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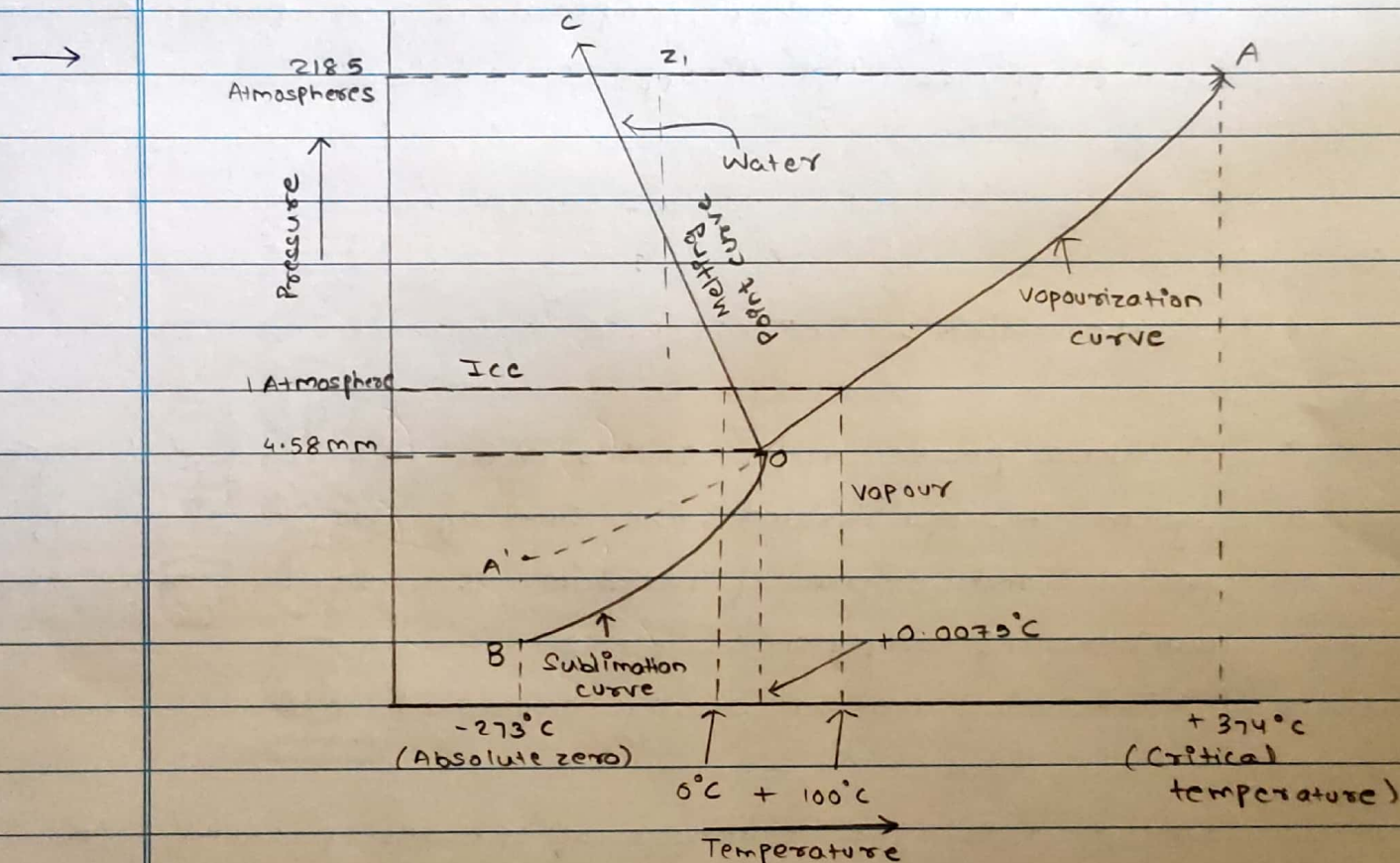
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Q. 2 a) With the help of neat and labelled phase diagram of water system, explain triple point.



Phase diagram of water system.

Triple Point:

- i) It has been found experimentally that the curves OA, OB and OC meet in a point O. This is called the triple point where all the three phases i.e. Ice, water and vapour co-exist.
- ii) Only at a particular value of temperature and pressure represented by the triple point, all the three phases can co-exist.



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iii) So, the system has no degrees of freedom at this point. The triple point corresponds to temperature of 0.0075°C and a pressure of 4.58 mm . At this point, if we change either temperature or pressure, one of the phases will disappear.

Q. 2 (b)

(i) State Gibb's Phase rule?

→ i) Gibbs phase rule states that in every heterogeneous system in equilibrium, the sum of the number of phases and degree of freedom is greater than the number of components by 2.

ii) This is mathematically expressed as:

$$P + F = C + 2$$

where P is the number of phases present in equilibrium, C is the number of components for the system and F is the number of degrees of freedom for the equilibrium.

iii) This rule is valid for any system at equilibrium at definite temperature and pressure, provided the equilibrium between any number of phases is not influenced by gravity, electrical or magnetic forces.



Q. 2 b)

ii) state any three limitations of phase rule?

→ Limitations of phase rule are:

i) Phase rule can be applied only for systems in equilibrium. It is not of much help in case of systems which attain the equilibrium state very slowly.

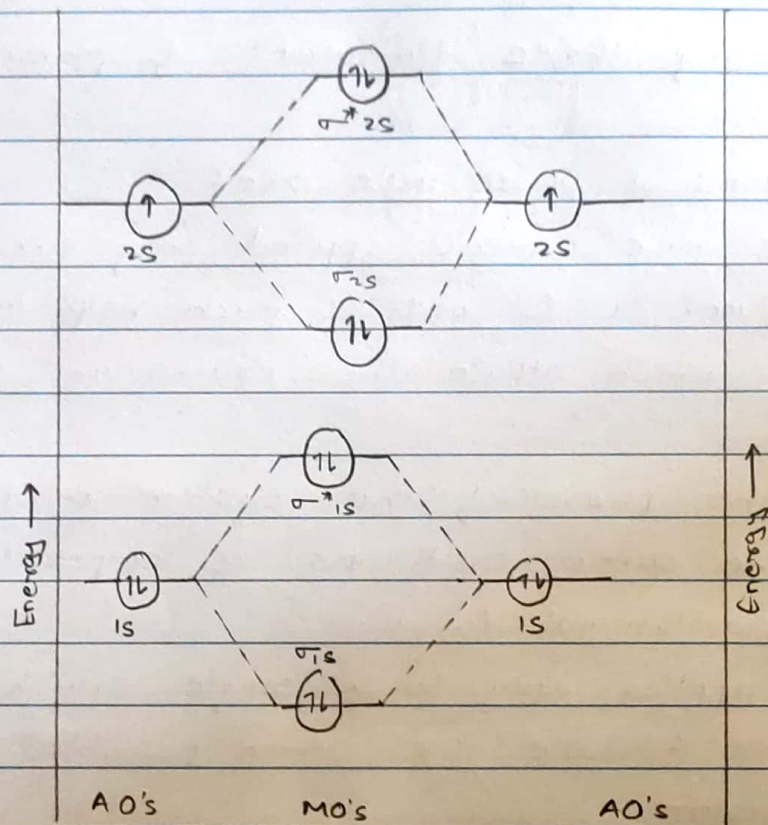
ii) All the phases of the system must be present under the same conditions of temperature, pressure and gravitational force.

iii) It applies only to a single equilibrium state. It does not indicate the other possible equilibria in the system.



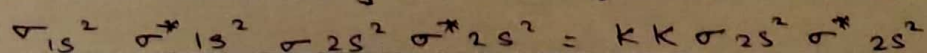
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Q. 1 a)

MO energy level diagram of Be_2

i) Beryllium molecule may be formed by the overlap of two beryllium atoms each having the electronic configuration of $1s^2 2s^2$. So, there are total of eight electrons which have to be accommodated in 4 molecular orbitals i.e. σ_{1s} , σ_{1s}^* , σ_{2s} and σ_{2s}^* .

ii) The eight electrons are filled in these 4 molecular orbitals according to aufbau principle and Pauli's exclusion principle. Hence, molecular orbital electronic configuration of Be_2 molecule is:





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iii) Since, the inner shell of filled σ is and σ^* is molecular orbitals do not contribute to the bonding and is sometimes written as KK which means K-shell is completely filled.

iv) Bond order (Be_2) = $\frac{1}{2} [N_b - N_a]$

$$= \frac{1}{2} [4 - 4]$$

$$= 0$$

The bonding effect is cancelled by antibonding effect where equal number of bonding and antibonding is present in Be_2 .

v) Since, the bond order is zero, Be_2 molecule does not exist.

Q. 1(b)

i)

→ Conditions for the formation of molecular orbitals:

i) The energy of AO's involved should not differ much from one another. For example in formation of homonuclear diatomic molecule, 1s-orbital of one atom does not combine with 2s orbital of another atom of same element.

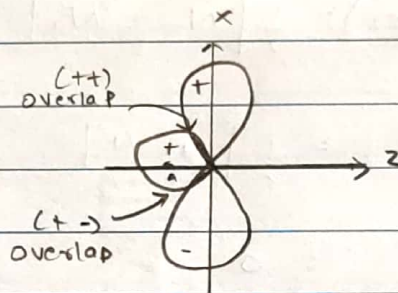
ii) Atomic orbitals combine only if they overlap to a considerable extent. With increased overlap, electron charge density between two nuclei is



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is also increased, thereby minimizing their mutual repulsion.

3) The Atomic orbital should have same symmetry about the molecular axis.



Q. 1 b)

ii)

sigma bond

Pi bonds

1) This bond is formed by end to end overlapping of s-s, s-p and p-p atomic orbitals.

2) It is less reactive

3) It is a strong bond as atomic orbitals overlap to a considerable extent.

4) The electron cloud of σ -bond is symmetrical about molecular axis.

1) This bond formed by sideways or particular overlapping of p-p atomic orbitals.

2) It is more reactive.

3) It is weak bond as atomic orbitals overlap to a little extent.

4) The electron cloud of π -bond is unsymmetrical.



Q. 5 (a)

→ i) Doping is obtained by exposing a polymer to a charge transfer agent either in gas phase or in solution phase. The conductivity of intrinsically conducting polymers can be increased by doping. It is of two types:

(a) P-doping:

(i) In this an intrinsically conducting polymer is treated with Lewis acid where oxidation process takes place and positive charges on the polymer backbone are created. Commonly used p-dopants are I_2 , Br_2 , AsF_5 , PF_6 , naphthylamine, etc.

(b) N-doping:

(i) In this an intrinsically conducting polymer is treated with a Lewis base where reduction takes place and negative charges are created on the polymer backbone. Commonly used n-dopants are Li , Na , Ca etc.

Applications of Conducting Polymers:

- 1) In wiring in aircrafts and aerospace components.
- 2) In electromagnetic screening materials.
- 3) In photovoltaic devices.
- 4) In molecular wires and molecular switches.



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Q. 5(b)

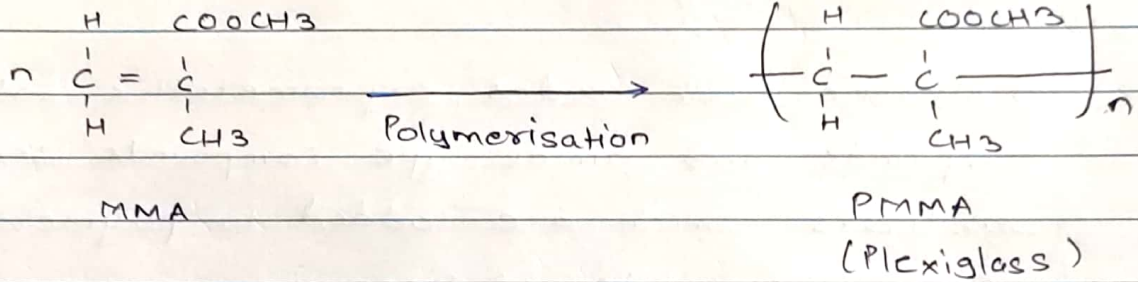
- i) Aromaticity of benzene can be best described by using the molecular orbital concept. The orbital structure of benzene shows that each carbon atom in benzene is sp^2 hybridized.
- 2) The C-H bonds in benzene are sp^2-s , σ bonds. The C-C bonds are sp^2-sp^2 , σ bonds. The sp^2 hybridization of carbon atoms of the ring are in same plane with angle of 120° .
- 3) Thus, for a compound to be aromatic it is not just enough to have Huckel number of electrons on the planar ring, there must be circular delocalized cloud of π electrons.
- 4) The cyclic unsaturated compounds will be aromatic if they contain $(4n+2)$ delocalized π electrons in the form of circular cloud above and below the plane of ring.
- 5) Thus in terms of molecular orbital theory, resonance is delocalization of electrons in number of adjacent molecular orbitals.



Q. 3 (a)

→ i)

→

i) Synthesisii) Properties:

- It has high optical transparency.
- It has low scratch resistance.
- $T_g = 65^\circ\text{C}$.

iii) Uses:

- It is used in display, TV screens.
- Used in paints and adhesives.
- It is used in signal light lenses, glazing skylights.

99)

→

Filters:

- Filters are added to a base polymer to lower the manufacturing cost of a product made from it.
- It reduces the cost of plastic and increases the tensile strength and hardness.
- It decreases the shrinkage during moulding and reduces the flexibility.



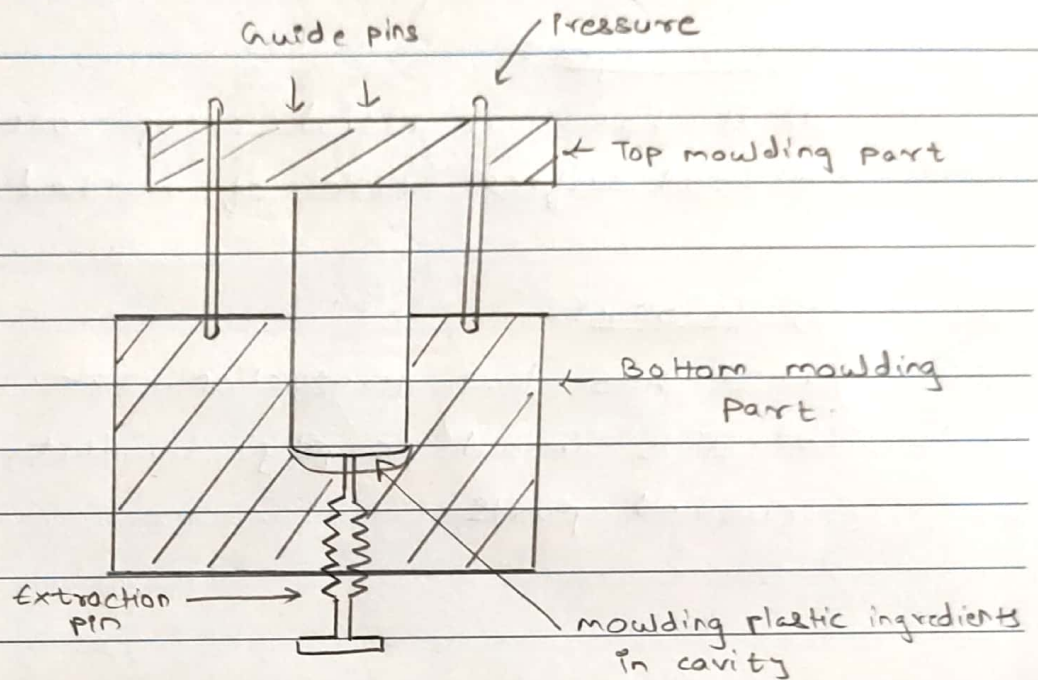
iv) eg: mica, talc, asbestos, chalk etc.

Stabilizers:

- i) Alkaline earth oxides, organometallic salts, epoxy compounds and amine type compounds serve as stabilizers which are added to polymers to prevent their degradation.
- ii) Their purpose is to improve the thermal stability during processing.
- iii) For example, during the moulding of vinyl chloride and vinylidene chloride polymers, heat stabilizers are used.



Q. 3 b)



i) It is most common method for moulding thermosetting materials which can withstand high temperature and pressure.

ii) This process consists of compressing the molten resinous material into the desired shape by use of moulds, heat and pressure.

3) A predetermined quantity of resin powder is preheated to about 120°C before the cavity of mould is filled with it.

4) After charging the mould, the 2 parts are brought together and compressed by hydraulic pressure.

5) After the curing, the moulding articles are taken out by opening mould apart.

6) A variety of products ranging from ash trays and switch boxes are manufactured this way.



⇒ Advantages :

- a) It has low initial setup cost.
- b) Good surface finish of molded parts.

8) Limitations :

- a) It has low production rate.
- b) It is limited largely to flat or moderately curved parts.