOCl + NH_3 \uparrow$
- $CINH_2$ is a long lasting compound, it will not produce any bad smell and it will give good taste to treated water.
- It is not widely used a it is costly method.
- $O_3 : O_3$ is an excellent disinfectant, O_3 is produced by passing O_2 through electric are O_3 is highly unstable and dissociates into O_2, and nascent oxygen. (O)

  $O_3 \rightarrow O_2 + (O)$ Nascent oxygen
- Nascent oxygen is powerful oxidising agent which can act. as disinfect.
- Nascent Oxygen can kill germs and oxidise the organic matter.
- This process removes colour, smell, taste from water.
- If excess is added it decomposes into oxygen so it is not harmful.
- This is costlier process.
- Sterelisation can also be carried out by passing U.V. radiation.

Desalination of Brackish water :

The process of removing common salt from water is called desalination.

Water containing dissolved salts with a salty taste is called brackish water (or) saline water. Sea water contains 3.5% salts, so it is called brackish water. Water consist of NaCl salt called brine solution. Brackish water is not safe for drinking.

- **Desalination is carried out in two methods :**

  i) Electrodyalisis ii) Reverse osmasis
- **Electrodyalisis :** By keeping two electrodes i n the brackish water required amount of electricity is passed with which ions are pulled out from water.

➔ **Reverse osmasis :** When two solutions of unequal concentration are separated by a semi permeable membrane, then solvent flows from lower concentration to higher concentration which is called osmasis.

If hydrostatic force is applied on more concentration side then solvent flows from more concentration to less concentration side which is called reverse osmasis. When desalination is carried out with reverse osmasis process, salts organic matter and colloidal particles etc., will be removed from water which is used as a boiler feed water. The purification process using reverse osmasis can also be called as super (or) hyper filtration.

➔ **Different substances in allowable limits for drinking.**

Substances	ppm
Total hardness	200
Total dissolved solids	500
Florine	1
Fe	0.3
Cd	75
Mg	50
Cl	250
SO_4^{-2}	200
As	0.05
Pb	0.05
CN^-	0.01
pH	7 to 8.5

➔ **Points to be noted further :**

1. Among different coagulants, potash alum is a common inorganic coagulant.
2. Calgon removes the hardness of water by complex formation, which is also called Graham's process.
3. The high boiling point of water is due to hydrogen bonding.
4. Water has greater density at 4^0C $\left(3.9^0\ C\right)$
5. Evaporation of water from the earth and coming down in the form of rain is water cycle
6. In water the physical impurities are colour, odour, turbidity and chemical impurities are hardness, alkalinity (Basicity), Acidity etc.
7. Soap is sodium or potassium salt of stearic acid $\left(C_{17}H_{35}COONa\right)$ or Oleic acid $\left(C_{17}H_{33}COONa\right)$ or Parmitic acid $\left(C_{15}H_{31}COONa\right)$
8. Natural zeolite is also called green sand

9. In water Iron and Manganese salts give colour while As, Pb, Hg salts give toxicity.
10. In Zeolite method of softening, the treated water contains more dissolved Na salts.
11. $CaOCl_2$ is acidic salt
12. Swimming pools water should not be sterilized with U.V. radiation.
13. $KMnO_4$ is a disinfectant called red medicine
14. Copers $FeSO_4$ produces $Fe(OH)_3$ and acts as coagulant.
15. Zeocarb is a cation exchange resin
16. Calgon is called Graham's salt
17. Rate of sedimentation is inversely, poroportional to viscosity.
18. Alkalinity (Basicity) in water is due to the presence of CO_3^{-2}, HCO_3^- and OH^- (i.e., carbonates, bicarbonates and hydroxides)
19. Alkalinity can be estimated by titrating water with standard HCl using methyl orange indicator. Colour change at the end point is yellow to orange red.
20. 1000 ml of 1 M HCl = 50 gr of $CaCO_3$ equipment alkalinity
21. NH_3 in water can be estimated by Nessler's method
22. Available chlorine in bleaching powder will be estimated by Iodimetry with starch indicator
23. Chlorides in water can be estimated by Argentometry by titrating with standard $AgNO_3$ solution using indicator K_2CrO_4 (potassium chromate), colour change at the end point is yellow to brick red. 1000 ml of 1 M $AgNO_3$ = 35.5 gr of chlorides.
24. Fluorides in water can be detected by Zinconium - alizarin - S -dye

ALL POWER IS WITHIN YOU YOU CAN DO ANY THING AND EVERY THING

01. pH of sea water is
1) O 2) < 7 3) 7 4) > 7

02. Which of the following is used in Clark's process
1) $Mg(OH)_2$ 2) NaOH
3) $Ca(OH)_2$ 4) KOH

03. Only permanent hardness of water is removed by
1) Soda 2) Clark's method
3) permutit method
4) Caustic Soda method

04. Spent permutit can be regenerated by
1) Aqueous NaOH 2) Aqueous NaCl
3) KOH solution 4) Na_2SO_4 solution

05. Chemically soap is
1) a salt 2) a base 3) an acid 4) all these

06. Lime soda method can remove
1) Permanent hardness
2) Temporary hardness
3) Both these 1 and 2
4) None of these

07. Colloidal impurities in water can be removed by
1) Filtration 2) Sedimentation
3) Screening 4) Coagulation

08. Hardness caused by dissolved CO_2 is
1) Permanent 2) Temporary
3) Both 4) None

09. Which of the following is a Grahma's salt
1) $Na_2[Na_2(PO_3)_6]$
2) $Na_2[Na_4(PO_3)_6]$
3) $Na_4[Na_2(PO_4)_6]$
4) $Na_2[Na_4(PO_4)_6]$

10. Anionic resin can be regenerated using
1) Acids 2) Salt solution
3) Alkalies 4) Brine solution

11. Zeocarb is
1) Cationic resin 2) Anionic resin
3) Steriliser 4) Coagulant

3) $HCl + Cl_2$ 4) $HOCl + HCl_4$

13. Erichrome Black. T is used as indicator in the method
1) Soap Titratior 2) E.D.T.A
3) Total alkalinity 4) Permutit method

14. Which of the following is Brackish water
1) Rain water 2) Spring water
3) Sea water 4) River water

15. Desalination can be done by
1) Freezing 2) Reverse osmosis
3) Electrodialysis 4) All these

16. Oxidation number of chlorine in Bleaching powder is
1) +1 2) -1 3) -1 and +1 4) 0

17. Indicator used in Argentometric method is
1) Methyl orange 2) Starch
3) K_2CrO_4
4) Erichrome Black - T

18. Major impurity in Brackish water is
1) $NaCl$ 2) $CaCl_2$
3) $Mg(OH)_2$ 4) $CaSO_4$

19. Ion acts as coagulant in Alum is
1) K^+ 2) Al^{+3} 3) Fe^{-2} 4) Mg^{+2}

20. Removal of harmful bacteria is known as
1) Filtration 2) Sedimentation
3) Coagulation 4) Sterilisation

21. A water sample contains 100 PPM hardness. its type is
1) soft 2) Moderate soft
3) Hard 4) Very hard

22. Dosage of any coagulant should be in the range
1) 0 - 5 mg/lit 2) 5 - 100 mg/lit
3) 100 -200 mg/lit 4) 200 - 500 mg/lit

23. A water sample has hardness 80 p.p.m. Express this value in British unit
1) 8^0 Fr 2) 5.6^0 Cl
3) 40 EPM 4) 8^0 Cl

24. Hardness of water sample contain 30 mg/lit of $MgSO_4$ is
1) 30 PPM 2) 50 PPM
3) 25 PPM 4) 60 PPM

25. Water neither attached to cation nor to anion is called
1) Lattice water 2) Hydrated
3) Heavy water 4) Oxidised water

26. Indicator used in the determination of alkalinity of water is
1) Phenopthalene 2) Methyl orange
3) Phenol red 4) K_2CrO_4

27. 500 ml of water sample consumes 20 ml of 0.01 M.E.D.T.A its hardness is
1) 20 PPM 2) 40 PPM
3) 60 PPM 4) 50 PPM

28. Number of water molecules in common alum is
1) 7 2) 10 3) 14 4) 24

29. Which of the following is an artificial zeolyte
1) Calgon 2) Permutit
3) Graham's salt 4) Resin

30. Total oxidation number of chlorine in bleaching powder is
1) +1 2) -1 3) 0 4) +2

31. Percentage of chlorine gives by bleaching powder is
1) 30 - 35 2) 35 - 38
3) 38 - 42 4) 25 - 30

32. In Iodometry method for the estimation of available chlorine indicator used is
1) Starch 2) Methye Orange
3) $KMnO_4$ 4) Phenol Red

33. Which of the following is an example of acid buffer
1) $NH_4OH + NH_4Cl$
2) $HCl + NaCl$
3) $NaOH + NaCl$
4) $CH_3COOH + CH_3COONa$

34. Amount of chlorine present in 500ml of sample water which consumes 50ml of 0.01 M $AgNO_3$ in chlorine method is
1) 17.75 mg/ lit 2) 35.5 mg/lit
3) 50 mg/lit 4) 71 mg / lit

35. Best Method to express the hardness of water is
1) PPM 2) ^{o}French
3) ^{o}Clark 4) EPM

36. Important stage in the purification of drinking water is
1) Screening 2) filtration
3) sterilisation 4) coagulation

37. End point in soap solution Method is
1) Red to Blue 2) Blue to Red
3) Yellow to Red 4) Stable lather

38. 20ml of a sample of a litre of hard water required 4ml of 0.05 M EDTA on a complexometic titration. The hardness of the sample in mg/lit is
1) 1000 2) 1500 3) 100 4) 500

39. The available chlorine content of a good sample of bleaching powder is about
1) 20-30% 2) 35-38%
3) 40-50% 4) 50-60%

40. One litre of hard water contains 81 mg of $Ca(HCO_3)_2$. The hardness of water in P.P.M of
1) 50 2) 81 3) 162 4) 25

41. When the quantity of dissolved salts of Ca^{+2} and Mg^{+2} present in water to the extent of 250 parts per million of $CaCC_3$ equivalents, the water is classified as
1) not too bad 2) hard
3) very hard 4) very soft

42. The process to remove colloidal particles from water is
1) Coagulation 2) Filtration
3) Sedimentation 4) Disinfection

43. The gas that is used in sterilisation of water is
1) CO_2 2) O_2 3) H_2S 4) Cl_2

44. Which one of the following is not a water softener
1) Calgon 2) Permutit
3) Na_2CO_3 4) Na_2SO_4

45. The exhausted perumutit is generally regenerated by percolating through it a solution of
1) $NaCl$ 2) $CaCl_2$ 3) $CaSO_4$ 4) $Ca(OH)_2$

46. The temporary hardness of water be removed by adding

1) $CaCO_3$ 2) $CaCl_2$

3) $CaSO_4$ 4) $Ca(OH)_2$

47. The high boiling point of water is due to

1) Its high specific heat

2) Hydrogen bonding between water molecules

3) Weak dissociation of H_2O molecules

4) Its high dielectric constant

48. High boiling point of water is due to

1) Polar bond 2) Hydrogen bond

3) electrovalent bond 4) coordinate bond

49. Water has the maximum density at

1) 0^0C 2) $3.9\ ^0C$ 3) $25\ ^0C$ 4) $37\ ^0C$

50. hardness can not be removed by using

1) $Ca(OH)_2$ 2) NaOH

3) Na_2CO_3 4) Any one

51. Which sterilises the water?

1) CO_2 2) O_3 3) N_2 4) SO_3

52. Permanent hardness of water is due to the presence of

1) $CaSO_4$ 2) $MgCl_2$

3) Sulphates, chlorides of Ca, Mg

4) None

PRACTICE SET-I KEY

1) 4	2) 3	3) 1	4) 2	5) 1
6) 3	7) 4	8) 2	9) 2	10) 3
11) 1	12) 1	13) 2	14) 3	15) 4
16) 3	17) 3	18) 1	19) 2	20) 4
21) 2	22) 2	23) 2	24) 3	25) 1
26) 2	27) 2	28) 4	29) 2	30) 3
31) 2	32) 1	33) 4	34) 2	35) 1
36) 3	37) 4	38) 1	39) 2	40) 1
41) 2	42) 1	43) 4	44) 4	45) 1
46) 4	47) 2	48) 2	49) 2	50) 2
51) 2	52) 3			

PRACTICE SET - II

01. The ion absent in exhausted permutit is

1) Na^+ 2) Al^{3+} 3) Ca^{2+} 4) Si^{4+}

02. The ion absent in permutit is

1) Na^+ 2) Al^{3+} 3) Ca^{2+} 4) Si^{4+}

03. Which of the following ions causes hardness to water

1) Calcium chloride 2) Calcium sulphate

3) Calcium bicarbonate 4) All the above

04. Which of the following ions causes hardness to water

1) Al^{3+} 2) Mg^{2+} 3) Na^+ 4) Li^+

05. Exhausted permutit is regenerated by adding

1) HCl 2) NaOH

3) Brine solution 4) H_2SO_4

06. Water having large amounts of dissolved salts is

1) River water 2) Sea water

3) Well water 4) Spring water

07. The following impurity need not to be removed from drinking water

1) Dissolved salts 2) Bacteria

3) Suspended organic impurities

4) Colloidal impurities

08. The compound used in recharging of permutit is

1) NaCl 2) HCl 3) $CaCO_3$ 4) $CaCl_2$

09. Which of the following group of ions makes the water hard

1) Sodium and carbonate

2) Potassium and sulphate

3) Magnesium and sulphate

4) Ammonium and chloride

10. Temporary hardness of water is due to

1) Dissolved bicarbonates of Ca & Mg

2) Dissolved chlorides of Na & Ca

3) Dissolved chlorides & sulphates of Ca & Mg

4) Dissolved chlorides sulphates of Na

11. Sterilisation means

1) Killing of harmful micro-organisms

2) Killing of insecticides

3) Killing of rats 4) Killing of rabbits

12. The water which is free from all dissolved salts is called
1) Salt water 2) Deionised water
3) Mineral water 4) Hard water

13. Acidic resins exchange
1) $(-)OH$ ions 2) H^+ ions
3) H^+ ions & $OH^{(-)}$ ions 4) Na^+ ions

14. Anion resins exchange
1) $OH^{(-)}$ ions 2) H^+ ions
3) H^+ & $OH^{(-)}$ ions 4) Na^+ ions

15. Acidic resins can be regenerated by passing
1) Na_2CO_3 solution 2) $CaCO_3$ solution
3) HCl solution 4) $MgCO_3$ solution

16. Basic resins can be regenerated by passing
1) NaOH solution 2) $CaCO_3$ solution
3) HCl solution 4) $MgCO_3$ solution

17. Hardness of water is due to
1) Inorganic suspended substances
2) Organic suspended substances
3) Colloidal impurities 4) Dissolved salts

18. Permanent hardness of water is due to
1) $Mg(HCO_3)_2$ 2) $Ca(HCO_3)_2$
3) $MgSO_4$ 4) Na_2SO_4

19. If M is the Molecular weight of dissolved salt, the multiplication factor for calculating hardness is
1) M/100 2) 100/M 3) 100/2M 4) 2 × 100/M

20. In EDTA method, the colour at end point is
1) Wine red 2) Blue
3) Green 4) Violet

21. Water used in industries should not contain the following impurities
1) Dissolved salts, bacteria
2) Suspended impurities, dissolved salts
3) Bacteria and gases
4) Suspended impurities. Colloidal impurities, gases & dissolved salts

22. Water is said to be soft when it is
1) Colourless
2) Gives no lather with soap
3) Has no suspended impurities
4) Gives lather or fram readily with soap

23. When zolite is treated with hard water, sodium ions are exchanged with
1) H^+ ions 2) SO_4^{2-} ions
3) Mg^{2+} ions 4) K^+ ions

24. The permissible turbidity in mg/l for drinking water is
1) 10 to 15 2) 20 to 30
3) 30 to 40 4) 2-5 to 10

25. Method used to remove permanent hardness of water is
1) Ion-exchange method
2) Boiling method
3) Clark's method
4) Duman's method

26. Degree of hardness is expressed in the following unit(s):
1) PPm 2) mg/lit
3) French degree 4) All the above

27. Formation of scales in boilers causes
1) Increase in efficiency of the boiler
2) No loss of heat
3) Wastage of fuel
4) Contraction of boilermeteal

28. Municipal treatment of water does not involve
1) Sedimentation 2) Coagulation
3) Disinfection 4) Demineralisation

29. Ozone acts as bleaching agent by producing the following
1) Molecular oxygen 2) Atomic oxygen
3) Moisture 4) Heat

30. Purest form of natural water is
1) River water 2) Sea water
3) Rain water 4) Lake water

31. Calgon is a trade name given to
1) Sodium silicate
2) Calcium phosphate
3) Sodium hexametaphosphate
4) Sodium zeolite

32. The pH of drinking water should be
1) 8-8.5 2) 5 – 8 3) 7 4) 4-12

33. Blow - down operation causes the removal of
1) Scales 2) Sludges
3) Both scales & sludges
4) Hot water only

34. Resins are
1) Perfumes 2) Nitro compounds
3) Organic polymers 4) Enzymes

35. Calgon is a
1) Fuel 2) Water softener
3) Drug 4) Fire extinguisher

PRACTICE SET-II KEY

1) 1	2) 3	3) 4	4) 2	5) 3
6) 2	7) 1	8) 1	9) 3	10) 1
11) 1	12) 2	13) 2	14) 1	15) 3
16) 1	17) 4	18) 3	19) 2	20) 2
21) 4	22) 4	23) 3	24) 4	25) 1
26) 4	27) 3	28) 4	29) 2	30) 3
31) 3	32) 1	33) 2	34) 3	35) 2

SELF TEST

01. Which of the following is not a water softner
1) Calgon 2) Permutit
3) Na_2CO_3 4) Na_2SO_4

02. The temporary hardness of water can be removed by adding
1) $CaCO_3$ 2) $CaCl_2$
3) $CaSO_4$ 4) $Ca(OH)_2$

03. Coagulants help is setting of
1) Suspended impurities only
2) Find suspended impurities only
3) Coloured particles only
4) Both the suspended & colloidal particles

04. The indicator used is complexometric titration using EDTA for the determination of hardness of water is
1) Methyl orange 2) Phenolphthalein
3) Methyl Red 4) Erichromo Black – 7

05. The gas that is used in sterilization of water is
1) SO_2 2) O_3 3) NH_3 4) NO_2

06. The calgon process of softening the water, the reagent used is
1) $Ca(OH)_2$ 2) $Ca(HCO_3)_2$
3) $Na_2(Na_4(PO_3))$ 4) $Na_2Al_2Si_2O_8$

07. One of the material responsible for hardness of water is
1) $Ca[NO_3]_2$ 2) K_2SO_4
3) $CaCl_2$ 4) NH_4Cl

08. The method used for making drinking water hygienically pure is
1) Softening 2) Sterilization
3) Deaeration 4) Filtration

09. The permutit process for softening of water is based on the principle of
1) Ion exchange properties of zeolite
2) Precipitation of Ca^{2+} and Mg^{2+} as carbonates
3) Absorption properties of zeolite
4) Formation of soluble complexes of Ca^{2+} and Mg^{2+}

10. The hardness of water containing 60.0 mg of $MgSO_4$ per litre is expressed in equipments of $CaCO_3$ as
1) 60 ppm 2) 50 ppm
3) 100 ppm 4) 240 ppm

11. Permanent hardness of water is due to
1) The chlorides of calcium and Magnesium
2) The sulphates of calcium and Magnesium
3) both chlorides of sulphates of calcium and Magnesium
4) The bicarbonates of calcium and Magnesium.

12. A sample of water contains 58.5 ppm of NaCl and 5.6 ppm of KOH. The hardness of the water sample is
1) 58.5 ppm 2) 5.6 ppm
3) zero 4) 64.1 ppm

13. Simple setting of hearies particles in water by gravity is
1) Filtration 2) Sterilisation
3) Disinfection 4) Sedimentation

14. Indicator used in the estimation of hardness of water by EDTA is
1) Erichromo Black – T 2) Potassium Chromate 3) Phenophthalein 4) Methyl acid

15. One litre of hard water contains 81 milli grams of $Ca(HCO_3)_2$. The hardness of water in PPM is (given automic ωt: H =1, C = 12, O = 16 and $Ca = 40$)
1) 50 2) 81 3) 162 4) 25

16. When the quantity of dissolved salts of Ca^{2-} and Mg^{-2} present in water is to the extent of 250 parts per million [PPH) of $CaCO_3$ equivalents, the water is classified as
1) not too hard 2) hard
3) very hard 4) very soft

17. The aromatic chlorine content of a good sample of bleaching power is about :
1) 20 – 30 % 2) 35 – 38 %
3) 40 – 50% 4) 50 – 60 %

18. The process of removing colloidal particles from water is
1) Coagulation 2) Filtration
3) Sedimentation 4) Disinfection

19. The chemical used in sterilization of drinking of water is
1) Washing soda 2) Baking soda
3) Bleaching soda 4) Calcium Chloride

20. EDTA used for determination of hardness of water, is, chemically?
1) Ethylene diamine tetra-acetic acid
2) Ethylene diamine tetra – acetic acid disodium salt
3) Ethylene diamine tetra-acetic acid dehydrate
4) Ethylene diamine tetra-acetic acid tetra sodium salt

21. Calgon is the name given to
1) Zeolite
2) Sodium hexametaphosphate
3) Sodium silicate 4) Calcium phosphate

22. The hardness of water is usually expressed in the units of
1) Mg / L 2) PPm
3) clark 4) all the above

23. Which of the following is not a softening method
1) permutit method 2) soda line method
3) Ion-exchange method
4) EDTA method

24. Alum is added to remove.....impurities
1) bacterial 2) suspended and colloidal
3) chemical 4) all the above

25. The purest form water is
1) Sea water 2) River water
3) Rain water 4) lake water

26. Which chemical protects water from bacteria for longer durations
1) Ozone 2) Chloramines
3) Cl_2 4) Bleaching powder

27. When EDTA is added to water, metal ions are exchanged by
1) H^+ ions 2) Na^+ ions
3) COOH group 4) CH_3COO^- ions

28. By boiling of water
1) temporary hardness of water is removed
2) disinfection is possible
3) both 1 and 2
4) non-carbonate hardness is removed

29. On exposure to the UV radiations the following impurity is specifically removed from water
1) arsenic 2) bacteria 3) mercury 4) Lead

30. Water for civil supplies is commonly purified by
1) Chlorination 2) Distillation
3) Filtration 4) Sterilization

31. In swimming pools disinfection may not be done by
1) Ozone 2) VV light 3) Cl_2 4) None

32. Magnesium salts are removed in line soda process as
1) $MgSO_4$ 2) $MgCl_2$
3) $MgCO_3$ 4) $Mg(OH)_2$

33. A water sample contain 1.2 Mg/lt. Magnesium sulphate. Its hardness is equal to
1) 1.44 mg/lt 2) 10 mg/lt
3) 1 mg/lt 4) None

34. Tricking filters are employed
1) to filters dust and smoke from chimney exhausts
2) in the treatment of potable water
3) in the treatment of sewage
4) to reduce the concentration of Co in automobile vehicles

35. Which of the following can be used for sterilization of drinking water ?
1) Sodium chloride 2) Potassium chloride
3) Sodium hypochloride
4) Calcium chloride

SELF TEST KEY

1) 4	2) 4	3) 4	4) 4	5) 2
6) 3	7) 3	8) 2	9) 1	10) 2
11) 3	12) 3	13) 4	14) 1	15) 1
16) 2	17) 2	18) 1	19) 3	20) 2
21) 2	22) 4	23) 4	24) 2	25) 3
26) 2	27) 2	28) 3	29) 2	30) 1
31) 2	32) 4	33) 3	34) 3	35) 3

PREVIOUS ECET BITS

ECET-2009

01. Hardness or water is caused by the soluble salts of
1) Sodium chloride 2) Potassium nitrate
3) Calcium chloride 4) Sodium nitrate

02. One degree french (°Fr) of hardness of water is equivalent to
1) 1 ppm 2) 10 ppm 3) 100 ppm 4) 0.1 ppm

03. The exhausted zeolite (permutit) is regenerated by percolating it with the solution of
1) $CaCl_2$ 2) $MgCl_2$ 3) $NaCl$ 4) $AlCl_2$

04. The amount of lime required to remove 60 ppm $MgSO_4$ hardness of 5000 litres of water is
1) 18.5 g 2) 185 g 3) 22.2 g 4) 222 g

ECET-2010

05. The purest water from following is
1) Sea water 2) River water
3) Spring water 4) Rain water

06. The amount of time required for the removal of 50ppm of calcium temperory hardness in terms of $CaCO_3$ equivalents is
1) 37 mg/l 2) 18.5 mg/l
3) 3.7 mg/l 4) 30 mg/l

07. Zeolites are basically
1) Cation exchanger 2) Anion exchangers
3) Radical exchanger 4) Chloride exchanger

08. The process of allowng water to stand undistributed in big tanks for setting of the suspended particles due to force of gravity is known as
1) Coagulation 2) Filtration
3) Sedimentation 4) Disinfection

ECET - 2011

09. One of the following dissolved salts causes temporary hardness of water
1) $CaCl_2$ 2) $Ca(NO_3)_2$
3) $CaSO_4$ 4) $Ca(HCO_3)_2$

10. Which of the following mechanism is involved in biochemical treatment of sewage effluents ?
1) Oxidation 2) Reduction
3) Dehydration 4) Fermentation

11. A sample of water contain 11.1 mg/l of $CaCl_2$. Its hardness in terms of $CaCO_3$ equivalents is
1) 100 mg/l 2) 10mg/l
3) 12 mg/l 4) 20 mg/l

12. In water treatment, alum $\left[Al_2(SO_4)_3\right]$ is used for
1) Filtration 2) Coagulation
3) Sedimentation 4) Disinfection

ECET - 2012

13. Water sample showed it to contain 1.20 mg/lit of magnesium sulphate. Then, its hardness in terms of calcium carbonate equivalent is
1) 1.0 PPm 2) 1.20 PPm
3) 0.60 PPm 4) 2.90 PPm

14. Soda used int he L.S process for softening of water is, chemically
1) Sodium bicarbonate
2) Sodium carbonate decahydrate
3) Sodium carbonate
4) Sodium hydroxide (40%)

ECET - 2013

15. The adsorbent used in Permutit process is
    1) Sodium aluminostannate
    2) Potassium aluminozincate
    3) Sodium aluminosilicate
    4) Potassium zincostannate

16. Which of the following can be the best for sterilization of water?
    1) N_2 2) Chlorine 3) Lime 4) Na_2CO_3

ECET - 2014

17. The pH value of potable water should be between
    1) 1 to 1.5 2) 6.5 to 8
    3) 13 to 14 4) 4 to 5

18. Deaeration of high pressure boiler feed water is done to reduce
    1) Foaming from boilers
    2) Its dissolved oxygen content
    3) Its silica content
    4) Caustic embrittlement

19. Presence of non-biodegradable substances like alkyl benzene sulphonate from detergents in polluted water stream causes
    1) Fire hazards 2) Explosion hazards
    3) Persistent foam
    4) Depletion of dissolved oxygen

T.S ECET - 2015

20. Which one among the follwoing water sample contains more hardness available as
    1) 5000 ppm of hardness
    2) $0.5g\ of\ CaCO_3$ in 100 ml of water
    3) 50 equivalents of $CaCO_3$ in 100 ml of water
    4) 50 moles of $CaCO_3$ in 100 ml of water

21. 100 ml of a water sample contains 40 mg of Ca^{2+} ions. What is the hardness of the water
    1) 500 ppm 2) 100 ppm 3) 400 ppm 4) 1000 ppm

22. Which solution is used to regenerate the cationic exchange resin
    1) NaOH 2) NaCI 3) HCI 4) KCI

AP - ECET - 2015

23. Which of the follwoing salt is recognizable for temporary hardness of water
    1) $CaSO_4$ 2) $MgSO_4$
    3) $CaCl_2$ 4) $Ca(HCO_3)_2$

24. What is Zelite
    1) hydrated potassium alumino sulphate
    2) hydrated sodium aluminium sulphate
    3) hydrated sodium alumino silicate
    4) hydrated potassium alumino silicate

25. Which one is the commonly used coagulant for water treatment
    1) $CaSO_4$ 2) Alum
    3) Colgon 4) Agar - Agar

T.S ECET - 2016

26. Degree French $\left({}^0F\right)$ is
    1) the parts of $CaCO_3$ equivalent hardness per 10^5 parts of water
    2) the parts of $CaCO_3$ equivalent hardness per 10^6 parts of water
    3) the parts of $CaCO_3$ equivalent hardenss per 10^4 parts of water
    4) the parts of $CaCO_3$ equivalent hardness per 10^7 parts of water

27. The chemical formula of Zeolit is
    1) $Na_2OAl_2O_3xSiO_2yH_2O(x=2-10, y=2-6)$
    2) $K_2OAl_2O_3SiO_2H_2O$
    3) $CaOAl_2O_3xSiO_2yH_2O(x=2-10, y=2-6)$
    4) $BaOAl_2O_3SiO_2H_2O$

28. The total dissolved solids in drinking water should be
    1) less than 600 ppm 2) less than 700 ppm
    3) less than 500 ppm 4) less than 1000ppm

AP-ECET-2016

29. Hard water contains
1) small stones 2) oil
3) dissolved calcium & magnesium salts
4) bacteria

30. The unit used to express hardness of water is
1) siemens 2) volts 3) mg/L 4) moles

31. Ion exchange process is done in water to remove
1) solid particles 2) colour
3) smell 4) dissolved salts

T.S ECET-2017

32. Water acts as an excellent solvent, due to which property among the following
1) high viscosity
2) high entholpy of formation
3) high dielectric constant
4) high density

33. A sample of water has $Mg(HCO_3)_2 = 73\,mg/L$, $Ca(HCO_3)_2 = 162$ mg/L, $MgCl_2$=95 mg/L and $CaSO_4 = 136\,mg/L$ temporary hardness in ppm is
1) 150 2) 350 3) 500 4) 200

34. The process which removes all ionic, colloidal and high molecular weight organic matter in water is
1) ion exchange process 2) zeolite process
3) reverse osmosis 4) lime soda process

AP-ECET-2017

35. Zeolite sofening process removes
1) only permanent hardness of water
2) only temporary hardness of water
3) both temporary and permanent hardness of water
4) the dissolved gases in permanent hard water

36. The permanent hardness of water is caused by the presence of
1) bicarbonates fo Ca and Mg
2) carbonates of Na and K
3) chlorides and sulphates of Ca and Mg
4) phospates of Na and K

37 The secondary treatment of water uses_____to consume wastes in water
1) filtration 2) sedimentation
3) chemicals 4) microorganisms

T.S ECET-2018

38. A raw water sample has 300 ppm calcium ions and its $CaCO_3$ equivalent in ppm is_____
1) 625 2) 750 3) 1500 4) 25

39. A process which removes ionic, non ionic, colloidal and organic matter from water_____
1) ion exchange process
2) permutit process
3) zeolite process
4) reverse osmosis

40. The exhausted anion exchange column in the demineralization process is regenerated by passing a solution of___
1) dil H_2SO_4 2)dil HCl
3) dil NaOH 4) dil NH_4OH

AP-ECET-2018

41. Temporary hardness is caused by
1) carbonates of calcium and magensium
2) chlorides of calcium and magnesium
3) sulphates of calcium and magensium
4) nitrates of calcium

42. Hardness of water is exprssed in terms of equivalent of
1) Na_2CO_3 2) K_2CO_3
3) $MgCO_3$ 4) $CaCO_3$

43. The exhausted zeolite bed can be regenerated by washing with
1) NaCl 2) dil. NaOH
3) dil. HCl 4) distilled water

PREVIOUS ECET BITS KEY

01) 3	02) 2	03) 3	04) 4	05) 4
06) 1	07) 1	08) 3	09) 4	10) 1
11) 2	12) 2	13) 1	14) 3	15) 3
16) 2	17) 2	18) 2	19) 3	20) 4
21) 3	22) 3	23)4	24)3	25) 2
26) 1	27) 1	28) 3	29) 3	30) 3
31) 4	32) 3	33) 1	34) 3	35) 3
36) 3	37) 4	38) 2	39) 4	40) 3
41) 1	42) 4	43) 1		

CORROSION

- Any process of deterioration of. metallic materials with chemical (or) electro chemical attack by the environmental substance on the metal surface is called corrosion.
- Corrosion is an unwanted reaction in which loss of metal takes place.
- In corrosion metal reacts with environmental substance to form a metallic compound which is called corrosion product.
- The corrosion product depends on the substance with which metal reacts

Ex: Metal + Env. Substance $\rightarrow$ Corrosion product.

$Fe + H_2O + O_2 \rightarrow Fe_2O_3 . xH_2O$

$Cu + CO_2 + H_2O \rightarrow CuCO_3 . Cu(OH)_2$

$Al + O_2 \rightarrow Al_2O_3$

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

$Sn + 2HCl \rightarrow SnCl_2 + H_2$

- Metallic compound will be having lesser energy when compared to metal, so metallic compound is more stable than metal. Hence metals undergo corrosion to form metallic compounds in the environment.i.e, Metal gets more stability when it undergoes corrosion.
- Extraction of metal from its ore is a reduction process (i.e., gain of electrons takes place).
- Corrosion is reverse to extraction of metal so corrosion is an oxidation process (i.e., loss of electrons, takes place by metal)

Ex : $Fe_3O_3 \underset{\text{Corrosion}}{\overset{\text{Extraction}}{\rightleftharpoons}} Fe$

- Extraction is a non spontaneous process and corrosion is a spontaneous process.
- Extraction of metal is a process from its ore in which energy is consumed ,corrosion is a process in which energy is released. i.e. endothermic and exothermic processes respectively.
- Noble metals Ag Au,Pt can occur in their native state and they will not undergo corrosion in normal environmental conditions.

⇨ Corrosion can be broadly classified into two categories.

1. Dry corrosion (direct chemical corrosion) 2. Wet corrosion (electro chemical corrosion)

⇨ **Dry corrosion:** This corrosion takes place with the direct chemical action of environmental substance on the metal surface in the absence of conducting medium at low or high temperature. Conducting medium is any liquid, solution or moisture.

⇨ In the dry corrosion there should not be any conducting medium.

Ex : $Mg + N_2 \rightarrow Mg_3N_2$ $Sn + Cl_2 \rightarrow SnCl_4$ $Al + O_2 \rightarrow Al_2O_3$

⇨ If a metal undergoes corrosion with the direct chemical action of oxygen in the absence of moisture, it is called oxidation corrosion.

⇨ Oxidation corrosion is a dry corrosion which takes place with oxygen.

⇨ In oxidation corrosion metal oxide is formed as a corrosion product.

⇨ In Oxidation corrosion metal atoms will loose electrons to form positively charged metal ions and oxygen atoms gain electrons to form oxide ions (O^{-2})

⇨ Metallic ions and oxide ions join, together to form metallic oxide

Ex : $4Al + 3O_2 \rightarrow 2AlO_3$ $Fe + O_2 \rightarrow Fe_2O_3$

⇨ When a metal undergoes oxidation corrosion a metaloxide layer is formed on the surface of the metal

⇨ Depending on the formed metal oxide layer further corrosion of metal can be continued or it can be prevented.

⇨ The metaloxide layers can be classified into four types

♦ **Unstable metaloxide layers :** If a metal forms an unstable metaloxide layer further corrosion of the metal can be prevented.

Unstable metaloxide will dissociate into metal and oxygen. So corrosion cannot be continued.

Noble metals like silver, gold, platinum (Ag, Au, Pt)

will form unstable metaloxide layer

♦ **Stable metaloxide:** If a metal forms stable metal oxide layer further corrosion of the metal can be stopped.

A stable metal oxide will prevent metal exposure to oxygen so corrosion can be prevented.

Metals like copper, tin, zinc, aluminium, lead can form stable metal oxide layers (Cu, Sn, Al. Pb, Ti, Cr, etc).

- **Porous metaloxide layers:** If the metal oxide layer is porous, oxygen will enter through the pores and attack fresh metal surface i.e. a porous oxide layer will allow the metal to undergo continuous corrosion.

  Alkali and alkaline earth metals will form porous oxide layers.

- Volatile oxide layers: Volatile oxide will continuously evaporate into the atmosphere. So metal will undergo corrosion continuously.

  tungston (W), molybidnum (Mo) can form volatile oxide layers.

⇨ PILLING - BEDWORTH RULE :

- Pilling-Bedworth rule predict the nature of metal oxide. :
- According to this rule, if the metal oxide volume is equal to or greater than the volume of a metal from which it is formed, then it is non-porous and protective.
- If the volume of metal oxide layer is less than the volume of metal from which it is formed. Then that metal oxide is porous and non-protective.
- Alkali and alkaline earth metals will form the metal oxide having less volume than the metal undergoes corrosion. So those are porous
- Metals like Cu, Sn, Al, Pb, Ti, Cr will form a metal oxide with, more volume than the volume of the metal so those are non-porous.and protective

⇨ WET CORROSION (OR) ELECTRO CHEMICAL CORROSION:

- Electro chemical corrosion takes place when a metal is in contact with conducting medium (or) when two different metals are connected to each other in presence of conducting medium.
- When a metal is in contact with conducting medium, then on the metal surface there will be anodic area and cathodic area formed and the corrosion takes place with the electro chemical reaction.
- Anodic area undergoes oxidation process and it continuously undergoes corrosion.
- From anodic area metal atoms will loose electrons to form positively charged metal ions
- The released electrons will transfer from anodic to cathodic area through the metal and at cathodic area these are consumed i.e., at cathodic area reduction takes place.
- Between anodic and cathodic area current flows.
- In the electrochemical corrosion always anodic area undergoes corrosion and cathodic area will be protected.
- The metallic ions from anodic area and the non metallic ions from cathodic area will diffuse together and join with each other to form a corrosion product between anodic and cathodic area, i.e., at the cathodic area.

⇨ The characteristic features of electro chemical corrosion are ;

⇒ The presence of conduction medium on the metal surface

⇒ Formation of anodic and cathodic areas. Corrosion of anodic area only

Formation of corrosion product between anodic and cathodic areas. Electro chemical corrosion can take place either with evolution of hydrogen (or) with absorption of oxygen

⇨ EVOLUTION OF HYDROGEN TYPE E.C:

- When metals undergo corrosion in presence of acid, it takes place with evolution of hydrogen.
- Depending on the metal and acid, corrosion product will be formed.
- In presence of acid, on the metal surface a large anodic area and small cathodic area will be formed.
- From anodic area metal atoms will loose electron to form metallic ions.
- These electrons will be consumed by H^+ ions of acid to form hydrogen gas.
- Metallic ions and non metallic ions of acid join together to form corrosion product.

Ex : ♦ If iron undergoes corrosion in presence of HCl ferrous chloride is corrosion product

$$Fe + 2HCl \rightarrow FeCl_2 + H_2$$

♦ $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

♦ $H_2SO_4 + Fe \rightarrow FeSO_4 + H_2$

♦ $Sn + 4HCl \rightarrow SnCl_4 + 2H_2$

- All the metals above the hydrogen in the electro chemical series undergo corrosion in the acidic medium.

⇨ OBSORPTION OF OXYGEN TYPE E.C:

- For the obsorption of oxygen type electro chemical corrosion, rusting of iron in the neutral conducting medium can be taken as an example.
- In this type of corrosion a small anodic area and a large cathodic area will be produced on the metal surface.
- From anodic area metal atoms will loose electrons to form metallic ions [Fe^{2+}]
- At cathodic area electrons will be gained by oxygen in presence of water to form OH^- ion.
- Fe^{2+} and OH^- ions join together to form ferrous hydroxide.
- In the sufficient amount of oxygen ferrous hydroxide will be converted into ferric hydroxide [$Fe(OH)_3$] which can be called hydrated ferric oxide [$Fe_2O_3 . x H_2O$] and it is formed as a final corrosion product. (It is yellow rust)
- In the limited supply of oxygen ferraso ferricoxide is the corrosion product (Fe_3O_4,) (it is also called black magnatite)
- Electro chemical corrosion can be compared with electro chemical cell.

- In the electro chemical cell chemical energy is converted into electrical energy

  In the electrolytic cell electrical energy will be converted into chemical energy..
- Electro chemical cell can also be considered as galvanic cell (or) voltaic cell.
- In the electro chemical cell at anode electrons are released which is at higher potential i.e., oxidation takes place at anode.
- At cathode electrons are consumed i.e., reduction takes place and cathode is at lower potential.
- The tendency of loosing electrons (or) gaining electrons will be given by the electrode potential value of the metal
- Electrode potential value of the metal can be expressed in two ways oxidation potential or reduction potential
- The tendency of loosing electrons by a metal will be given by oxidation electrode potential.
- Reduction electrode potential will indicate the tendency of gaining electron by a metal.
- If the oxidation potential is +ve then its reduction potential is -ve and vice versa. ;
- The metal with more oxidation potential or less reduction potential can loose electrons easily. It undergoes oxidation easily, it is more active and it can act as anode.
- If a metal has less oxidation potential or more reduction potential can gain electrons easily, i.e., reduction takes place easily, it is less active or more noble and it can act as cathode.
- If two metals are connected together, among them the metal with more oxidation potential can act as anode and it undergoes corrosion. And the metal with less oxidation potential value will act as cathode and it is protected.
- A series of metals in which the metals are arranged according to their decreasing order of oxidation potential or increasing order of reduction potential is called as electro chemical series.
- The electrode potential values of various metals can be calculated by comparing with standard hydrogen electrode which is having zero electrode potential.
- In the electro chemical cell anode should be written left hand side and cathode should be written right hand side.
- In the electro chemical cell connecting two half cells (i.e., anode and cathodes) there will be a salt bridge or porous diaphram which allows only ions to move from one electrode to another electrode.
- Anode and cathode are connected with an external wire through which the electrons will move from anode to cathode.
- Danial cell is an example for electro chemical cell.

- In danial cell Zn in $ZnSO_4$ will be taken as anode and Cu in $CuSO_4$ will be takes as cathode. The cell representation or notation is $Zn/ZnSO_4 // CuSO_4/Cu$
- The difference of potential between anode and cathode because of which the electrons will move from anode to cathode is called as electromotive force (emf)
- $EMF = E_{right} - E_{left}$
- In an electro chemical cell if anode is having -0.77 volts of potential and cathode is having +0.33 volts of potential what is the emf.

  Sol : $emf = 0.33 - (0.77) = 1.1$ volts
- In electro chemical cell anode is indicated with -ve sign and cathode with +ve sign.
- In electrolytic cell anode is indicated with +ve sign and cathode with -ve sign.
- The potential development, when a metal is placed in its own solution of 1M con. and at 25°C is called standard electrode potential.
- If standard electrode potential is known, the potential at same concentration at same temperature can be known with nerust reaction.
- Nerust equation is $\in = \epsilon^0 + \frac{2.303}{nF} \log\left[M^{+n}\right]$
- If a metal 'x' has potential -0.6 volts and 'y'. has +0.8 volts, then what is anode and cathode among them? What is emf if they are connected together in an electrochemical cell ?

  Sol : X is anode and y is cathode emf = + 0.8-(-0.6) = 1.4 volts
- Offering more corrosion resistance than expected is called as passivity.
- Passivity is offered by certain metals in specific environments only.
- In the oxidation atmosphere titanium, Al, Cr, stainless steels containing chromium will offer passivity.
- They form a very thin (i.e. upto 0.0004mm) protective layer which is self-hearing.
- Even though oxidation potential of Al is more than iron, it undergoes less corrosion in oxidation atmosphere due to passivity.
- The corrosion resistance property of stainless steel is due to the Cr present in it. It forms a protective oxide layer over it.
- Due oxidation nature of concentrated nitric acid Fe offer passivity in concentrated nitric acid. It forms a protective Fe_3O_4
- In dilute nitric acid iron undergoes corrosion with evolution of hydrogen.
- By studying corrosion activity of various metals in a specific environment, they can be arranged in a series which is called as galvanic series.

- In galvanic series metals and alloys are arranged and it changes with corrosive medium.
- Galvanic series gives correct order of corrosion of metals and alloys in a specific corrosive medium.
- In electro chemical series metals and non-metals are arranged.
- In electrochemical series the position of elements are fixed.

Ex: For electrochemical series

Li - K - Ca - Na - Mg - A l - Zn - Cr - Fe - Ni - Sn - Pb - Cu - Ag - Pt - Au - F

for galvanic series in sea waver

Mg - Mg alloys - Zn - Al - Cd - Al alloys - Fc - steel

Pb - Sn - Brass - Cu - Ni - Cr - Ag - Au - Pi

Corrosion fatigue : It is the reaction of fatigue strength of a metal in the corrosive medium.

The electrochemical corrosion takes place will electrochemical cell formation which are

i) Composition cell ii) Concentration cell and iii) Stress cells

⇨ **GALVANIC CORROSION : (Composition cell formation)**

- When two different metals are connected together in the presence of a conducting medium, the more active metal (i.e, metal having more oxidation potential) will act as anode and noble metal or less active metal (metal having less oxidation potential) will act as cathode. It is called composition cell formation.
- Anodic metal undergoes oxidation and it will continuously undergo corrosion, less active metal will be protected.
- In galvanic corrosion in presence of acidic medium hydrogen evolution takes place.
- In presence of basic medium or neutral medium galvanic corrosion takes place with obsorption of oxygen,
- Depending on the corrosive medium the corrosion product will be formed.
- Ex for this corrosion; Steel screws fitted in different machine parts. if metals or alloys are joined in a machine Cu screws fixed with steel screws.

⇨ **CONCENTRATION CELL CORROSION: (Concentration cell formation)**

- Metal surface party exposed to more concentrated corrosive medium and partly less concentrated, then concentration cell will be formed.
- The area under more concentration will become anodic and less concentration becomes cathodic.
- When a metal is exposed to different air concentration then this type of corrosion takes place.
- The part of the metal surface which is exposed to more air (i.e, more oxygen) can act as cathodic area and remaining part of the metal surface which is exposed to less air / less oxygen can act as anodic area. (Differential aeration or oxygen concentration cell corrosion)

- If a metal part is covered with another metal (or) if some dust is present on the metal surface (or) if some dust is present on the metal surface (or) if drops of liquid present on the surface of the metal (or) if

  part of metal is covered with wooden block (or) mirror (or) asbestos etc. Then this type corrosion takes place.

⇨ STRESS CORROSION (Stress cell Formation)

- Stress corrosion is a combined effect of stress and corrosive environment.
- Continuous stress on the metal will develop some strains which act as anodic areas and rest of the metal surface will acts as cathodic area.
- Copper, brass, will undergo stress corrosion if ammonia is present as corrosive environment.
- Steel will undergo stress corrosion in presence of alkali or nitrate solutions. Stainless steel can undergo stress corrosion in acid chloride solution.

⇨ WATER LINE CORROSION

- If a metal is exposed to different oxygen concentration below and above the water level then this type of corrosion takes place.
- The metal surface which is under the water will not be exposed to air and it can act as anodic areas and metal surface which is above the water level will be exposed to air and it can act as cathodic area.
- If a metal is partially immersed in water this corrosion takes place.
- This type of corrosion can be observed in water tanks, ship hulls.

⇨ PITTING CORROSION

- Pitting corrosion is a localised and fast corrosion resulting in the formation of pinholes or pits.
- It is due to the breakdown of protective film on a metal at specific points. That specific points will act as anodic areas.
- The developed craks, pits will act as anodic areas 'and corrosion takes place very fastly.
- In this type of corrosion the anodic areas are very small and cathodic area is larger
- Specific metals in the specific environments, undergo pitting corrosion.
- Pitting corrosion can also be due to surface roughness, non-uniform finish, cut edges, local stress, chemical attack, impurities on the surface of the metal etc.

  Ex: Stainless steel and aluminium undergo pitting corrosion in the chloride solution

⇨ INTERGRANULAR CORROSION :

- This corrosion takes place along the grain boundaries of metals,
- This corrosion takes place internally and it cannot be seen externally until the metal piece breaks

- This corrosion takes place due to the deposition of certain substances along the grain boundaries which can act as anodic areas and grain centre can act as cathodic area.
- This corrosion can be observed in welded stainless steels.
- In the welding process due to high temperature chromium carbide is formed in the stainless steel and it will be deposited along the grain boundaries which will act as anodic area.
- With this intergranular corrosion the coordination to the grains will be lost and metal breaks.

⇨ THERMO GALVANIC CORROSION

- With the electricity leakage or with sudden heating and cooling if a metal undergoes corrosion then it is called thermo galvanic corrosion.

⇨ SOIL CORROSION OR UNDER GROUND CORROSION :

- If the metals undergo corrosion in the soil or under ground then it is called as soil corrosion.
- The extent of soil corrosion depends on moisture in the soil, salt contents in soil, soil nature (acidic or basic) degree of aeration, soil texture, conductivity of soil etc. The pipes present in the soil, can undergo soil corrosion.

⇨ MICRO BIOLOGICAL CORROSION :

- The corrosion that takes place with micro organism on the metal surface is called microbiological corrosion
- With the metabolic activities, the micro organisms will release certain substances on the metal surface which gives corrosion of the metal.

⇨ CAUSTIC EMBRITTLEMENT :

- It is a type of boiler corrosion. It takes place with the basic substance like sodium carbonate Na_2CO_3 present in the water
- Na_2CO_3 will react with water to form NaOH (sodium hydroxide) which will enter into the cracks or criveges or joints of the boiler where its concentration will be increased.
- The part of boiler material with more concentrated NaOH will act as anodic area and remaining part with less concentrated NaOH will act as cathodic area. And anodic area undergoes corrosion,
- Iron reacts with concentrated NaOH to form sodium ferroate (Na_2FeO_3) which again reacts with water to form ferrasoferricoxide (Fe_3O_4).

⇨ SELECTIVE LEACHING :

- If a particular metal undergoes corrosion from an alloy or if a particular metal dissolves in an electrolyte from an alloy it is called selective leaching.
- If zinc dissolve in an electrolyte from an alloy it is called dezincification. If Al dissolves it is called deallumination.

⇨ EROSION CORROSION

- It is caused by the combined effect of the abrading action of flow of gases, or liquids and mechanical rubbing of solid over a metal surface.
- It takes place due to the breakdown of protective film on the metal surface.
- The areas on which protective film is broken can act as anodic areas and remaining part can act as cathodic area.

⇨ FACTORS EFFECTING CORROSION

- The factors which. will effect corrosion can be classified into two types.

i) The factors which related to environment ii) The factors which related to nature of metal

⇨ Nature of the metal :

- ♦ Position of the metal in galvanic series or emf series.
- ♦ Purity of metal : pure metals will not undergo corrosion easily when compare to impure metal.
- ♦ Physical state of metal
- ♦ Passivity of metal
- ♦ Nature of surface film
- ♦ Relative size of anodic and cathodic area.

If the anodic area is small and cathodic area is large corrosion takes place from anodic area very fastly because the electron supplying area is less and consuming area is more

If anodic area is large & cathodic area is small then corrosion takes place from anodic area slowly.

⇨ Environmental Factors :

- ♦ Presence of moisture in the atmosphere
- ♦ Presence of impurities and suspended particles in the air
- ♦ pH of the corrosive medium
- ♦ If oxidising agents are present in the environment those will increase-the rate of corrosion.
- ♦ Temperature of environment-: Temp may increase the corrosion or decrease the corrosion.
- ♦ The dissolved salts in the corrosive medium will increase the corrosion.
- ♦ The ability of corrosive medium to dissolve the corrosion product.
- ♦ Rate of corrosion can be expressed as loss of metal per area per time (mils per year - Milligrams of

Corrosion controlling Methods :

⇨ Design of the equipment :

- Based on designing of the equipment corrosion can be controlled.
- In the designed instrument, sharp corners recessess must be avoided.
- Along with the metal, using of wood, cloth, asbestos mirrors etc must be avoided.
- The metal surface must not be covered with liquid drops, dust etc.
- Pure metals and alloys must be useful for designing the machines or instruments because pure metals or alloys offer more corrosion resistance.
- Metal surface should be smooth and uniformly exposed to air.

⇨ Cathodic protection:

- In this method the metal which is to be protected will be forced to act as cathode.
- There are two method with which a metal can be forced to act as cathode.

⇨ Sacrificial anodic protection :

- In this process the metal which is to be protected will be connected with a more active metal. More active metal will act as anode and the metal to be protected will act as cathode.
- More active metal will have more oxidation potential and it undergoes oxidation easily.
- The metals which are connected are called as sacrificial anodes or auxiliary anodes.
- The sacrified anodes by undergoing corrosion themselves they protect the metals,
- This process can also be called as galvanic coupling. The sacrificial anodes will undergo galvanic corrosion.
- Mg, Zn, Al and their alloys-will generally act as sacrificial anodes.
- With this method underground pipelines, under ground cables, marine structures, ship hulls, water tanks, industrial boilers and transmission tower can be protected.

⇨ Impressed current cathodic protection :

- In this method the metal structure to be protected is made as cathode by passing direct current from a battery with an insoluble anode.
- As long as current passes through the metal it will not undergo corrosion.
- Inert electrodes like Pt, Pb graphite, stainless steel can be taken as anodes.
- This type of protection is used to water box coolers, water tanks, burried water or oil pipes, ship hulls and bridges, marine pipes, transmission tower, laid up ships, this method-is useful mainly for large structures in long operations.

⇨ MODIFYING THE ENVIRONMENT :

- The corrosive nature of the environment can be decreased by modifying the environment.
- Environment can be modified either by removing harmful substances or by adding certain substances,
- Corrosion due to oxygen can be decreased by removing oxygen with mechanical deairation process or by adding chemicals like Na_2CO_3 H_2N-NH_2 (hydrozine), sodium sulphite.
- Corrosion due to CO_2 can be controlled by removing CO_2 mechanically.
- Corrosion due to moisture can be controlled by adding dehumidification agents like Al_2O_3. silica gel.
- Acidic environment can be neutralised by releasing basic substance into the environment.;

⇨ BY ADDING INHIBITORS :

Use of Inhibitors:

- ♦ A substance which when added in small quantities to the corrosion environment effectively decreases the corrosion of metal is called as inhibitor.
- ♦ Inhibitors are of two types- anodic inhibitors and cathodic inhibitors.
- ♦ Anodic inhibitors form protective fill on the anodic area to reduce corrosion.
- ♦ Examples for anodic inhibitors are chromates, 'phosphates, tungstates and other ions of transition elements having oxygen content.
- ♦ If any break occurs in the protective film it forms a large cathodic and small anodic area which is dangerous.
- ♦ Inhibitors which reduces cathodic reaction is called cathodic inhibitor.
- ♦ Examples for cathodic inhibitors are oxides of arsinic (As) and Antimony (Sb) and organic compounds like amines, mercaptans, heterocyclic nitrogen compounds and substituted urea.

- In the design of the instrument two different metals contact must be avoided as *lit* as possible,
- If two different metals are in contact with each other it is better to have an insulation between them
- The choosen different metals be very close in the electro chemical series.
- When two different metals are in contact with each other then the anodic metals surface area must be large to decrease corrosion.
- Metals like Al,Zn,Pb are called as amphoteric metals because they undergo corrosion in acidic and basic medium.
- Caustic embrittlement which is a type of boiler corrosion can be taken as a stress corrosion.

⇨ APPLICATION OF PROTECTIVE COATINGS :

Protective coatings are of 3 types

- ♦ Metallic coatings

- ♦ Chemical conversion coatings or Inorganic Coatings
- ♦ Organic coatings

- Metallic coatings: Applying a metal as a layer over another metal in order to protect it from corrosion is called metallic coating.
- The metal which is used as coating is called coating metal and the metal over which it is applied is base metal.
- Metallic coatings are of two types : i) Anodic coatings ii) Cathodic coatings

⇨ **Anodic coatings;**

- ♦ Applying a metal as a coating which is more active than base metal is called anodic coating. That is coating metal is anodic to base metal, (coating metal is having more oxidation potential than base metal).
- ♦ Anodic coating will protect the base metal sacrificially.
- ♦ If any break occurs in the anodic coating a galvanic cell will be formed in which the coating metal acts as anode and base metal acts as cathode and coating metal only undergoes corrosion.

  Ex: Coating of Zn, Mg, Al, Cadmium (Cd) on iron and steel.

- **Cathodic coating:** Coating a more noble metal than the base metal is called cathodic coating i.e., coating metal is less active than base metal.
- Coating metal will have less oxidation potential than base metal.
- Cathodic coating will protect the base metal because of its noble nature.
- If any break occurs in the cathodic coating, then base metal will act as anode and coating metal will act as cathode and a small anodic area and a large cathodic area will be developed and bae metal udergoes faster corrosion.

Ex: Applying tin (Sn), silver ; (Ag), Cromium (Cr), Copper (Cu), Nickel (Ni) over iron and steel

⇨ **Applications of metallic coating:**

♦ Hot dipping ♦ Metal cladding

♦ Cementation or diffusion coating ♦ Electro planting. ♦ Metal spraying

⇨ **Hot dipping :**

♦ In the process coating metal will be melted and in the molten coating metal the base metal will be dipped.

♦ This is applicable for the coating metals having less melting point and base metal having high melting point.

Ex: Coating of Zn, Sn, Pb, Al on iron, steel or copper

♦ Coating of Zn over iron is called galvanising.

♦ Coating of Sn is called tinning.

♦ Food stuffs can't be stored in the galvanised containers because Zn is more active and it reacts with food stuff. But tinned containers can be used

⇨ **Metal cladding :**

- ♦ In this process on the surface of the base metal thin sheets of coating placed and passed through hot rollers by pressing, then coating metal will be fixed to base metal This process is called metal cladding.
- ♦ This process can be used for coating steel, Al, Cu. Ni, with, silver, (Ag), Pb, Cu, Ni alloys, Cu alloys and Pb alloys.
- ♦ Al cladding is used to make the bodies of aeroplanes, which are obtained by coating of duralumin sheets covered on both the sides of pure Al sheets. (Al Clad).

⇨ **Cementation (or) diffusion coating:**

- It is the process of coating a base metal with coating metal powder.
- Coating metal power is taken in large rotating drums and small base metal articles are taken in it and they will be rotated at high temperature, then coating metal powder will be diffused into base metal surface.
- This process will be used for coating small articles.
- As the coating metal is diffused into base metal at the junction of coating metal and base metal there will be formation of alloy of two metals. Above this alloy coating metal layer and below this alloy base metal will be present.
- This type of coating will be useful for the coating of Zn, Cr, Al on iron and steel.
- If Zn power is coated over iron or steel it is called sheradising this process will be used for small steel articles.
- Coating of Al powder on iron or steel is called clorising. This process can be used for coating of furnace parts.
- Coating of a mixture of Cr powder and Al oxide powder over iron and steel is called chromising. This can be used to protect turbine parts.
- Coating of silicate powder is called enamelling.

⇨ **Electroplating:**

- Coating of metal over another metal using electrolysis process is called electroplating.
- In this process coating metal will be taken as anode and base metal will be taken as cathode coating metal

  salt solution will be taken as electrolyte.
- In the electroplating anode dissolves in electrolyte, and it will be deposited over cathode.
- In the electroplating process a uniform coating of required thickness will be formed.

- In this process coating will be fixed to the base metal strongly
- In this process a bright and hard coating will be formed which will give decorative value to the article.
- Electroplating depends on

  i) Temperature of electrolytic path ii) Composition of electrolytic path

  iii) pH of electrolyte iv) Agitation of electrolyte v) Area of cathode

  vi) Current density
- In the electroplating process anode undergoes oxidation and produced metallic ions come into the solution.
- At cathode reduction takes place and the neutral metal will be deposited.
- In electroplating electricity is used to carry out chemical reaction so it belongs to electrolytic cell. Hence electroplating can be considered as reverse to corrosion.

⇨ **Displacement by immersion technique :**

- A more active metal will replace or displace a less active metal from its salt solution.
- The replaced metal can form as a loose coating over the base metal.
- These coatings can be useful as primary coatings.
- Example : Zn will replace Cu from Cu^{2+} solution

  $Zn + Cu^{2+} \rightarrow Cu + Zn^{2-}$ Mg will replace Zn from Zn^{2+}

⇨ **Metal spraying :**

- This process is useful for coating low melting metals over the base metal.
- In this process molten metal will be taken in the spraying guns and it will be sprayed over the base metal.
- With this process large structures can be coated uniformly.

  Ex: Zn, Sn, Pb etc can be coated over iron, steel.

Chemical conversion coatings (or) Inorganic coatings :

- These coatings are inorganic compounds produced by chemical or electro chemical reactions brought at the surface of the base metal.
- This type of coatings are used as primary coatings.
- On the metal, if phosphoric acid (H_3PO_4) solution is applied the metal phosphate formed as a coating.
- Phosphate coatings can be applied on iron, manganese (Mn), Zn, steel and in a lesser content it can be applied for Al, Cd, Sn.
- Phosphate coatings will be in gray colour.
- By applying chromic add chromate coatings can be formed. In places of chromic acid potassium [illegible]neutral) can also be used.

- Chromate coating will give more corrosion resistance.
- Chromate coatings will be in yellow colour.
- Ex: On Zn, Cd, Al, Mg these coatings can be applied.

⇨ **Oxide coatings :**

- By applying alkaline (basic) oxidising agents, metal oxide coating can be formed over the metal.
- [alkalyne oxidising agent like ($KMnO_4$), (potassium permanganae. $K_2Cr_2O_7$]
- Oxide coatings will give corrosion resistance and they act as primary coatings
- If a metal oxide layer is formed over the metal by using electrolysis it is called anodising.
- In anodising process the metal on which oxide coating is to be formed will be taken as anode and an inert electrode like platinum, graphite can be taken as cathode.
- In anodising the electrolyte is dilute acid like HCl, H_2SO_4 HNO_3, potassium permanganate or potassium chromate like oxidising agent can also be used.
- In the anodising the basic principle is protection of metal by the formation of its own oxide layer.
- Anodising process can be applied for the formation of aluminium oxide (Al_2O_3 on Al, Fe_2O_4 on iron or steel and it can also be used to form oxide layers on copper,Sn, Cr etc.
- Anodising can protect the metals which can form stable metal oxides.
- If any pores are present in Al_2O_3 layer those will be covered by keeping the metal which is covered with aluminium oxide in boiling water in which Al_2O_3, $2H_2O$ will be formed.

⇨ **Organic coatings :**

- Paints, varnishes, lacquers, enamels are belonging to organic coatings.
- Organic coatings are useful for the protection of metal against corrosion and also for the decoration purpose.
- **Paint :** Paint is a mixture of one or more pigments in a Vehicle. Vehicle is nonvolatile film forming material which is called drying oil and a volatile solvents called thinner.
- Pigment will give a desirable colour to the paint, for example ZnO (zinc oxide) will give white colour Fe_2O_3 will give red colour. Cr_2O_3, will give green colour.
- Drying oil is a non volatile oil which will form a paint film.
- Examples for drying oils are linsead oil, soyabeen oil, dehydrated castor oil etc
- Thinner will reduce viscosity of paint and it dissolves pigment and drying oil.
- Thinner will increase penetration power of paint and it helps in drying.
- Examples for thinner are terpentine oil, C_6H_6 (benzene), dipentene, naptha, tolol, xylol, kerosene, methylated naphthalene.

- Apart from the three main constituents, other substances like driers, extenders, plasticizers antiskining agents etc can also be used.
- Driers will help in drying the pains, these are oxygen carrier catalyst

  Ex: Cobalt substances (Co), lead substances (Pb) and Mn substances can act as driers.
- Extenders will increase toughness (or) hardness of paint.

  Ex: Barium sulphate ($BaSO_4$). gypsum, asbestos, magnesium silicate, silica and calcium sulphate can act as extenders.
- Plasticizers will give elastic property to the paint.

  Ex: Tricresyl phosphate, triphenyl phosphate, tributylphthalate ..
- Anti skinning agents will decrease pealing of paint film.

  Ex: Poly hydroxy phenols.
- Varnish is a mixture of natural or synthetic resin with a drying oil or thinner or both.
- Varnish can have decorative value along with corrosion protection property.
- Varnish will give a hard transparent glossy, lustrous film.
- Lacquers are a mixture of cellulose derivative resin, plasticizer and solvent
- Enamels are mixture of varnish and pigment.
- Rubber like resin in water with a dryinig oil pigment and extender is called emulsion paint.
- Corrosion protection can be carried out by taking different alloys
- For example by alloying iron with cromium (or) stainless steel can be produced which is corrosion resistant.
- A stainless steel with 13% cromium can be used in cutlery, surgical instruments etc.
- More than 13% to 26% Cr steels are called ferrite stainless steels. These are used in turbine brackets and heat resistant parts.
- 18/8 stainless steels is 18% chromium and 8% Nickel.

SUCCESS IN LIFE
Mostly depends on the
Power of concentration
Clear thinking and
Intellectual Understanding
are very easy for a
Concentrated mind

PRACTICE SET - I

01. Gradual disintegration of a metal due to chemical reactions is called
1) Oxidation 2) Corrosion
3) Decomposition 4) Reduction

02. Destruction of a metal by physical means is called
1) Corrosion 2) Erosion
3) Oxidation 4 Reduction

03. Dry corrosion occurs in the absence of
1) Oxygen 2) Hydrogen
3) Air 4) Liquid

04. Electro chemical corrosion can take place only if
1) Oxygen is in contact with the metal
2) Air is in contact with the metal
3) Liquid is in contact with the metal
4) CO_2 is in contact with the metal

05. During corrosion of magnesium in oxygen the corrosion product is
1) MgO_2 2) MgO 3) Mg_2O 4) Mg_3N_2

06. During electro chemical corrosion, destruction of metal occurs at
1) Anodic area 2) Cathodic area
3) Anodic or cathodic area
4) Surface

07. The rate of corrosion of Fe with the following metal will be high
1) Sn 2) Cu 3) Ag 4) Pt

08. For corrosion of iron to take place
1) Presence of moisture is sufficient
2) Presence of both oxygen and moisture is essential
3) Hydrogen is required
4) Acid is necessary

09. The passitivity of aluminium is due to the formation of
1) AlO_3 scale 2) Al_2O_3 layer
3) Al_2O_3 precipitate 4) Al_2O_3 gas

10. During electro chemical corrosion
1) Electrolytic cells are formed
2) Concentration cells are formed
3) Galvanic cells are formed
4) Daniel cells are formed

11. If non-porous oxide layers are formed by metals, the rate of corrosion of the metal is
1) Very high 2) Less
3) High 4) Negligible

12. The reverse process of extraction of metals may be called
1) Reduction 2) Corrosion
3) Rusting 4) Hydration

13. In a galvanic cell
1) Electrical energy is converted chemical energy
2) Chemical energy is converted into electrical energy
3) Electrical energy is consumed
4) Chemical energy is consumed

14. Galvanic corrosion occurs if
1) two different metals are present together
2) two different metals are present together in the presence of an electrolyte
3) two metals are present together in the absence of electrolyte
4) a metal is in contact with air

15. In cathodic protection, the metal to be protected is made
1) Cathode 2) Anode
3) Anode of Cathode 4) None

16. In sacrificial anode method, the metal to be protected is connected to
1) Less anodic metal 2) More anodic metal
3) Metal of the same kind
4) None

17. The following can be used as a sacrificial anode for aluminium
1) Copper 2) Iron
3) Magnesium 4) Cadmium

18. In a galvanic cell flow of electrons is form
1) cathode 2) Anode to cathode
3) Battery to the cell 4) None

19. The rate of corrosion is more for the metal, if the pH value of the environment is
1) 5.5 2) 6.5 3) 7.8 4) 4.2

20. Galvanisation is an example of
1) Anodic coating 2) Cathodic coating
3) Non metallic coating 4) None

21. If zinc coating is to be given on iron by electroplating, the electrolytic to be used is
1) ZnO 2) $ZnSO_4$
3) $FeSO_4$ 4) $ZnSO_4$ or $ZnCl_2$

22. In an electrolytic cell
1) Chemical energy is converted into electrical energy
2) Electrical energy is converted into chemical energy
3) Electrical energy is stored
4) Chemical energy is stored

23. Temperature
1) increases rate of corrosion
2) decreases rate of corrosion
3) increases or decreases rate of corrosion
4) has no effect on rate of corrosion

24. The underground structures are protected by
1) Anodic protection 2) Cathodic protection
3) Anodisation 4) Electroplating

25. The rate of corrosion increases if the metal is acted upon by
1) reducing agents 2) oxidising agents
3) oxidising agents or reducing agents 4) none

26. Metal that can form a protective layer
1) Fe 2) Cu 3) Mg 4) Zn

27. List of standard electrode potential values of various electrodes is called
1) EMF series 2) Galvanic series
3) Chemical series 4) None

28. In a galvanic cell, anode an cathode act as
1) Oxidising agent and reducing agent
2) Reducing agent and neutralising agent
3) Reducing agent and Oxidising agent
4) Complexing agents

29. If four electrodes E_a, E_b, E_c are E_d have standard oxidation potentials values of 0.4V. 0.2V. -3.0 V are -0.8 V respectively, the strongest oxidising agent is
1) E_d 2) E_b 3) E_a 4) E_c

30. EMF produced in a galvanic cell is more if the difference in the electrode potential values is
1) less 2) more 3) more or less 4) very less

31. Least electro positive metal
1) Cu 2) Zn 3) Fe 4) Ag

32. Oxidation processes involve
1) gain and loss of electrons
2) loss of electrons
3) loss and gain of electrons
4) gain and loss of electrons

33. Copper from $CuSO_4$ solution can be displaced by
1) Fe 2) Ag 3) Au 4) Pt

34. Metal whose rate of corrosion is high is
1) Zn 2) Cu 3) Fe 4) Mg

35. Electrode potential value varies with concentration of
1) Electrolyte 2) Oxygen
3) Electrolyte or oxygen 4) Moisture

36. During corrosion of aluminium, the reaction at anode is
1) $A^{3+} + 3e^- \rightarrow Al$ 2) $Al \rightarrow A^{3+} + 3e^-$
3) $Al \rightarrow Al^{++} + 2e^-$ 4) $Al^{++} \rightarrow 2e^- \rightarrow Al$

37. During electro chemical corrosion the reactions that occur are
1) Oxidation 2) Reduction
3) Oxidation and reduction 4) Neutralisation

38. During corrosion of aluminium in air, the corrosion product is
1) Al_2O_3 2) AlN 3) Al_4C_3 4) Al

39. The rate of corrosion of Zinc with the following metal is least
1) Al 2) Fe 3) Cu 4) Sn

40. During rusting of iron, rust is deposited at
1) Anode 2) Cathode
3) Anorde or Cathode 4) None

41. If copper is exposed to air, the protective layer formed by it is
1) Cu_2S 2) Cu_2O 3) $CuCO_3$ 4) None

42. During electro chemical corrosion
1) current is produced 2) current is consumed
3) current is produced or consumed 4) none

43. If porous oxide layers are formed by metals, the rate of corrosion of the metal is
1) High 2) Less 3) Very less 4) Negligible

44. If Zn & aluminium are present together, in the presence of an elctrolyte the rate of corrosion of Zn is
1) Less 2) High 3) Very high 4) Zero

45. One of the following in a feature of noble metals
1) they occur in combined form
2) they can occur in free state
3) they occur rare in nature 4) none

46. Current is produced a Daniel cell due to the following reaction
1) $Zn \rightarrow Zn^{++} + Ze^{-}$ 2) $Cu^{++} + Ze^{-} \rightarrow Cu$
3) $Zn + Cu^{++} \rightarrow Zn^{+2} + Cu$
4) $Zn^{++} + Cu \rightarrow Zn + Cu^{++}$

47. During cathodic protection
1) anodic part of the metal is supplied with electrons
2) cathodic part of the metal is supplied with electrons
3) anodic and cathodic parts are supplied with electrons 4) none

48. During direct current method metal to be protected is connected to
1) the positive end of the battery
2) negative end of the battery
3) positive or negative end of the battery
4) none

49. For iron the sacrificial anode used is
1) Copper 2) Tin
3) Lead 4) Zinc

50. During electroplating the metal to be used for coating is made
1) Cathode 2) Anode
3) Anode or cathode 4) None

51. Tin plating on iron is an example of
1) Anodic coating 2) Cathodic coating
3) Anodic or cathodic coating
4) Oxide coating

52. Sherardising is a method in which iron is coated with
1) Aluminium dust 2) Copper turnings
3) Zinc dust 4) Magnesium dust

53. If silicates are coated on the metal surface, the method is called
1) Calorising 2) Shreadising
3) Enameling 4) Galvanisation

54. Ship hulls undergo
1) Pitting corrosion 2) Water line corrosion
3) Atmospheric corrosion
4) Soil corrosion

55. Rust may have the composition
1) FeO 2) $Fe(OH)_2 + FeO$
3) Fe_2O_3 4) $Fe(OH)_2$

56. In an electrolytic cell, the reactions involved are
1) oxidation 2) reduction
3) oxidation and eduction
4) hydrolysis

57. Calorising is a method in which iron is coated with
1) Zinc 2) Copper
3) Aluminium 4) Tin

58. When iron sulphate solution is stirred zinc rod
1) Zinc dissolves 2) iron precipitates
3) zinc dissolves and iron precipitates
4) Zinc precipitates

59. Strongest oxidising agent among the following
1) Cu 2) Fe 3) Zn 4) Al

60. When zinc sulphate solution is stirred with iron rod
1) Zinc dissolves 2) Iron precipitates
3) Zinc dissolves and precipitates
4) No reaction takes place

61. In a galvanic cell made -up of silver and nickel, the anode is
1) Silver 2) Nickel 3) Silver or nickel 4) None

62. More anodic among the following
1) Zn 2) Cu 3) Fe 4) Al

63. Cell reaction in a galvanic cell is more if the difference in the electrode potential values is
1) less 2) more
3) more or less 4) zero

64. Stress cells form due to difference in
1) energy level
2) concentration of electrolyte
3) concentration of oxygen
4) concentration of hydrogen

65. Difference in concentration of the electrolyte forms
1) Electrolytic cell 2) Oxygen cell
3) Concentration cell 4) Electrolyte cell

66. Small steel pipe tilted in a large copper tank undergoes
1) Less corrosion 2) no corrosion
3) very less corrosion 4) rapid corrosion

67. Alloying of metals
1) decrease rate of corrosion of metals
2) increase rate of corrosion of metals
3) May increase or decrease rate of corrosion
4) does not have any effect on rate of corrosion

68. Chromate coating on zinc is an example of
1) Metallic coating 2) Organic waiting
3) Non-metallic coating
4) Anodized coating

69. The reverse process of extraction of a metal is
1) Oxidation 2) reduction
3) Oxidation or reduction
4) neutralisation

70. The following is a volatile oxide layer
1) Na_2O 2) MgO 3) Al_2O_3 4) WO_3

PRACTICE SET - I KEY

01) 2	02) 2	03) 4	04) 3	05) 2
06) 1	07) 4	08) 2	09) 2	10) 3
11) 2	12) 2	13) 2	14) 2	15) 1
16) 2	17) 3	18) 2	19) 4	20) 1
21) 4	22) 2	23) 3	24) 2	25) 2
26) 2	27) 1	28) 3	29) 1	30) 2
31) 4	32) 2	33) 1	34) 4	35) 1
36) 2	37) 3	38) 1	39) 1	40) 2
41) 3	42) 1	43) 1	44) 1	45) 2
46) 3	47) 1	48) 2	49) 4	50) 2
51) 2	52) 3	53) 3	54) 2	55) 3
56) 3	57) 3	58) 3	59) 1	60) 4
61) 2	62)1	63) 2	64) 1	65) 3
66) 4	67) 1	68) 3	69) 1	70) 4

Araise ! Awake ! And stop not till the goal is reached

PRACTICE SET - II

01. Which of the following favours corrosion
1) Position of metal in the electrochemical series
2) Moisture 3) Oxygen 4) All the above

02. Which of the following metal undergoes corrosion easily
1) Fe 2) Mg 3) Cu 4) Ag

03. Which of the following metal is added to Iron in the galvanisation
1) Al 2)Mg 3) Zn 4) Cu

04. Corrosion can be reduced by
1) Applying stress 2)Adding little impurity
3) Exposing to O_2 4)Alloying

05. Corrosion is a
1) Physical process 2) Chemical process
3) Thermal process 4) Dual process

06. Coating of Sn on Iron is called
1) Galvanisation 2) Tarnishing
3) Mercurisation 4) Tinning

07. The following are essential for corrosion
1) O_2, CO_2 2) O_2, CO
3) O_2, Moisture 4) O_2, CO_2, Moisture

08. If a metal is exposed to differential aeration, the galvanic cell formed is
1) Concentration cell 2) Composition cell
3) Stress cell 4) Electrolytic cell

09. The general type of corrosion is
1) Chemical 2) Physical
3) Electrochemical 4) Thermal

10. A general type of corrosion is
1) Composition 2) Stress
3) Concentration 4) All of the above

11. The hurried iron pipes used for the transportation of oil are protected from corrosion by
1) Sacrificial anode method
2) Impressed voltage method
3) Protective coating method
4) Alloying method

12. The area of a metal under the dirt acts as
1) Anode 2) Cathode
3) Depends on the metal
4) Depends on the dirt

13. Which metal easily undergoes corrosion
1) Gold 2) Iron 3) Sodium 4) Silver

14. Composition cell is formed between
1) Two dissimilar non-metals
2) Two dissimilar gases
3) Two dissimilar metals
4) One metal and another non-metal

15. Corrosion of Iron is called
1) Roasting 2) Smelting
3) Rusting 4) Calcination

16. A concentration cell is formed due to difference in
1) Temperature 2) Pressure 3) Application of force 4) Aeration

17. The composition of rust is
1) $Fecl_3$ 2) FeO
3) $Fe(OH)_3$ 4) $Fe_2O_3.xH_2O$

18. The following process reduces the corrosion
1) Alloying 2) Applying stress
3) Adding impurity 4) Exposing to O_2

19. Zn, Cu plates are connected by dipping in acid solution, the type of cell formed is
1) Conentration cell 2) Composition cell
3) Stress cell 4) Electrolytic cell

20. Tinning of Iron is an example of
1) Organic coating 2) Inorganic coating
3) Anodic coating 4) Cathodic coating

21. In the paint, turpentine oil is an example of
1) Drier 2) Thinner
3) Drying oil 4) Pigment

22. The film coating constituent of paint is
1) Pigment 2) Vehicle
3) Thinner 4) Drier

23. The white pigment is
1) Pb_3O_4 2) ZnO 3) Cr_2O_3 4) $PbCrO_4$

24. The position of a nail that undergoes corrosion is
1) Head part 2) Middle part
3) Head and end parts 4) Whole

25. Which of the following are used for coating to protect corrosion
1) Metallic coatings 2) Paints
3) Inorganic coatings 4) All of the above

26. Corrosion is an example of
1) Oxidation 2) Reduction
3) Electrolysis 4) Erosion

27. In a reversible Daniel cell, the cell reaction is
1) $Zn^{++} + 2e^- \rightarrow Zn$
2) $Zn + Cu^{++} \rightarrow Zn^{++} + Cu$
3) $Zn^{++} + Cu \rightarrow Zn + Cu^{++}$
4) $Cu \rightarrow Cu^{++} + 2e^-$

28. For electro chemical corrosion to occur the requirements are
1) Anode 2) Anode, Cathode
3) Anode, Cathode, Electrolyte
4) Cathode, Electrolyte

29. Passive metals can be protected by
1) Anodisation 2) Direct current method
3) Galvanic coupling 4) Cathodic protection

30. Protection of metals against corrosion involves the principle of
1) Galvanic cell 2) Electroytic cell
3) Reversible galvanic cell
4) Reversible electrolyte cell

31. In an alloy of brass, removal of the following meal takes place first
1) Copper 2) Zinc
3) Tin 4) Aluminium

32. In the lab, the unit of rate of corrosion is
1) mg 2) md 3) mdd 4) grams

33. Electroplating is the reverse process of
1) Electrolysis 2) Corrosion
3) Neutralisation 4) Reduction

34. Small crack on a metal surface leads to
1) Water - line corrosion
2) Pitting corrosion
3) Thermo galvanic corrosion
4) Stress corrosion

35. If the meta surface is uniformly exposed to oxygen, it acts as
1) Cathode 2) Anode
3) Anode and Cathode 4) None

36. In a combination of iron and copper, iron acts as anode because its electrode potential value is
1) more 2) less
3) very less 4) zero

37. When nitric acid is added to iron, it reduces iron passive due to the formation of a protective larger of
1) FeO 2) Fe_2O_3 3) Fe_3O_4 4) $Fe(OH)_3$

38. Cathodic protection is based on the principle of
1) Electrolytic cell 2) Galvanic cell
3) Reversible Galvanic cell
4) Daniel cell

39. The deciding factor in atmospheric corrosion is
1) Presence of oxygen in air
2) Humidity of the air
3) Presence of gases like CO_2
4) Presence of hydrogen in air

40. During oxygen concentration cell type corrosion, the corrosion occurs at
1) less oxygenated part
2) more oxygenated part
3) uniform oxygenated part
4) cathodic area

41. During electro chemical corrosion, in acidic environment
1) Oxygen evolution on takes place
2) Oxygen absorption occurs
3) Hydrogen evolution takes place
4) Hydrogen absorption occurs

42. For corrosion of iron to take place
1) Presence of moisture is sufficient
2) Presence of both oxygen and moisture is essential
3) Hydrogen is necessary
4) Oxygen is necessary

43. Rusting of iron is catalysed by
1) Fe 2) O_2 3) OH^- 4) H^+

44. Anodic coating protects coated metal
1) due to its noble character
2) by acting as sacrificial anode
3) due to its low electrode potential
4) due to its less reactivity

45. Cathodic coating, if punctured
1) has no effect on the base metal
2) causes less corrosion of the base metal
3) causes accelerated corrosion of the base metal
4) coating metal undergoes corrosion

46. Electroplating process obeys
1) Ohm's law 2) Arhenius theory
3) Ostwald's law 4) Faraday's laws

47. To prove oxygen concentration cell, the indicator used is
1) Phenolphthalein 2) Methyl orange
3) Ferroxyl indicator 4) Phenol red

48. Ferroxyl indicator is a mixture of
1) Phenolphthalein and methyl orange
2) Methyl orange and phenolphthalein
3) Phenol red and methyl orange
4) Potassium ferri cyanide and phenolphthalein

49. Rate of corrosion can be decreased by removing the following from the environment
1) Oxygen 2) Water
3) Oxygen and Water 4) Hydrogen

50. Rust is
1) $Fe(OH)_2$ 2) $Fe(OH)_3$
3) $Fe(OH)_2 + Fe(OH)_3$
4) FeO

51. De aerations of environment will
1) increase rate of corrosion
2) decrease rate of corroion
3) increase or decrease rate of corrosion
4) no effect on rate of corrosion

52. 'Deactivation' is a method used to decrease rate of corrosion of a metal by adding
1) gases 2) liquids 3) chemicals 4) solids

53. Oxygen for the environment can be neutralised by adding
1) $Na_2S_2O_3$ 2) Na_2SO_4 3) Na_2CO_3 4) Na_2SO_3

54. Aluminia or silica gel is used in
1) decoration 2) Dehumidification
3) deactivation 4) Alloying

55. If the corrosion product is soluble, the rate of corrosion is
1) more 2) less 3) veryless 4) zero

56. If the grain size of the metal is small, the rate of corrosion of the metal is
1) less 2) high 3) very less 4) zero

57. During stress corrosion of an iron nail the anodic area is
1) head of the nail 2) pointed end of the nail
3) head and pointed end of the nail 4) none

58. Rusting of iron is due to
1) Impurities, oxygen 2) Impurities, moisture
3) Oxygen, moisture
4) Impurities, oxygen, moisture

59. Metal which can undergo corrosion in acidic as well basic medium
1) Zn 2) Fe 3) Cu 4) Ni

60. The reaction taking place at anode during corrosion process is generally known as
1) Reduction 2) Oxidation
3) Neutralisation 4) Hydrolysis

61. The process in which metals are coated by their own oxides is called
1) Galvanisation 2) Calorising
3) Anodisation 4) Tinning

62. Which of the following metal is most readily corroded in moist air
1) copper 2) iron 3) silver 4) nickel

63. If an aluminium spoon is used to stir solution of copper nitrate
1) Copper will be precipitate out
2) An alloy of copper and aluminium will be formed
3) Aluminium will be precipltated out
4) Both aluminium an copper will be precipitation out

64. Corrosion of lime stone in nature is called
1) Acid rain 2) Dosimetry
3) Coagulation 4) Stone leprosy

65. Iron gets corroded in
1) Dry atmosphere 2) Humid atmosphere
3) Vaccum 4) Helium atmosphere

66. Even though the standard oxidation potential of Al is higher than that of Fe, Iron undergoes fast corrosion than aluminium because
1) ionisation of iron is easier than aluminium
2) Oxygen has more reactivity with iron than with aluminium
3) Aluminium oxides forms a protective oxide layer where as iron does not
4) Moisture has more adaptivity on iron than aluminium.

67. One of the methods of inhibiting corrosion of iron is the surface coating with
1) Zinc 2) Cadmium
3) Mercury 4) Lead

68. The process of removing basic oxides from the surface of metals before applying metal coating is called
1) galvanising 2) Tinning 3) Polling 4) Picking

69. If two dissimilar metals are connected and are in contact with a conducting medium, one of the following takes place
1) The metal with higher reduction potential will be oxidised
2) The metal with lesser reduction potential will be reduced
3) The metal with lower reduction potential will be oxidised
4) The metal with higher oxidaiton potential will be deposited on cathode

70. Which one of the following metals will not reduce H_2O?
1) Ca 2) Fe 3) Cu 4) Li

PRACTICE SET -II KEY

01) 4	02) 2	03) 3	04) 4	05) 2
06) 4	07) 4	08) 1	09) 3	10) 1
11) 1	12) 1	13) 3	14) 3	15) 3
16) 4	17) 4	18) 1	19) 2	20) 4
21) 2	22) 2	23) 2	24) 3	25) 4
26) 1	27) 3	28) 3	29) 1	30) 1
31) 2	32) 3	33) 2	34) 2	35) 1
36) 1	37) 3	38) 2	39) 2	40) 1
41) 3	42) 2	43) 4	44) 2	45) 3
46) 4	47) 3	48) 4	49) 3	50) 3
51) 2	52) 3	53) 4	54) 2	55) 1
56) 2	57) 3	58) 4	59) 1	60) 2
61) 3	62) 2	63) 1	64) 4	65) 2
66) 3	67) 1	68) 4	69) 3	70) 3

ALL POWER IS WITHIN YOU
YOU CAN DO ANYTHING AND EVERYTHING

SELF TEST

01. Which of the following metals is most readily corroded in moist air?
1) Copper 2) Iron
3) Silver 4) Nickel

02. Galvanization of iron denotes coating with
1) Cu 2) Sn 3) Al 4) Zn

03. During electrochemical corrosion in acidic environment
1) Oxygen evolution occurs
2) Oxygen absorption occurs
3) Hydrogen evolution occurs
4) Hydrogen absorption take place

04. During wet corrosion
1) The anodic part undergoes oxidation
2) The cathodic part undergoes oxidation
3) The anodic part undergoes reduction
4) Neither anodic nor Cathodic parts undergo any changes

05. Iron gets corroded in
1) Dry atmosphere 2) Humid atmosphere
3) Vaccum 4) Helium atmosphere

06. The reaction that takes place at an anode in corrosion cell is
1) Reduction 2) Gain of....
3) Oxidation 4) None of these

07. In the cathode reaction rusting of iron, electrons are consumed by
1) Cl^- ions 2) Fe^{2+} ions
3) OH^- ions 4) H^+ ions

08. Which one of the following metals is used as a coating for the prevention of corrosion in iron?
1) Magnesium 2) Sodium
3) Chromium 4) Vandieum

09. Corrosion of iron by Galvanic cell action takes place by the presence of the following metal impurity?
1) Zinc 2) Copper
3) Aluminium 4) Magnesium

10. If 20ml of 0.4N NaOH solution completely neutralizes 40ml of dibasic acid, the molarity of the acid solution will be
1) 0.1 M 2) 0.2 M 3) 0.3 M 4) 0.4 M

11. Rusting of iron is .....reaction
1) Reduction 2) Oxidation
3) neutral 4) not a chemical

12. The most affected metal of the following in corrosion reaction is
1) Zn 2) Pb 3) Cu 4) Fe

13. Prevention of corrosion of metals is most effectively achieved by
1) Protective covering 2) Inorganic coatings
3) Organic coating 4) Alloying

14. Stainless steel is corrosion resistant because of the presence of
1) W 2) Fe 3) Al 4) Cr

15. In electro-chemical series, the metals are arranged in a series on the basis of
1) Electron affinity 2) Electronegativity
3) Electro positivity reduction potential
4) Thermal conductivity

16. The metal that forms a protective oxide film which prevents further corrosion is
1) Al 2) Zn 3) Cu 4) Fe

17. The element used as sacrifical electrode for protection against electrochemical corrosion of iron is
1) Cadmium 2) Copper
3) Zinc 4) Lead

18. The process of removing basic oxides from the surface fo metals before applying metal coating is called
1) Galvanising 2) Anodising
3) Polling 4) Pickling

19. In Cathodic protection, the metal standing....in the galvanic series are used.
1) high 2) low 3) middle 4) last but none

20. Extent of corrosion of metals usually determined by measuring loss in
1) volume 2) weight
3) pressure 4) resistance

21. Calorising is the process of coating iron with
1) Zinc 2) aluminium
3) tin 4) silicates

22. Metal at the top of electrochemical series is
1) most stable 2) least stable
3) most noble 4) most active

23. A pure metal rod half immersed in water starts corroding at____
1) the bottom
2) the top
3) the boundary
4) slightly above the boundary

25. Corrosion of metals is most efficiency prevented by
1) Organic coating
2) Alloying
3) Electro plating
4) Inorganic coatings

26. Rust is .....
1) ferrous hydroxide 2) ferraso ferricoxide
3) hydrated ferric oxide
4) ferric oxide

27. Electro - chemical corrosion "takes place" if
1) air is in contact with metal
2) liquid medium is in contact with metal
3) N_2 is in contact with metal
4) CO_2 is in contact with metal

28. The substance which when added in small quantities to the aqueous corrosive environment, effectively decreases the corrosion rate of metal. The sustance is called
1) Plasticizer 2) Insulator
3) Inhibitor 4) Moderator

29. Calorising is the process of coating iron with
1) tin 2) Zinc 3) Copper 4) Alluminium

30. Corrosion is the reverse process of
1) tinning
2) Galvanization
3) Electroplating
4) Rusting

31. In cathodic reaction in rusting of iron electrons are consumed to form
1) Cl - ions 2) Fe^{2+} ions
3) OH - ions 4) H^+ ions

32. During electro chemical corrosion, the product formed at cathode in the presence of dissolved oxygen and acidic medium is
1) OH^- 2) H_2O
3) H_2 4) H_2 & OH^-

33. Aluminium differs from iron in that
1) It does not undergo corrosion
2) It does not react with oxygen
3) Initial protective oxide formation prevents further oxidation
4) Its oxide is easily removed from its surface

34. In electro chemical corrosion, the metal is destroyed at
1) cathode
2) anode
3) both
4) either cathode or anode

35. Electro chemical theory was proposed by
1) Lewis
2) Brownsted
3) Whitney
4) clark

SELFTEST KEY

01) 2	02) 4	03) 3	04) 1	05) 2
06) 3	07) 2	08) 3	09) 2	10) 1
11) 2	12) 4	13) 3	14) 4	15) 2
16) 1	17) 3	18) 4	19) 1	20) 2
21) 2	22) 4	23) 1	24) 3	25) 1
26) 3	27) 2	28) 3	29) 4	30) 3
31) 3	32) 1	33) 3	34) 2	35) 3

PREVIOUS ECET BITS

ECET-2010

01. One of the following metal gives passive layer over iron metal to protect iron from corrosion.
1) Sodium 2) Magnesium
3) Zinc 4) Chromium

02. The method of protection base (iron) metal from corrosion by attaching a small anode metal is known as
1) Sacrificial cathode 2) Sacrificial anode
3) Impressed current 4) Passive method

ECET-2011

03. 18/8 stainless steel contains
1) 18% chromium and 8% nickel
2) 18% chromium and 8% molybdenum
3) 18% nickel and 8% chromium
4) 18% molybdenum and 8% nickel

04. The process of coating Zinc iron to improve corrosion resistance of iron is called
1) Annealing 2) Galvanising
3) Zincification 4) Tempering

05. Which of the following is most prone to atmospheric corrosion.
1) Silver 2) Iron
3) Tin 4) Copper

ECET-2012

06. Corrosion of a metal is fastest in
1) rain-water 2) acidulated water
3) distilled water 4) de-ionised water

07. The process of cementation with zinc powder is known as
1) sheradizing 2) zincing
3) metal cladding 4) electroplating

ECET-2013

08. Which of the following metal ions will undergo fastest reduction ?
1) K^+ 2) Al^{+3} 3) Cd^{+2} 4) Ag^+

09. A zinc rod half immersed in a beaker containing water
1) Corrodes fastest at the top
2) Does not corrode at all
3) Corrode fastest at the water-metal boundary
4) Corrodes fastest at the bottom

10. The effect of sulphur dioxide on iron is to
1) Decrease the rate of corrosion
2) Increase the rate of corrosion
3) First decrease and then increase the rate of corrosion
4) Bring no change in its corrosion

ECET - 2014

11. Glass is corroded by
1) Fluorine (dry or wet)
2) Sulphuric acid (concentrated)
3) Phosphoric acid 4) Carbonic acid

12. The most resistant material to alkaline corrosion is
1) Cast iron 2) Nickel
3) Aluminium 4) Brass

TS- ECET-2015

13. Which one of the follwoing reaction takes place under standard conditions
1) a strip of lead is placed into an aqueous solution of zinc nitrate
2) a strip of copper is palced into an aqueous aolution of zinc nitrate
3) a strip of silver is palced into an aqueous solution of copper nitrate
4) a strip of iron is placed in the air under acidic conditions

14. How is anode metal selected ot prevent corrosion by sacrificial anodic protection method
1) oxidation potential of anode metal is higher than that of protected metal
2) oxidation potential of anode metal is lower than that of protected metal
3) reduction potential of anode metal is higher than that of protected metal
4) sacrificial anode is always zinc

15. whcih one of the following statement is correct
1) aluminum corrodes faster than iron in air
2) rusting of iron is quicker in saline water
3) corrosion do not occur in steel pipe connected to copper plumbing
4) bolts and must made of the different metals are preferred to prevent corrosion

AP - ECET- 2015

16. The metal commonly employed as sacrificial anodes is
1) iron 2) magnesium
3) vanadium 4) sodium

17. The process of coating rion or a steel sheet with a thin coat of Zinc to prevent them from rusting is known as
1) galvanization 2) tinning
3) electro plating 4) metal cladding

S-ECET-2016

8. The chemical composition of rust is

1) $Fe_2O_3.XH_2O$ 2) Fe_2O_3

3) $Fe_3O_4.XH_2O$ 4) Fe_3O_4

9. Which one of the following could provide cathodic protection to iron

1) Cu 2) Zn 3) Ni 4) Co

AP-ECET-2016

20. Wet corrosion is best explained by

1) bohr's theory
2) electrochemical theory
3) bronsted-lowry theory
4) arrhenius theory

21. By using cathodic protection technique the corrosion of metal surface is avoided by making it work as

1) salt bridge of electrochemical cell
2) anode of electrochemical cell
3) cathode of electrochrmical cell
4) insulator

TS-ECET-2017

22. Which one of the following metals could provide cathodic protection to iron

1) Cu and Ni 2) Zn and Cu
3) Al and Zn 4) Al, Zn and Ni

23. Rusting of iron is catalysed by which of the following

1) Fe 2) zn 3) O_2 4) H^+

AP-ECET-2017

24. Difficult to monitor and very dangerous form of corrosion is

1) galvanic 2) pitting 3) crevice 4) stress

25. When Pt and Co are electrically connected, which one gets corroded

1) Co 2) Pt 3) none 4) both

TS-ECET-2018

26. In the preparation of wrought iron from cast iron, the furnace employed is _____

1) electrical 2) open hearth
3) reverberatory 4) blast

27. The type of protection against corrosion applied to marine piers and water box coolers is _____

1) impressed current cathodic protection
2) metal rusting
3) tinning
4) metal painting

28. A metal is dipped separately in different pH solutions of 1, 2, 3 and 4. In which pH solution is the metal easily corroded

1) 1 2) 2 3) 3 4) 4

AP-ECET-2018

29. The composition of rust is

1) $Fe(OH)_3$ 2) $FeCl_3$

3) FeO 4) $Fe_2O_3.xH_2O$

30. Corrosion is an example of

1) oxidatioin 2) reduction
3) electrolysis 4) halogenation

PREVIOUS ECET BITS KEY

01) 4	02) 2	03) 1	04) 2	05) 2
06) 1	07) 1	08) 4	09) 4	10) 2
11) 1	12) 4	13) 4	14) 1	15) 2
16) 2	17) 1	18) 1	19) 2	20) 2
21) 3	22) 3	23) 4	24) 2	25) 1
26) 3	27) 1	28) 1	29) 4	30) 1

Araise ! Awake ! And stop not till the goal is reached

POLYMERS

- The process of joining many molecules to form a lengthy chain is called polymerisation.
- The produced lengthy chain is called polymer and each molecule participating in polymerization is called monomer or basic unit.

  Eg: Polymerisation of ethylene gives polyethylene or polyethene

  $nCH_2 = CH_2 \rightarrow \{-CH_2 - CH_2-\}_n$

  Ethylene (ethene) (Polyethylene) Polyethene
- In Latin language plastics means to mould.
- Many monomers Join together to form a polymer and a polymer is a giant molecule. Or Macro molecule
- Polymers are classified into 2 types according to their occurrence i.e., natural and synthetic polymers.
- Natural polymers: Cellulose, proteins, Insuline, nucleic acids, natural rubber, wood, cotton, silk, glass, Diamond, Graphite.
- Polyethene, PVC. Bakelite, Teflon, Nylon, Polystyrene are examples of synthetic polymers.
- The no. of monomers which join together to give a polymer chain is called degree of polymerisation.
- For polymerisation monomers should have unsaturation (C = C or C ≡ C). To carry out polymerisation, high temperature and high pressure arc required. Sometime catalysts and initiators are also required. Unsaturated monomers = C_nH_{2n} or C_nH_{2n-2}, saturated molecules (C_nH_{2n+2}) can not undergo polymerisation.
- Depending on the monomers which join together polymers can be; classified as

  i) Homopolymers ii) Co-polymers
- If same monomers join together, it is called homopolymer.
- Eg: Polyethene, PVC, Teflon, polystyrene etc.
- If different monomers join together, it is called a co-polymer.

  Eg: Bakelite is produced from phenol & formaldehyde
- Eg: Buna - S rubber (Butadiene + styrene)

  Nylon 6, 6 is produced by (Adpic acid + Hexa methylene diamine

  Polyester is produced by (ethylene glycol + Terepthalic acid) etc.
- The number of reactive sites in a monomer is called functionality.

➔ Ethylene is a bifunctional molecule. Phenol and acetylene are trifunctional molecules

➔ bifunctional monomers give straight chain polymers with high flexibility

Trifunctional monomers give branched chain polymers with less flexibility

Polyfunctional monomers give cross – linked and network structured polymer with high strength

➔ If only carbon atoms are present in a basic polymeric chain, it is homochain polymer.

➔ If other atoms are present along with carbon atoms in a basic polymeric chain it is heterochain polymer.

TYPES OF POLYMERISATION REACTIONS :

➔ Polymerisation reactions can Be classified into 2 types, i) Addition polymerisation

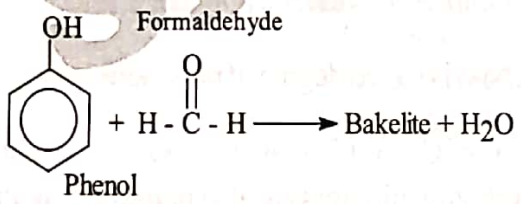
ii) Condensation polymerisation.

➔ Monomers add up together without the elimination of any by product is called addition polymerisation '

Eg: Polyethene, PVC, Teflon, Polystyrene etc.

➔ If Monomers join together with the elimination of small molecules as by product, it is called condensation polymerization

Eg: Formation of bakelite from phenol and formaldehyde



➔ When monomers join to form bakelite, water molecules are eliminated as byproduct.

➔ Other example for condensation polymerization are Nylon, Polyester, Urea – formaldehyde resin etc.

➔ Addition polymerisation is a slow process, and each time one monomer adds to the growing chain.

➔ Condensation polymerisation is a fast process and simultaneously many growing chains are possible

➔ In addition polymerisation molecular weight of produced polymer is equal to the sum of the molecular weights of monomers

➔ In condensation polymerisation, molecular weight of the polymer is less than sum of the molecular weights of monomers.

CO-ORDINATION POLYMERISATION :

➔ It is a type of addition polymerisation but it takes place in presence of catalyst called "Zeigler-Natta", catalyst so it is called Zeigler - Natta polymerisation.

- Zeigler Natta catalyst is triethyl aluminum $(C_2H_5)_3$ Al mixed with transition metal halide like $TiCl_4$
- Zeigler-Natta catalyst is organometallic compound with transition metal halide.
- In Zeiger-Natta polymerisation stereo -specific polymer is produced.
- The arrangement of monomers in a polymeric chain i.e., configuration of polymer is called tacticity.
- According to tacticity polymers are isotactic, syndiotactic and atactic polymers.
- Plastic is a polymer which is moulded into a desired shape. All the plastics are classified into 2 types. They are

  i) Thermoplastics ii) Thermosetting plastics

THERMOPLASTICS	**THERMOSETTING PLASTICS**
These plastics will become soft upon heating and they regain their hard nature after cooling	These plastics will become hard upon heating and they remain hard after cooling
These will undergo a temporary change upon heating (Physical change)	These will undergo permanent change upon heating & cooling (chemical change)
These are produced from addition polymerisation .	These are generally produced from condensation polymerization,
These are linear polymers	These are branched polymer with network & three dimensional structure.
These are having weak intermolecular forces & soft in nature.	These are hard, rigid, brittle with strong inter molecular forces.
These are soluble in organic solvents	These are insoluble.
These can be recycled and reused.	These cannot be recycled and reused.
All vinylic polymers like PVC (Polyvinyl chloride) Polymethyl Methacrylate, Teflon and Polyamide like nylon, Poly cellulose acitates are thermo plastics	Eg:- Polyster, Phenol formaldehyde Resins i.e., bakelite, Urea formaldehyde resin, alkyl resins, Epoxy resins & silicone resins.

- Polyethene (Polyethylene) : It is produced from the polymerisation of ethylene. It is homopolymer produced from addition polymerisation and is thermoplastic.

$$\underset{\text{(ethylene)}}{n(H_2C=CH_2)} \xrightarrow[O_2]{\text{Polymerisation}} \underset{\text{(Polyethene)}}{[CH_2-CH_2]_n}$$
(ethene)

If high pressure is used, low density polythene is produced and in low pressure high density polythene is produced.

➔ **Uses:** It is used to produce insulating parts, flexible bottle caps, kitchen and domestic appliances, toys, sheets for packing materials, tubes and pipes, coated wires, cables and bags.

Polyvinyl chloride (PVC) : It is produced from the polymerisation of vinyl chloride. It is a homopolymer produced from addition polymerisation and is thermoplastic.

$$n\ H_2C=\underset{\text{Cl}}{\underset{|}{CH}} \xrightarrow[H_2O_2\text{(or)}]{\text{Polymerisation}} \left[-CH_2-\underset{\text{Cl}}{\underset{|}{CH}}\right]_n$$

(vinyl chloride) (chloroethene) Benzoylperoxide

➔ **Uses :** It is used to produce pipes, electric insulators, tank linings, safety helmets, refrigerator components, tyres, cycle and motor cycle mudguards

➔ PVC mixed with plasticizers like dibutyl phthalate tri cresylphosphate, dioctylphthalate is used to make plastic curtains, rain coats, table cloths etc.

Polystyrene : Styrene upon polymerisation, it gives polystyrene. It is a homopolymer, thermoplastic and produced from addition polymerisation.

➔ **Uses :** It is transparent light stable moisture resistant polymer. It is used to produce toys, combs, buttons, buckets, radio and television parts, refrigerator components, battery cases, electric insulators and lenses.

➔ **Teflon (fluon) :** Chemical name is polytetrafluoroethylene. It is homopolymer, thermoplastic produced from addition polymerisation.

$$n\ \underset{\text{F}}{\underset{|}{\overset{\text{F}}{\overset{|}{C}}}}=\underset{\text{F}}{\underset{|}{\overset{\text{F}}{\overset{|}{C}}}} \xrightarrow{\text{Benzoyl Peroxide}} \left[\underset{\text{F}}{\underset{|}{\overset{\text{F}}{\overset{|}{C}}}}-\underset{\text{F}}{\underset{|}{\overset{\text{F}}{\overset{|}{C}}}}\right]$$

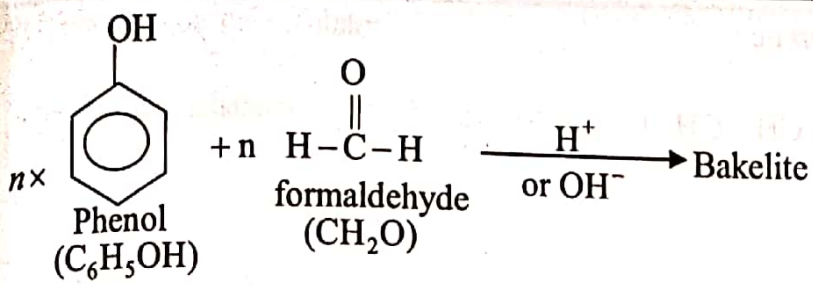
➔ **Uses :** Teflon is very hard having high softening point about 350°C and is highly chemical resistant except hot alkalies. Teflon is is used in the production of insulating materials, gaskets, chemical carrying pipes, non-sticky kitchen ware and tank linings.

➔ The above mentioned four polymers are belonging to vinylic group.

➔ Polyvinyl acetate used to making chewing gums, surgical dressings paints adhesives

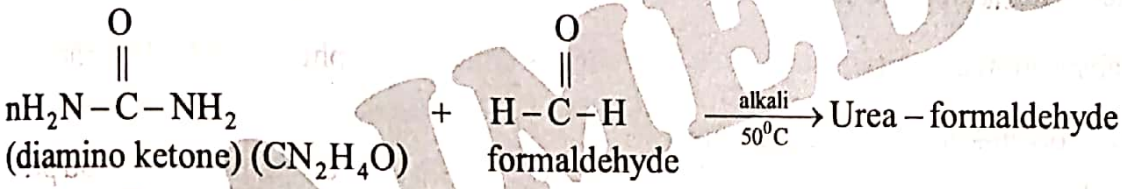
➔ Polymethyl methacrylate (Perspex) is used to produce adhesives.

➔ **Bakelite :** It is produced from the polymerisation of phenol and formaldehyde. It is a copolymer, thermosetting' plastic and produced from condensation polymerisation, phenol and formaldehyde initially form a straight chain polymer which is called novalac resin, it changes into highly branched and network structure polymer called bakelite.



➔ **Uses :** Bakelite is very hard rigid plastic resistant to acids, bases and many other chemicals. It is used in the production of electric insulator parts, switches, plugs, switch boards, heater handles, telephone parts, cabinets of T V and radio, bearings and to produce adhesives and paints.

➔ **Urea formaldehyde resin :** It is produced from the polymerisation of urea and formaldehyde in 2 : 1 ratio in presence of alkali. It is a copolymer, thermosetting plastic produced from condensation polymerisation. It is belonging to amino group of resins. Urea and formaldehyde initially form primary products monomethylol urea and dimethylol urea which undergo polymerisation to form urea formaldehyde resin.



RUBBER

➔ Rubber is an elastomer having elastic property.

➔ Its elastic property is in excess of 300%. A rubber band can be stretched 4 to 10 times of its original length.

➔ Rubber is having coiled structure and in coiled structure it will have amorphus nature with weak inter molecular forces.

➔ When stretched, it becomes crystalline with strong intermolecular force of attraction.

➔ Rubbers are two types according to occurance, they are (1) Natural Rubber (2) Synthetic Rubber

➔ Natural rubber is produced from rubber plants Have a Brasilians and gaugule

➔ Rubber plants are mainly grown in Indonesia, Malaysia, Thailand, Ceylon, India & South America

➔ In India, rubber plants are mainly grown in Kerala. India occupies 5th rank in rubber production (2.7%)

➔ Rubber plants will give Latex in which 26 to 35% of rubber is present, remaining is water, proteins, enzymes, nucleic acids, inorganic solids and other acids.

➔ Latex must be diluted and treated with acetic acid or formic acid and subjected to coagulation, then rubber is produced. This phenomenon is processing of rubber (For 200 kg of rubber material, 1 kg of acetic acid or formic acid must be added).

➔ Natural rubber is polymer of Isoprene units C_5H_8. Isoprens is Methyl 1,3 - butadiene

➔ Natural rubber is polymer of cis-polyisoprene

$$n CH_2 = \underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}} - CH = CH_2 \rightarrow \left[CH_2 - \underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}} = CH - CH_2 \right]_n$$

➔ Transpolyisoprene is called Guttapercha.

➔ It is produced from the leaves of Dichopsis gutta and Palagub Gutta

DRAW BACKS OF RAW RUBBER:

01. Low tensile strength (around 200 kg/cm^2)

02. Plastic in nature

03. It is weak

04. It can be used in temp range of 10°C to 160°C

05. It has large water absorption capacity

06. It can be attacked by solvents and oxidizing agents

07. It .swells in inorganic solvents and it dissolves in organic solvents

08. It will have tackiness

09. Little durability and it undergoes permanent deformation

VULCANISATION :

➔ Heating rubber with sulphur is called vulcanisation. It was invented by Charles Good Year.

➔ For vulcanisation, H_2S, S_2Cl_2 or carbondisulphide (CS_2) can also be used.

➔ In vulcanisation, the heating temperature may be 40°C to 140°C.

➔ In vulcanisation, rubber looses its elastic property and becomes hard.

➔ In vulcanisation, branched chains are formed with cross linking structure.

➔ A normal vulcanised rubber contains 3 to 10% sulphur

➔ Rubber containing 33 % of sulphur is ebonite rubber or vulcanite and it is used to produce battery cases.

ADVANTAGES OF VULCANISED RUBBER :

➔ It has good tensile strength (5000 kg/cm^2)

➔ It posses low water absorption capacity.

➔ It has excellent resilience.

- It is better electrical insulator
- It has higher resistance to oxidation or solvents
- It is useful in temp range 40 to 100°C
- Its tackiness is very less.

COMPOUNDING OF RUBBER:

- Adding certain substances into the polymeric materials to have desired properties is called compounding.
- Common substances used in compounding of rubber are

1) Vulcanising agents : These are added to increase hardness

Eg :- Sulphur, Sulphurmonochloride (S_2Cl_2), H_2S, Carbondisulphide, Benzoyl Chloride, Trinitro Benzene or certain other sulphides.

2) Plasticisers & Softners : These are added to improve softness and plasticity

Eg : Vegetable oils, waxes, stearic acid, resin etc.

3) Accelerators : These materials will decrease the time for vulcanisation

Eg ; 2- Mercaptol, Benzothiozole and Zinc - Alkylxanthate.

4) Antioxidants : These are to resist oxidation.

Eg :- Phosphites, β - napthol

5) Colouring agents : These are added to get desired colour.

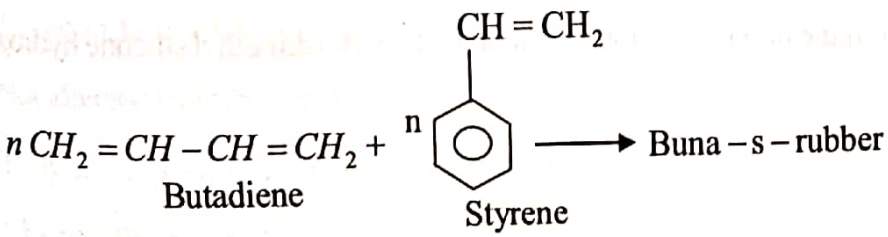
Eg: Titanium oxide (white). Chromium oxide (green), Ferric oxide (Red), Antimony sulphide (Crimson), Lead chromate (Yellow).

6) Fillers (reinforcing fillers) : These will increase strength & rigidity of rubber.

Eg: Carbon black, Zinc oxide, calcium carbonate and magnesium carbonate.

SYNTHETIC RUBBER:

- Buna-S or (G.R.S) rubber: It is produced by mixing butadiene and styrene in 75% & 25% respectively



Uses: It has high load bearing capacity but it swells in oils and solvents and readily oxidised. It is used to produce tyres, floor tiles, shoes soles, foot wear components, gaskets, cable insulation, carpets, adhesives (gums) and tank linings.

➔ **Butyl rubber:** It is produced in the polymerisation of isobutylene with 1 to 5% of isoprene

$$CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}}=CH_2+CH_2=\underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}}-CH=CH_2 \rightarrow \text{Butyl rubber}$$

Uses: It has low permeability to air and other gasses, resistant to chemicals and solvents. It is used to make cycle and automobile tubes, automobile parts, conveyor belts, tank linings and insulation parts.

➔ **Neoprene rubber:** It is produced in the polymerisation of chloroprene. It is a homopolymer.

$$nCH_2=\underset{\displaystyle Cl}{\overset{\displaystyle |}{C}}-CH=CH_2 \rightarrow \left[CH_2-\underset{\displaystyle Cl}{\overset{\displaystyle |}{C}}=CH-CH_2\right]_n$$

chloroprene — neoprene

➔ It is related to natural rubber, resistant to oils, soluble in some solvents and it can be made hard by compounding with zinc oxide or magnesium oxide.

➔ It is used to produce gaskets, tubes for oils and chemicals, sponges, conveyor belts and adhesives.

➔ Thikol rubber: It can also be called polysulphide rubber or GR-P rubber. It is produced from sodium polysulphide (Na_2S_2) and ethylene dicchloride (Cl - CH_2 - CH_2 - Cl). It is used to produce cable coverings, oil tank linings and solid propellant for rocket fuels.

➔ **Buna-S:** It is produced from the polymerisation of butadiene and acrylonitrile

$$CH_2=CH-CH=CH_2+CH_2=\underset{\displaystyle CN}{\overset{\displaystyle |}{C}}H \rightarrow \text{Buna}-S$$

(butadiene) — Acrylonitrile (Vinyl cyanide)

Uses: It is used to produce conveyor belts, air craft components, tank lining, gaskets, adhesives and automobile parts.

➔ **Silicone rubber:** It is produced from the polymerisation of silicon hydroxide (dimethyl silicone hydroxide)

$$HO-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{\displaystyle |}{\underset{\displaystyle |}{Si}}}}-OH$$

It is very hard and can withstand high temperature upto 200^0C. It is used as sealing material and to produce tyres for aircrafts, insulating materials in various industries, paints and protective coatings, lubricants, artificial heart valves, transfusion tubings.

GENERAL USES OF RUBBER

01. It is used as insulating coating on wires and cables electrical power transmission and in electrical equipment,
02. Used for making rubber bands, mechanical rubber goods, golf ball, printing rollers, tubes for automobiles, aeroplanes.and bicycles etc.
03. In making rubber lined metal tanks, tyres, foot wear, conveyor belts, shock absorbers.
04. Rubber hoses are used for transfusion of petrol, oils etc.
05. For making storage battery cases, electrical switch board panels, plugs, sockets, telephone receivers, rubber fittings and valves.
06. Sponge rubber is used for shock absorption, thermal insulation and sound insulation.
07. Foam rubber is used for making pillows, mats, pads, etc.
08. Rubber can also be used for making gaskets, transfusion tubings, padding for plastic surgery etc.
09. Used to produce adhesives, sport goods and toys, polysulphide rubber is used as solid propellant in rocket fuels.

Properties of the plastics:

01. Lighter in weight
02. Specific gravity varies from 1-1.4
03. Good thermal and electrical insulators
04. Resistant to corrosion
05. Casting, moulding, drilling etc is easy.
06. They have high adhesive properties.
07. Low fabrication cost.
08. Plastic surface will be shining and glassy appearance.
09. Not affected by infects and fungi.
10. They can expand and contract depending on temperature.
11. Chemically inert and they do not need any protective coatings so maintenance is easy.
12. Some plastics have transparent nature and have high refractive index.
13. Their colors will not fade and they have some shock absorption capacity.

14. Certain plastics like teflon are very hard, they do not absorb water.

Compounding agents for plastics :

i **Fillers :** To increase hardness, strength, capacity and to reduce brittleness and shrinkage. Eg : clay, paper pulp. Saw dust, wood floor, graphite, cottonfibre, marble floor, ground cork, cereal husk, carbon black.

Quartz , mica, carborundum or metallic oxide of zinc and lead are added to improve hardness.

Asbestos is added to increase heat resistance and corrosion resistance.

Fillers which enhance the mechanical strength are called reinforcing fillers. eg. Cotton fibre, rags or wood chips.

Barium salts are added to render the plastic impervious to X-rays.

Plasticizer : Improves the plasticity and flexibility of resin.

Eg : Non-drying vegetable oils, comphor, esters of oleic, stearic and phthalic acid, tributyl phthalate acid, tricerylphosphate, triphenylphosphate, triacetin etc.

Lubricant : Makes moulding easy gives flawless and glossy finish, prevent from sticking to moulding equipment.

Eg : oils, waxes and soaps

Acecelerator : Accelerates the polymerisation process

Eg : Hydrogen peroxide, Benzoyl peroxide, metals such as

Ag, Cu, Pb, ZnO, Ammonia and its salts.

Pigment : Colouring agent.

Stabilizer : Increases thermal stability Eg : Salts of lead (white lead, lead chromate, red lead, litharge, lead silicate and lead naphthenate)

Transparent moulding compounds such as stearic acid salts of lead, cadmium or barium are also used as stabilizers.

THERE IS NO SUBSTITUTE TO HARDWORK

PRACTICE SET - I

01. High polymers are :
1) liquids 2) gaseous 3) solids 4) colloidal

02. Bakelite is prepared by the condensation of
1) benzene and formaldehyde
2) phenol and formaldehyde
3) phenol and acetaldehyde
4) glycerol and phtalic acid

03. The raw material used for the manufature of polyester are :
1) vinyl chloride 2) urea + formaldehyde
3) glycol + terphatalic acid
4) phenol + formaldehyde

04. The fibre obtained by the condensation of hexamethylene diamine and Adipic acid is :
1) dacron 2) nylon 3) rayon 4) terylene

05. Which one is not a macromolecule ?
1) Protein 2) Insulin
3) Ice 4) Cellulose

06. Which of the following is a synthetic polymer ?
1) Cellulose 2) PVC
3) Proteins 4) Nucleic acids

07. Which of the following has the largest molecular mass ?
1) Monomer 2) Dimer
3) Oligomer 4) Polymer

08. Generally, reative molecular mass of a polymer is over :
1) 101 2) 100 3) 1000 4) 10,000

09. The number of repeating units in polymer is
1) about twenty 2) relatively large
3) small 4) very small

10. Which of the following has ester links ?
1) Nylon 2) Bakelite 3) Terylene 4) PVC

11. Which of the following has amide links ?
1) proteins 2) Nylon
3) peptide 4) All of the above

12. Which of the following intermolecular forces are present in Nylon-66 ?
1) Dipole-walls 2) Hydrogen bonding
3) Dipole-dipole interactions
4) None of the above

13. Caprolactam is the monomer of
1) nylon-6 2) glyptal
3) PTFE 4) melamine

14. Which one of the following compounds contains both chlorine and fluorine ?
1) Teflon 2) Bleaching powder
3) Freon 4) Cryolite

15. Which of the following polymers contains nitrogen
1) Nylon 2) Teflon
3) PVC 4) Terylene

16. Terylene is :
1) Polyamide 2) polyester
3) polyglycol 4) polycarbonate

17. A common catalyst used in addition polymerisation is :
1) nickel 2) Y-zeolite
3) zeigler-Natta catalyst
4) Platinum

18. Amorphous polymers do not possess any clear
1) glass transition temperature
2) melting point
3) both of these 4) none of these

19. Low density polythene is obtained by using :
1) anionic catalyst 2) free radical indicator
3) Zeiger-Natta catalyst
4) cationic catalyst

20. Perspex is
1) an adhesive 2) a rubber
3) a nylon 4) a polyester

21. The monomer used in the preparation of polystyrene has the molecular formula
1) C_2H_4 2) C_2H_7 3) C_8H_7 4) C_8H_8

22. Terylene is formed from
1) terephtalic acid 2) Glycol
3) terephtalic acid and glycol
4) Glycol and adipic acid

23. The chemical name of 'Saran' is
1) Poly vinyl chloride 2) Polytetra flurothylene
3) Polymethyl methacrylate
4) Polyvinyledene chloride

24. The chemical name of acrylic resin which is commonly known as Lucite or plexi glass is
1) Polymethyl 2) Teflon
3) SARAN 4) Bakelite

25. Poly ethylene is a ___polymer
1) Condensed 2) Linear
3) CO 4) All

26. GR-S rubber is an example of
1) condensation polymerisation
2) copolymerization
3) addition polymerisation in which single monomer takes part.
4) cross-linked polymer.

27. India occupies_____ position in the world in rubber production
1) 6th place 2) 5th place
3) 8th place 4) 10th place

28. Which of the following is true with regard to rubber
1) having the coiled structure
2) amorphous nature
3) weak intermolecular forces
4) all the above

29. The percentage of elasticity of rubber can be upto
1) 300% 2) 100%
3) 30% 4) none of the above

30. Which of the following is used for processing of rubber from latex solution is
1) acetic acid 2) sulphuric acid
3) acetaldehyde 4) dil HCl

31. Trans polyisoprene is called as
1) Guttapercha 2) plastic
3) polymer 4) copolymer

32. The process of culcanisation of rubber was developed by
1) Bohr 2) Clark
3) Charles good year 4) Whitney

33. The mixing of chemicals to the raw rubber is called
1) Fabrication 2) Compounding
3) Co a gulation 4) Tramsformation

34. The first synthetic rubber is
1) Buma – s 2) G R -1
3) G R – M 4) Polylsoprene

35. The na in Buna - s indicates
1) Native njbber
2) Sodium used as a catalyst
3) Nitrogen used as a catalyst
4) Sulphur used as a catalyst

PRACTICE SET - I KEY

01) 4	02) 2	03) 3	04) 2	05) 3
06) 2	07) 4	08) 4	09) 2	10) 3
11) 4	12) 2	13) 1	14) 3	15) 1
16) 2	17) 3	18) 2	19) 2	20) 1
21) 4	22) 3	23) 4	24) 1	25) 2
26) 2	27) 2	28) 4	29) 1	30) 1
31) 1	32) 3	33) 2	34) 1	35)2

PRACTICE SET - II

01. The percentage of sulphur present in vulcanised rubber is
1) 2 0 - 3 0 2) 1 – 50
3) 5 0 - 100 4) 1 - 32

02. Isobutylene on co-polymerisation with isoprene forms
1) Buna - S rubber 2) Butyl rubber
3) Neoprene rubber 4) Bakelite

03. The polymer of chloroprene is
1) neoprene 2) Buma – S
3) Butyl rubber 4) Ebonite

04. Co-polymerisation involves addition of _____monomers
1) Same 2) Different
3) Same with plastics
4) Different witli plastics

05. Which of the following is an odd compound
1) Buna - S 2) G R -1 3) Bakelite 4) G R - S

06. The polymer prepared by co-polymerisation is
1) P V C 2) Teflon
3) Neoprene 4) Buna - S

07. All plastics are
1) Fuels 2) Polymers
3) Condensers 4) Conductors

08. Find odd polymer
1) Buna – S 2) G R -1
3) Urea-formaldehyde 4) G R – S

09. Natural rubber is a polymer of
1) Neoprene 2) Butadiene
3) Isoprene 4) Chloroprene

10. In vulcanisation of rubber, the element used is
1) Sulphur 2) Sodium 3) Magnesium 4) Zinc

11. Elastomers are .
1) Valcanilis 2) Synthetic rubber
3) Thermoplastics 4) Thermosetting plastics

12. The monomer of PVC is
1) $H_2C = CH_2$ 2) $H_2C = CHCN$
3) $H_2C = CHCl$ 4) $F_2C = CF_2$

13. Formula of styrene is
1) $H_2C = CH_2$ 2) $H_2C = CHCl$
3) $H_2C = CHC_6H_5$ 4) $H_2C = CHCN$

14. Neoprene is a polymer of
1) Isoprene 2) Chloroprene
3) Propylene 4) Vinyl chloride

15. The monomer in teflon is
1) Tetrachloroethylene 2) Ethylene chloride
3) Tetrachloroethylene 4) Vinylchloride

16. PVC is a/an
1) Addition polymer 2) Used in making pipes
3) Vinylchloside is the monomer
4) All the above

17. NOVOLAC is an intermediate in the formation of
1) Bakelite 2) Buna – s
3) Neoprene 4) Butylrubber

18. Bakelie is produced from
1) Phenol + formaldehyde 2) Phenol + acetaldehyde
3) Urea + formaldehyde 4) Urea + acetaldehyde

19. Plastics are
1) biodegradable 2) non-biodegradaboe
3) conductors 4) elastomers

20. Buna - S rubber is prepared by
1) condensation polymerization 2) combustion
3) co-polymerisation
4) addition polymerisation

21. Basic material of natural rubber is
1) latex 2) isoprene 3) butane 4) urea

22. Commerical name of H_2NCONH_2 is
1) ketone ammonia 2) ammonia ketone
3) urea 4) diaminoketone

23. Polystyrene is prepared by
1) condensation polymerization 2) addition
3) Polyethene 4) Tetraethylene

24. Teflon is
1) Tetrabromoethylene
2) Tetraflouroethylene
3) Tetrachloroethylene
4) Tetraiodo ethylene

25. Ethylene on polymerisation gives
1) Polypropylene 2) Polybutene
3) Polyethene 4) Tetraethylene

26. The simple molecules in the formation of polymers are called
1) Macromolecules 2) Micro-molecules
3) Monomer 4) Elastomers

27. Which of the following is added to rubber during vulcanisation
1) Silicon 2) Carbon
3) Sulphur 4) Posphorous

28. Synthetic rubber is called as
1) elastomer 2) natural rubber
3) vulcanised rubber 4) gutta-percha

29. The nature of bond present between monomers in polymer is
1) Ionic bond 2) Metallic bond
3) Covalent bond 4) Hydrogen bond

30. The type of polymerisation which involves different types of monomers is called as
1) Addition polymerization
2) Condensation polymeriation
3) Co-polymerisation
4) Homopolymerisation

31. Which of the following is monomer in natural rubber
1) Isoprene 2) Chloroprene
3) Neoprene 4) Vinylchloride

32. Which of the following is condensation polymer
1) Polythene 2) Bkelite
3) Teflon 4) Polystyrene

33. Which of the following is monomer in Bakelite
1) Formaldehyde 2) Ethylene
3) Urea 4) Acetylene

34. Rubber exhibits property
1) Plasticity 2) Elasticity
3) Britteeness 4) All the above

35. The monomer of PVC is
1) $H_2C = CH_2$ 2) $H_2C = CHCN$
3) $H_2C = CHCl$ 4) $F_2C = CF_2$

36. The polymerisation in which many molecules react with the elimination of small molecules is
1) addition 2) condensation
3) co-polymerisation 4) homopolymerisation

37. Phenol and formaldehyde on polymerisation form a plastic known as
1) P V C 2) Polyvinylcyanide
3) Urea formaldeyde 4) Bakelite

38. The plastic used in the manufacture of electrical articles is
1) P V C 2) Polythene
3) Bakelite 4) Polystyrene

39. Teflon is used in the manufacture of
1) Packing covers 2) Tyres
3) Buttons 4) Gaskets

40. The coagulation of latex forms
1) Coaguium 2) Plastomer
3) Thermoplastics 4) Neoprene

PRACTICE SET - II KEY

01) 4	02) 2	03) 1	04) 2	05) 3
06) 4	07) 2	08) 3	09) 3	10) 1
11) 2	12) 3	13) 3	14) 2	15) 1
16) 4	17) 1	18) 1	19) 2	20) 3
21) 1	22) 3	23) 2	24) 2	25) 3
26) 3	27) 3	28) 1	29) 3	30) 3
31) 1	32) 2	33) 1	34) 2	35) 3
36) 2	37) 4	38) 3	39) 4	40) 1

SELF TEST

01. Buna - S is a polymer of
1) Butadine 2) Butadine and styrene
3) Styrene
4) Butadiene and chloroprene

02. The widely used plastic PVC is a polymer of
1) $CH_2 = CH_2$ 2) $CH_2 = CCl_2$
3) $CHCl = CHCl$ 4) $CH_2 = CHCl$

03. Which of the following is a thermosetting plastic ?
1) PVC 2) Perpex 3) Bakelite 4) Nylon

04. Bakelite is obtained from formaldehyde and
1) Cresol 2) Phenol
3) Alcohol 4) Butanol

05. Thermosetting plastics are obtained by
1) Isomerisation 2) Simple polymerisation
3) Polycondensation 4) Reforming

06. Bakelite is obtained from
1) Phenol and formaldehyde
2) Phenol and ethylene 3) Phenol and acetaldehyde
4) Phenol and urea

07. Adipic acid and hexamethylene diamine undergo polycondensation to yield
1) Perspex 2) Polyethylene
3) Polyvinyl chlorided 4) Nylon

08. Polyvinyl is obtained by
1) Addition polymerisation 2) Co-polymerisation
3) Condensation polymeriation 4) None

09. Raw rubber on vulcanization becomes
1) Plastic 2) Tacky 3) Soft 4) less elastic

10. Natural polymer among the following is
1) PVC 2) PVA 3) Cellulose 4) Polyster

11. Polystyrene is a
1) Thermoplastic 2) Thermosetting plastic
3) Side chain plastic 4) Crystalline polymer

12. The repeating unit in natural rubber is
1) Ethylene 2) 1, 3- Butadiene
3) Isoprene 4) Propylene

13. Teflon is obtained by the polymerization of
1) Vinyl chloride 2) Tetrachloro ethylene
3) Tetrafluro ethylene 4) None

14. Te major difference between addition and condensation polymers is in their
1) Thermal properties 2) Mechanical properties
3) Electrical properties 4) Optical properties

15. A Co-polymer of butadiene and styrene is could
1) GR-S rubber 2) Nitrite - rubber
3) Teflon 4) Silicon

16. Which of the following is not an addition polymer
1) P.V.C 2) Bakelite 3) Polythene 4) Polystyrene

17. Buna-S is obtained from
1) butadiene + styrene
2) adipic acid + hexadiamine
3) urea + formaldehyde 4) chloroprene

18. A thermoplastic is formed by the process of
1) Chlorination
2) condensation polymerization 3) Nitration
4) Chain polymerization

19. Which of the following is true with respect to thermo setting resins ?
1) Soluble in organic solvents 2) Re shaped
3) soft and flexible 4) Hard and brittle

20. "Polyvinyl chloride" is prepared by
1) heating water emulsion of vinyl chloride in presence of benzoyl peroxide
2) heating water emulsion of vinyl chloride in presence of hydrogen peroxide
3) both 1 and 2
4) heating water emulsion of vinyl chloride in presence of ethyl alchol.

SELF TEST KEY

1) 2	2) 4	3) 3	4) 2	5) 3
6) 1	7) 4	8) 1	9) 4	10) 3
11) 1	12) 3	13) 3	14) 1	15) 1
16) 2	17) 1	18) 4	19) 4	20) 3

PREVIOUS ECET BITS

2007

01. The structure of vinyl chloride is :
1) $CH_2 = CHCl$ 2) $CH_3 - CH_2Cl$
3) $CH_2Cl - CH_2Cl$ 4) $CH_2 = CH - CH_2Cl$

02. The substance used for Vulcanisation of natural raw rubber is :
1) ebonite 2) elemental sulphur
3) phenol 4) selenium dioxide

03. Which of the following monomers is used in the copolymerisation reaction leading to the formation of Buna-S ?
1) 1-Butene 2) Chloroprene
3) Styrene 4) Acrylonitrile

04. Which of the following compounds cannot be used as a monomer to bring about polymerisation reactions?
1) Tetrafluoroethylene 2) Phenol
3) Butadiene 4) Formic acid

05. The structure of isoprene (C_5H_8), the building block for natural rubber is :
1) $CH_2 = C(CH_3) - CH = CH_2$
2) $CH_2 = CH - CH = CH(CH_3)$
3) $CH_3 - C \equiv C - CH_2 - CH_3$
4) $H_2C = C = CH - CH_2 - CH_3$

06. If the degree of polymerisation is 500, then the molecular weight of a sample of polythene is :
1) 500 2) 10,000 3) 28,000 (4) 14,000

07. Which one of the following is a thermoplastic polymer ?
1) Bakelite 2) Polythene
3) Natural Rubber
4) Urea-formaldehyde resins

2009

08. GR-S is the alternative name for
1) Butyl rubber 2) Neoprene rubber
3) Buna-S rubber 4) Urea-formaldehyde resin

09. Which of the following cannot be used as monomer to bring about addition polymerization ?
1) Ethyl chloride 2) Butadiene
3) Propylene 4) 2-Butene

10. Free-radical Polymerization can be initiated by using
1) benzoic acid 2) dibenzoyl peroxide
3) Nitroethane 4) benzophenone

2010

11. Natural rubber is a polymer of
1) Isoprene 2) Propylene
3) Propane 4) Ethylene

12. Which of the following is synthetic polymer
1) Cellulose 2) Bakelite
3) Protein 4) Vinyl chloride

13. The monomer of PVC polymer is
1) Ethylene 2) Styrene
3) Propylene 4) Vinyl chloride

14. The elastomers are the following polymers
1) Natural rubbers 2) Synthetic resins
3) Thermo plastics 4) Thermosets

2011

15. Ion exchange resigns are made of
1) Lucite 2) Sulphonated bakelite
3) Polystyrene 4) Teflon

16. Diphenylamine is added to rubber to
1) Valcanise it
2) Protect it from deterioration on exposure to air
3) Make it non-inflammable
4) Make it thermosetting.

17. Which of the following rubbers has the widest application
1) butyl rubber 2) nitrile rubber
3) polythene 4) silicone rubber

18. Which of the following additives are added to plastics to make it in previous to X-rays.
1) Asbestos 2) Barium salt
3) Carborundum 4) Phthalic acid

2012

19. Which of the following is a thermoset polymer ?
1) Polystyrene 2) PVC
3) Polythene 4) Urea-formaldehyde resin

20. Chemically, neoprene is
1) polyvinyl benzene 2) polyacetylene
3) polychloroprene 4) poly-1,3-butadiene

21. Vulcanization involves heating of raw rubber with
1) selenium element
2) elemental sulphur
3) a mixture of Se and elemental sulhpur
4) a mixture of selenium and sulphu

2013

22. Formaldehyde is manufactured by
1) Dehydrogenation of methanol over a catalyst at high temperature
2) Hydrolysis of urea followed by addition of H_2
3) Dehydrogenation of formic acid
4) Decarboxylation of acetic acid

23. Match the following and indicate the best combination :
a) Bakelite
i) Made from ethylbenzene
b) PVC
ii) Thermoset polymer
c) Natural rubber
iii) Made from 1-chloroethylene
d) Styrene
iv) Polymer of isoprene unit
1) (a + iii) (b + iv) (c + i) (d + ii)
2) (a + ii) (b + iii) (c + iv) (d + i)
3) (a + i) (b + iv) (c + iii) (d + ii)
4) (a + iv) (b + ii) (c + i) (d + iii)

24. Phenol is manufactured by
1) Heating benzene with NaOH 2) Hydrolysis of chlorobenzene with KOH
3) Oxidation of cumene to its hydropentoxide followed by hydrolysis
4) Reduction of benzoic acid with hydrogen over a catalyst

2014

25. The monomer of polyvinyl chloride is
1) Chloro ethene 2) Ethylene dichloride
3) Ethyl chloride 4) Chloroform

26. Polythene is
1) An addition polymerization product
2) A condensation polymerization product
3) Thermosetting
4) Polymer of amylopectin

27. Teflon is
1) Phenol formaldehyde
2) An inorganic polymer
3) Poly tetrafluoroethylene
4) A monomer

T.S ECET-2015

28. The synthetic polymer which resembles natural rubber is
1) neoprene 2) chloroprene
3) nylon 4) polyphenol

29. What is meant by mastfication of rubber
1) its softening
2) depression of its freezing point
3) a treatment ot retard its deteriration due to acids
4) improving its curing rate

30. What is the monomer used to make teflon
1) tetra fluoto ethane
2) tetra fluoro ethylene
3) di fluoro ethylene 4) tetra fluoro acetylene

AP-ECET-2015

31. Which one is the example of Thermo-setting polymer
1) PVC 2) Teflon 3) Bakalite 4) PE

32. What is the % of 'S' in battery case rubber
1) 25% 2) 28% 3) 32% 4) 30%

33. Co-polymerization of Butadiene and styrene is
1) buna-N 2) buna -S 3) neoprene 4) PVC

T.S ECET-2016

34. The monomer of Teflon is
1) FCIC = CCIF 2) $Cl_2C = CCl_2$
3) $F_2C = CF_2$ 4) $FClC = CF_2$

35. Which one of the following is a thermosetting polymer
1) nylon 2) terylene
3) bakelite 4) poly ethane

36. The monomers of Buna-S polymer are
1) vinyl chloride & vinylidene
2) stryene & butadiene
3) acrylonitrile & butadiene
4) isobutylene& isoprene

AP-ECET-2016

37. The type of polymerization reaction while forming polyvinylchloride from vinyl chloride is
1) addition polymerization
2) condensation polymerization
3) ionisation 4) decomposition

38. Which among the below is an example of thermosetting polymer
1) bakelite 2) polyethelene
3) teflon 4) polyvinyl chloride

39. The chemical used in vulcanization process to make rubber hard is
1) salt 2) chloride
3) sulphur 4) ethyl acetate

T.S ECET-2017

40. The monomer used in PVC preparation is
1) ethene 2) chloroethene
3) dichloroethene 4) tetrachloroethene

41. The chemical used for accelerating vulcanization is
1) ZnO 2) SiO_2
3) sulphur 4) zinc sterate

42. Which one of the following type of forces are present in Nylon
1) electrostatic forces of attraction
2) hydrogen bonding
3) three dimensional network of bonds
4) metallic bonding

AP-ECET-2017

43. What rubber was invented when Dr. Josphe C. patrick tried to made antifreeze
1) methyl rubber 2) chloroprene
3) bruna N 4) thiokol

44. The first plastic ever synthesized was called
1) bakelite 2) nylon
3) dacron 4) cellulose

45. _____ is a brand of polyester textile fiber is wrinkle resistant and strong
1) cellulose 2) dacron
3) bakelite 4) nylon

T.S ECET-2018

46. Which one of the following is not an example of addition polymer?
1) polythene 2) terylene
3) neoprene 4) polystyrene

47. Which of the following is an example of fibre polymer?
1) rubber 2) PVC
3) bakelite 4) nylon-66

48. Which of the following can enhance the physical properties of rubber?
1) ZnO 2) Zn stearate
3) sulphur 4) SiO_2

AP-ECET-2018

49. The monomers of buna-S rubber are
1) styrene and butadiene
2) styrene and 2-propene
3) isoprene and butadiene
4) sytrene and sulphur

50. The plastics which soften when heat is applied with or without pressure, but require cooling to set them to shape are called as
1) thermosofting materials
2) thermosetting materials
3) thermoplastic materials
4) thermostatting materials

51. Which one of the following statement is not true?

1) natural rubber has the trans-configuration at every double bond

2) buna-S is a copolymer of butadiene and styrene

3) natural rubber is a 1, 4-polymer of isoprene

4) in vulcanization, the formation of sulphur bridges between different chains makes rubber harder and stonger

PREVIOUS ECET BITS KEY

01) 1	02) 2	03) 3	04) 4	05) 1
06) 4	07) 2	08) 3	09) 1	10) 2
11) 1	12) 2	13) 4	14) 1	15) 3
16) 2	17) 4	18) 2	19) 4	20) 3
21) 2	22) 1	23) 2	24) 3	25) 1
26) 1	27) 3	28) 1	29) 1	30) 2
31) 3	32) 4	33) 2	34) 3	35) 3
36) 2	37) 1	38) 1	39) 3	40) 2
41) 3	42) 2	43) 4	44) 1	45) 2
46) 2	47) 4	48) 3	49) 1	50) 3
51) 1				

ALL POWER IS WITHIN YOU
YOU CAN DO ANYTHING AND EVERYTHING

SPACE FOR IMPORTANT NOTES

FUELS

Fuel: A substance which upon combustion releases heat energy is called fuel.

- Combustion is a process of burning a substance in presence of air (oxygen).
- A fuel upon combustion, It forms combustion products along with releasing heat.
- Combustion is an exothermic reaction (heat releasing)

$$\text{Fuel} + O_2 \xrightarrow{\text{combustion}} \text{combustion products} + \text{heat}$$

- Main combustable elements of fuel are carbon and hydrogen. Sulphur and nitrogen if present as impurities also combustable.
- CO_2, H_2O (water vapour) and SO_2, NO_2 are produced as combustion products.

  Moisture, volatile matter, ash content etc can be present as impurities in a fuel depending on its occurrence and nature.
- According to the occurrence, fuels can be classified into two types :
- 1, Primary (natural fuels) 2. Secondary fuels (derived fuels)
- The fuels which are existing in the nature as they are called primary fuels. / Ex : wood, coal, dung, crude oil (petroleum oil) natural gas etc.
- The fuels which are derived from primary fuels are called secondary fuels. Ex : coke, charcoal, tar kerosene, diesel, petrol, coal gas, bio gas etc.
- According to the physical state, fuels are three types :
- Solid, liquid and gases fuels. Ex : Primary solid fuels : wood, coal, peat, lignite, anthralite & Bituminous coals, dung etc.
- Primary liquid fuel is crude oil (petroleum oil)
- Primary gaseous fuel is natural gas.
- Secondary solid fuels are coke, charcoal, briquette.
- Secondary liquid fuels are kerosene, diesel, petrol, fuel oil and tar.
- Secondary gases fuels are coal gas, water gas, oil gas, biogas, producer gas, blast furnace gas, coke oven gas. L.P.G (liquified petroleum gas).
- The fuels which are stored and available in the earth crust are called fossil fuel. (conventional energy sources)

⇨ Conventional energy sources are non-renewable. Ex : coal, wood, petroleum fuels

⇨ Non conventional energy sources are renewable in nature. Eg : Solar energy. Wind, Geothermal, Hydel and tidal energy.

⇨ Charcoal in produced from the partial combustion of wood.

⇨ Nuclear energy sources are also non-renewable in nature.

Characteristics of a good fuel:

- ♦ It should have high calorific value.
- ♦ Moderate ignition temperature.
- ♦ Low moisture content.
- ♦ Low non-combustable matter
- ♦ Moderate velocity of combustion.
- ♦ Products of combustion should not be harmful.
- ♦ Low cost.
- ♦ Easy to transport.
- ♦ Combustion should be easily controlable.
- ♦ Should not undergo spontaneous combustion.
- ♦ Low storage cost.
- ♦ Should burn In air efficiently without much smoke.
- ♦ High carbon and hydrogen percentage.

SOLIDS	LIQUIDS	GASES
1. Easily available and cheap	Costly	Costlier (except natural gas)
2. Transport, storage and handling is easy with no risk of explosion	Transport, storage and handling will be difficult with some danger of explosion	Special measures must be taken for transport, storage and high danger of explosion
3. Least danger of fire hazards	Some danger of fire hazard	Highest danger of fire
4. Slow combustion process but controlling is not easy.	Combustion process is moderate and controlling is easy.	Fast combustion and controlling is easy.
5. More handling charges, i.e., labour is required for storage and supply.	Less handling charges	Less handling charges

6. Gives more ash and smoke upon combustion	No ash is produced but some liquid fuels (aromatic) will give smoke	Neither ash nor smoke is produced
7. This can't be used in internal combustion engines.	Can be used	Can be used
8. Calorific value Is less	High	Highest
9. Least calorific intensity or syrometric effect	High	Highest

Calorific Value : The amount of heat released when unit mass of fuel is burnt completely in presence of oxygen is called calorific value.

- The amount of heat released when unit mass of fuel is completely combusted and the products of combustion are cooled to room temperature, it is called higher calorific value or gross calorific value.
- When unit mass of fuel is completely combusted and products of combustion are allowed to escape into atmosphere, then the released heat is called lower calorific value or net calorific value.
- When the products of combustion are cooled to room temperature then the latent heat of combustion products will be released. (i.e. latent heat of steam)

Units for heat:

- Calories, kilo calories, centigrade heat unit and British thermal unit.
- Calorie : The amount of heat required to raise the temperature of 1 gm of water by 1 °C is called calorie.
- Kilocalorie : The amount of heat required to raise the temperature of 1 kg of water by 1 °C is called K.cal.
- Centigrade heat unit : The amount of heat required to raise the temperature of 1 pound of water by 1^0C is called centigrade heat unit (usually from 15^0C to 16^0C)
- **British thermal unit :** The amount of heat required to raise the temperature of 1 pound (lb) of water by 1F heat is called British thermal unit. (B. Th. U)

1 K. Cal = 1000 cal = 3.968 B. Th. U = 2.2 CHU

Units for calorific value :

$$1 \text{ K.cal}/\text{kg} = 1.8 \times \text{B. Th. U}/\text{lb}$$

$1\ K.cal/m^2 = 0.1077 \times B.Th.U/ft^3$

$1\ B.Th.U/ft^3 = 9.3\ K.cal/m^3$

Solid Fuels : Coal, coke, wood are solid fuels.

Wood : Freshly cut wood may contain 25% to 50% of moisture. Air dried wood may contain around 15% of moisture.

Average percentage of carbon in wood is 55%, and calorific value of wood may be 3500 to 4500 Kcal/kg. It is used mainly as a domestic fuel.

It burns with more smoke and leaves much ash.

Coal: Coal consists of carbon, hydrogen, nitrogen, oxygen, sulphur with some non combustable inorganic matter.

- Coal is formed in the earth crust with the decomposition of vegetable matter especially wood.
- To explain the formation of coal, two theories have been proposed.

  i) insitue theory 11) Drift (transportation) theory.
- According to insitue theory coal formation took place at the place of vegetation.
- According to drift theory the trees were transported from one place to other place covered with soil and transformed into coal with the decomposition under high temperature and pressure in the absence of O_2 and presence of anaerobic bacteria (anaerobic decomposition)
- During the decomposition, gases like CO_2, methane may be released.

Classification Coal: The process of transformation of wood into coal is called coalification.

- As the coalification process increases, moisture content decreases, hydrogen, oxygen, nitrogen, sulphur contents will decrease, volatile matter decreases and carbon content, calorific value and hardness will be increased.
- According to the extent of caloirification coal can be classified into peat, lignite, bituminus coals and anthracite coal.
- Peat is the lowest rank coal and anthracite is highest rank coal.
- Peat is a brown fibrous jelly like coal and it is produced in the first stage of coalification of wood.
- Average composition of peat is C-57%, H_2 = 6%, O_2 = 35%, ash - 2.5 - 6%.
- Calorific value is 5400 Kcal/kg.

➪ Available in Nilgiri Hills.

Lignite : It is called brown coal.

➪ Average composition is C - 60-70%, O - 20% remaining is H_2 and other compounds.

➪ The calorific value is 6500 to 7100 Kcal/kg available in Assam, Kashmir, Rajasthan (at Palana) and Madras.

➪ Lignite may be generally used for steam raising, house hold fuel, and for the manufacture of producer gas.

Bituminus : Bituminous coals are called common coals.

➪ These are having laminated structure i.e., layered structure.

➪ Bituminous coals can be again classified into Sub Bituminous, Bituminous and Semi Bituminous coals.

➪ Sub-Bituminous coals will have carbon % of 75 to 80 and calorific value is 7000 Kcal/Kg to 7500 Kcal/Kg.

➪ Bituminous coal will have carbon percentage 78 to 90 and calorific value is 8000 to 8500 Kcal/Kg.

➪ Semi Bituminous coal will have carbon % from 90-95 with calorific value 8500 to 8600 Kcal/Kg.

➪ Bituminous coals will be used to produce coke, coal gas and steam raising.

➪ Bituminous coals are present in Bihar, Bengal, Madhya Pradesh and Orissa.

Anthracite coal: Anthracite coal is highest rank coal with carbon 92% - 98%

➪ These are hardest coals with lustrous appearance.

➪ Calorific value is 8650 to 8700 K. cal/kg.

➪ These are available in Kashmir and Eastern Himalayas,

Selection of Coal:

- ♦ High calorific value,
- ♦ Least moisture content.
- ♦ Low ash content.
- ♦ Fusion temperature of ash must be high.
- ♦ Calorific intensity must be maximum.

➪ The maximum temperature reached when the coal is completely burnt is called calorific intensity.

➪ Calorific intensity depends on quality, nature and specific heat of combustion products.

- It must be uniform in size.
- Less Sulphur, Nitrogen, Phosphorous contents.
- Coking quality coal is required.
- When coal is heated in the absence of air, it becomes soft plastic like fusible mass which are called coking coals. If that mass becomes hard, porous then it is called coking coals.
- Coke is hard, porous with high percentage of carbon having highest calorific value and which is used for metallurgical purpose.
- Process of heating In the absence of air is called distructive distillation. In this process coal is converted into coke, which is also called carbonisation process.
- Upon distructive distillation, coal will not become a fusible mass, then it is called free burning coal or non-coking coal.
- Percentage of moisture, ash content, volatile matter and fixed carbon can be determined with a process called proximate analysis.
- Percentage of carbon, hydrogen, sulphur, nitrogen can be determined with a process called ultimate analysis.
- In a good quality coal carbon, hydrogen and fixed carbon percentage must be more and remaining all other constituents (compounds) must be less.
- If moisture content will increase the weight of coal will be increased and decreases calorific value.
- Ash content increases weight of coal, gives more pollution, destroys furnace walls and interacts with metallurigcal process. Volatile matter decreases the calorific intensity.
- Sulphur and nitrogen gives corrosion of metals and pollution.
- Powdered coal is called as pulverised coal.
- Pulverised coal will give uniform combustion process. It requires less air, for combustion volatile matter will be expelled and easy controlability of combustion.
- Carbonisation process can be carried out at low temperature or high temperature.
- Coke produced from low temperature carbonisation (500-700°C) will have less carbon percentage and it is mechanically not strong, useful for domestic purpose.
- In high temperature carbonisation less coke is produced but (900-1200°C) it will have more carbon percentage and very strong and useful for metallurgical process.

- Carbonisation can be carried out using Behive's oven or Ottohoffman's byproduct oven.
- When the coal is subjected to carbonisation process it gives byproducts, coke oven gas which contains Ammonia, H_2S, Naphthalein, Benzene, Tar, Moisture, Xylene, Toulene, anthracine

Liquid Fuels:

- Petroleum oil (crude oil) is a dark greenish brown viscous oil found deep in the earth crust.
- Petroleum oil contains various hydrocarbons like Paraffins (Alkanes), Cyclo Paraffins, Naphthaleins, Olifines (Alkenes), Armoatic compounds (like benzene) etc.
- Petroleum oil exists upon a layer of brine solution ($NaCl$).
- Over the petroleum oil a layer of natural gas exists.
- Average composition of crude oil is carbon 79.5 to 87.1% hydrogen 11.5 to 14.8%, Sulphur 0.1 to 3.5%, Nitrogen + Oxygen 0.1 to 0.5%.
- In the earth crust petroelum oil was formed with the decomposition of animals, vegetable matter etc, by the Anaerobic bacterial decompo'sition under high pressure.

Classification of Petroleum Oil :

- Depending on the chemical nature of petroleum oil, it can be classified into 3 types.
- Paraffinic Base Crude : It contains mainly saturated hydro carbons from CH_4 to $C_{35}H_{72}$ with little naphthalein and aromatics. $C_{18}H_{38}$ to $C_{35}H_{72}$ are called waxes.
- Asphaltic Base Crude : It contains mainly cycloparaffins and naphthaleins with little paraffins and aromatic compounds.

Mixed Base Crude : This contains both paraffinic and asphaltic hydrocarbons and it is very rich in waxes.

- Crude oil can be separated into various fractions by fractional distillation.
- Fractional distillation can be carried out in refineries and the process is called refining of crude oil.
- **Refining of Petroleum Oil :** Refining will be carried out in refineries, it is a process of separation of components of crude oil. This process can be carried out with fractional distillation
- Before separating various fractions, water and sulphur compound must be removed from crude oil.
- Water can be removed with electrolysis process called Cottrell's Process.
- Sulphur compounds will be removed by treating with Copper Oxide (CuO) by which sulphur will be precipitated as Copper Sulphide.

⇨ Crude Oil will be heated to 400°C in which all the compounds will be vapourised.

⇨ The produced vapours will be passed into fractionating column, in which different fractions will be condensed at different temperature.

⇨ As the vapours move from bottom to top in the fractionating column, their temperature decreases.

Name of the Fraction	Temperature	Approximate Composition	Use
1. Uncondensed Gas	Below 30°C	C_1 to C_4	used as domestic and industrial fuel as L.P.G.
2. Petroleum Ether	30° - 70°	C_5 to C_7	Used as a Solvent
3. Gasoline (Motor Spirit or Petrol)	40°- 120°	C_5 to C_9	Used as a Motor Fuel and solvent in Dry Cleaning
4. Naphtha (or) Solvent Spirit	120°-180°	C_9 to C_{10}	Used as solvent in Dry cleaning
5. Kerosene	180°-250°	C_{10} to C_{16}	Used as an illuminant, jet engine fuel and for preparing lab gas
6. Diesel (or) fuel oil (or) gas oil	250° - 320°	C_{10} to C_{18}	Used as a diesel engine fuel
7. Heavy oil	320° - 400°	C_{19} to C_{30}	to get synthetic petrol by cracking

⇨ Heavy oil is consisting of lubricating oils, petroleum gelly (vaseline), Grese and paraffin wax residue of crude oil remained after heating is called asphalt (or) petroleum coke. It can be used for water proofing of roofs and road making. Petroleum coke can be used as fuel.

➪ Kerosene contains carbon 84% H-16%. Calorific value is 4000 Kcal/Kg.

	PETROL	DIESEL
1.	Costlier.	Less costly
2.	Consumption for Unit Power production is more.	Less
3.	Thermal efficiency is less	more
4.	Cumbustion requires less complex device	Requires more complex and expensive device
5.	It gives more pollution	Less air pollution

➪ Petrol which is directly separated from crude oil is called straight run petrol.

➪ Petrol can be produced with the cracking process of heavy oil.

➪ Cracking is a process of heating a substance in the absence of air in which big molecules will be broken into small molecules.

Cracking can also be called "Pyrolysis".

With the cracking process heavy hydrocarbon of heavy oil will be broken into small hydrocarbons, resembling to petrol

Cracking process can be carried out thermally or catalytically.

In thermal cracking, high temperature and high pressure is used.

If the temperature is 475° - 530°C with 100 Kg/ cm^2 - pressure, it is called Liquid Phase Thermal Cracking.

In vapour phase thermal cracking 600 - 650°C and 10-20 kg/cm^2 pressure is used.

Synthetic Petorl:

➪ Petrol can be produced synthetically with different processes (1) Polymerisation (2) Fischer - Tropsch process (3) Bergius process

➪ In polymerisation process, lower olefins (alkenes) and paraffins (alkanes) are polymerised in presence of high temperature and pressure with or without catalyst.

➪ In Fischer - Tropsch process, water gas and hydrogen mixture is passed through a catalyst in which petrol is produced.

➪ Water gas is a mixture of carbonmonoxide and hydrogen gas.

➪ Catalyst used in this process is cobalt, thoria, magnesia and Keiselguhar earh in 100 : 5 : 8 : 200 at 200 to 300°C

- In Bergious process low ash coal and heavy oil are taken as raw material and passed through a catalysts tin or nickel oleate, at 450°C & 200 to 250 atmosphere.

REFINING OF GASOLINE :

- Process of purification i.e. removal of undesirable substances is called refining.
- From petrol, sulphur compounds can be removed by alkaline (basic) sodium plumbite (Na_2PbO_2) with controlled addition of sulphur and this process of removal of sulphur compounds as disulphide is called Doctor's Process or Sweetening process.
- Undesirable olefine and colouring matter are removed by percoalting through Fuller's Earth.

REFORMING PROCESS :

- Structural modification of the components of petrol is to be carried in reforming process to improve antiknock characteristics.
- Reforming process can be carried out thermally and catalytically.
- In catalytic process, 0.75% of platinum supported on alumina is used.
- In reforming process, isomerisation and Aromatization will be carried out.
- Isomerisation - Straight chain into branched chain, Aromatization - Straight Chain (or) branched chain into cyclic chain.

KNOCKING OF ANTIKNOCKING PROPERTY :

- In the Internal combustion engines fuel and air must be mixed in an appropriate ratio.
- The ratio of the gaseous volume In the cylinder at the end of the suction stroke to the volume at the end of the compression stroke of the piston is known as compression ratio.
- Efficiency of internal combustion engine increases with increase in compression ratio.
- Compression ratio depends on the nature of the constituents present in the petrol.
- Ignition of fuel and air mixture instantaneously producing explosive sound is known as knocking
- Knocking gives loss of efficiency
- Knocking property increase in the following order, straight chain paraffins > branched chain paraffins > olefins > cyclo paraffins > aromatics.
- To increase antiknocking property. (TEL) Tetra Ethyl Lead (or) Tetraethyl Tellurium $\left[(C_2H_8)_2\ Te\right]$ can be used as anti knocking agent

- In motor spirit 0.5 ml of tetra ethyl Lead per litre will be added.
- In aviation fuel, 1 to 1.5 ml/litre will be added.
- To remove lead oxide, ethylenedibromide is added. It removes lead oxide as Lead Bromide.
- Sulphur compounds will decrease the efficiency of tetraethyllead.

OCTANE NUMBER :

- Normal heptane will have highest knocking property. Its antiknocking value is zero.
- Isoctane (2, 2, 4 trimethyl pentane) will have least knocking property, so Its antiknocking value is 100.
- Octane number indicates the quality of petrol.
- Octane number is the percentage of isooctane in a mixture of isoctane and normal heptane
- Isooctane is C_8H_{18} and heptane is C_7H_{16} which are branched and straight chain respectively
- For example, if octane number of petrol is 60, it means that petrol will behave like a mixture in which 60% of isooctane and 40% of normal heptane are present.
- Antiknocking characteristics of a diesel fuel follows in the order normal alkanes > naphthalenes > alkenes > branched alkanes > aromatics.
- A poor gasoline fuel is a good diesel fuel.
- Quality of diesel will be indicated with cetane number.
- 2 Methyl napthalene (cyclic structured) will have least antiknocking property whose cetane number is zero and normal hexa decane (straight chain hydrocarbon) will have highest antiknocking property whose cetane number is 100.
- n-Hexadecane ; $(C_{16}H_{24}) \longrightarrow$ cetane no. – 100

  2-methyl naphlthalene cetane no. is 0.
- Cetane number indicates the percentage of normal hexa decane in a mixture of 2-methyl napthalene and normal hexadecane.
- For example if cetane no. of diesel is 40, it behaves like a mixture in which 40% of normal hexadecane and 60% of 2- methyl napthalene are present.

➪ More octane number and cetone number indicate more quality petrol and Diesel respectively.

ADDITIONAL POINTS :

➪ For high speed diesel time log in getting the diesel droplets heated to ignition point is very less.

➪ They require cetane number 45 to 60.

➪ For low speed diesel, time log in getting diesel droplets heated to ignition point is high & the required cetane no. is around 25.

➪ For medium speed diesel, cetane no. is around 35.

➪ LPG is also called bottled gas (or) refinery gas.

➪ LPG is a mixture of hydrocarbons in which normal butane is present as a major component.

➪ Its calorific value is 27000 kcal/m^3

➪ In LPG, Organic Sulphides (mercaptans) are added as smelling agents.

➪ LPG is more advantageous than petrol.

➪ Benzol and power alcohol are non petroleum fuels.

➪ Benzol is a product of coal carbonization. It contains mainly benzene and it is used as a blending agent with gasoline.

➪ Calorific value of benzol is 10000 cal/kg.

➪ Power alcohol is ethyl alcohol and it is mixed with petrol.

GASEOUS FUELS :

i) **Natural Gas :** It is obtained from petroleum oil wells.

➪ It is mainly consisting of methane (75 to 90%)

➪ Calorific value is 12000 to 14000 kcal/m^3.

Uses : i) Used as domestic fuel, to produce various chemicals carbon black and hydrogen. Carbo black useful to produce printing ink.

ii) It is also used in synthesis of ammonia and proteins.

ii) **Coal Gas :** It is produced in the coal carbonization.

➪ It has major components methane (32%) and hydrogen (40%)

➪ Calorific value is 4900 kcal/m^3

➪ It is colorless with characteristic odour lighter than air-, burns with smoky flame.

Uses -.i) It is used as illuminant in cities and towns.

ii) Used as fuel in metallurgical operations.

iii) It is used to provide reducing atmosphere due to the presence of hydrogen.

Purified coal gas is stored over water in gas holders.

iii) **Producer gas :** It is a mixture of carbonmonoxide and nitrogen associated with hydrogen and carbondioxide.

➪ It is prepared by passing air and steam mixture over red hot coal or coke at 1100°C in a reactor called gas producer.

Composition: CO – 22.3% N_2 – 52 – 55% H – 8 – 12% CO_2 – 3%

Calorific value is 1300 k.cal/m^3

Uses: i) It is used for heating furnace and retorts and ii) It is used as reducing agent in metallurgical operations due to the presence of CO

iv) **Water Gas :** It is a mixture of carbon monoxide and hydrogen with little non combustable gases like carbon dioxide & nitrogen.

➪ It is produced by passing steam and air mixture through red hot coal or coke maintained at 900 - 1000°C.

➪ Hydrogen 14%, CO - 41 %, N_2 - 4% and CO_2 - 41 %

Calorific value is 2800 k cal/m^3

Uses : i) It is used as fuel gas, illuminating gas, source of hydrogen

Water gas mixed with hydrocarbons is called carborated water gas and its calorific value will be around 4500 kcal/m^3.

Bio Gas : It is produced by the decomposition of biological matter by anaerobic bacterial oxidation.

Bio gas is produced by decomposition of dung, organic waste matter and sewage etc. Gobar gas which is an example for biogas can be produced by anaerobic decomposition of cattle dung. It mainly consists of methane (55%) and CO_2 (35%) H (7.4%), N_2 (2.6%) and traces of H_2S.

➪ Its calorific value is 5300 kcal/m^3 used for cooking and Illumination purpose.

Acetylene (C_2H_2): It is-produced by the hydrolysis of calcium carbide.

$$CaC_2 + 2H_2O \longrightarrow C_2H_2 + Ca(OH)_2$$

➪ It is also produced with partial oxidation of methane or by passing carbon and hydrogen in an electric arc.

➪ It burns in air to produce oxyacetylene flame, which will have around 3000C. So it is used in welding intensity. It is also used for illuminating purpose in hawkers lamp and light houses.

➪ To produce substances like ethyl chloride, ethylalcohol, acetaldehyde and acetic acid etc.

PRACTICE SET - I

01. Which of the following fuels possesses the maximum calorific value ?

1) $C = 84\%, H = 6\%, S = 4\%$ and $O = 6\%$

2) $C = 84\%, H = 12\%, S = 1\%$ and $O = 1\%$

3) $C = 90\%, H = 5\%, S = 2\%$ and $O = 3\%$

4) $C = 94\%, H = 2\%, S = 2\%$ and $O = 2\%$

02. A good fuel should possess

1) high ignition temperature

2) moderate ignition temperature

3) high calorific value 4) both 2 and 3

03. Ignition temperature of a fuel is the

1) temperature at which the fuel can be stored safely

2) lowest temperature at which the fuel must be pre-heated so that it starts burning smoothly

3) temperature attained with the fuel is burnt

4) temperature at which the fuel ignites for a moment, but does not burn after then

04. Which of the following is not an advantage of gaseous fuels over solid and liquid fuels

1) they can easily be conveyed through pipelines to the actual place of use

2) they can be lighted at moment's notice

3) they cannot be pre-heated by the heat of hot wast gases

4) their combustion can readily be controlled

05. The maximum temperature reached, when the coal is completely burnt in the theoretical amount of air, is called

1) fusion temperature 2) calorific intensity

3) ignition temperature 4) none

06. Which of the following in coal decreases its calorific value

1) carbon 2) hydrogen 3) oxygen 4) sulphur

07. Peat is

1) soft brown coloured 2) brown jelly-like mass

3) pitch-black coal 4) last stage of coalification

08. Which of the following contain highest percentage volatile matter

1) peat 2) lignite 3) bituminous coal 4) anthracite

09. Higher calorific value of fuel assumes that it

1) contains H_2O in liquid form

2) contains H_2O in vapour form

3) contains H_2O partly in liquid and partly in vapour form

4) Ignores the presence of H_2O

10. Bomb calorimeter is used for determining the calorific value of

1) solid fuel 2) liquid fuel

3) gaseous fuel 4) both 1 and 2

11. Gas with least calorific value is

1) coal gas 2) water gas

3) producer gas 4) natural gas

12. The process of splitting bigger hydrocarbons into smaller hydrocarbon molecules is called

1) pyrolysis 2) thermal decomposition

3) cracking 4) combustion

13. Isooctane (2, 2,4- trimethyl pentane) has an octane rating of

1) 100 2) zero 3) 50 4) above 100

14. Which of the following possess zero octane number

1) Isooctane 2) Petrol 3) n-Heptane 4) LPG

15. Suitabiliy of a diesel fuel is determined by

1) octane rating 2) percentage of carbon

3) length of hydrocarbon chain

4) cetane number

16. For good performance, the hydrocarbon molecules in a diesel fuel should be

1) branch-chained 2) side-chained

3) straight-chained 4) aromatic

17. The cetane rating of hexadecane is

1) 100 2) 0 3) 50 4) none

18. Producer gas is a mixture of

1) $CO + H_2$ 2) $CH_4 + H_2$

3) $CO + N_2$ 4) $CO + CH_4$

19. Gas obtained by cracking kerosene is called

1) town gas 2) producer gas

3) natural gas 4) oil gas

20. Which of the following is a biogas

1) producer gas 2) natural gas

3) water gas 4) coal gas

21. A fuel which can lighted at a moment's notice is

1) coal 2) wood 3) oil gas 4) charcoal

22. Anthracite
1) is lowest rank coal
2) contains high percentage of carbon
3) contains highest percentage of volatile matter
4) possesses highest calorific value and highest carbon percentage

23. A good fuel should have
1) high moisture content 2) low calorific value
3) moderate ignition temperature 4) high ash content

24. Lignite is
1) lowest rank coal 2) highest rank coal
3) used in metallurgy of iron
4) contains no moisture

25. The easiest way of judging the utility of a coal sample lies in the determination of
1) carbon content 2) calorific value
3) proximate analysis 4) ultimate analysis

26. The fraction of petroleum distilling over between $40\text{-}120^0C$ is used
1) in jet engines 2) in diesel engines
3) furnace heating 4) in motor engines

27. Solid fuels can be used
1) in internal combustion engines
2) in diesel engines 3) in jet engines
4) for heating boilers

28. A good coal should have high
1) moisture content 2) ash content
3) volatile matter
4) fixed carbon content

29. Gaseous fuels
1) possess low heat content
2) cannot flow through pipes
3) can be lighted at a moment's notice
4) burn producing ash

30. The octane rating of gasoline refers to its
1) percentage of octane in the gasoline
2) perentage of saturated hydrocarbons in the gasoline
3) ability to resist engine knocking
4) percentage of unsaturated hydrocarbons in the gasoline

31. Natural gas is composed primarily of
1) methane 2) n-butane
3) n-octane 4) a mixture of octanes

32. Petroleum is formed below earth's crust by chemical changes in
1) inorganic matter 2) vegetable matter
3) animal matter 4) both 2 and 3

33. When petroleum is heated gradually, the first batch of vapour evolved will be rich in
1) kerosene 2) petroleum ether
3) diesel oil 4) lubricating oil

34. Octane number of n-heptane is
1) 0 2) 100 3) 80 4) 50

35. Catalytic cracking of heavy oil is carried out to get better quality
1) gasoline 2) kerosene oil
3) diesel oil 4) lubricating oil

36. A knocking sound is produced in the internal combustion engine, when the fuel
1) burns slowly 2) bruns fast
3) contains some water
4) is contaminated with lubricating oil

37. Gasoline (or petrol) contains the hydrocarbons containing
1) C_4 to C_{12} 2) C_1 to C_4
3) C_{15} to C_{23} 4) C_{20} and above

38. The purpose of the "cracking" is to
1) break large molecules into molecules or more convenient size
2) increase the supply of gasoline
3) increase the supply of lubricating oil
4) increase the supply of natural gas

39. Petrol is a mixture mainly of
1) alkenes 2) alkanes
3) alkynes 4) aromatic hydrocarbons

40. Domesting cooking gas consists mostly of
1) methane and ethane
2) liquefied butane and isobutane
3) ethylene and carbon monoxide
4) acetylene and hydrogen

41. For improving anti-knock property of petrol, it is mixed with
1) lead bromide 2) allyl bromide
3) tetra ethyl lead
4) tetra ethyl lead and ethyl bromide

42. "Octane number" means
1) percentage of isooctane in petroleum
2) percentage of isooctane in a mixture of n-heptane and isooctane which matches the given fuel in knocking
3) mixture of n-octane and n-heptane, which matches of n-octane and n-heptane, which matches the given fuel in combustion characteristic
4) none of these

43. The calorific value of a fuel is expressed as
1) kcal cm 2) kcal cm^{-3}
3) kcal m^{-3} 4) cal m^{-3}

44. Petrochemicals can used to prepare :
1) PVC plastics 2) polystyrene plastics
3) Terylene fibres 4) None of the above

45. In Orsat's apparatus, potassium hydroxide is used to absorb :
1) Oxygen 2) Carbon dioxide
3) carbon monoxide 4) Sulphur dioxide

46. Orsats apparatus is used to obtain :
1) Specific heats of components
2) Molecular weights of components
3) Gravimetric analysis of a gas mixture
4) Volumetric analysis of flue gases

47. Stoichiometric quantity of air is the quantity of air required for complete combustion of fuel with :
1) Some excess oxygen 2) No oxygen left unused
3) 50% excess air 4) 100% excess air.

48. Analysis of fuel gases is done by
1) Boy's gas calorimeter 2) Orsat apparatus
3) Retort 4) bomb calorimeter

49. Proximate analysis of fuel is determination of percentage of
1) C,H,N,S, H_2O
2) C, H_2O, ash and volatile matter
3) C only 4) Useful heat evolved

50. Ultimate analysis of fuel is determination of percentage of
1) C,H,N, H_2O
2) C, H_2O, ash and volatile matter
3) Sulphur only 4) Fixed carbon only

51. Incomplete combustion can be best judged by
1) Smoky chimney exit
2) Measuring air in flue gases
3) Measuring CO in flue gases
4) Measuring O_2 in flue gases

52. Which of the following is used as a jet engine fuel
1) LPG 2) Kerosene
3) Power alcohol 4) Coal

53. Alcohol has an octane number of about :
1) 50 2) 60-70 3) 90 4) 25

54. Alcohol-blended petrol possesses :
1) Better caloric value
2) Better anti-knock properties
3) Poorer anti-knock properties 4) none

55. During fermentation of molasses, the enzyme which converts glucose and fructose into alcohol is :
1) Zymase 2) Lypase 3) Invertase 4) Maltase

56. The amount of nitrogen in coal is determined by
1) Its proximate analysis
2) Burning, it completely in air 3) Ultimate analysis
4) Burning it in the absence of air

57. In the proximate analysis of the coal, the moisture is determined at a temperature of :
1) 75^0C 2) 105^0C 3) 25^0C 4) 500^0C

58. In the proximate analysis
1) Volatile matter is determined of 925^0C
2) Ash content is determined at 105^0C
3) Moisture content is determined at 500^0C
4) Fixed carbon is determined by burning coal and collecting CO_2

59. Out of the following fractions of petroleum, the fraction having lowest boiling point is :
1) kerosene oil 2) Diesel
3) Gasoline 4) heavy oil

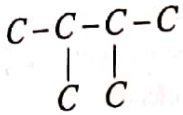
60. The usefulness of a given sample of coal is determined by
1) gas analysis 2) volumetric analysis
3) proximate analysis 4) salt analysis

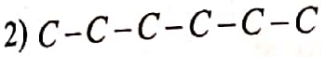
61. Fuel suitable for use in motor engines is
1) Kerosene 2) Gasoline
3) diesel 4) heavy oil

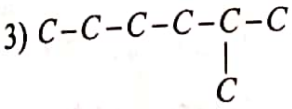
62. Laboratory gas is obtained by cracking
1) Coal 2) diesel oil 3) kerosene oil 4) petrol

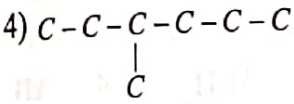
63. Importance of coal analysis summed up as follows
1) high moisture content is useful
2) high volatile matter containing coals burns without smoke
3) nitrogen has no calorific value
4) ash increases flame temperature

64. Which one of the following hydrocarbon isomers would have the highest octane rating ?

1) 

2) 

3) 

4) 

65. The unit to measure combustible value of fuel is calorie. The calorific value of coal gas is
1) 1,300 kcal m^{-3} 2) 1,900 kcal m^{-3}
3) 2,900 kcal m^{-3} 4) 4,900 kcal m^{-3}

PRACTICE SET - I KEY

01) 2	02) 4	03) 2	04) 2	05) 2
06) 3	07) 2	08) 1	09) 2	10) 4
11) 3	12) 3	13) 1	14) 3	15) 4
16) 3	17) 1	18) 3	19) 4	20) 2
21) 3	22) 4	23) 3	24) 1	25) 3
26) 4	27) 4	28) 4	29) 3	30) 3
31) 1	32) 4	33) 2	34) 1	35) 1
36) 2	37) 1	38) 1	39) 2	40) 2
41) 4	42) 2	43) 3	44) 4	45) 2
46) 4	47) 2	48) 2	49) 2	50) 1
51) 3	52) 2	53) 3	54) 2	55) 1
56) 3	57) 2	58) 1	59) 3	60) 3
61) 2	62) 3	63) 3	64) 1	65) 4

PRACTICE SET - II

01. In Fischer-Tropsch process, petrol is prepared from
1) Water gas 2) Producer gas
3) Bio gas 4) Natural gas

02. Primary liquid fuel is
1) Kerosene 2) Petrol
3) Crude oil 4) Diesel oil

03. The fuel gas used in the welding is
1) Bio gas 2) Coal gas
3) Producer gas 4) Acetylene gas

04. Secondary gaseous fuel is
1) Water gas 2) Bio gas
3) Producer gas 4) All of the above

05. Fractional distillation of creude oil gives
1) Gasoline 2) Kerosene
3) Heavy oil 4) All of the above

06. Lubricating oil, petroleum jelly etc. are produced from
1) Petrol 2) Heavy oil
3) Diesel 4) Kerosence

07. Which of th6 following is not a natural fuel
1) Petroleum 2) Kerosene
3) Coal 4) Wood

08. Which of the following is used in welding
1) Water gas 2) Producer gas
3) Acetylene 4) Bio gas

09. Bio gas is produced with the help of
1) Plants 2) Viruses 3) Bacteria 4) Insects

10. Which of the following contains highest percentage of hydrogen
1) Coal gas 2) Water gas
3) Producer gas 4) Bio gas

11. The efficiency of pertol is expressed in terms of
1) Octane number 2) Cetane number
3) Knocking number 4) Hexane number

12. The gaseous fuel produced by passing air through red hot coke is
1) Water gas 2) Producer gas
3) Coal gas 4) Bio gas

13. The fuel used in industries is
1) Water gas 2) Kerosene 3) Petrol 4) Coal

14. Producer gas is a mixture of
1) $CO + H_2$ 2) $CO + N_2$
3) $CO_2 + O_2$ 4) $NO_2 + CO$

15. Natural fuels are
1) Primary fuels 2) Secondary fuels
3) Solid fuels 4) Liquid fuels

16. Calorific value of gobar gas is
1) 2000 KJm^{-3} 2) 3000 KJm^{-3}
3) 4000 KJm^{-3} 4) 5000 KJm^{-3}

17. Which of the following has high calorifive value
1) Coal gas 2) Water gas
3) Producer gas 4) Bio gas

18. Which of the following is used as reducing agent in metallurgy
1) Coal gas 2) Water gas
3) Producer gas 4) Bio gas

19. Secondary liquid fuel is
1) Petrol 2) Bio diesel
3) Kerosene 4) All of the above

20. Which of the following is the major component in gobar gas
1) Ethane 2) Butane 3) Propane 4) Methane

21. Coal gas mainly contains
1) $CO + H_2$ 2) $CH_4 + H_2$
3) $CH_4 + CO_2$ 4) $CO_2 + N_2$

22. Natural gas is a mixture of
1) Alkanes 2) Butan 3) Alkynes 4) Methane

23. The sulphur compounds present in the crude oil are removed by using
1) Carbon 2) Nickel oxide
3) Copper oxide 4) Iron oxide

24. The gas used for cutting and welding of metals is
1) Ethylene 2) Methane
3) Pentane 4) Acetylene

25. Gasoline is an example of
1) Primary liquid 2) Secondary gas
3) Secondary liquid 4) Primary solid

26. Water present in crude oil is separated by _____process
1) Transportation 2) Cottrell's
3) Distillation 4) Cracking

27. Water gas is a mixture of
1) $NO_2 + O_2$ 2) $CO_2 + O_2$
3) $CO + N_2$ 4) $CO + H_2$

28. Formula of acetylene is
1) CH_4 2) C_2H_4 3) C_2H_2 4) C_6H_6

29. The sulphur present in petroleum is separated by passing through
1) CuS_2 2) CuO_2 3) FeO_2 4) MnS_2

30. Which substance(s) will be obtained after the fractional distillation of crude oil
1) Gasoline 2) Naphtha
3) Lubricating oil 4) All the above

31. Which of the following has more calorific value
1) Water gas 2) Coal gas
3) Producer gas 4) Semi water gas

32. The best fuel among the following is
1) Solid 2) Liquid 3) Gaseous 4) Semisolid

33. Calorific value of producer gas is low because of
1) High % of N_2 2) Low % of CO
3) High % of C O 4) Low % of N_2

34. Gobar gas contains
1) CH_4 2) CO_2 3) H_2 4) All the above

35. The calorific value of water gas is about
1) 900 kcal / m^3 2) 2700 kcal / m^3
3) 1200 kcal / m^3 4) 4500 kcal / m^3

36. In the preparation of synthetic petrol by Bergius process, the catalyst used Is
1) Ferric oxide 2) Nickel oxide
3) Nickel oleate 4) Chromium oxide

37. Gaseous fuels are better than solid and liquid fuels because
1) Their calorific value is high
2) They leave no solid residue
3) They can be easily handled 4) All of the above

38. Fuel gas with least calorific value is
1) Coal gas 2) Water gas
3) Producer gas 4) Natural gas

39. A fuel gas which is used as a source of hydrogen is
1) Producer gas 2) Water gas
3) Coal gas 4) Natural gas

40. Main constituent of LPG is
1) Methane 2) Propane 3) Benizene 4) Butane

41. Gobar gas is produced by ____of gobar (dung)
1) Hydrolysis 2) Fermentation
3) Oxidation 4) Dehydration

42. The quality of best fuel is
1) Low cost 2) Negligible ash
3) High calorific value 4) Easy availability

43. In Bergius process for manufacture of synthetic petrol, the following raw material is used
1) Coal + H_2 2) Water gas + N_2
3) Producer gas + O_2 4) Coal gas + Cl_2

44. In Fischer-Tropsche process synthetic petrol is prepared from
1) Water gas 2) Producer gas
3) Biogas 4) Acetylene gas

PRACTICE SET - II KEY

01) 1	02) 3	03) 4	04) 4	05) 4
06) 2	07) 2	08) 3	09) 3	10) 2
11) 1	12) 2	13) 1	14) 2	15) 1
16) 4	17) 1	18) 3	19) 4	20) 4
21) 2	22) 4	23) 3	24) 4	25) 3
26) 2	27) 4	28) 3	29) 2	30) 4
31) 2	32) 3	33) 1	34) 4	35) 2
36) 3	37) 4	38) 3	39) 2	40) 4
41) 2	42) 3	43) 1	44) 1	

SELF TEST

01. A good fuel should possess
1) high ignition temperature
2) moderate ignition temperature
3) high calorific value 4) both 2 and 3

02. Producer gas is a mixture of
1) $CO + H_2$ 2) $CH_4 + H_2$
3) $CO + N_2$ 4) $CO + CH_4$

03. An example of primary fuel is
1) Natural gas 2) petrol
3) wood charcoal 4) coke

04. Main constituent of natural gas is
1) carbon monoxide 2) Methane
3) Hydrogen 4) Ethane

05. A fuel gas, which is also a source of hydrogen is
1) producer gas 2) water gas
3) coal gas 4) Natural gas

06. Bergius process of synthetic petrol involves mainly
1) passing water gas over heated powdered coke under pressure
2) catalytic hydrogenation of coal
3) heating coal alone under pressure
4) cracking of heavy oil

07. The process of splitting bigger hydrocarbons into smaller molecules is called
1) Pyrdysis 2) Thermal decomposition
3) Cracking 4) combustion

08. Water gas is primarily a mixture of
1) $N_2 + CO$ 2) $H_2 + CH_4$
3) $CO + H_2$ 4) $N_2 + H_2$

09. Petrol is a mixture mainly of
1) alkenes 2) alkanes
3) alkynes 4) aromatic hydrocarbons

10. Fuel suitable for use in motor engines is
1) Kerosene 2) Gasolene
3) Diesel 4) Heavy oil

11. When petroleum is heated gradually, the first batch of vapour eoolved will be rich in
1) Kerosene 2) Petroleum ether
3) Diesel oil 4) Lubricating oil

12. The Octane rating of gasoline refers to its
1) percentage of Octane is the gasoline
2) percentage of saturated hydrocarbons in the gasoline
3) ability of resist engine knocking
4) percentage of unsaturated hydrocarbons is the gasoline

13. Which of the following is bio-gas
1) Producer gas 2) Natural gas
3) Water gas 4) Coal gas

14. Cracking is
1) Come what similar to polymerization
2) Conversion of long-chain hydrocarbons to shortest ones
3) The production of unsaturated molecules from saturated one
4) Distillation of crude oil to obtain kerosene

15. Which of the following gas is produced by the anaerobic Fermentation of cattle dung
1) Producer gas 2) Bio gas
3) Water gas 4) Coal gas

16. Petroleum is
1) Pitch-black coal
2) dark greenish – brown coloured oil
3) Soft brown coloured oil
4) a by product of coal

17. Petrochemical can be used to prepare
1) pre plastics 2) polystyrene plastics
3) Terylene fibres 4) None of these

18. Main constituent of LPG is
1) Methane 2) Propane
3) Benzene 4) butane

19. Petroleum is formed below earth's crust by chemical changes in
1) inorganic mattes 2) vegetable mattes
3) animal mattes 4) both 2 and 3

20. The chief component of petroleum is
1) Carbon 2) Hydrogen
3) Sulphur 4) Nitrogen

21. Which of the following gas is used in the sythesisation of petrol by Fischer-Tropsch method
1) producer gas 2) water gas
3) LPG 4) coal gas

22. Gas obtained by cracking kerosene is called
1) Town gas 2) Producer gas
3) Natural gas 4) oil gas

23. Fuel suitable for use in motor engines is
1) Kerosene 2) Gasolene
3) Diesel 4) Heavy oil

SELF TEST KEY

01) 4	02) 3	03) 1	04) 2	05) 2
06) 2	07) 3	08) 3	09) 2	10) 2
11) 2	12) 3	13) 2	14) 2	15) 2
16) 2	17) 4	18) 4	19) 4	20) 1
21) 2	22) 4	23) 2		

PREVIOUS ECET BITS

ECET - 2009

01. Orsat apparatus is used for the
1) determination of fuel value of petrol
2) volumetric analysis of fuel-gases
3) measurement of heat-capacities of fuels
4) estimation of calorific value of diesel fuels

02. Which one of the following is best as petrol fuel?
1) Water - gas 2) Natural - gas
3) Acetylene 4) Bio-gas

ECET - 2010

03. Which of the following coal sample contains the highest percentage of volatile matter?
1) Peat 2) Lignite
3) Bituminous 4) Anturacite

04. Bergins method of synthetic petrol preparation involves
1) Water gas passing over cake powder
2) Catalytic hydrogenation of coal
3) Heating and cooling of coal
4) Cracking of heavy oil

05. A fuel gas that is also used as source of hydrogen for reduction reaction is
1) Coal gas 2) Producer gas
3) Water gas 4) Natural gas

ECET - 2011

06. Main constituents of LPG are
1) Methane & Hydrogen
2) Propane & Butane
3) Acetylene & methane 4) CO and H_2

07. Water gas constitutes mainly of
1) CO_2 & H_2 2) CO & H_2
3) CH_4 & H_2 4) CO & N_2

08. Octane number of 2,2,4-trimethyl pentane is
1) 0 2) 100 3) 1000 4) 500

ECET - 2012

09. Petrol largely contains
1) a mixture of unsaturated hydrocarbons $C_5 - C_8$
2) a mixture of benzene, toluene and xylene
3) a mixture of saturated hydrocarbons $C_{12} - C_{14}$
4) a mixture of saturated by hydrocarbons $C_6 - C_8$

10. Which of the following gases is largely responsible for acid-rain?
1) SO_2 & NO_3 2) CO_2 & water vapour
3) CO_2 & N_2 4) N_2 & CO_2

ECET - 2013

11. Natural gas is
1) A mixture of $C_1 - C_4$ hydrocarbons
2) Made by cracking of gasoline
3) A mixture of $C_4 - C_6$ hydrocarbons
4) Made from bio-gas by compression followed by distillation

ECET - 2014

12. Water gas constitutes mainly of
1) CO and H_2 2) CO and N_2
3) CO_2 and H_2 4) CH_4 and H_2

TS- ECET - 2015

13. What are the constituents of coal gas
1) methance and carbon dioxide
2) methance and hydrogen
3) methance, hydrogen and carbonmonoxide
4) methance and butane

AP- ECET - 2015

14. Water gas is a mixture of
1) $CO + H_2$ 2) $CO + N_2$
3) $CO_2 + N_2$ 4) $CO_2 + H_2$

TS- ECET - 2016

15. Which one of the following is present in maximum amount in Natural gas
1) CH_4 2) C_2H_6
3) C_3H_8 4) C_2H_4

AP- ECET - 2016

16. Biogas is generated when an organic compound is subjected to
1) esterification
2) aerobic decomposition
3) anaerobic decomposition
4) distillation

TS- ECET - 2017

17. Which one of the chemical substance is maximum in natural gas
1) CH_4 2) C_2H_6
3) H_2 4) $CO + CO_2$

AP- ECET - 2017

18. Water gas is a mixture of
1) $H_2 + CO$ 2) $N_2 + CO$
3) $H_2 + CO_2$ 4) $H_2 + CH_4$

TS- ECET - 2018

19 The highest ranking coal is_____
1) Anthracite 2) lignite
3) bituminous 4) peat

AP- ECET - 2018

20. Which one of the following statement is not true about ideal fuel
1) high calorific value
2) high moisture content
3) low cost
4) moderate ignition temperature

PREVIOUS ECET KEY

01) 4	02) 2	03) 1	04) 2	05) 3
06) 2	07) 2	08) 2	09) 1	10) 1
11) 3	12) 1	13) 3	14) 2	15) 1
16) 3	17) 1	18) 1	19) 1	20) 2

THERE IS NO SUBSTITUTE TO HARDWORK

ENVIRONMENTAL

- The branch of chemistry which deals with the interaction of chemical substances with Air, water and soil in the environment is called environmental chemistry.
- Environment : The place surrounding us comprising of air, water, soil, plants, animals, etc., is called environment.
- Environment gives us favorable conditions to live.
- The earth summitook place on 3-14 June 1992 in "Rio - de- Janaero" in Brezil.
- The Bhopal gas tragedy took place on 3rd December 1984.
- The World Earth days celebrated on April 22nd every year.
- The World Environment Day is celebrated on June 5th every year.
- The environment comprises of the following 4 segments. They are : 1. Atmosphere. 2. Hydrosphere 3. Lithosphere 4. Biosphere
- Atmosphere : The protective thick gaseous cover of air surrounding earth is called atmosphere.
- The atmosphere extends to a height of 1600 KM but 99% of atmosphere lies below 30 KM altitude.
- The pressure of atmospheric air on human body is 7Kgs/6 sq. cm. But of course we do not feel it.
- **Atmosphere prevents**

- entry of cosmic rays from outer space on earth.
- entry of U.V and I.R radiation from sun on earth.
- Warming of earth and balances the heat
- Atmosphere is classified into Troposphere (upto 8 km), stratosphere (upto 50 km), Mesosphere (upto 80km), and Ionosphere (80 km).

- Hydrosphere is the 75% of earth's surface covered by water comprising oceans, seas, rivers etc.
- **Lithosphere :** The solid component of earth comprising soil, mountains, rocks etc.is called lithosphere.
- **Biosphere :** It is the space where living organism plants, animals etc. live in the environment comprising atmosphere, hydrosphere and lithosphere
- **Pollution :** The contamination of Air, water, soil, etc. with undesirable chemicals which spoil the natural quality of the environment is called pollution.
- The pollution is two types, natural and artificial or man made.
- **Pollutant :** The substance which causes pollution is called pollutant.

POLLUTANTS

Primary	Secondary
Emitted directly from source	Derived from primary pollutants.
Ex : SO2, Oxides of Nitrogen etc.	Ex : PAN produced from Nitrogen Oxides + Hydrocarbons

⇨ Air pollution : The excessive concentration of foreign matter in air which adversely affects the living organism and property on earth is called air pollution.

⇨ Composition of Air : The gases present in air are divided into 3 types.

AIR

Major gases	Minor gases	Trace gases
N_2, O_2	Ar, CO_2	Ne, He, CH_4, Kr, H_2, H_2O, CO, O_3, NH_3, NO_2, SO_2 etc.

⇨ The air pollution is measured in parts per million.

ppm = No. of particles 1,000,000 particles

⇨ **Major Gases :**

- The most abundant gas in atmospheric air is N_2 (78.09% by volume)
- The second most abundant gas in atmospheric is O_2 (20.94% by volume)

⇨ **Minor gases :**

- The most abundance inert gas in atmospheric is Argon (0.93% by volume)
- The abundant of CO_2 in Air is (0.03% by volume)

⇨

Gas	Abundance	Gas	Abundance
Ne	-18ppm	CO	-0.10
He	-5.2	O_3	-0.02
CH_4	-1.3	NH_3	-0.01
Kr	-1.0	NO_2	-0.001
H_2	- 0.5	SO_2	-0.0002
H_2O	-0.25		

⇨ The killer gas in Bhopal gas tragedy is Methyl isocyanate CH_3NCO

⇨ The pesticide prepared by the union Carbide by using MIC is Carbyl Carbamate.

⇨ Environment means air, water, soil and other solid materials which are presence on the earth

⇨ The solid component of the earth is called as Lithosphere.

⇨ All the water component of the earth is called hydrosphere.

- Part of the earth in which, life exists is called as Biosphere.
- Air on the earth is called as Atmosphere.
- Portions of atmosphere, hydrosphere, lithosphere in which life exists is called as Biosphere
- The upper portion of the atmosphere is called as stratosphere.
- The average percentage composition of clean and dry air near the sea level in Nitrogen 78.9%, O_2 - 20.94%, Ar - 0.95%, CO_2 - 0.0318%, Ne-0.018%.

  $He + Kr + Xe + H_2 + CH_4 + O_3 + NO_2 + N_2O + SO_2$ = rest
- **Pollutions :** Air pollution is mainly concerned with troposphere.
- Pollution is defined as the addition of any foreign materials like in organic, inorganic, biological, radio active substance (or) any physical change occur in nature which many effect the organisms directly or indirectly either immediately or after some time.
- Pollution can be cause accidentally or naturally or man made.

  Examples for Natural pollutions are valcanos eruption, floods, Tsunamies forest fires, earth quakes, pollen grains. etc.

  Examples for Accidental pollution are oil slick, gas leakage, Radiation leakage etc.
- Man made pollutants are deforestation, population growth, industriliazation, urbanisation, automobile pollution unserupulous exploitation of nature, natural phenomenon like volcanicereption, ratio activity strong winds, forest fires floods, will give pollution.
- A part from natural and man made pollution there are accidental pollutions oil.....leakage
- Pollution can be classified in to various categories

  1) Air pollution 2) Water pollution 3) Soil pollution 4) Noise pollution

CAUSES OF AIR POLLUTION	
Natural sources	**Man made sources**
1. Volcanic eruptions	Transportation services
2. Pollen grains	Rapid Industrilisation
3. Forest fires	Increase of population
4. Marsh gases	
5. Organic and inorganic decays	Deforestation

- Transportation Service : About 75% of air pollution is due to automobile exhausts.
- The incomplete combustion of motor fuels produce about 77% CO, 8% Nitrogen Oxides and 14% Hydrocarbons with lead particles.

- The oxides of Nitrogen react with uncombustible petrol and diesel and form petrochemical Smog.
- The mixture of the Smoke, and Fog is called Smog.
- Rapid industriliasaton is responsible for 20% of Air pollution.

Industry	Pollutant	Effect
Cotton Industry	Cotton dust	White lungs
Fluor Mills	Fluor	White lungs
Asbestos	Asbestos dust	Asbestosis
Glass	Silica dust	Silicosis
Petrol bunks	Petrol, Benzene	Headache.

- Increase of population : Explosion of population leads to global warming, emission of green house gases, loss of forest and wild life.
- Deforestration : plants maintain the balance of CO_2 and O_2 in atmosphere by the process of photosynthesis.
- The gas absorbed in photosynthesis is CO_2 and the gas liberated is O_2
- Deforestration cause decrease of conc. of O_2 and produce respiratory problems.
- **Air Pollutants**
- Pollen grains causes allergic diseases to individuals.
- **Aerosol** : The solid or liquid, particles of microscopic size released under pressure dispersed in gaseous media are called Aerosols.

  Eg : Dust, Smoke, Mist, Fog, Fumes of jet planes.
- **Dust** : The large solid particles dispersed in gaseous medium are called dust particles.

  - The size of dust particles of fly ash from chimneys is 3- 80 μ
  - The size of dust particles of cement industry is 10 - 150 μ
- **Smoke** : The fine particles produced by incomplete combustion for carbon or combustible materials is called smoke.

  - The size of smoke particles of coal is 0.01 to 0.2 μ
  - The size of smoke particles of oil is 0.03 to 1.0 μ
- **Mist :** The dispersion of liquid particles of large size in low concentration in air is called mist.

  - The size of mist particles in atmosphere is 40 - 50 μ
- Fog : The visible aerosis in which the dispersed phase is a liquid is called fog.

  - The size of fog particles is 1-40 μ

➪ Fumes : The solid particles generated by condensation from the gaseous state after volatilisation from melted substances are called fumes.

➪ Gases and Vapours

Type	Examples
S compounds	SO_3, SO_2, H_2S
O compounds	CO_2, CO, O_3
N compounds	NO, NO_2, NH_3
Halogens	HCl, HF etc.
Organic	Aldehydes, Hydrocarbons
Radioactive	Radioactive gases.

➪ CO forms a complex Carboxyl haemoglobin with iron of haemoglobin. Therefore the Oxygen carrying capacity of blood decreased.

➪ Aldehydes are produced by the consumption of gasoline, diesel oil and natural gas.

S.l.No	Air Pollutant	Source	Effect on Man
1.	SO_2	Combustion of coal and Petroleum Products, H_2SO_4 plants, paper mills	Death by respiratory disorders
2.	Nitrogen Oxides	Automobile exhausts, HNO_3 plants	Lung diseases
3.	H_2S	Refineries, Chemical Industries	Nausia, Irritation of eyes, Fatigue
4.	CO Petrol products	Incomplete combustion of Coal, capacity of blood.	Heart attack, reduce CO_2 carrying
5.	HCN	Blast furnace, fumigation, metal	Dry throat, of vision, headache poisoning
6.	HF	Fluorine or fluoride plants Bone,	Tooth, respiratory diseases
7.	HCl or Cl_2	HCl plants, Chemical Industries	Respiratory diseases
8.	NH_3	Explosive Dye Making fertilizers plants	Respiratory diseases
9.	$COCl_2$	Chemical and Dye making pulmonary Edema	Caugh irritation and fatal
10.	Aldehydes	Oil, fat and glycerol Industry	Nasal and respiratory disorders
11.	Ozone	Atmosphere, Transformers	Respiratory disorders
12.	Dust	Industries & Moto Vehicles	Silicosis Respiratory trances.

- Formaldehyde causes irritation in eyes.
- The London smog killed 5000 people in 1952
- The London smog or sulphurous smog is a mixture of smoke, fog and SO_2 formed from burning of coal
- The sulphurous smog kills people due to bronchial irritation.
- The components of photochemical smog are unsaturated Hydrocarbons, Nitrogens Oxides and sulphur compounds.
- The effect of photochemical smog (or) Los Angeles smog is loss of vision, eye irritation and plant damage.
- **Formation of Photochemical smog**

From Industries :

$S + O_2 \rightarrow SO_2$

$2SO_2 + O_2 \rightarrow 2SO_3$

$SO_2 + H_2O \rightarrow H_2SO_3$

$SO_2 + H_2O \rightarrow H_2SO_4$

From Motor Vehicles :

$N_2 + O_2 \rightarrow 2NO$

$2NO + O_2 \rightarrow 2NO_2 + \text{Unsaturated Hydrocarbon}$

$$NO_2 + \text{Unsaturated Hydrocarbon} \xrightarrow[\text{from SUN}]{\text{UVLight}} \underset{\text{Peroxyacetyl Nitrate}}{\text{PAN}} + \text{Ozone}$$

- The PAN is responsible for the pollution of photo chemical smog.
- Green House Effect : The increase of atmospheric temperature due to accumulation of green house gases is called green house effect.
- The important green house gases are CO_2, CH_4, N_2O and chlorofluorocarbons etc.
- The green house gases prevent the escape of heat into upper atmosphere.
- The Ozone layer is surrounding earth protects the entry of UV radiation from sun.
- The Ozone layer is destroyed by chlorofluro Carbons.
- Important Chloro fluoro carbon are :

a) Difluorochloro methane CF_2Cl_2 (Freon) b) Flurotrichloro methane CFCl3

➪ The chloro fluoro carbons are used in Airconditioning and refrigeration industry.

Reactions :

$CF_2Cl_2 \xrightarrow{hv} CF_2Cl\bullet + Cl\bullet$ [free radical]

$O_3 \xrightarrow{hv} O_2 + O$; $O_3 + Cl \rightarrow ClO + O_2$

$\therefore$ Ozone is converted to Oxygen

➪ Effect of Air pollution on Animals is a two step process. Air pollutants accumulate in vegetation. The spreading of disease from Vegetation to Animals.

➪

Air Pollutant	Effect of Animals
F	Lameness, Loss of weight Diarrheae
As	Poison
Pb	Loss of apetite, paralysis and diarrhoea

➪ **Effect of Air pollution on plants**

Air Pollutant	Effect on plants
SO_2	Intervenial chlorotic bleaching of leaves.
O_3	Collapse of leaf, necrosis and bleaching
Fluorides	Necrosis of leaf tip
NO_2	Suppress growth leaf bleaching
HCl / Cl_2	Damage to vegetation

➪ **Control of Air Pollution :**

- Use of Non polluting energy sources
- Use of energy sources which cause less pollution.
- Control of air pollutants to safer limits.
- Cleaning of exhaust gases after combustion in Automobiles by using catalysts.

➪ **Smoke in internal combustion energies is reduced by**

- correct method of firing
- adding correct amount of air.
- maintaining high temperature.
- feeding fuel continuously

➪ Smoke is a colloidal solution of negatively charged carbon particles in air.

⇨ Smoke is controlled by cottrell electrostatic precipitator by using +30,000 volts. Therefore the smoke particles are settled at the bottom.

⇨ Zoning of residential and industrial places reduce air pollution.

⇨ **Air Pollution**

⇨ Discharge of undesirable foreign substances in to the atmosphere air effecting the quality of air adversely causing damage to life is called as air pollution.

⇨ The air pollutants are gases like CO, CO_2, Oxides of N_2, F_2, Cl_2, NH_3, Chemical compounds such as PH_3, ASH_3, HF detergents, phenol, benzene, acidic fumes toxic.....such as Cd, Hg, Pb, Fe, Zn etc.

⇨ Air pollution can also be caused by herbicide pesticides, fungicides, fertilizer reactions substances such as Ar-40, Co-60, I-131, Si-127.

⇨ Air pollution can be caused by dust, micro organisms etc. The pollutants are classified into two types

i) Primary pollutants ii) Secondary pollutants.

- Substances which are released directly from the sources are called as Primary Pollutants.

Ex : SO_2, NO, NO_2 etc.

- Substances which are produced in the reaction between primary pollutants are called as secondary pollutants.

Ex : Peroxy Acetyl Nitrate (PAN), SO_3, O_3 etc.

- The pollutants are again 2 types

a) Biodegradable b) Non biodegradable

- Pollutants which can be decomposed by natural process with micro organisms are called as biodegradable.

Ex : Domestic sewage

- Pollutants which are non decomposed by micro organisms are called non biodegradable.

Ex. Phenolic compounds, metals like aluminium, iron mercury and ethylene etc.

Gases pollutants in air : Various gases which may given air pollutants are SO_2, NO_2, N_2O, NO, CO_2, H_2S, HCN, O_3, Br, HF. Organic gases like C_2H_6, C_3H_8, C_2H_2, CH_4, C_6H_6 farmaldehyde etc can give air pollution.

SO_2 : Sulphur dioxide is released from thermal power plants in which sulphur containing coal and fuels are burnt. It can be released from petroleum industry, oil refineries, sulphuric acid plants. Sulphuric ore roasting plants.

⇨ **Bad Effects :**

- SO_2 causes cardiac and respiratory problems. It causes asthama, bronchitis, it damages agriculture it gives corrosion of metals and also eye - irritation.

⇨ **SO_3**

- It is produced by the oxidaiton of sulphur dioxide.

- SO_2, & SO_3 can react with water to form H_2SO_3 (Sulphurous acid), H_2SO_4 (Sulphuric acid) which give acidic rains, damaging marbul plants, cloth leather buildings and metals.

➪ **Oxides of nitrogen :**

➪ It is produced from combustion of fuels, coal, petrol, diesel.

➪ It can be released from explosive industries.

➪ **Bad Effects :**

➪ It gives respiratory problem, irritation of eyes, lungs problems.

➪ It sun light nitrogen oxides and hydrocarbons combined together to form smog which causes poor visibility and it cause eye irritation difficulty in breath in , Asthama, Bronchitis.

➪ Oxides of nitrogen like NO_2, $N2O_5$ etc dissolved in water to form acid range (CO_2, CO also can be observed by moisture to given acidic environment.)

➪ **CO**

➪ It is released from the partial combustion of fuels from automobiles and industries cigarettes and bedies.

➪ It is released from domestic heat appliances.

➪ Every year 290 million tons of CO is being released.

➪ It is a colourless, non corrosive but very toxic gas

➪ It cause headache, visual difficulty, paralysis, asphyxia (loss of consciousness) and even death

➪ Carbon monoxide reacts with hemoglobin of blood to form carboxy haemoglobin which decreases oxygen carrying capacity of blood. This causes headache, giddiness, decrease in visual perception, damage of casdio-vascular system and at lastly death.

➪ **CO_2**

- It is released as smoke from burning fuels, it is released by the respiration of animals and plant
- The percentage of CO_2 increases with deforestation and population growth.
- CO_2 gives respiratory disorders and suffocation
- CO_2 placed a major role in heating of atmosphere trapping of infra red radiation from the sun. This is called green house effect.
- Heating up of atmosphere is called global arming.
- Every year CO_2 is increased by 0.75 ppm and every year temperature is raising by 0.05° C.
- Ozone can also given to see extent green house effect, some other gas which can also shown green house effect are CH_4, N_2O, SO_2 and chloro, fluoro carbons.
- Green house effect can be prevented by growing more trees.

⇨ O_2

- Ozone is an allotrope of oxygen and it is produced in the upper layer of atmosphere about 20km above the earth surface.
- Ozone absorbs UV radiation from the sun.
- Ozone destroys cloths rubber goods, crops etc.
- Chloro fluoro carbons which are released from refrigeration and air condition, exhausts of supersonic.
- With the depletion of ozone layer life effected with many problems like cancer. DNA replication, that leads to even death.

⇨ HF

- It is released from phosphate fertilizer industry, aluminium industries, metallurgical industries and coal burning industries, it gives irrigation, disorders of bone, tooth and skeleton and it also gives respiratory disorder and fluorosis in cattle.

⇨ Aerosois :

- There are certain chemicals released into the atmosphere with force as moist vapour
- There are released in the upper atmosphere from jet and aeroplane emissions
- Aerosols contains chloro fluoro carbons, sulful dioxide, and nitrogen dioxide deplete ozone layer.

⇨ Photochemical oxidants :

- Difference urburnt hydro carbons react with oxides of nitrogen to a form peroxy acyl nitrates in presence of sun light (PAN) which are called as photo chemical oxidants.
- Photo chemical oxidants will cause respiratory problems, eye, nose, throat problems destroys plants, and rubber products.
- Photochemical oxidations form smog which is a mixer of smoke and fog
- Smog can be 2 types i) London smong ii) Los angle smog

  i) London smog is a mixer of coal, smoke and fog in this the fog part is mainly SO_2, SO_3 humidity

  ii) This London smog is very bad in early morning and become worst after sunrise.

  iii) This photochemical smog (Los angle smog) causes irritation of lung, nose, throat, asthama and damage of plants.

⇨ Hydro Carbons :

- Hydro carbons enter in to the atmosphere from incomplete combustion of fuels and also from oil refining.
- Saturated hydro carbons are less harmful when compared to unsaturated hydro carbons.
- Aromatic hydro carbons are more danger (Benzene and benzene related)
- Hydro carbons causes cancer, respiratory problems, effects nervous system, DNA and cell growth.

⇨ Particulars :

Dust : Sources of dust and mines, quarries, furnaces, power houses, vehicles traffic, house cleaning dust, and ceramic factories, forest fires, natural winds, earth moments, materials processing factories and engine exhausts

- Dust causes allergy and respiratory proteins and it also causes corrosion, dust consisting of silica (SO_2) causes a disease called silicosis.
- If the particle size is from 0.1 - 0.25 microns it is called dust.
- Smoke : Smoke contains carbon particle ash, and oil droplets etc. These are released from incomplete combustion of fuels.
- Smoke will be released into atmosphere from rails, road, locomotion, diesel engines, domestic wood and industrial power plants.

⇨ Bad Effects :

- Smoke spoils cloths, buildings, loss of fuel value and increasing smoke may cause cancer.
- Smoke can also from smog

⇨ Asbestos :

- These are fibres silicate miners and used for strength, resistant to heat, thermal insulation.
- Asbestos particles will cause a diseases asbestosis, This is a lungs disease it digestive track and also causes cancer.

⇨ Lead :

- It is toxic to human metabolism.
- It enters into the air as Pb^{2+} or tetra ethyl lead.
- Tetra ethyl lead is more poisonous than Pb^{2+}
- Lead should no exceed 40 ppm
- Tetra ethyl lead is used in the fuel to improve antinoking property.
- Lead will be released into the air from the exhaust gases of vehicles.
- Lead causes brain damage, Animia, it effect central nervous system and kidney function.
- Road side plants are more polluted by lead.
- The two most commonly used agents to remove lead are EDTA (or) 2,3 dimercapto propanol (British anti Lewisite)

⇨ Mercury :

- Mercury is one more important pollutant.
- If mercury vapour is present in the air it is very dangerous causing irritation, and disturbance of lungs.
- Mercury in vapour sate adversely effect neurological behaviour.

⇨ **Split Mercury :**

- Is impossible to recover and evaporates in the form of vapour.
- Split mercury is to be covered with sulphur powder which prevents evaporation and converts into mercuric sulphide HgS.
- Mercuric salts are generally soluble and toxic except $HgCl_2$.
- Mercuric chloride is not very toxic and it is used in medicine as purgative and to kill intestinal worms.
- Mercuric ions will be stored in kidneys and lever.
- Mercury causes sore gums and loose teeth.
- It dangerous brain in infants leading loads to a condition called as errethism.
- The most toxic of all mercuric compounds is dimethyl mercury and methyl mercuric ion. They separate blood from brain.
- Dimethyl mercury causes a disease minimata.
- In lakes and rivers contain bacteria and micro organisms convert mercury into mercuric ions and which form dimethyl mercury.
- The building up of any poison along a food chain is called as biomagnification.
- To reduce the poisoning of mercury EDTA is useful.
- Other metallic pollutants are Cr, Be, Mn, Cd, etc.
- Pesticides like DDT, benzene bexa chlorides, endosulphons can also given air pollution.
- DDT - dychloro diphenol and trichloro ethane.
- Deforestation gives more CO_2 in air.
- Internal combustion will given more CO_2 and to some extent CO, hydro carbons, oxides of sulphur and nitrogen.
- Combustion engines will decrease O_2 concentration and increases CO_2 concentration.
- Combustion, fermentation and respiration will give more CO_2.

WATER POLLUTION

⇨ Water pollution : The contamination of water with undesirable substances to make it unfit for human, animal, aquatic animal and agricultural consumption is called water pollution.

⇨ The rain water is acidic in nature ($pH < 7$)

⇨ The distilled water is neutral in nature ($pH = 7$)

⇨ The ground water is basic in nature ($pH > 7$)

⇨ The rain water contain dissolved O_2, N_2, CO_2 in it

⇨ The diseases caused by drinking water are called water born diseases.

- Cholera is caused by vibrio cholerae bacteria
- Typhoid is caused by salmonella typhi bacteria.
- Amoebiasis is caused by the virous Hepatitis.
- Jaundice is caused by the virous Hepatitis.
- Polio is caused by poliomyetitis virus.
- The pollutant which cause water pollution are : sewage, fertilizers, pesticides and industrial wastes.
- The type of water pollutants that are not degraded by microorganism of the water. Chemical pollutants.
- The main factors that cause water pollution because of industriliazation are industrial affluents and hot water.
- The pollution due to letting of industrial hot water into water reservoirs is called. Thermal pollution.
- The type of pollution that influences the reproductivity rate in some aquatic animals is : Thermal pollution.
- According to present rules the temperature of industrial waste water letting into water reservoiers should not exceed 67° C
- The toxic metals which cause water pollution are Mercury, Lead, Arsenic, Cadmium, Copper, Barium, Zinc, Selenium, Chromium, Cobalt etc.

Name of the Metal	Toxic Effect of Metal of Man
Mercury	Abdominal pain, headache, diarrhoea, hemolysis, chest pain
Lead and	Anaemia, Vomiting, loss of appetite, Commulsions, damage of brain, liver kidney
Arsenic	Mental disturbance, liver cirrhosis, lung cancer, kidney damage
Cadmium	Diarrhoea, Growth retardation, bone deformation, kidney damage
Copper	Hypertension, Coma, Sporadic fever
Barium	Excessive salivation, Vomiting, Paralysis, Colic pass
Zinc	Vomiting, renal damage, Cramps
Silver	Liver and lung disease
Selenium Low	Damage of liver, Kidney and sleeplessness, Fever, Nervousness, Vomiting, blood pressure, Blindness and death
Chromium	Nephritis, diseases in central nervous system
Cobalt	Diarrhoea, low BP, lung irritation paralysis
Manganese	Sterility, eye disease, loss of memory]
Sodium	Kidney disease

⇨ COMMON IMPURITIES AND THEIR CAUSES AND EFFECTS

Impurity	Cause	Effect
A. INORGANIC		
1. Suspended and Colloidal Impurities	a. Clay slit	Turbidity
	b. Colloids	Turbidity, colour
	c. Colloids associated with bacteria	Disease
2. Dissolved impurities	a. Carbonates and Bicarbonates of Calcium and Magnesium	Temporary hardness
	b. Chlorides and sulphates of Calcium, Magnesium	Permanent hardness
	c. Carbonates and Bicarbonates of Sodium	Alkalinity and softness
	d. Chlorides of sodium	Brakish taste
	e. Fluorides of 1 mg/lit of sodium 1.5 mg/lit	Dental caries Mottled enamel of teeth, Fluorosis
	f. Iron oxide	Taste, colour hardness
	g. Manganese	Taste, black and brown colour
	h. Nitrates (excess over 50 mg/l) called "Blue baby" in children	Mathemoglobinaema also
	i. Lead	Lead poisoning
	j. Arsenic	Toxic
	k. Carbondioxide	Acidity, Corrosion
	l. Amonia	Taste, Odour
	m. Hydrogen sulphide	Rotten egg odour acidity
B. ORGANIC		
1. Suspended impurities and Colloidal impurities	a. Decayed leaves, Algae, Fungi	Turbidity, colour taste, Odour acidity
	b. Bacteria	Disease
2. Dissolved impurities	a. Large quantities of albuminoid Nitrogen with free Ammonia and Chlorides	Disease producing bacteria water harmful

⇨ The Beauro of Indian standards has prescribed the following standards for domestic water supply

Sl.No	Impurity	Generally
1.	Turbidity of silica scale	2.5 mg/l
2.	Colour on platinum cobalt scale	5 mg/l
3.	Taste and odour	un objectionable
4.	Temperature	10^{o} C
5.	pH value	7 to 8.5
6.	Total solids	500 mg/l
7.	Hardness as $CaCO_3$	200 mg/l
8.	Chlorides	200 mg/l
9.	Sulphates	200 mg/l
10.	Fluorides	1.0 mg/l
11.	Nitrates	45 mg/l
12.	Calcium	75 mg/l
13.	Magnesium	30 mg/l
14.	Iron	0.1 mg/l
15.	Zinc	5 mg/l
16.	Copper	0.05 mg/l
17.	Arsenic	0.05 mg/l
18.	Cadmium	0.01 mg/l
19.	Lead	0.1 mg/l
20.	Radium	3×10^{-12}
21.	Phenolic Compounds	0.001 mg/l

Water pollution :

- Any change on the physical or chemical or biological properties of water and also contamination with any foreign substances which gives health hazards decreasing the quality of water is called as water pollution.
- The sources of water pollution are domestic sewage, industrial wastes, suspended particles, pests and fertilizers (plant nutrients) radio active substances etc.
- Micro organisms presents in water will give many diseases like cholera, typhoid, dysentery, worm infection, viraland malarial diseases.
- Chemical industries like acid, alkaline acid, soaps etc. paper industries, distilleries, textiles refineries etc can given much water pollution.
- Fertilizers will given nitrates in water which can cause a disease methenaglobinamia in children.

Causes of Water Pollution

i. Faulty sewage system

ii. Industrial effluents :

iii. Unhygienic practices

iv. Agricultural wastes

v. Oil pollution

vi. Radioactive Pollution

⇨ Effects of Water Pollution :

- Spreading up waterborne diseases to human beings and animals :
- Effect on aquatic and other life
- Effect on agriculture

i) The use of polluted ground water for irrigating agricultural fields severely damage crops and decreases grain production

ii) Polluted water actually effects soil fertility by killing bacteria and soil micro organisms

iii) Contaminated ground water increases alkalinity in the soils

iv) Water pollution affects plant metabolism severely and disturbs like whole ecosystem.

- Effect on Property

⇨ Water Pollution control methods :

- Recycling of water must be carried out with a suitable treatment.
- Recycling can be done using chemicals, removal of pollutants from water can also be done using technique like a absorption ion exchange process electro dialysis reverse osmosis process etc.
- Proper drainage and treatment of drainage water for disposal.

⇨ Sewage treatment :

- Sewage is the liquid waste which contains human and house hold waste water, street washings and industrial waste which contains organic and inorganic matter in dissolved or suspended or colloidal state.
- Sewage contains both biodegradable and non biodegradable matter.
- Certain bacteria will decompose sewage matter in the presence of oxygen which are called as aerobic bacteria.
- Certain bacteria will decompose sewage matter in the absence of oxygen which are called as enaerobic bacteria.
- Aerobic decomposition will not give bad smell and it is non purifying.
- Produces of aerobic decomposition are nitrates, nitrides, phosphates etc.
- Enaerobic decomposition will give a bad smell which gives purification. In this process CH_4, H_2S, Ammonium sulphide $(NH_4)_2S$ are the products.

- The sewage which undergoes enaerobic decompositions is called as septic sewage.
- The length of aerobic decomposition can be increased by increasing the percent of free oxygen in the sewage.
- The amount of free oxygen required conditions is called biological oxygen demand (at 20°C) for a period of five days (BOD).
- Units for BOD is PPM or mg/litre.
- BOD determines the amount of organic matter decomposable in aerobic conditions.
- An average sewage has biological oxygen demand of 100 to 150 mg/lit
- Chemical oxygen demand is amount oxygen required decompose both biodegradable matter and non-biodegradable matter.
- Chemical oxygen demand determines total amount of decomposed matter in the sewage.
- In sewage treatment the harmful compounds will be converted into harmless compounds.
- Sewage treatment of sewage, removing harmful compounds and making it safe to discharge in natural water.
- Artificial sewage treatment is called as sewerage.
- Carbon of sewage is converted into CO_2, Nitrogen will be converted into NH_3 and NH_2 will be finally converted to nitrites and nitrates.

⇨ **Sewage Treatment serves the following purposes**

- To render the sewage inoeffensive as far as nuisances are concerned.
- To prevent destruction of aquatic life. e.g., fish and other wild life.
- To prevent the danger of contaminating water supplies, bathing areas etc.

The following methods are considered to be of potential importance in sewage treatment. They are

a) broad irrigation in which sewage is disposed off on land

b) sewage farming in which the water and fertilizing elements like nitrogen, phosphorus and potash are utilised for crops

c) dilution in which sewage is discharged into large bodies of water like rivers, sea etc.

⇨ **The artificial sewage treatment process called sewage involves the following steps**

- Primary treatment or Mechanical treatment
- Secondary treatment of Biological treatment
- Teritiary of Advanced Biological, chemical and physical treatment.

⇨ **Primary treatment involves :**

- Priliminary process : This process causes removal of large and coarse solids, inorganic matter-suspended or floating in the sewage. This involves in passing the sewage through bar screens and mesh screnes
- Settlement process : In this process greater portion of the suspended inorganic and organic solids are removed from the liquid sewage.

Chemical treatment is sometimes given to sewage, just before sedimentation, Chemical treatment precipitates the solids of flocculation or coagulation.

According to a report of American chemical society primary or mechanical treatment reduces about 60% of the total suspended solids, 35% BOD 30% COD (chemical oxygen demand), 20% total nitrogen and about 10% of the total phosphorus.

⇨ **Secondary of biological treatment** : After sedimentation tank treatment, the effluent is further oxidised by 'Aerobic chemical oxidation'. As a result, the carbon of the organic matter is converted into CO_2 and nitrogen is converted into NH3 and finally into nitrites and nitrates. Bases present react with nitrites and nitrates to form nitrites and nitrates of calcium, potassium and ammonium.

- Biological treatment involves particularly the tricking filters and activated sludge processes.
- The normal trickling filter removes about 90% BOD.

⇨ **Activated sludge process :** This process is based on the principle that adequate amount of oxygen or air passes through sewage containing aerobes. Complete aerobic oxidation occurs, through slowly.\

⇨ **Teritiary treatment :** The most important purpose of territiary treatment is an effective and efficient removal of pollutants than in primary and secondary treatment and it can be applied any stage of the total treatment. The main function of territiary treatment is to decrease the load of nitrogen and phosphorus compounds present in the effluents by the following processes.

- Precipitation : Calcium oxide is removed with phosphorus compounds in the form of calcium phosphate.
- Nitrogen strippling : It is removed in the form of ammonia gas
- Chlorination : It removes nitrogen and phosphorus with chlorine molecule

⇨ **Controlling measures for noise pollutions are :**

- Setting industries away from residential areas well designed industries and proper lubrications of machines.
- Using acoustic material which absorbed sound and planting trees.

⇨ **General Points :**

- Hot water from thermal nuclear reactors decreases dissolved oxygen in rivers which effect aquatic life.
- Soap and detergents from industrial wastes will give form in water.
- A typical analytical data of sewage is BOD (Biological Oxygen Demand) is 20 pm total solids 500 ppm. Suspendent particles 100-150 ppm. Volatile matter 150 to 200 ppm. Grease 50-75 ppm.
- The world earth day April 22.
- World environment day June 5.
- PSI (Pollution Standard Index) upto 100 - Normal, Below 100 - Pollutions free, above > 400 Hazards to life.
- Atomic bomb for second world war was produced by transium nitrate.
- Methyl iso cyanate CH_3NCO (Bhopal gas tragedy)

- Rapid industrilization will given 20% of air pollution.
- Air pollution is also due to pollengrain which gives Asthama and respiratory problems.
- HCN is produced from blast furnace and other metallurgical process which causes throat problems loss of vision and headache.
- Ammonia is released air from explosive and damaging plants and fertilizers which gives respiratory disorders.
- The rain water as it enters into the atmosphere it gets acidic nature.
- Ground water will have basic nature.
- Distilled water pH is always 7.
- Cholera will be caused by vibriocholera.
- Typhoid will be caused by salmonella typhi.
- Amoebiasis caused by entamoeba palarites.
- Jaundice caused by virous hepatitis.
- Polio caused by Polimycitis.
- The water temperature that is left in rivers must not cross 67° and optimum temperature is 37°.
- The toxic metal for water pollution is Hg, As, Cu, Ba, Gn, Bh, Cr, Ci, Se, Cd.
- Disease causing organisms in drinking water called as pathogens.
- The plants in sewage which supply nitrogen to other plants is blue green algae.
- Soil pollution will effect food value.
- Osmoscope is used to know intensity of smell.
- Turbidity is determined by using Jackson apparatus.
- The scale used for measuring coloral of polluted water is Pt-Cobalt
- Carbides in polluted water determined by Mohr's method using in $AgNO_3$.
- The fluorides and nitrates in polluted water are determined by colorimetric method.
- Dissolved oxygen in polluted water in determined by Winkler method.
- The residual fluorine in polluted water is determined by Starch - iodide method.
- The cotton and flour will give white lungs.
- Smoke particles (Carbons particles) will given black lungs.
- Radioactive inert Ga is Radon
- H_2S will be released from refineries.
- Street dust contains silica
- Sb-Abdominal pain, Diarrhea, Chest pain.
- Pb- Anemia, Vomiting, Loss of Appealte, Convulsion, Damage to Brain & Liver, Kidney
- As - Mental disturbance, Liver Cirrohis, Lung Cancer, Kidney damage.

- Cd-Diarrhea, Growth retardation, Bone deficiency, Kidney damage.
- Accumulation of plant nutrients like Phosphates and Nitrates in the soil is called eutriphication

⇨ Types of Energy Sources

- Renewable (non conventional) energy sources

  a) Solar energy can be find by using 2 methods

  1) Thermal method 2) Normal method

  b) Tidal energy

  c) wind mills

  d) Hidel power

  e) Geothermal energy

  f) Bio gas

- Non renewable (or conventional) energy sources

  a) coal

  b) Oil (Petroleum)

  c) Natural gas

⇨ Advantages of using Alternative (Renewable) Energy Sources :

- Alternative energy sources are completely free from pollution.
- These sources are inexhaustable.
- The energy from these sources is replaced as we use them.
- These sources not only help in conservation of energy, but also contribute immesely to afforestation, improvement of the environment and also for the increase of health and hygiene.

⇨ Limitations or Disadvantages of Renewable Energy Sources :

- **Solar energy :**

a. The main problem of solar energy is that it is only available during the day. It is less available in cloudy weather.

b. Systems that use solar energy as a source must store with batteries or use supplementary sources of energy when sunlight is not available.

⇨ Hydel Power :

- The initial capital investment is very high
- Construction work takes a long time.
- Due to construction of hydel projects, agriculture and forest lands are lost and large population are to be displaced.

⇨ Wind Energy :

- It is generally favourable in geographic locations which are far away from cities.
- Wind turbine design and installation is complex for varying atmospheric conditions.
- For large scale generation, wind power is not economical.

⇨ Geothermal Energy :

- The overall efficiency for power production is quite low.
- Drilling operations at geothermal sites cause noise population.
- Air pollution occurs in case of release of gases like H_2S, NH_3, CO_2 present in the steam and the hot water coming out of the geothermal sources.

⇨ Biogas :

- Collection of human or animal wastes and storing is costly.
- In the beginning the supply is uncertain.
- The conversion efficiency in the production of gas is low.

⇨ ECOSYSTEM :

- **Ecology :** The branch of science which deals with plant and animal relation ship with their environment is called ecology.

  In other words, ecology is the science of inter-relation between living organisms and their environment.

  The plants, animals and micro organisms together with the environment in which they live make up an independent unit, called Ecosystem.

  Definition : The Ecosystem is defined as any unit that includes all the organisms i.e., communities in a given area which interact among themselves and with the physical environment, so that a flow of energy leads to clearly defined trophic (nourishing) structure, biodiversity and material cycle (exchange of materials) within the system.

⇨ Functional Component Soil Ecosystem :

An ecosystem consists of mainly two components. They are

- Abiotic components : The non living component examples.

  Sunlight, water, soil, temperature etc.
- Basic component : The living organisms of an ecosystem are known as biotic component.

⇨ The living organisms are of three types. They are

- Producers or Autotrophs
- Consumers or Heterotrophs
- Decomposers.

⇨ **Producers :**

The living things that can manufacture their own food are called producers. Since all producers are synthesizing their own food, they are self sufficient in the nutrition and they are called

Autotrophic organisms :

Example : All the plants come under this category since all plants produce their own food by the process known as photosynthesis.

⇨ **Consumers :**

These are the living things which obtain their food by earthing plants or animals or both. Consumers can be classified into three types depending on their eating habits. They are

i) Primary consumers : These animals are known as Herbivores and they directly feed upon plants

Ex : Rabbits, Squirrels, Deers.

ii) Secondary consumers (Carnivores) : These are a group of (flesh eaters) lower level carnivores, that feed on primary consumers. Ex. Dogs, Cats, Wolves, etc

iii) Teritiary consumers : These are a group of higher level comivores animals. These animals directly feed on secondary consumers.

Example : Larger Fishers, Tiger, Vulture etc.

⇨ **Decomposers :** These organisms like bacteria and fungi will attack the head bodies or producers and consumers and bring about the decay. All the organisms and their wastes are finally decomposed and recycled by decomposers.

⇨ **BIO DIVERSITY AND THREATS TO BIODIVERSITY**

⇨ Biodiversity : Biodiversity is the biological diversity that exists. In other words it means the existence of a large number of different kinds of living things (Plants and animals at micro and macro level) which make a balanced environment at a given place and time. It is the basis of human survival and economic well being.

⇨ **Biodiversity :** is defined as "the ensemble and interaction of genes, species and ecological diversity at a given place and time.

In simplest terms, biodiversity is the variety of life and its processes; and it includes the variety of living organisms, the genetic differences among them and the communities and ecosystem in which they occur.

THREATS OF BIODIVERSITY :

⇨ **The various threats of Biodiversity are as given below :**

- Destruction of forests.
- Habitat loss, degradation and fragmentation.
- Over exploitation of resources.
- Urbanisation
- Industrilization

- Pollution
- Soil degradation and erosion.
- Climatic change
- Diminishing green cover.
- Invasion of non-native species
- Mining for ores, roads, and river valley projects.
- Loss of land fertility
- Poaching of wild animals
- Natural factors like floods, drought, forest fires and desertification.

⇨ Radio Active pollution :

- Radio active pollutions takes place from nuclear explosion, discharge from nuclear reactor.
- Radio active substances will not present for a long time in the air except transium 90 - (Sr-90) and Iodine 137 (I - 137) they undergo decay slowly.
- The radiation on released by radio active substance is dangerous and giving long term hazards.
- Radiation will disturb normal functioning of organisms and they cause genetic mutation and also cancer.
- Radio active pollution can be stopped with the prevention of radiation leakage from the reactors.
- Radio active substances must be burried in the ground or disposed in see after making it harmless.

⇨ Noise Pollution.

- The unit for noise is db.
- Another unit for noise is Bel.
- 1 dB is 1/10 of a bel.
- A human can tolerate upto 120 dB of noise.
- With the noise pollution various can be caused like disturbances in sleep, emotional behaviour, high blood pressure, fatigue, heating loss, increases the rate of heart beat, digestive problems, decreased perception, impairment of night vision, dilation of pupil of eyes.

SOIL POLLUTION

⇨ Substances which negatively effect fertility of soil are called : Soil pollutants.

⇨ The soil pollution is mainly due to fertilizers, insecticides and pesticides, dead bodies of trees and animals, faecal matter of animals.

⇨ The type of pollution that cannot spread to other parts is soil pollution.

⇨ The soil becomes acidic due to acid rains.

⇨ The type of the pollution that effects food value is soil pollution.

KNOW THESE POINTS

- The insecticides commonly found in meat and eggs sold in Indian market are : DDT and BUC.
- Highly polluted river in India is : Ganges
- The project engaged in the pollution control of Ganges water is : Indo French Project.
- Less air polluted city in India is : Chandigarh.
- Highly polluted city in India is : Calcutta
- Highly polluted country in the world is : America
- The country which is more attentive in the control of pollution is : Russia
- National Environmental Engineering Research Institute (NEERI) is located at Nagpur.
- Deforestation leads to the increase of an air pollutant in the atmosphere is carbondioxide
- The type of pollution that can be controlled by electric cremation of dead bodies is : Air pollution.
- The presence of excess of fluorine in water causes a disease Fluorisis.
- The absence of fluorine in drinking water (below 1mg/lt) causes : Dental decay.
- The disease which caused death to many Japanese after eating infections fish is Minimata.
- The metal pollutant of water responsible for minimata disease mercury.
- The deaths of marine animals in gulf region recently is due to : split of oil into sea.
- The disease causing organism in drinking water is called Pathogens.
- The most common method of destroying pathogen in drinking water is Chlorination.
- Mercury pollutant in water is converted by bacteria into methyl mercury and dimethyl mercury.
- The metal pollutant of water which brings about chromosomal mutations is mercury.
- The oxygen used by bacteria in decomposing organic substance in water is referred as : Biochemical Oxygen Demand (B.O.D).
- The potentials that cause genetic disorders are radio active materials.
- The most stable pesticidal water pollutant is DDT.
- The pollutant in the form of colloidal suspensions of the particles in gas Aerosols.
- The non pollutant power plants are : Hydro electric power projects
- Inhaling of asbestos particles cause, Emphasema. (difficulty in exhale)

- The presence of excess amount of bleaching powder in water causes diarheae and lung disease.
- The pollution caused by dumping of garbage, used tins package materials in water is called Third pollution.
- The only way to control third pollution is recycling of biproducts and waste materials.
- The plants present in sewage which supply nitrogen to plants is blue green algae.
- The thermal pollution can be controlled by using Cooling towers.
- Excess amount of bleaching in drinking water causes a disease called : Sphaerotilusnations.
- The intensity of odour is measured by using Osmoscope.
- The dilution ratio at which odour is just detectable is called Threshold Number.
- By using osmoscope threshold number is calculated.
- Turbidity is measured by using Jackson turbidimeter.
- The colour of polluted water is measured in Hazen units.
- The scale used for measuring colour pollution is Pt - cobalt scale.
- The hardness of water is measured by EDTA method.
- The carbides in polluted water are determined by Mohr's method by using $AgNO_3$ solution
- The fluorides Nitrates in polluted water are determined by colourimetric method.
- The dissolved oxygen in polluted water is determined by Winkler method.
- The residual chlorine in polluted water is determined by Starch lodide method.

SUCCESS IN LIFE
Mostly depends on the
Power of concentration
Clear thinking and
Intellectual Understanding
are very easy for a
Concentrated mind

PRACTICE SET - I

01. Which of the following is a secondary pollutant
1) CO 2) NO 3) F_2 4) PAN

02. The parameter used to indicate the water pollution is
1) BOD 2) Sink
3) Pollutant
4) Threshold limit value (TLV)

03. Which is reduced by growing trees
1) CO 2) CO_2 3) CH_4 4) O_2

04. The most important green house effect gas is
1) CO 2) CO_2
3) NO 4) CO_2

05. Skin cancer is caused due to the
1) Green house effect 2) Ozone depletion
3) Acid rain 4) Polluted water

06. Deforestation causes
1) Acid rain 2) Deplection of ozone
3) Global warming 4) All of the above

07. Life of of buildings is effected by
1) Depletion of ozone layer
2) Global warming
3) Acid rains 4) Carbon monoxide

08. Major portion of CO2 is absorbed by
1) Animals 2) Human beings
3) Plants 4) Water

09. Global warming can be prevented by
1) Plantation 2) Deforesation
3) Sinks 4) Receptors

10. Fluorosis is caused due to the presence of
1) Fluorine impurity in water
2) Chlorine impurity in water
3) Nitrate impurity in water
4) Bromine impurity in water

11. Which of the following is not a Non - conventional energy source
1) Solar energy 2) Wind energy
3) Geothermal energy 4) Natural gas

12. Which of the following is major pollutant in vehicle exhaust
1) CO_2 2) NO_2
3) CO 4) SO_2

13. The relation between living beings and non-living things in environment is called
1) Ecology 2) Ecosystem
3) Biosphere 4) Biotic component

14. Which of the following gas was responsible for Bhopal gas tragedy
1) MIN 2) MIC 3) PAN 4) CFC

15. This is an example for non-conventional energy
1) Electrical energy 2) Magnetic energy
3) Solar energy 4) Energy from coal

16. Forests maintain balance between
1) CO_2 & O_2 2) CO_2 & N_2
3) CO_2 & H_2O 4) CO & NO

17. The effect of smoke is reduced in the industries by
1) trickling filter 2) chemical sonibber
3) cottrell's electrostatic precipitator
4) growing more trees

18. Which is a natural pollutant
1) Smoke 2) Fog
3) FC's 4) Carbon monoxide

19. Acid rains contain acids
1) H_2SO_4 & HNO_3 2) HCl & H_3PO_4
3) CH_3COOH & H_2CO_3 4) HCl & H_2CO_3

20. Which of the following layers of atmosphere contains ozone gas
1) Troposphere 2) Stratosphere
3) Ionosphere 4) Mesosphere

21. Which of the following is secondary pollutant
1) CO_2 2) PAN 3) NO_2 4) CFCs

22. Which of the following is air pollutant
1) CO 2) SO_2 3) Pb 4) All the above

23. Which of the following is renewable energy source
1) Coal 2) Petrol
3) Natural gas 4) Wind energy

24. The medium that is subjected to pollution effects is called
1) Targer 2) Sink 3) Receptor 4) Host

25. Environmental segment is
1) Atmosphere 2) Thermosphere
3) Troposphere 4) All the above

26. The lowest segment of atmosphere is known as
1) Thermosphere 2) Stratosphere
3) Mesosphere 4) Troposphere

27. Presence of CO In the air is harmful to human beings because, it reacts with
1) Bones 2) Enzymes
3) Haemoglobin 4) Eyes

28. The gas that was released into the air during Bhopal tragedy
1) Methyl cyanide 2) Methyliso cyanate
3) Hydro cyanide 4) Cyanogen

29. The p^H of acid-rain is approximately
1) 4-5 2)2-3 3) 1-2 4) 6-7

30. The important water pollutants are
1) Fluorides 2) Chlorides
3) Carbonates 4) Bicarbonates

31. Excess fluoride concentration in drinking water affects
1) Eyes 2) Bones 3) Blood 4) Skin

32. Bioaccumnlation of pollution is caused by
1) Plants 2) Fish 3) Birds 4) All the above

33. The sink for CO_2 and SO_2 is
1) Aq. KOH 2) Plants
3) Sea water 4) Soil

34. Acid rain does not generally contain
1) HNO_3 2) H_2SO_4
3) H_3CO_3 4) HCl

35. In Nalgonda technique to defluorination, the substances used are
1) Alum 2) Lime
3) Bleaching powder 4) All the above

PRACTICE SET - I KEY

01) 4	02) 1	03) 2	04) 2	05) 2
06) 4	07) 3	08) 3	09) 1	10) 1
11) 4	12) 3	13) 2	14) 2	15) 3
16) 1	17) 3	18) 2	19) 1	20) 2
21) 2	22) 4	23) 4	24) 3	25) 1
26) 4	27) 3	28) 2	29) 1	30) 1
31) 2	32) 4	33) 3	34) 4	35) 4

PRACTICE SET - II

01. The Bio-sphere comprises is common to
1) Atmosphere 2) Hydrosphere
3) Lithosphere 4) All

02. The solid component of earth comprising soil, mountains, rocks etc. is
1) Hydrosphere 2) Biosphere
3) Lithosphere 4) Atmosphere

03. The major gases in air are
1) H_2 2) CO_2, Ar
3) Ne, CH_4 4) N_2, O_2

04. The minor gases which are not trace gases in air are
1) Ar, CO_2 2) N_2, O_2
3) NO_2, SO_2 4) CO, O_3

05. The most abundant inert gas in atmospheric air is
1) Kr 2) Xe 3) Ar 4) Ne

06. The formula of marsh gas is
1) CH_4 2) C_2H_6 3) C_2H_4 4) C_2H_1

07. The photochemical smog consists of
1) Unsaturated Hydrocarbons
2) Nitrogen oxides
3) Sulphur compounds 4) All the above

08. The most polluted city in the world is
1) Calcutta 2) Tokyo
3) New york 4) Karachi

09. Excess of organic wastes in water reduce this in water
1) Oxygen 2) Hydrogen
3) CO_2 4) None

10. The most polluted city in India is
1) Bombay 2) Calcutta
3) Delhi 4) Madras

11. Which of the following is a biodegradable pollutant
1) Compounds of lead
2) Mercuric salts
3) Pesticide 4) Domestic waste

12. Which of the following is a main air pollutant?
1) CO_2 2) N_2 3) S 4) CO

13. The invaluable energy source that does not cause pollution is
1) Petroleum 2) Solar
3) Fossil fuel 4) Nuclear

14. Which air pollutant is released by scooters and cars
1) SO_2 2) CO_2 3) CO 4) All the above

15. Green house effect is mainly due to
1) CO_2 2) CH_4 3) CFC 4) O_3

16. Pollutants released by Jet planes are called
1) Physical pollutant 2) Chemical pollutant
3) Photochemical oxidants 4) Aerosols

17. Which of the following is not a primary pollutant
1) CO_2 2) CO 3) SO_2 4) SO_3

18. Main sink for CO_2 is
1) Sea water 2) Chlorophyll of plant
3) Lakes 4) All the above

19. Silent killer gas is
1) CO_2 2) CO 3) CH_3NCO 4) O_3

20. Gas liberated from Marshy soils is
1) Methane 2) Ammonia
3) Both 4) None

21. Medium effected by pollutant is called
1) Sink 2) Receptor 3) Both 4) None

22. Sediment forms due to
1) Dissolution of Minerals 2) Acid rains
3) Soil erosion 4) Detergent

23. Air pollution from Industries can be controlled by
1) Filters 2) Cyclones
3) Electrostatic precipitators
4) All the above

24. Photochemical smog is characterised by
1) Visibility reducing Haze
2) Irritates the eyes
3) Unpleasant effect on lungs
4) All the above

PRACTICE SET - II KEY

01) 4	02) 3	03) 4	04) 1	05) 3
06) 1	07) 4	08) 2	09) 1	10) 2
11) 4	12) 4	13) 2	14) 3	15) 1
16) 4	17) 4	18) 1	19) 2	20) 1
21) 2	22) 3	23) 4	24) 4	

PRACTICE SET - III

01. The percent of earth's surface covered by the Biosphere is
1) 25% 2) 75% 3) 100% 4) 33%

02. The most abundant gas in air after Nitrogen is
1) Cl_2 2) O_2 3) CO_2 4) F_2

03. The abundance of O_2 gas in air by volume is
1) 40% 2) 20.94% 3) 10% 4) 33.33%

04. The highest air pollution in major cities is due to
1) High population 2) Industries
3) Transportation 4) Deforestation

05. The disease associated with the workers in Cotton mills is
1) Silicosis 2) Black Lungs
3) White lungs 4) Loss of vision

06. Deforestation
1) Increase the amount of CO_2 in air
2) Decreases the amount of O_2 in air
3) Produce imbalance of CO_2 and O_2 in air
4) all the above

07. The charge of smoke particles from a chimney is
1) positive 2) negative 3) neutral 4) none

08. The peroxy acetyl nitrate is formed by the reaction in UV light of Sun between
1) SO_2 and H_2O 2) 2NO and O_2
3) NO_2 and unburnt hydrocarbon
4) SO_2 and NO_2

09. The greatest air pollutant in the following
1) SO_2 2) CO 3) CO_2
4) Nitrogen oxides

10. Which of the following changes the colour of the white paper and marble stone into brown colour
1) CH_4 2) SO_2
3) Nitrogen Oxides 4) CO_2

11. The ecological problem confronting the mankind all over the world is
1) Food problem 2) Energy crisis
3) Population exploration
4) Pollution

12. The presence of which of the following in drinking water in large quantities cause sterility and loss of memory
1) Arsenic 2) Manganese
3) Silver 4) Mercury

13. The amount of Oxygen used by bacteria in decomposing organic waste in polluted water is known as
1) COD 2) BOD
3) Dissolved Oxygen
4) Soluble Oxygen

14. Pollution by the addition of Garbage, Bottles, packing materials and building materials to the soil is called
1) first pollution 2) second pollution
3) third pollution 4) rare pollution

15. The toxic gas which killed 4 Indian Scientists in Antarcitica is
1) CO_2 2) CO 3) SO_2 4) NO_2

16. The presence of the following metal cause paralysis, blindness and deafness is
1) Mg 2) Ba 3) Ca 4) Hg

17. The harmful microbes from polluted water are removed by adding
1) Bleaching powder 2) Glauber's salt
3) D.D.T. 4) Malathion

18. The radio active pollutants cause
1) Fluorosis 2) Mutations
3) T.B 4) None

19. The form of Mercury which enters food chain from water and undergoes bio magnification
1) $C_3H_7 - Hg$ 2) $C_2H_5 - Hg$
3) $C_4H_9 - Hg$ 4) $CH_3 - Hg$

20. D.D.T is a
1) Non - biodegradable pollutant
2) Biodegradable pollutant
3) Antibiotic 4) None

21. Spraying of D.D.T. on crops produces pollution of
1) Air only 2) Air and soil only
3) Air soil and water only
4) Air and water only

22. Drinking of water rich in nitrates cause a decease called
1) Lung Cancer 2) Minimata
3) Kwashiorker 4) Methamoglobinemia

23. The respiratory disease which is characterised by difficulty in exhale is
1) Bronchitis 2) Asthma
3) Emphasema 4) Neumonia

24. The Industrial area in A.P. which is considered as hell on earth is
1) Autonagar - Vijayawada 2) Patancheru
3) Ramachandrapuram 4) Kattedan

25. Lung disease is four times greater in urban area than of rural areas - reason is the presence of
1) N_2 2) SO_2 3) CO_2 4) Water

26. Which of the following is not an air pollutant
1) H_2 2) H_2S 3) SO_2 4) O_3

27. Stone leprosy is caused by
1) SO_2 2) SO_3 3) SO_2 & SO_3 4) SO_2 & CO

28. Tolerance of fluoride content in water is
1) 1 PPM 2) 4 PPM
3) 12 PPM 4) 6 PPM

29. Minimita disease is caused by
1) Hg 2) CH_3Hg 3) $(CH_3)_2 Hg$ 4) $HgSO_4$

30. Optimum level of CO in air is
1) 9 PPM 2) 0.1 PPM
3) 1 PPM 4) 12 PPM

31. Which of the following is a reducing smog?
1) Fog + Smoke + NO_2
2) Fog + Smoke + CO_2
3) Fog + Smoke + SO_2
4) Fog + Smoke + NO

32. Eutrophication means
1) Increased productivity of lakes due to nutrient enrichment
2) Increased productivity of lakes due to nutrient pesticides
3) Nutrient poor water with high value of DO
4) All the above

33. Petro crops are
1) Plants that produce petrol
2) Plants that contain hydrocarbons
3) Micro organisms that produce methane
4) All the above

34. Itai - Itai disease caused by
1) Mercury 2) Nickel 3) Lead 4) Cadmium

35. Blue revolution means
1) Extensive culture of aenatic organisms
2) Extensive culture of fruit gardens
3) Extensive industriliasation
4) Extensive Deforestation

36. Gas produced in poultry form is
1) HCN 2) NH_3 3) CH_4 4) C_2H_6

37. Compounds used as refrigerants prior to Freon -12
1) SO_2 & CO_2 2) SO_2 & NH_3
3) NH_3 & CO_2 4) CO & CO_2

38. Which gas interfers with the functioning of blood?
1) CO 2) CO_2 3) NO_2 4) DO

39. Diseases caused by fluorides less than 1 ppm is
1) B.P. 2) Lung tumors
3) Skeleton fluoresces 4) Dental carries

40. De fluoridation by Nalgonda Process is carried out by using
1) Activated carbon 2) defluoron
3) Bleaching powder + lime + Alum
4) Lime & Alum

41. The formula of Killer gas of Bhopal is
1) CH_3CNO 2) CH_3CN
3) CH_3NC 4) CH_3NCO

42. A secondary pollutant in the following
1) PAN 2) SO_2 3) CO_2 4) NO_2

43. The abundance of N_2 gas in air by volume is
1) 78.09% 2) 95%
3) 33% 4) 66.3%

44. Which of the following is a trace gas in air
1) N_2 2) O_2 3) CO_2 4) SO_2

45. The pesticide manufactured by using MIC gas at Bhopal is
1) Carbaryl carbamate 2) BHC
3) DDT 4) DDFT

46. Smog is a mixture of
1) Fog and Mist 2) Smoke and Fog
3) Smoke and Dust 4) Gases and Vapours

47. The potential used in Cortell electrostatic precipitator is
1) 60,000 volts 2) 10,000 volts
3) 90, 000 volts 4) 30,000 volts

48. An example for Chloro fluro carbon is
1) CF_2Cl_2 2) $CHCl_3$ 3) CH_2Cl_2 4) None

49. The chief source of Chloro Flurocarbon pollutants is
1) Dyes industry 2) Drug industry
3) Eelctroplating industry
4) Refrigeration and Air conditioning industry

50. The reaction of Chloro Fluorocarbons with ozone passes through..... mechanism.
1) Addition 2) Substitution
3) Free radical 4) Combustion

51. The complex formed when CO reacts with Haemoglobin of Blood is
1) Carburated Haemoglobin
2) Peroxy Haemoglobin
3) Acetyl haemoglobin
4) Carboxyl Haemoglobin

52. Which of the following is a phytotoxic air pollutant causing chlorosis and Necrosis
1) H_2S 2) Nitrogen oxides
3) SO_2 4) CO

53. The thinning of Ozone layer is due to chemicals present in aerosols. They are
1) Fluorocarbons 2) Hydrocarbons
3) Chlorinated Hydrocarbons
4) Organophosphates

54. The toxic substance responsible for the fish kill and Minimta disease in an area of Japan is
1) Tetra Ethyl Lead 2) D.D.T
3) Methyl Mercury 4) Cadmium

55. Gases responsible for acid rains are
1) CO and CO_2 2) CO_2 and SO_2
3) CO and NO 4) SO_2 and CO_2, NO_2

56. The major air pollutant gas present in Smog is
1) SO_2 2) CO 3) NO_2 4) All

57. The pollutant from motor car exhausts which cause mental disorders
1) Pb 2) Hg 3) NO_2 4) SO_2

58. The most dangerous radio active pollutant is
1) Stromium (90) 2) Phosphorus
3) Sulphur (35) 4) Calcium (40)

59. The type of pollution that interferes the reproductive rate of adequate animals is
1) Thermal pollution 2) Air pollution
3) Hydro electro pollution
4) Soil pollution

60. Which of the following metal isotope is released during nuclear weapon explosion
1) I - 134 2) C - 14 3) Sr - 90 4) All

61. Emphysema is
1) Trouble during respiration
2) Trouble during inhalation
3) Trouble during exhalation 4) All

62. Benzo pyrines are cancer causing pollutants released from
1) Exhausts of Petrol fuel
2) Exhausts of Diesel fuel
3) Exhausts of Gasohol
4) All the above

63. The main source of Phosphate pollutants in water is
1) Sediment 2) Sewage
3) Detergents 4) Pesticides

64. Sewage water can be used for growing
1) Water Hyacinth 2) Agricultural crops
3) Shrimp culture 4) All

65. Chemical that replace Freon - 12 is
1) Activated Carbon 2) Bioact FC - 7
3) Resins 4) All

66. Knock - Knee disease is caused by
1) Mercury 2) Nickel
3) Lead 4) Fluorine

67. Disease that attacks due to sewage contaminants is
1) Hepatitis 2) Fluorosis
3) Minamata 4) All the above

68. Which of the following causes air, water Soil pollution?
1) Aerosols 2) Hydrocarbons
3) pesticides 4) All the above

69. Bacteria that feeds on oil is
1) Myelitis 2) Salmonella Typhil
3) Entamoeba Histolytica
4) Pseudomonos putida

70. Ozone layer is depleted by other than CFC is
1) SO_2 2) SO_3 3) NO 4) CO_2

71. Bregoil is
1) Water from paper industry which absorbs oils
2) Water from fertilizer industry which absorbs oils
3) Water from pesticide industry which absorbs oils
4) Water from cloth industry which absorbs oils

72. Anaerobic bacteria survive in
1) Presence of DO 2) Absence of DO
3) Presence of COD 4) Presence of BOD

73. Third pollution refers to
1) Sewage passed into water
2) Gases dissolved in water
3) Solid wastes dumped into water 4) None

74. $COCl_2$ Phosgene or war gas is released in
1) Kilns 2) Metal industries
3) Dye industries 4) Blast furnace

75. The value which gives a measure of organic pollution of water is
1) pH value 2) Salinity 3) BOD 4) DO

76. Sewage water can be used for growing
1) Water Hyacinth 2) Agricultural crops
3) Shrimp culture 4) All

PRACTICE SET - III KEY

01) 1	02) 2	03) 2	04) 3	05) 3
06) 4	07) 2	08) 3	09) 2	10) 2
11) 4	12) 2	13) 2	14) 3	15) 2
16) 4	17) 1	18) 2	19) 4	20) 1
21) 3	22) 4	23) 3	24) 2	25) 2
26) 1	27) 3	28) 1	29) 3	30) 1
31) 3	32) 1	33) 3	34) 4	35) 1
36) 2	37) 2	38) 1	39) 4	40) 3
41) 4	42) 1	43) 1	44) 4	45) 1
46) 2	47) 4	48) 1	49) 4	50) 3
51) 4	52) 3	53) 1	54) 3	55) 4
56) 4	57) 1	58) 1	59) 1	60) 3
61) 3	62) 2	63) 3	64) 1	65) 2
66) 4	67) 1	68) 3	69) 4	70) 3
71) 2	72) 2	73) 3	74) 3	75) 3

SELF TEST

01. Earth protected from UV radiations by
1) Ozone layer 2) Nitrogen layer
3) Carbon dioxide layer
4) Oxygen layer

02. Lung diseases are four times more in urban areas than rural areas. This is due to presence of
1) N_2 2) CO_2 3) Water vapour 4) SO_2

03. If BOD of river of high, it means that the river is
1) Not polluted
2) Polluted with inorganic chemicals
3) Very polluted with organic chemicals which are decomposed by microorganisms
4) Polluted with dust particles

04. Fluorosis, the bone disease is caused by the presence of
1) Pesticides in water 2) Fluorides in water
3) CO in air 4) Sulphur dioxide in air

05. Bacterial decomposition shifts from aerobic to anaerobic when dissolved oxygen in water
1) Increases 2) Decreases
3) Remains unaltered 4) None of these

06. The measure of pollution of sewage contamination of fresh water is given in by
1) Chloride content 2) Organic nitrogen
3) Coliform count 4) Ammonia nitrogen

07. "Minamata disease" is caused due to pollution with a heavy metal in water. That heavy metal is
1) Mercury 2) Lead
3) Bismuth 4) Arsenic

08. Green House Effect is attributed to the presence of
1) Excess nitrogen in the air
2) Excess green plants on the land
3) Excess usage of green leaves for the roofs of house
4) Excess carbon dioxide in the air

09. Which one is not the water pollutant ?
1) Plant nutrients 2) Automobile exhaust
3) Oxygen demanding wastes
4) Disease causing agents

10. Freon-11 is
1) Fluorochloromethane
2) Trichlorodifluoromethane
3) Dichlorodifluoromethane
4) Tetrafluoromethane

11. The radiation absorbed in the ozone layer in the upper reaches of the atmosphere from the sun is
1) I.R. radiation 2) Visible radiation
3) U.V. radiation 4) Far infra-red radiation

12. A sample of air in Hyderabad city contains 10 ppm of CO ; 20 ppm of CO_2 ; 15 ppm of SO_2 ; 5 ppm of NO_2 and 40 ppm of N_2. The amount of air pollution load in Hyderabad city is
1) 50 ppm 2) 90 ppm 3) 10 ppm 4) 30 ppm

13. Pathogenic bacteria present in water is removed by
1) Lime- soda process 2) Zeolite process
3) Ion exchange process 4) Chlorination

14. When air contaminated with mercury is inhaled, it effects
1) Nervous System 2) Blood circulation
3) Skin 4) Hair

15. Ozone depletion in the stratosphere is mainly caused by
1) CO_2 2) NO_2 3) NO
4) Chlorofluoro carbon

16. BOD is
1) Biological Oxygen Demand
2) Basic Oxygen Decline
3) Building Oxygen Depot
4) Bacterial Oxygen Depletion

17. Silent killer gas which combines with haemoglobin of the blood is
1) NO 2) NO_2 3) CO_2 4) CO

18. Dissolved oxygen (DO) in water is a measure of water pollution. This can be estimated by
1) Winkler method 2) Nessler's method
3) Mohr's method 4) EDTA titration method

19. Freon which is used as coolent in refrigerator is an air pollutant because it alters the amount of
1) Ozone 2) Oxygen 3) CO_2 4) NO

20. Cottrell process is used for
1) Removing CO and CO_2 from chimney exhaust
2) Removing radioactivity
3) Controlling soil erosion
4) Removing dust and smoke from chimney exhausts

21. One of the major pollutant that comes out along with exhaust gases in automobile vehicle contains
1) Mercury 2) Lead 3) Nickel 4) Zinc

22. The major difference between the tropospheric and stratospheric air lies in the concentration of
1) N_2 2) CO_2 3) O_3 4) NO

23. A major pollutant from the dye-industry is
1) SO_2 2) NH_3 3) HCN 4) H_2S

24. Marble statues are damaged by which of the following air pollutants ?
1) Carbon dioxide 2) Sulphur dioxide
3) Ozone 4) Hydrocarbons

25. Poisonous gas present in the exhaust fumes of a car is
1) Carbon dioxide 2) Methane
3) Ethylene 4) Carbon monoxide

26. A sample of air in Vishakhapatnam city contains 5 ppm of CO, 10 ppm of CO_2, 5 ppm of SO_2, 5 ppm of NO_2, 15 ppm of water vapour and 40 ppm of N_2, Assuming the absence of any other pollutant, the air-pollution load in Vishakhapatnam is
1) 80 ppm 2) 40 ppm 3) 25 ppm 4) 65 ppm

27. Which of the following gases, present in the upper layers of earth's atmosphere, is responsible for absorbing harmful UV radiations from the sun ?
1) SO_2 2) CO_2 3) N_2 4) O_3

28. Measurement of the following parameter is the key test for determining pollution in water
1) COD 2) Permanent hardness
3) Temporary hardness 4) BOD

29. Growing more trees helps to
1) increase CO_2 and increase O_2 in the atmosphere
2) reduce CO_2 and increase O_2 in the atmosphere
3) decrease CO_2 and decrease O_2 in the atmosphere
4) increase CO_2 and decrease O_2 in the atmosphere

30. Automobile air pollution is due to
1) nitrogen and oxygen 2) Oxygen
3) hydrogen sulphide
4) carbon dioxide and carbon monoxide

31. In 'Chain Smokers' blood
1) CO level is high 2) CO_2 level is high
3) both 1 and 2
4) Carbon deposits more

32. 'Ozone' present in stratosphere
1) Filters ultravoilet light
2) Filters infrared light
3) Filters all radiations except blue
4) Filters all radiations except red in evening times.

33. 'Cairox method' is used to
1) remove SO_2 from air
2) remove SO_3 from air
3) remove N_2O_3 from air 4) all the above

34. Chemical Oxygen Demand (COD) indicates
1) measure of oxidisable impurities present in sewage
2) measure of oxidisable biological impurities
3) measure of biologically inert oxidisable impurities
4) all the above

35. The device in which the seperation of dust particles is brought about by sudden change of direction of steam is
1) Fabric filter 2) Lower collector
3) Settling chamber 4) Electrostatic precipitator

36. Zoning means
1) Separating forests from industrial area
2) Separating industrial area and domestic area
3) Separating industries from natural water sources
4) None of the above

37. In Bhopal tragic incidence, leaked out gas from Union Carbide plant is
1) Ethyl isocynide 2) Methyl isocyanide
3) Methyl cynide 4) Methyl isocynate

38. Trickling filters are employed
1) to filter dust and smoke from chimney exhausts
2) in the treatment of potable water
3) in the treatment of sewage
4) to reduce the concentration of CO in automobile vehicles

39. The main contributors of sulphur dioxide (SO_2) emissions are
1) Automobiles 2) Textile industries
3) Thermal Power Stations
4) All the above

40. Which of the following air pollutant effects vegetation
1) CO 2) CH_4 3) CO_2 4) NO_2

41. Due to green house effect
1) leaves and plant loose their green colour
2) byssionosis decrease will be caused
3) the sea level will rise
4) atmosphere will be supercooled

42. Persons in asbestos factories are effected by air pollution. The most effected part of their body is
1) eye 2) throat 3) lungs 4) skin

43. Charcoal is often used in gas masks because of its high capacity for absorbing
1) liquids 2) gases
3) coloured matter 4) suspended solids

44. Carbogen is
1) Pure form of carbon
2) $COCl_2$ 3) Mixture of CO & CO_2
4) Mixture of O_2 & CO_2

45. Ozone tails merceurty the reaction is
1) radiation 2) oxidation
3) substitution 4) none

46. Oxygen and Ozone are
1) isotopes 2) isomers
3) isobars 4) allotropes

SELF TEST KEY

01) 1	02) 4	03) 3	04) 2	05) 2
06) 4	07) 1	08) 4	09) 2	10) 3
11) 3	12) 1	13) 4	14) 1	15) 4
16) 1	17) 4	18) 1	19) 1	20) 4
21) 2	22) 3	23) 2	24) 2	25) 4
26) 3	27) 4	28) 4	29) 2	30) 4
31) 1	32) 1	33) 1	34) 1	35) 2
36) 2	37) 3	38) 3	39) 3	40) 2
41) 3	42) 3	43) 4	44) 2	45) 2
46) 4				

PREVIOUS ECET BITS

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1) N_2 2) CO_2 3) O_3 4)NO

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03. Poisonous gas present in the exhaust fumes of a car is
1) Carbon dioxide 2) Methane
3) Ethylene 4) Carbon monoxide

04. The highly dangerous carboxyl hemoglobin complex levels in the human blood increases due to
1) Excessive alcohol drinking
2) Smoking cigarettes
3) Over Sleeping 4) Jogging

05. Cottrell process is used for
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2) Excess green plants in the land
3) Excess usage of green leaves for the roots of houses 4) Excess carbon dioxide in the air

12. Corrosion of limestone or marble in nature is called
1) Acid Ran 2) Dosimetry
3) Coagulation 4) Stone leprosy

13. "Minamata disease" is caused due to pollution with a heavy metal in water. That heavy metal is
1) Mercury 2) Lead 3) Bismuth 4) Arsenic

14. The acid rain possesses
1) H_2SO_4 2) H_2SO_3
3) HNO_3 4) All of the above

15. Photochemical oxidant such as PAN are formed
1) By action of nitrogen oxides on hydrocarbons in presence of sunlight
2) By action of carbon dioxide on hydrocarbons in presence of sunlight
3) By action of hydrogen sulphide on hydrocarbons in presence of sunlight
4) By action of sulphur dioxide on hydrocarbons in presence of sunlight

16. If BOD of river is high. It means that the river is
1) Not polluted
2) Polluted with inorganic chemicals
3) Very polluted with organic chemicals which are decomposed by micro organisms
4) Polluted with dust particles.

17. Fluorosis, the bone disease is caused by the presence of
1) Pesticides in water 2) Fluorides in water
3) Co in air 4) Sulphur dioxide in air

18. The inert gas that is found in maximum amount in atmosphere is
1) Xe 2) Kr 3) Rn 4) Ar

19. Photochemical smog is formed by the interactions of
1) PAN and O_2 2) PAN and O_3
3) O_3 and O_2 4) PAN and CO_2

20. The amount of oxygen required to oxidise organic matter present in polluted water with biological treatment is
1) DO 2) TLV 3) COD 4) BOD

21. $CFCl_3$ is responsible for decomposition of ozone to oxygen which of the following reacts with ozone to form oxygen
1) Cl_2 2) Cl^- 3) F^+ 4) Cl

22. The reagent used to detect fluoride present in water is
1) Alum + CaO + $CaOCl_2$
2) de Aurron - I & II
3) Zinconium - alzarin-s-dyne
4) Calcium aluminium fluoride

23. Gases responsible for acid rain
1) NO and NO_2 2) SO_2 only
3) NO_2 and SO_2 4) CO and CO_2

24. Which of the following is responsible for Bhopal gas tragedy
1) CO_2 2) SO_2 3) CH_3NCO(MIC) 4) O_3

25. Which of the following is responsible for global-warming?
1) Nitrogen 2) Water-vapour
3) Oxygen 4) CO_2

26. Which of the following is a carcinogen?
1) SO_2 2) Benzene 3) NO_2 4) Toulene

ECET - 2014

27. BOD of raw municipal sewage may be about
1) 2-5 mg/lit 2) 5-12 mg/lit
3) 150-300 mg/lit 4) 2000-3000 mg/lit

28. Presence of soluble organics in polluted water causes
1) Undesirable plants growth
2) Depletion of oxygen
3) Fire hazards 4) Explosion hazards

TS- ECET-2015

29. Which one among the follwoing is NOT a green house gas
1) CH_4 2) CO_2 3) CO 4) NO

30. Which one among the follwoing causes deplection of ozone
1) CF_2Cl_2 2) CH_2F_2 3) CF_4 4) C_2H_3F

31. Which part of the atmosphere contains highest temperature
1) troposphere 2) mesosphere
3) stratosphere 4) thermosphere

AP-ECET-2015

32. Which one of the following is responsible for depletion of Ozone layer
1) CO_2 2) CFC 3) NO_2 4) CO

33. The following gas in atmosphere causes acid rain
1) NH_3 2) He 3) SO_2 4) CO_2

TS-ECET-2016

34. The chief pollutants which are responsible for ozone depletion
1) SO_2 & CO_2 2) CO & SO_2
3) CO & CO_2
4) oxides of nitrogen & CFC's

35. Which one of the following is secondary pollutant
1) CO 2) SO_2 3) PAN 4) Aerosol

36. The BOD value in clean water is
1) less than 5 ppm 2) more than 5 ppm
3) less than 10 ppm 4) more than 10 ppm

AP-ECET-2016

37. The effect of using chlorofluorocarbons on environment is
1) acid rain 2) ozone depletion
3) BOD 4) sound pollution

38. Dissolved oxygen content in water is expressed in
1) kg 2) mg 3) ppm 4) L

TS-ECET-2017

39. Whcih one of the following is a primary pollutant
1) CO 2) PAN 3) aldehyde 4) H_2SO_4

40. Ozone layer of upper atmosphere is being destroyed by
1) photochemical oxidants like O_2 and CO_2
2) chloro fluorocarbon
3) smog 4) SO_2

41. Eutrophication causes reduction ins
1) dissolved salts 2) dissolved hydrogen
3) dissolved oxygen 4) dissolved solids

AP-ECET-2017

42. Which of the following is not a greenhouse gas
1) CO 2) CO_2
3) water vapour 4) CH_4

43. Burning of fossil fuels causes
1) global warming 2) ozone depletion
3) acid rain 4) eutrophication

TS-ECET-2018

44. The basic component of the smog may be_____
1) O_3 2) O_3 + PAN
3) PAN+SO_2 4) O_3+PAN+SO_3

45. In antarctica, Ozone depletion is due to the formation of the following compound(s)
1) chlorine nitrate 2) PAN
3) Acrolein 4) SO_2 and SO_3

46. The pollutant responsible for smog formation and acid rain is_____
1) SO_2 2) CH_4 3) He 4) SO_2Cl_2

AP-ECET-2018

47. Environmental pollution affects
1) humans only 2) plants only
3) biotic components
4) both abotic and biotic components

48. Layer of atmpshere in which ozone layer lies is
1) troposphere 2) stratosphere
3) exosphere 4) mesosphere

PREVIOUS ECET BITS KEY

01) 3	02) 2	03) 4	04) 2	05) 4
06) 2	07) 1	08) 1	09) 2	10) 4
11) 4	12) 4	13) 1	14) 4	15) 1
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