CHEMISTRY GRADE 10 SAMPLE QUESTIONS AND SHORT NOTES FOR GRADE 12

Introduction to Organic Chemistry

THESE QUESTIONS ARE PROVIDED TO SEE IF YOU HAVE MASTERED THE CONCEPTS OF THE CHAPTER **"INTRODUCTION TO ORGANIC CHEMISTRY"** COVERED IN GRADE **10**. DO NOT USE YOUR BOOK OR NOTES ON YOUR FIRST ATTEMPT AT THESE PROBLEMS.

1. The first organic compound synthesized in the laboratory from an inorganic compound is:
   A. NH_4NCO B. NH_2-CO-NH_2 C. CH_3COOH D. CH_4
   Ans. The first organic compound synthesized in the laboratory from an inorganic compound is urea which is NH_2CONH_2.
   Before the beginning of the nineteenth century, chemists classified compounds into two classes; organic and inorganic. Those derived from living things (plants and animals) were classified as organic compounds, while those that came from mineral constituents of the earth or were found with non-living things are classified as inorganic compounds.
   Urea was the first organic compound synthesized in the laboratory. The synthesis of urea by Friedrich Wöhler and subsequent synthesis of other organic compounds marked the downfall of the 'life force' theory.
2. What are the two properties of carbon which lead to the huge number of carbon compounds we see around us?
   Ans. The two features of carbon that give rise to a large number of compounds are as follows:
   I. **Catenation**: It is the ability to form bonds with other atoms of carbon.
   The main reason for the presence of millions of carbon compounds is the unique property of carbon called **catenation.** Catenation is the ability of atoms of the same element to join together forming short or long chains and rings. A few other elements like sulphur, silicon and boron show this behaviour, but to a much lesser extent.
   II. **Tetravalency:** With the valency of four, carbon is capable of bonding with four other atoms.
3. There are many properties of the element carbon which make it an important, almost unique, element. Which one of the following is perhaps the least important to a pharmacist (though nonetheless, is still interesting)?
   A. Carbon is able to bond too many other elements in the periodic table and hence become a part of a very wide range of organic compounds.
   B. A number of allotropes of carbon are now familiar - initially just diamond and graphite were known, though more recently, buckminsterfullerene and grapheme have also been reported.
   C. Carbon is able to bond to itself and form chains of atoms (it is able to catenate) in a way that few other elements can.
   D. Carbon is able to form single, double and triple bonds with a neighboring carbon atom, affecting the shape (and other properties) of the resulting compounds.
4. What makes carbon such a unique element?
   A. Elemental carbon comes in two forms, diamond and graphite.
   B. Carbon forms four bonds, although the ground state configuration would predict the formation of fewer bonds.
   C. Carbon forms covalent bonds rather than ionic bonds.
   D. To a greater extent than any other element, carbon can bond to itself to form straight chains, branched chains and rings.
   E. Carbon has two stable isotopes, carbon-12 and carbon-13
5. Which functional group does not contain oxygen?
   A. Ketone B. Carboxylic acid C. Ester D. Alcohol E. **Amine**

The functional group is the part of a molecule or a compound that determines the **chemical properties** of that molecule or compound. This group also determines **some of the physical properties of a compound**.

Based on the functional groups they possess, the most common classification of organic compounds including alkanes, alkenes, alkynes, aromatics, alcohols, aldehydes, ketones, carboxylic acids and esters.

6. The common feature found in all unsaturated hydrocarbons is
   A. One or more carbon-carbon double bonds.
   B. **One or more carbon-carbon multiple bonds**
   C. One or more carbon-carbon triple bonds.
   D. One or more rings of carbon atoms.

Hydrocarbons are organic compounds composed of the elements carbon and hydrogen only. Hydrocarbons are subdivided into two groups, based on the **type of bonding between carbon atoms**, as **saturated hydrocarbons** and **unsaturated hydrocarbons**. **Saturated Hydrocarbons** are those compounds of carbon and hydrogen containing only carbon-carbon single bonds. Methane, ethane, and propane are typical examples of this group. **Unsaturated Hydrocarbons** are those compounds of carbon and hydrogen possessing one or more multiple bonds (double or triple bonds) between carbon atoms. Alkenes, alkynes and aromatic hydrocarbons are examples of unsaturated hydrocarbons.

7. Homologues differ from each other by one _____ group.
   A. **Methylene** B. Alcohol C. Ketone D. Amine
8. Which of the following hydrocarbons does not belong to the homologous series of alkanes?
   A. C_3H_8 B. C_8H_{18} **C. C_6H_{10}** D. $C_{10}H_{22}$

A homologous series consists of homologues that vary from each other by one **methylene group**. A methylene group possesses the general formula of CH_2. Homologous series have four main characteristics:

- ❖ The presence of the same functional group
- ❖ A series of hydrocarbons with the same general formula such that the addition of another methylene group increases the number of carbon by one.
- ❖ Similarities in chemical properties due to the functional group in common to the series
- ❖ The molecules of a homologous series have the same general method of preparation

However, the physical properties associated with homologous series follow specific trends in terms of their boiling and melting points. For example, molecules in a homologous series have different boiling points due to differences in **London dispersion forces**.

For example in CH_4 and C_2H_6, the difference is -CH_2 unit and the difference between C_2H_6 and C_3H_8 is also -CH_2 unit. So CH_4, C_2H_6, and C_3H_8 are homologs. The same thing can be observed in the case of alkenes in which the first member is ethene and the successive members are C_3H_6, C_4H_8, and C_5H_{10}. They differ from each other by a –CH_2 unit. The Alkene formula is written as C_nH_{2n}.

9. Which one of the following statements regarding alkanes is false?
   A. Alkanes are non-polar molecules
   B. Alkanes experience dispersion forces
   C. Alkanes are soluble in water
   D. Alkanes have low boiling points

Physical Properties of Alkanes

- At room temperature, the first four alkanes, methane to butane, are gases; whereas pentane (C_5H_{12}) to heptadecane ($C_{17}H_{36}$) are liquids, and the alkanes containing eighteen and more carbon atoms are solids.
- Alkanes are nonpolar organic compounds. Weak intermolecular forces called Van der Waal's forces hold their molecules together. The strength of these forces increases with the increasing surface area (molecular mass) of the alkanes.
- Since alkanes are non-polar, they are almost insoluble in polar solvents like water, but, they are soluble In non-polar solvents like benzene, toluene, ether and carbon tetrachloride.

- The density, melting point, and boiling point of the homologous series of alkanes increase as the carbon number increases. For alkanes of the same carbon number, branched-chain isomers have lower boiling points than the straight-chain(normal) alkanes.

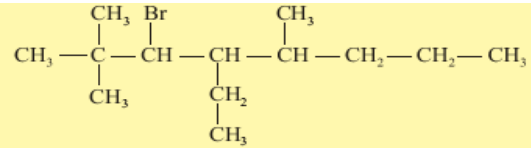
What is the correct decreasing order of boiling point?

1. Neopentane > Isopentane > Pentane
2. Pentane > Isopentane > Neopentane
3. Isopentane > Neopentane > Pentane
4. Neopentane = Isopentane = Pentane

10. Which of the following alkanes is a liquid at room temperature?

A. CH_4 B. **$C_{10}H_{22}$** C. C_4H_{10} D. C_3H_8

11. What is the IUPAC name of:



12. Which of the following statements are true about isomers:

A. They have the same molecular formula
B. They have different boiling and melting points
C. They are different compounds.
D. They have similar chemical properties.

The existence of two or more chemical compounds with the same molecular formula but different structures is called **isomerism**. The compounds that have the same molecular formula but different structures are called **isomers**. Alkanes exhibit a type of structural isomerism called **chain or skeletal isomerism**. These structures differ in the arrangement of the carbon atoms and hydrogen atoms. And because of different structural formulas, different isomers show **different physical and chemical properties, such as melting point, boiling point, and reactivity**, etc.

- Alkanes with 1-3 carbons, methane (CH_4), ethane (C_2H_6), and propane (C_3H_8,) do not exist in isomeric forms.

13. Draw all possible isomers for C_6H_{14} (There are five total).

Number of possible isomers = $2^{n-4} + 1$, $n \geq 4$ is no of c atoms

$= 2^{6-4} + 1$

$= 4 + 1$

$= 5$

14. Which among the following is not an alkane isomer with 6 carbon atoms?

A. Hexane B. 2,3-dimethylbutane C. 2,2-dimethylbutane D. Neopentane

Explanation: Neopentane is an isomer with 5 carbon atoms and hence it is not an isomer with 6 carbon atoms.

15. In the combustion reaction of alkanes if Ethane is used how many moles of oxygen are required?

A. 3 B. 4 C. 7 D. **3.5**

The major reactions of alkanes are the following:

I. **Combustion Reactions**: If alkanes are burned with limited supply of oxygen, they will form water and carbon monoxide and will liberate lesser amounts of heat energy. Alkanes burn in excess oxygen to form carbon dioxide and water, liberating a greater amounts of heat. The general equation for the reaction is:

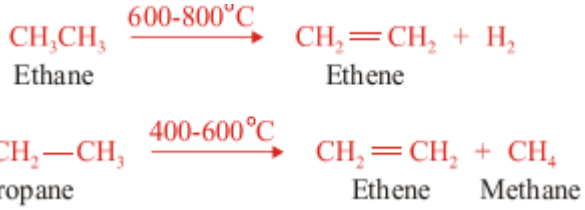
$$\mathbf{C_nH_{2n} + \frac{3n+1}{2} O_2 \rightarrow nCO_2 + (n+1)H_2O}$$

Example: $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

II. Substitution Reaction: This is a reaction that involves replacement of one atom or a group of atoms by another atom or group of atoms. Halogenation of alkanes is a very good example of substitution reaction. This reaction involves reacting alkanes with chlorine and bromine.

III. Elimination reaction: This type of reaction involves the removal of smaller molecules from a compound and leads to the formation of a compound containing a multiple bond (unsaturated compound). It can also involve the removal of hydrogen atoms from adjacent carbon atoms at relatively high temperatures.

Example:



16. Cycloalkanes have the same molecular formula as

A. Alkanes B. **Alkenes** C. Akynes D. Cycloalkenes

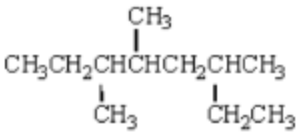
Cycloalkanes

Cycloalkanes are saturated hydrocarbons in which the carbon atoms are linked in such a manner as to form closed chains or ring structures. They are represented by the general formula, C_nH_{2n}, where $n \geq 3$. Cycloalkanes are isomeric with open-chain alkenes. Their names are obtained by prefixing "cyclo" to the name of an alkane containing the same number of carbon atoms. The following structures represent some examples of cycloalkanes.

17. What is the molecular formula of a cycloalkane that has six carbon atoms?

A. **C_6H_{12}** B. C_6H_{14} C. C_6H_{16} D. C_6H_{10} E. C_6H_7

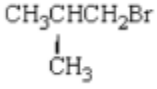
18. The correct IUPAC name for the following molecule is:



A. 6-ethyl-3,4,-dimethylheptane C. 2-ethyl-4,5-dimethylheptane

B. **3,4,6-trimethyloctane** D. 3,5,6-trimethyloctane

19. What is the common name for the following molecule?



A. **isobutyl bromide** B. tert-butyl bromide C. butyl bromide D. sec-butyl bromide

20. Which of the following structures is 2-methylpentane?

A) $CH_3CH_2CH_2CH_2CH_3$

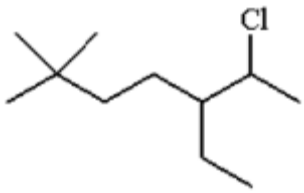
B) $CH_3CHCH_2CH_2CH_3$ (with CH_3 branch)

C) CH_3CCH_3 (with CH_3 and CH_3 branches)

D) 

E) $CH_3CH_2CHCH_3$ (with CH_3 branch)

21. The IUPAC name for the following molecule is:



A. 2-chloro-3-ethyl-6,6-dimethylheptane
B. 6-chloro-2,2-dimethyl-5-ethylheptane
C. 6-chloro-5-ethyl-2-dimethylheptane
C. 6-chloro-5-ethyl-2,2-dimethylheptane
D. 2,2-dimethyl-5-chloroethylheptane

22. Which among these is not a structural isomer of the compound C_4H_8?

A. But-1-ene B. But-2-ene C. **But-3-ene** D. 2-methylpropene

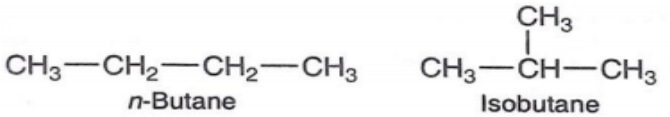
Alkenes

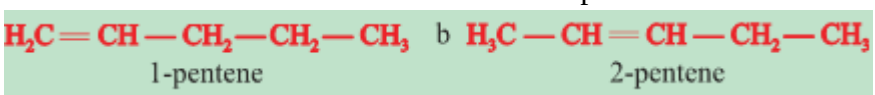
Alkenes are unsaturated hydrocarbons containing a carbon-carbon double bond as their functional group: They are also known as **olefins.** They form a homologous series represented by the general formula **C_nH_{2n}**

Isomerism in Alkenes

Alkenes containing two and three carbon atoms have only one possible structure. Alkenes containing four or more carbon atoms exhibit isomerism. Alkenes show the following three types of isomerism:

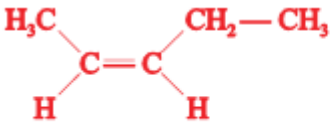
1. **Chain isomerism:** This is due to the difference in the arrangement of the carbon atoms in the longest continuous carbon chain.
   Example:



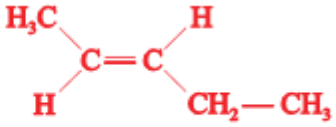
2. **Position isomerism**: This is due to the difference in the position of the double bond in the carbon chain.
   Example 

3. **Geometrical isomerism**. This results from the difference in the relative spatial arrangement of atoms or groups about the double bond. To differentiate geometrical isomers, we use the prefix 'cis' if two similar groups are on the same side of the double bond and 'trans' when the two similar groups are on opposite sides of it; 'cis' means the same and 'trans' means across.

Example:



cis-2-pentene or *cis*-pent-2-ene



trans-2-pentene or *trans*-pent-2-ene

Alkenes have more isomers than the corresponding alkanes.

23. For which of the following is cis-trans isomerism possible?

A. 1,2-dibromoethyne B. 1,1-dibromoethane C. 1,1-dibromoethene D. 1,2-dibromoethene

24. Select the incorrect statement regarding alkenes.

A. In alkenes, the carbons are connected by pi bonds

B. Alkenes have almost same physical properties as that of the alkanes

C. Alkenes are less reactive than alkanes

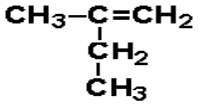
D. Alkenes undergo polymerization reaction

Explanation: Alkenes are not less reactive than alkanes, indeed they are very reactive compared with them due to the presence of C=C.

Physical Properties of Alkenes

- At room temperature, alkenes containing two to four carbon atoms are gases.
- Those containing five to seventeen carbon atoms are liquids, and those containing eighteen or more carbon atoms are solids.
- Alkenes are non-polar. Therefore, their molecules are held together by weak inter-molecular forces. Since they are non-polar.
- They are almost insoluble in polar solvents like water, but soluble in non-polar solvents like ether, benzene, toluene and carbon tetrachloride**.**

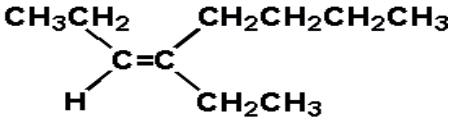
25. The correct name for the compound given below is:



A. **2-methyl-1-butene** C. 2-ethyl-1-propene E. 2-ethyl-1-pentane D.

B. 3-methyl-2-butene D. pentene

26. Select the best name for:



A. **4-ethyl-cis-3-octene** C. 4-ethyl-trans-3-octene

B. 4-butyl-cis-3-hexene D. 5-ethyl-trans-5-octene E. 5-ethyl-cis-5-octene

27. The reaction of propane with bromine is called? A.

A. halogenation B. addition C. elimination D. combustion

28. The product of the reaction ($CH_3–CH=CH–CH_2–CH_2–CH_3 + Br_2$) is

A. **$CH_3–CHBr–CHBr–CH_2–CH_2–CH_3$** C. $CH_3–CHBr_2–CHBr_2–CH_2–CH_2–CH_3$

B. $CH_2=CHBr–CHBr–CH_2–CH_2–CH_3$ D. $CH_3–CHBr =CHBr–CH_2–CH_2–CH_3$

29. Addition reaction of hydrogen Bromide to the unsymmetrical alkene follows _____

A. Anti markovnikov's rule C. Markovnikov's rule

B. Kharish effect D. Peroxide effect

Explanation: According to markovnikov's rule the negative part of the addendum which means adding molecule, gets attached to that carbon atom which possesses less number of hydrogen atoms, it's the opposite of anti markovnikov's rule.

Chemical properties of Alkenes

I. **Combustion reaction.** Alkenes burn in oxygen with a luminous flame to form carbon dioxide and water

General reaction: $C_nH_{2n} + \left(\frac{3n}{2}\right)O_2 \rightarrow nCO_2 + nH_2O + \text{heat}$

Example

$C_4H_8(g) + 6O_2(g) \rightarrow 4CO_2(g) + 4H_2O(g) + \text{heat}$

II. **Addition reaction**. Alkenes undergo mainly addition reactions. The addition occurs at the carbon-carbon double bond.

A. Addition Of Halogens: When a halogen molecule, X_2, (where, $X_2 = Cl_2$ or Br_2) is added to alkenes, the product is a dihaloalkane.

General reaction:

$$R-CH=CH_2 + X_2 \longrightarrow R-\underset{X}{CH}-\underset{X}{CH_2}; \quad (X_2 = Cl_2, Br_2)$$

Alkene Halogen Dihaloalkane

$$CH_3-CH=CH_2 + Cl_2 \longrightarrow CH_3-\underset{Cl}{CH}-\underset{Cl}{CH_2}$$

Propene 1,2-dichloropropane

Note: If bromine water (bromine in CCl_4) is added to alkenes, the reddish brown colour of Br_2 in CCl_4 will disappear. This is due to the addition of bromine (Br_2) across the double bond. So, Br_2in CCl_4 is used to detect unsaturation (presence of multiple bond) in a compound.

B. **Addition of hydrogen (Hydrogenation):** Addition of hydrogen molecule to alkenes in the presence of a nickel or platinum catalyst yields alkanes.

General reaction: $R-CH=CH_2 + H_2 \xrightarrow{Pt} R-CH_2-CH_3$

Alkene Alkane

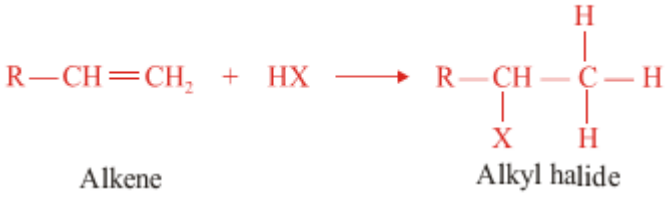
Example

$$CH_2=CH_2 + H_2 \xrightarrow{Pt} CH_3-CH_3$$

Ethene Ethane

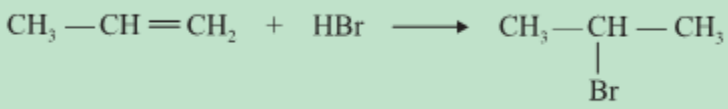
III. **Addition of hydrogen halides, HX (hydro halogenation):** Addition of hydrogen halide (HCl, HBr or HI) to alkenes leads to the formation of alkyl halides. The product of the reaction can be predicted **by Markovnikov's rule;** which states that "when an alkene reacts with hydrogen halide to give an alkyl halide, the **hydrogen adds to the carbon atom of the double bond that has the greater number of hydrogen atoms,** and the halogen to the carbon that has the fewer number of hydrogen atoms". The same is true when an alkene reacts with water in an addition reaction to form an alcohol.

General reaction:



Alkene Alkyl halide

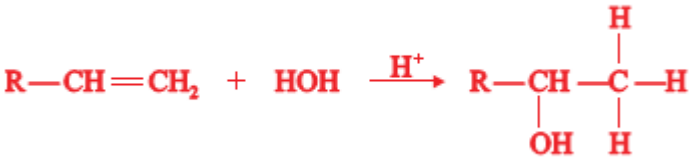
Example



Propene **2-bromopropane**

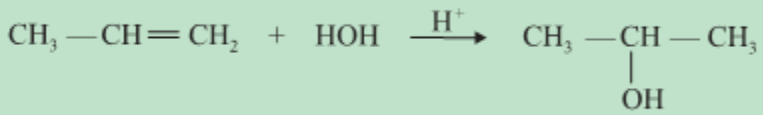
IV. **Addition of water (hydration):** When alkenes are hydrated in the presence of an acid catalyst, they produce alcohols, in accordance with **Markovnikov's rule.**

General reaction:



Alkene Alcohol

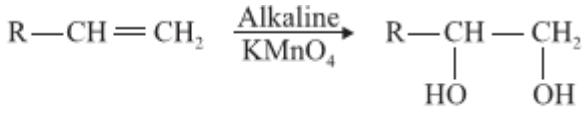
Example



Propene **2-propanol**

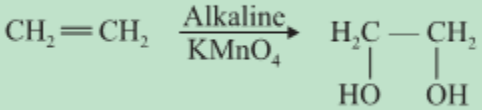
V. **Oxidation of alkenes**: Oxidation of alkenes with cold alkaline **potassium permanganate solution ($KMnO_4$)** forms **diols** (compounds containing two hydroxyl groups).

General reaction:



Alkene **Diol**

Example



Ethene **1,2-ethanediol**

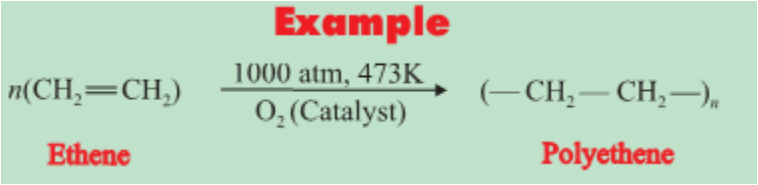
Note: Alkaline $KMnO_4$ solution is also used as a qualitative test for the identification of unsaturation in a compound. The solution is called Baeyer's reagent. In the presence of unsaturated hydrocarbons, the purple colour of alkaline $KMnO_4$ solution fades and a brown precipitate is formed.

30. Which of the following is a Bayer's reagent?

A. The neutral solution of HCL
B. An alcoholic solution of sodium carbonate
C. An acidic solution of potassium hydroxide
D. An aqueous solution of potassium permanganate

Explanation: The dilute aqueous solution of potassium permanganate is known as Bayer's reagent. Alkenes decolorize Bayer's reagent and it is used as a test for unsaturation in alkenes.

VI. **Polymerization (self-addition) of alkenes**: Polymerization is the union of small molecules called monomers to form a large molecule called a polymer.



31. Which of the following will undergo an addition reaction with chlorine?

A. $CH_3CH_2CH_2CH_3$ B. **$CH_3CH_2CH{=}CHCH_3$** C. C_6H_6 D. CH_3CH_2COOH E. CH_3CH_2OH

32. What is the expected product formed from the reaction between 2-butene and Cl_2?

A. 1-chlorobutane B. 2-chlorobutane C. 2,3-dichlorobutane D. 2,2-dichlorobutane E. 3,3-dichlorobutane

33. The segment $-CH_2CH_2CH_2CH_2CH_2CH_2-$ represents the polymer named _____ .

A. Polybutylene B. Polyhexene C. Polypropylene D. polystyrene E. polyethylene

34. Which of the following compounds can exhibit geometrical isomerism?

A. 2-Pentyne B. 2-Pentene C. 2-Methylpropene D. 2-Methyl-2-butene

Ans. 2-Pentene can exhibit geometrical isomerism as each doubly bonded carbon atom contains different groups.

35. Acetylene is also called

A. Ethyne B. ethene C. ethane D. methane

Alkynes are another group of unsaturated hydrocarbons possessing a triple bond as their functional group. The homologous series of alkynes is represented by the general formula C_nH_{2n-2}, where $n \geq 2$. The first member of the group is commonly known as acetylene. The homologous series of alkynes is also called acetylene series.

36. Which of the following is used for welding?

A. CH_4 B. **C_2H_2** C. C_2H_6 D. C_2H_4

Ans. Acetylene is a colorless, sweet-smelling gas in pure form and is insoluble in water. It is usually stored as a Solution of acetone in steel cylinders. Combustion of acetylene with oxygen produces an intensely hot Flame of about 3000°C. Thus, a large quantity of acetylene is used as a fuel in oxy-acetylene torches for Cutting and welding metals.

37. What is the IUPAC name of the following compound?



A. 2,6-diethyl-3-nonyne C. 2,5-diethyl-3-nonyne E. 3,7-dimethyl-5-nonyne
B. **3,7-dimethyl-4-nonyne** D. 2,6-diethyl-3-heptyne

38. Ethyne decolorizes Br_2 in CCl_4. This is due to the formation of:

A. 1,1-dibromoethane C. 1,1,2,2-dibromoethene
B. 1,2-dibromoethane D. **1,1,2,2-tetrabromoethane**

Table 1.8 Comparison of some properties of Ethane, Ethene and Ethyne

Property	Ethane	Ethene	Ethyne
Nature of flame	Non-luminous	Luminous	Smoky luminous
Effect on colour of Br_2 in CCl_4	No effect	Decolorizes	Decolorizes
Effect on colour of alkaline $KMnO_4$	No effect	Decolorizes	Decolorizes

Addition of halogens: When molecule of an alkyne reacts with one and two molecules of halogens, it gives a dihaloalkene and a tetrahaloalkane, respectively.