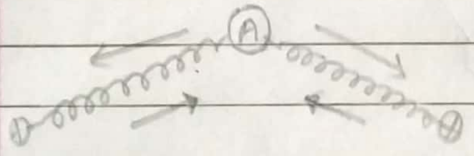
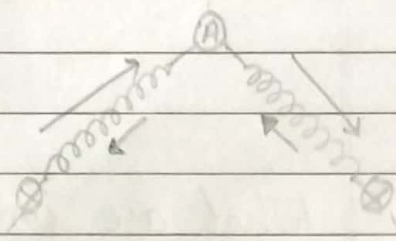
Q.8 (a)(i) Define IR spectroscopy. Discuss various molecular vibrations in this technique.

Ans) IR spectroscopy is the spectroscopic technique which uses the Infrared light and studies its interaction with the molecules.

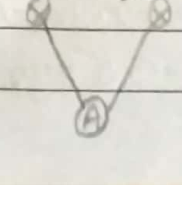
There are two types of molecular vibrations :-
(i) Stretching
(ii) Bending

I. Stretching :- When distance between two atoms is increasing or decreasing but atoms remain in same bond axis i.e. no change in the bond angle.
(a) Symmetric :- Movement of atoms w.r.t. particular atom is in the same direction.
(b) Asymmetric :- One atom approaches the central atom while the other departs from it.

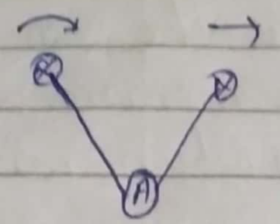




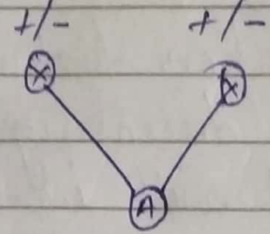
II. Bending :- Position of atoms changes w.r.t. original bond axis i.e. bond angle changes but internuclear distance does not change.
There are four types of bending vibrations.
(a) Scissoring :- When two atoms approach each other.



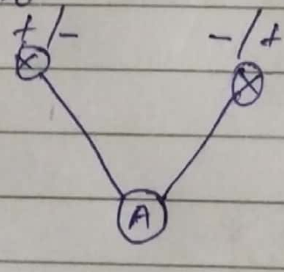
(b) Rocking: When the atoms is in the same direction.



(c) Wagging:- When two atoms move above or below the plane w.r.t central atom.



(d) Twisting:- One of the atom move up and other moves below the plane w.r.t. central atom.



(ii) What are ion-exchange resins? Describe in details the ion-exchange process for demineralization of water.

Ans) An ion-exchange resin or ion-exchange polymer is a resin or polymer that acts as a medium for ion exchange. It is an insoluble matrix normally in the form of small (0.25 – 0.5 mm radius) microbeads, usually white or yellowish, fabricated from an organic polymer substrate. The beads are typically porous, providing a large surface area on and inside them. The trapping of ions occurs along with the accompanying release of other ions, and thus the process is called ion exchange.

Ion-exchange process for demineralization of water:- Demineralization of water is the removal of essentially all inorganic salts by ion exchange. In this process, strong acid cation resin in the hydrogen form converts dissolved salts into their corresponding acids, and strong base anion resin in the hydroxide form removes these acids.

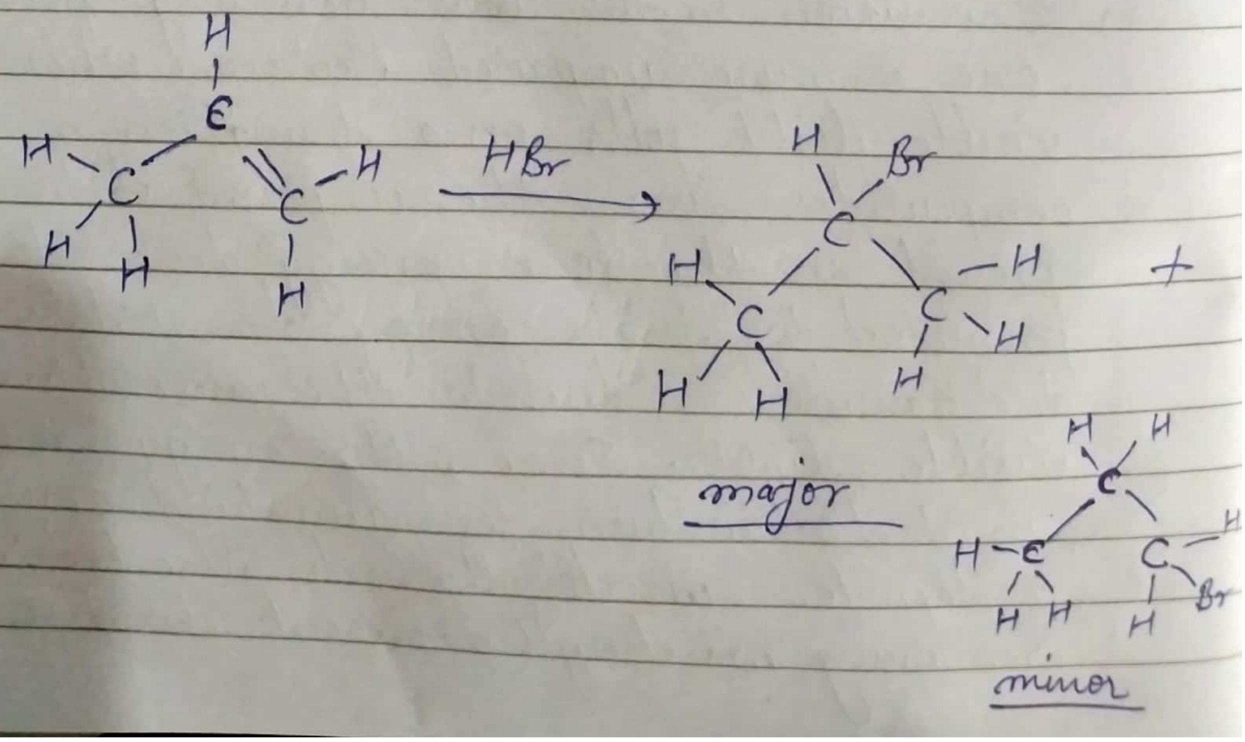
(iii) Why do transition elements form coloured compounds? explain.

Ans) Transition metal ions generally possess one or more unpaired electrons. When visible light falls on a transition metal compound or ion, the unpaired electrons present in the lower energy d- orbital get promoted to high energy d- orbitals, called d-d transition, due to the absorption of visible light. Since, the energy involved in d-d transition is quantised, only a definite wavelength gets absorbed; remaining wavelengths present in the visible region got transmitted. Therefore, transmitted light shows some coloured complementary to the absorbed colour.

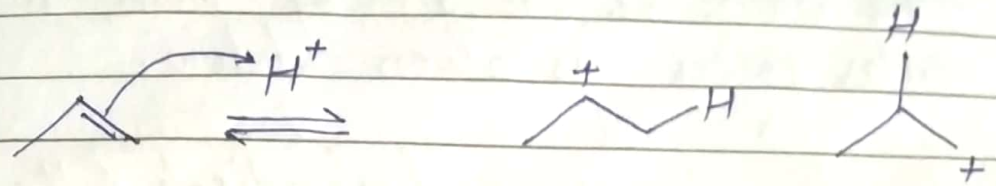
Q.9. (i) What is Markownikoff's rule? Give an example and discuss its mechanism.

Ans) In organic chemistry, Markownikoff's rule is used to describe the outcome of some chemical addition reactions.

Markownikoff's rule:- When a protic acid (HX) is added to an asymmetric alkene, the acidic hydrogen attaches itself to the carbon having a greater number of hydrogen substituents whereas the halide group attaches itself to the carbon atom which has a greater number of alkyl substituents.

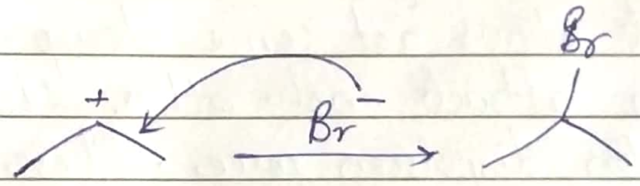


Mechanism :- Step-1 :-



Here are two types of carbocations that can be formed from the protonation of the alkene, one is a primary carbocation and the other is a secondary carbocation. However, the secondary carbocation is far more stable and therefore, its formation is preferred over the formation of a primary carbocation.

Step. 2 :-



The halide ion nucleophile now attacks the carbocation. This reaction yields the alkyl halide. Since the formation of the secondary carbocation is preferred, the major product of this reaction would be 2- bromopropane as illustrated.

(ii) Write a short note on London forces. What are the factors which affecting strength of these forces?

Ans-) The force of attraction between molecules which hold them together are called the intermolecular force of attraction. These forces are weaker than intramolecular forces. The order of strength of these intermolecular forces is given below:

London dispersion force < dipole-dipole < H-bonding < ion-ion

Thus London dispersion forces are a weakest intermolecular force. London dispersion forces can be defined as a temporary attractive force due to the formation of temporary dipoles in a non-polar molecules. When the electrons in two adjacent atoms displaced in such a way that atoms get some temporary dipoles, they attract each other through the London dispersion force. These intermolecular forces occur between non-polar substances. Due to these forces, they can condense to liquids and or freeze into solids at low temperature.

$\mu = \alpha \times E$

where μ = induced dipole moment

α = Polarizability

E = Electric field

London forces are determined with the help of μ.

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Factors affecting strength of these forces:-

1. Molecular Size :- Larger and heavier atoms and molecules exhibites stronger dispersion forces than smaller and lighter ones.

2. Molecular Shape:-
- At room temperature, neopentane (C_5H_{12}) is a gas whereas n-pentane (C_5H_{12}) is a liquid.
- London dispersion forces between n-pentane molecules are stronger than those between neopentane molecules even though both molecules are non polar and have the same molecular waight.

(iii) Consider a cell composed of the following half cells at 298 K:
(a) $Mg(s) \mid Mg^{2+}(aq)$;
(b) $Ag(s) \mid Ag^{+}(aq)$

the emf. of cell is 2.96 V at $[Mg^{2+}] = 0.130\,M$ and $[Ag^{+}] = 1 \times 10^{-4}\,M$. Calculate standard emf. of cell.

Soln:- Standard emf. of cell (E°_{cell}) = EMF of Cell (E_{cell})

$$+ \frac{0.0591}{2} \log \frac{[Mg^{2+}]}{[Ag^{+}]^2}$$

$$= 2.96 + \frac{0.0591}{2} \log \frac{[0.130]}{[0.0001]} = 2.96 + \frac{0.0591}{2} \log 1300$$

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$$= 2.96 + \frac{0.0591}{2} \times 3.1139$$

$$= 2.96 + 0.092 = \underline{3.05\ V}$$ Ans.