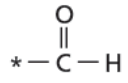
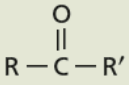
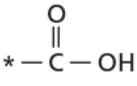
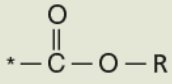
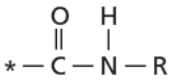
Chemistry Revision T3 – PART 2

Table 1 Organic Compounds and Their Functional Groups

Compound Type	General Formula	Functional Group
Halocarbon	R—X (X = F, Cl, Br, I)	Halogen
Alcohol	R—OH	Hydroxyl
Ether	R—O—R′	Ether
Amine	$R—NH_2$	Amino
Aldehyde		Carbonyl
Ketone		Carbonyl
Carboxylic acid		Carboxyl
Ester		Ester
Amide		Amide

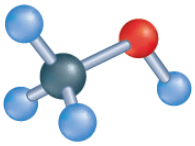
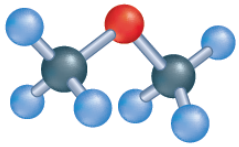
- The symbols R and R′ represent carbon chains or rings bonded to the functional group.
- An * represents a hydrogen atom, carbon chain, or carbon ring

Table 3 Substitution Reactions

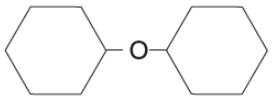
Generic Substitution Reaction $R—CH_3 + X_2 \rightarrow R—CH_2X + HX$ where X is fluorine, chlorine, or bromine	**Example of General Substitution Reaction (Halogenation)** $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$ Ethane Chloroethane
General Alkyl Halide-Alcohol Reaction $R—X + OH^- \rightarrow R—OH + X^-$ Alkyl halide Alcohol	**Example of an Alkyl Halide-Alcohol Reaction** $CH_3CH_2Cl + OH^- \rightarrow CH_3CH_2OH + Cl^-$ Chloroethane Ethanol
General Alkyl Halide-Ammonia Reaction $R—X + NH_3 \rightarrow R—NH_2 + HX$ Alkyl halide Amine	**Example of an Alkyl Halide-Ammonia Reaction** $CH_3(CH_2)_6CH_2Br + NH_3 \rightarrow CH_3(CH_2)_6CH_2NH_2 + HBr$ 1-Bromooctane 1-Octanamine

X can be fluorine, chlorine, or bromine, but **not** iodine. Iodine does not react well with alkanes

Table 5 Ethers

General Formula	Methanol and Methyl ether
ROR′ where R and R′ represent carbon chains or rings bonded to functional groups	 Methanol bp = 65°C  Methyl ether bp = −25°C

Examples of Ethers


Cyclohexyl ether

$CH_3CH_2CH_2-O-CH_2CH_2CH_3$
Propyl ether

$CH_3CH_2-O-CH_2CH_2CH_2CH_3$
Butyl ethyl ether

$CH_3CH_2-O-CH_3$
Ethyl methyl ether

Q1. Write the scientific term

1. An atom or group of atoms that always reacts in a certain way.
[.....] functional group

2. Any organic compound that contains a halogen substituent [.....] halocarbon

3. An organic compound containing a halogen atom covalently bonded to an aliphatic carbon atom. [.....] An alkyl halide

4. An alkyl halide that is used in the manufacturing process for silicone products, such as window and door sealants [.....] Chloromethane

5. An organic compound containing a halogen atom bonded to a benzene ring or other aromatic group [.....] aryl halide

6. A polymer that can be heated and molded while relatively soft [.....] plastic

7. A polymer that is provides a nonstick surface for many kitchen items, including bakeware
[.....] Polytetrafluoroethene (PTFE)

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8. A polymer that can be manufactured soft or hard, as thin sheets, or molded into objects. [……] polyvinyl chloride (PVC)

9. A reaction in which one atom or a group of atoms in a molecule is replaced by another atom or group of atoms. [……] substitution reaction

10. A reaction where hydrogen atoms of alkane can be replaced by atoms of halogens [……] halogenation reaction

11. Halogenated hydrocarbon which was first used as a general anesthetic in the 1950s. [……] halothane *(2-bromo-2-chloro-1,1,1-trifluoroethane)*

12. An oxygen-hydrogen group covalently bonded to a carbon atom [……] hydroxyl group

13. An organic compound in which a hydroxyl group replaces a hydrogen atom of a hydrocarbon [……] an alcohol

14. The product of reacting an alkyl halide with ammonia (NH_3) [……] alkyl amine

15. Ethanol to which small amounts of noxious materials, such as aviation gasoline has been added [……] Denatured alcohol

16. Industrial alcohol found in some paint strippers [……] Methanol

17. An alcohol that is found in some stains and varnishes [……] 2-butanol

18. An organic compound containing an oxygen atom bonded to two carbon atoms [……] An ether

19. A highly flammable substance that was commonly used as an anesthetic in surgery from 1842 until the twentieth century [……] ethyl ether

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20. Organic compounds that contain nitrogen atoms bonded to carbon atoms in aliphatic chains or aromatic rings and have the general formula RNH_2 [……] Amines

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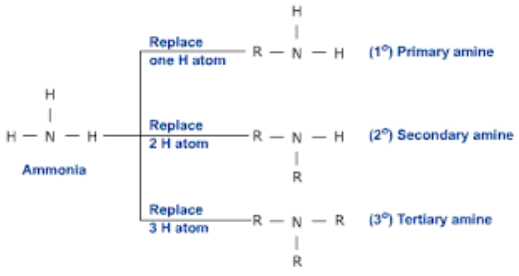
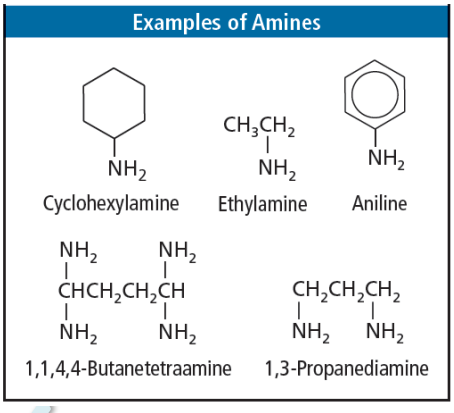
21. The amine that is used in the production of dyes with deep shades of color [……] aniline

Cyclohexylamine and **ethylamine** are important in the manufacture of pesticides, plastics, pharmaceuticals, and rubber that is used to make tires

Two amines found in decaying human remains are **putrescine** and **cadaverine**

- *Specially trained dogs are used to locate human remains using these distinctive odors*





22. The arrangement in which an oxygen atom is double-bonded to a carbon atom

- This group is the functional group in organic compounds known as aldehydes and ketones

[……] carbonyl group

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23. An organic compound in which a carbonyl group is bonded to a carbon atom on one side and a hydrogen atom on the other [……] An aldehyde

Table 7 Aldehydes

General Formula	Examples of Aldehydes
*CHO *represents an alkyl group or a hydrogen atom	Methanal (formaldehyde) Ethanal (acetaldehyde)
Carbonyl group	Benzaldehyde Salicylaldehyde Cinnamaldehyde

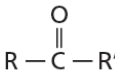
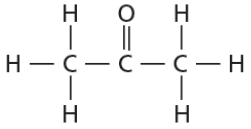
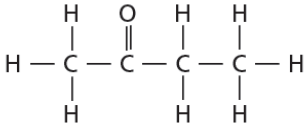
24. An Aldehyde that was used in the past to preserve biological specimens

[……] formaldehyde

25. An organic compound in which the carbon of the carbonyl group is bonded to two other carbon atoms. [……] A ketone

Ketones are polar molecules and are less reactive than aldehydes

Table 8 Ketones

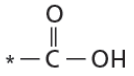
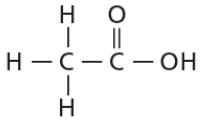
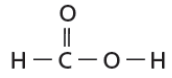
General Formula	Examples of Ketones
 where R and R′ represent carbon chains or rings bonded to functional groups	 2-Propanone (acetone)  2-Butanone (methyl ethyl ketone)

26. An organic compound that has a carboxyl group. [……] **A carboxylic acid**

27. A functional group consists of a carbonyl group bonded to a hydroxyl group.

[……] A carboxyl group

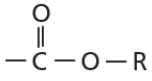
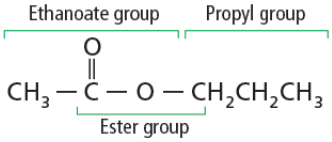
Table 9 Carboxylic Acids

General Formula	Examples of Carboxylic Acids
 where * represents a hydrogen atom, carbon chain or ring bonded to the functional group	 Ethanoic acid (acetic acid)  Methanoic acid (formic acid)

28. An acid with two carboxyl groups [……] a dicarboxylic acid

29. Any organic compound with a carboxyl group in which the hydrogen of the hydroxyl group has been replaced by an alkyl group [……] An ester

Table 10 Esters

General Formula	Example of an Ester
 Ester group	 Propyl ethanoate (propyl acetate)

The aroma of strawberries is due in part to methyl hexanoate.

Ethyl butanoate contributes to the aroma of pineapple

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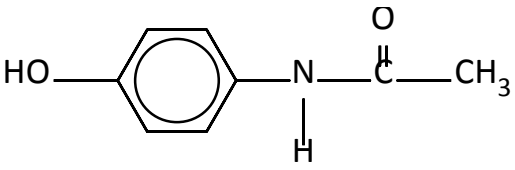
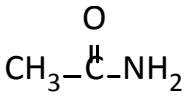
30. An organic compound in which the –OH group of a carboxylic acid is replaced by a nitrogen atom bonded to other atoms. [……] An amide



Acetaminophen



Ethanamide (acetamide)

UREA

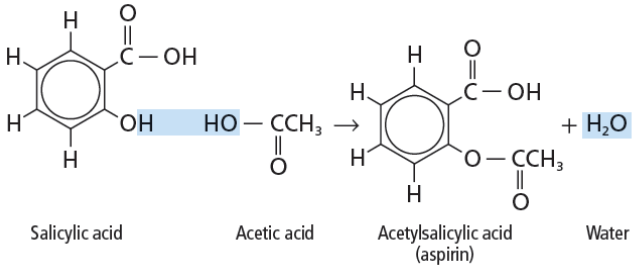
One important amide is **caramide (NH_2 –CO–NH_2)**, or urea

- Urea is an end product in the metabolic breakdown of proteins in mammals.
- It is found in the blood, bile, milk, and perspiration of mammals.
- When proteins are broken down, amino groups (NH_2) are removed from the amino acids.
- The amino groups are then converted to ammonia (NH_3) molecules that are toxic to the body.
- The toxic ammonia is converted to nontoxic urea in the liver.
- urea is a common commercial fertilizer.
- Urea is also used as a protein supplement for ruminant animals, such as cattle and sheep.

Classifying Reactions of Organic Substances

Condensation Reactions

two smaller organic molecules combine to form a more complex molecule, accompanied by the loss of a small molecule such as water



$$RCOOH + R'OH \rightarrow RCOOR' + H_2O$$

common way to synthesize an ester is by a condensation reaction between a carboxylic acid and an alcohol

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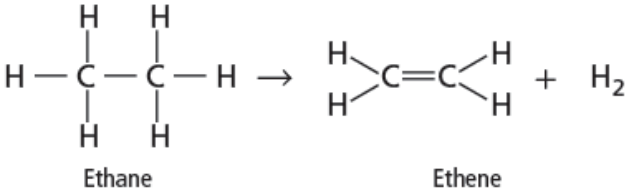
Elimination reactions

a reaction in which a combination of atoms is removed from two adjacent carbon atoms, forming an additional bond between them.

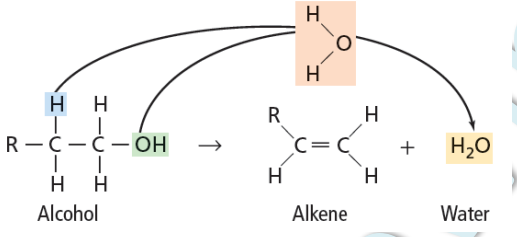
1. Dehydrogenation reaction

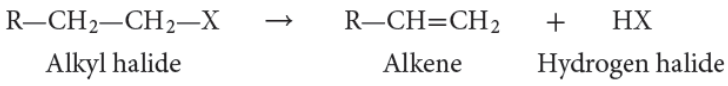
A reaction that eliminates two hydrogen atoms is called



2. Dehydration reaction

An elimination reaction in which the atoms removed form water





An addition reaction

Results when other atoms bond to each of two atoms bonded by double or triple covalent bonds.

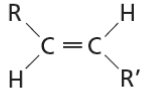
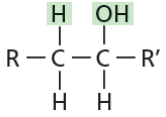
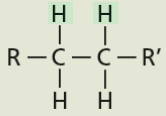
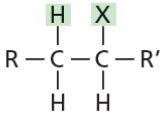
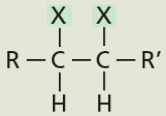
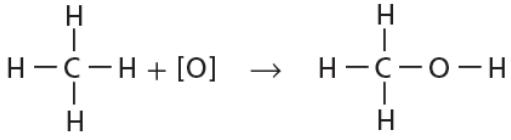
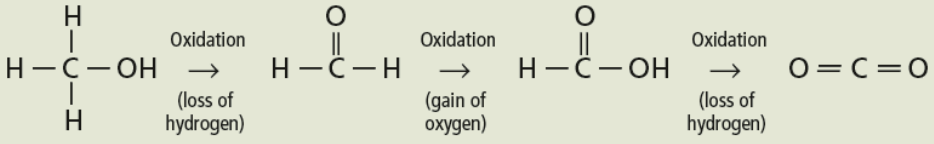
Reactant Alkene	Addition Reactant	Product
	Water (hydration) 	Alcohol 
	Hydrogen (hydrogenation) 	Alkane 
	Hydrogen halide 	Alkyl halide 
	Halogen 	Alkyl dihalide 

Table 13 Oxidation-Reduction Reactions

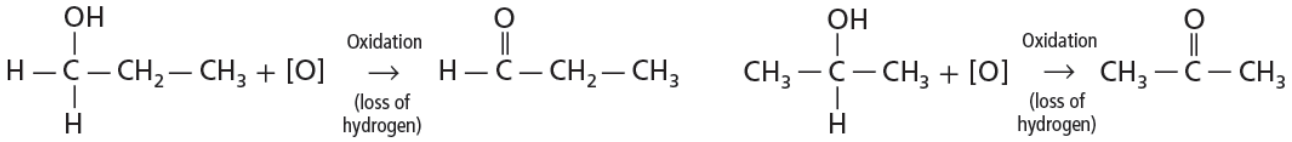
Oxidation of an alkane to an alcohol



A sequence of oxidation reactions



Oxidation of two isomers



$$2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l) \qquad \Delta H = -3120\ kJ$$

This reaction is considered as a burning and an oxidation reaction

31. Large molecules consisting of many repeating structural units [.....] Polymers

32. The first synthetic polymer, synthesized in 1909, was a hard, brittle plastic [.....] Bakelite

33. A molecule from which a polymer is made. [.....] A monomer

Polymerization reaction

A reaction in which monomer units are bonded together to form a polymer

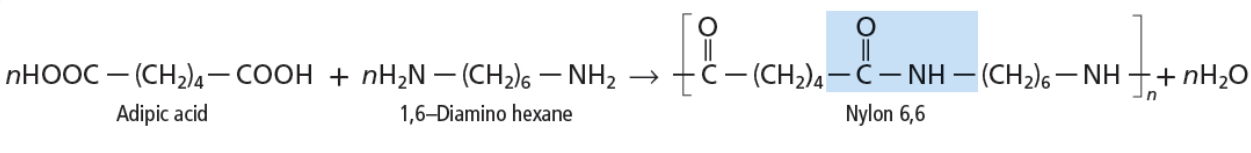


Figure 19 Nylon is a polymer consisting of thin strands that resemble silk.

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Addition polymerization	Condensation polymerization
1- Formed between similar monomers. 2- Monomer contains double bond . 3- Polymerization takes place by (breaking pi bond). 4- No co-polymer is formed. Ex. Polyethene , polypropene	1- Formed between two different types of monomers. 2- Monomer contains active groups like (-OH). 3- Polymerization takes place by emission of water. 4- co-polymer formed & that's able to polymerize. Ex. Bakelite , Nylon

A thermoplastic polymer	A thermosetting polymer
is one that can be melted and molded repeatedly into shapes that are retained when cooled.	is one that can be molded when it is first prepared, but after it cools, it cannot be remelted
Polyethylene and nylon	Bakelite

Thermosetting polymers are more difficult to recycle than thermoplastic polymers

because only thermoplastic materials can be melted and remolded repeatedly

Plastics recycling is somewhat difficult due to the large variety of different polymers found in products

Codes on plastic products aid in recycling because they identify the composition of the plastic

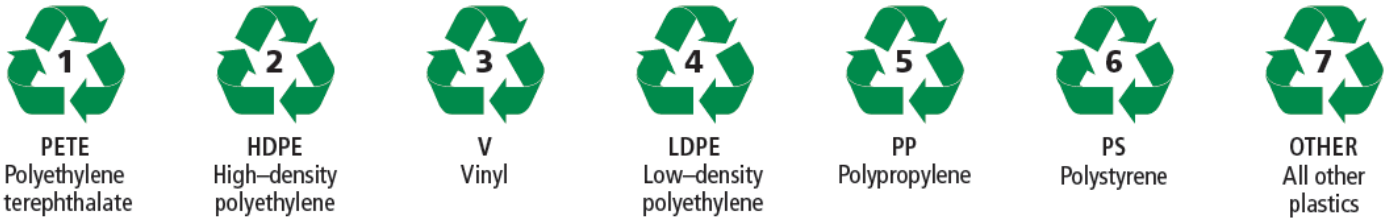

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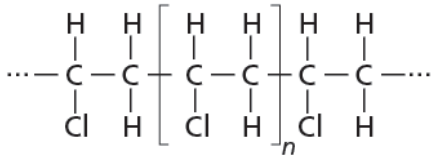
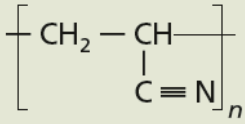
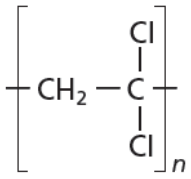
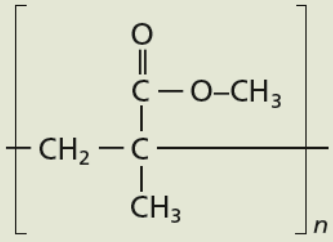
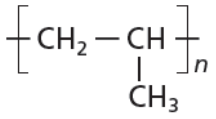
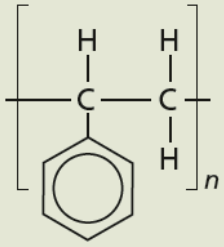
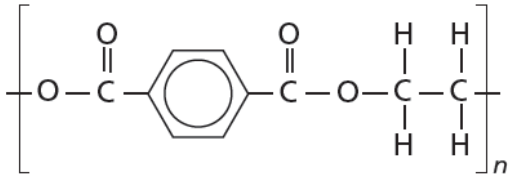
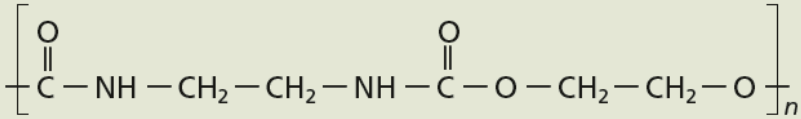
Table 14 Common Polymers

Polymer	Applications	Structural Unit
Polyvinyl chloride (PVC)	Plastic pipes, meat wrap, upholstery, rainwear, house siding, garden hose 	 Polyvinyl chloride
Polyacrylonitrile	Fabrics for clothing and upholstery, carpet	
Polyvinylidene chloride	Food wrap, fabrics 	
Polymethyl methacrylate	"Nonbreakable" (acrylic glass) windows, inexpensive lenses, art objects 	
Polypropylene (PP)	Beverage containers, rope, netting, kitchen appliances	
Polystyrene (PS) and styrene plastic	Foam packing and insulation, plant pots, disposable food containers, model kits 	
Polyethylene terephthalate (PETE)	Soft-drink bottles, tire cord, clothing, recording tape, replacements for blood vessels	
Polyurethane	Foam furniture cushions, waterproof coatings, parts of shoes	

Q2: Give reason

1. alkyl chloride has a higher boiling point and a higher density than the alkane with the same number of carbon atoms

- Alkyl chloride has higher molecular mass
- Alkyl chloride polar while the alkane is not polar
- Intermolecular forces between alkyl chloride is higher [need higher energy to break theses forces]

2. the boiling points and densities increase as the halogen changes from fluorine to chlorine, bromine, and iodine

- because the halogens from fluorine to iodine have increasing numbers of electrons that lie farther from the halogen nucleus
- this increases tendency to form temporary dipoles
- the energy needed to separate the molecules also increases

3. alkyl halides are often used as starting materials in the chemical industry.

- Halogen atoms bonded to carbon atoms are more reactive than the hydrogen atoms they replace
- halogen atom is replaced by another atom or group of atoms.

4. Alkyl halides are used as solvents and cleaning agents

- because they readily dissolve nonpolar molecules, such as greases

5. Alcohols have much higher boiling points than hydrocarbons of similar shape and size
Or. ethanol is completely miscible with water

- the hydroxyl groups of alcohol molecules are moderately polar
- and are able to form hydrogen bonds

6. Small amounts of noxious materials, such as aviation gasoline is added to Ethanol

- to prepare denatured ethanol in order to make it unfit to drink

7. ethers (& Aldhydes) are generally more volatile and have much lower boiling points than alcohols of similar size and mass

→***Ethers are much less soluble in water than alcohols***

- have no hydrogen atoms bonded to the oxygen atom
- their molecules cannot form hydrogen bonds *with each other*

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8. aldehydes are more soluble in water than alkanes but not as soluble as alcohols or amines.

- Water molecules can form hydrogen bonds with the oxygen atom of aldehydes,

9. Carboxylic acids can ionize in water solution

- because the two oxygen atoms are highly electronegative and attract electrons away from the hydrogen atom in the –OH group.
- As a result, the hydrogen proton can transfer to another atom that has a pair of electrons not involved in bonding, such as the oxygen atom of a water molecule

$$CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$$

Ethanoic acid (acetic acid) Ethanoate ion (acetate ion)

10. Catalysts are usually needed in the hydrogenation of alkenes

- because the reaction's activation energy is too large without them.
- Catalysts such as powdered platinum or palladium provide a surface that adsorbs the reactants and makes their electrons more available to bond to other atoms.

11. Bakelite is still used today in stove-top appliances

- Because of its resistance to heat

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Q3. Choice the correct answer

1. The boiling point of methanol is much higher than that of ethane. This is primarily due to

a. the difference in molar masses of methanol and ethane

b. the hydrogen bonding in methanol

c. the significant molecular size difference between methanol and ethane

d. the carbon oxygen double bond in the methanol

2. In which kind of reaction is a combination of atoms removed from two adjacent carbon atoms, forming an additional bond between the carbon atoms?

a. substitution **b.** elimination **c.** addition **d.** condensation

3. In which kind of reaction is an atom or group of atoms in a molecule replaced by another atom or group of atoms?

a. substitution **b.** elimination **c.** addition **d.** condensation

4. Which of the following is an example of a thermosetting plastic?

a. nylon **b.** polyethylene **c.** Bakelite **d.** none of the above

5. The simplest carboxylic acid is commonly known as

a. acetic acid. **b.** acetone. **c.** formaldehyde. **d.** formic acid.

6. Which of the following tend to be basic?

a. amides **b.** amines **c.** alcohols **d.** ethers

7. Which of the following is a type of addition reaction?

a. hydrogenation **b.** dehydration **c.** dehydrogenation **d.** halogenation

8. According to IUPAC rule, the name of the acid is ended by the suffix ……

a- ol. **b-** al. **c-** one. **d-** oic.

9. The IUPAC name of formic acid is …….

a- methanoic acid. **b-** ethanoic acid. **c-** propanoic acid. **d-** butanoic acid.

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10. What is the final product formed when CH_3CH_2OH is refluxed with acidified potassium dichromate(VI)?

A. CH_3CHO

B. $CH_2==CH_2$

C. CH_3COOH

D. $HCOOCH_3$

11. Which type of compound can be made in one step from a secondary alcohol?

A. an aldehyde

B. an alkane

C. a carboxylic acid

D. a ketone

12. Which formulas represent butane or its isomer?

I. $CH_3(CH_2)_2CH_3$

II. $CH_3CH(CH_3)CH_3$

III. $(CH_3)_3CH$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

13. Which substance is **not** readily oxidized by acidified potassium dichromate(VI) solution?

A. propan-1-ol

B. propan-2-ol

C. propanal

D. propanone

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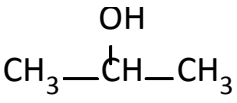
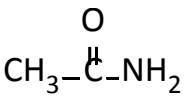
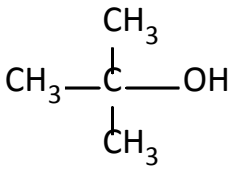
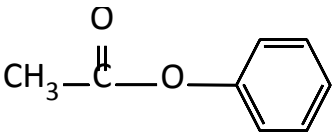
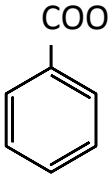
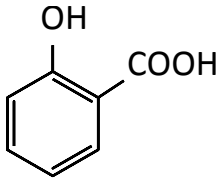
Q4- Study the following table then answer the following questions

1		**2**		**3**	
4		**5**		**6**	
7	$HCOOCH_3$	**8**	CH_3CH_2CHO	**9**	$C_6H_5COOCH_3$

(1) Choose from the previous table :

(1) An aliphatic compound which contains two functional groups.
(2) An aromatic compound which contains two functional groups.
(3) Compounds that convert litmus paper into red color
(4) Two structural isomers.
(5) Tertiary alcohol.
(6) Compound is oxidized to ketone.
(7) Compound is produced by oxidation of primary alcohol.
(8) An Amide
(9) A compound gives ethanoic acid by hydrolysis.
(10) An isomer of acetic acid.
(11) An alcohol is oxidized difficulty by normal oxidation factors.

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