NDA → 4-5 ⇒

① Acid & Base
② Oxid. & Red.
③ Carbon & comp.

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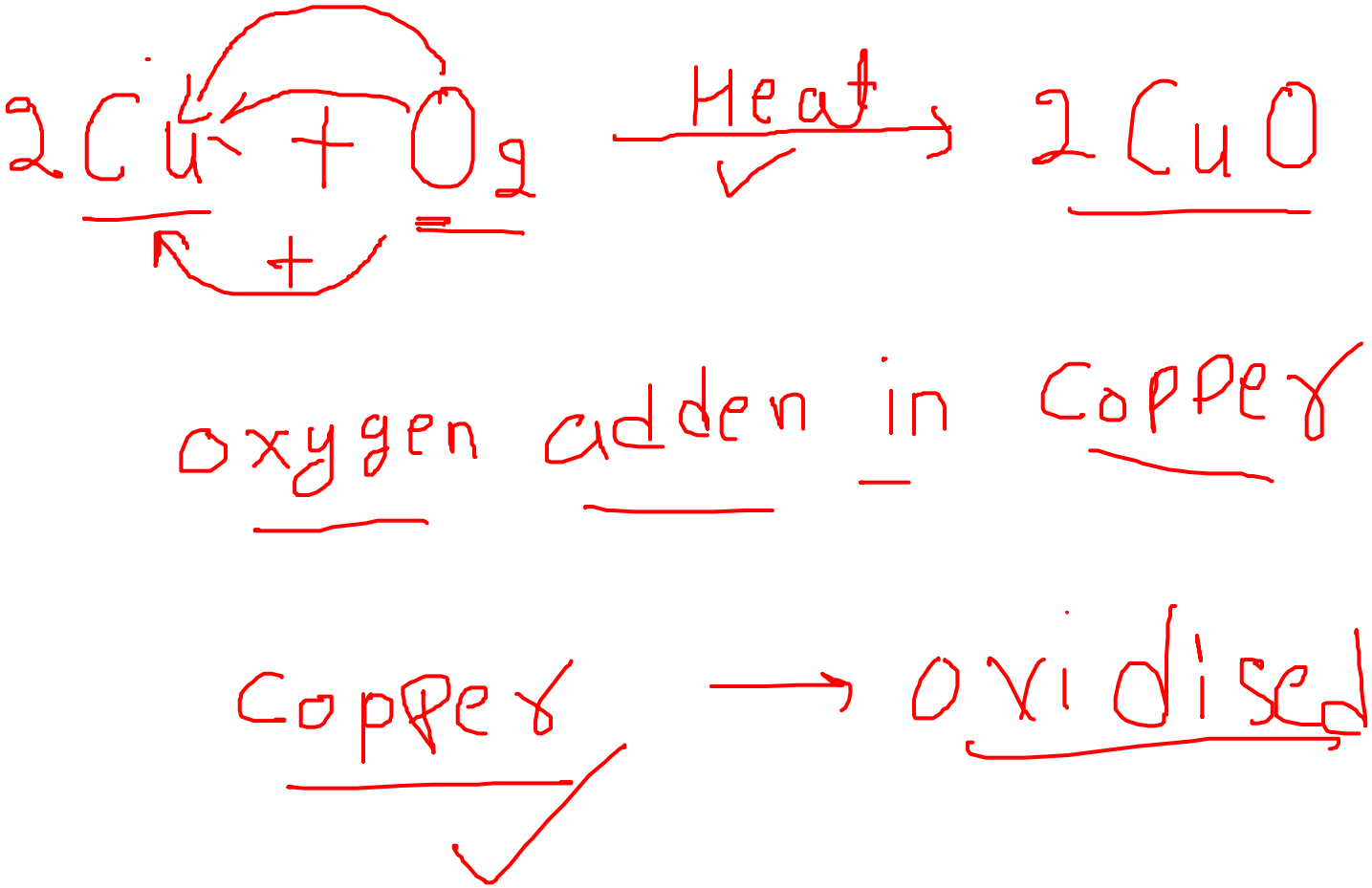
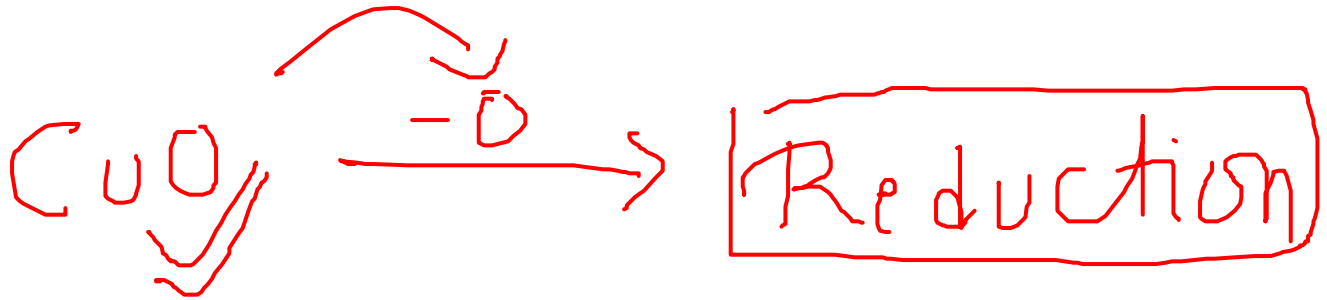
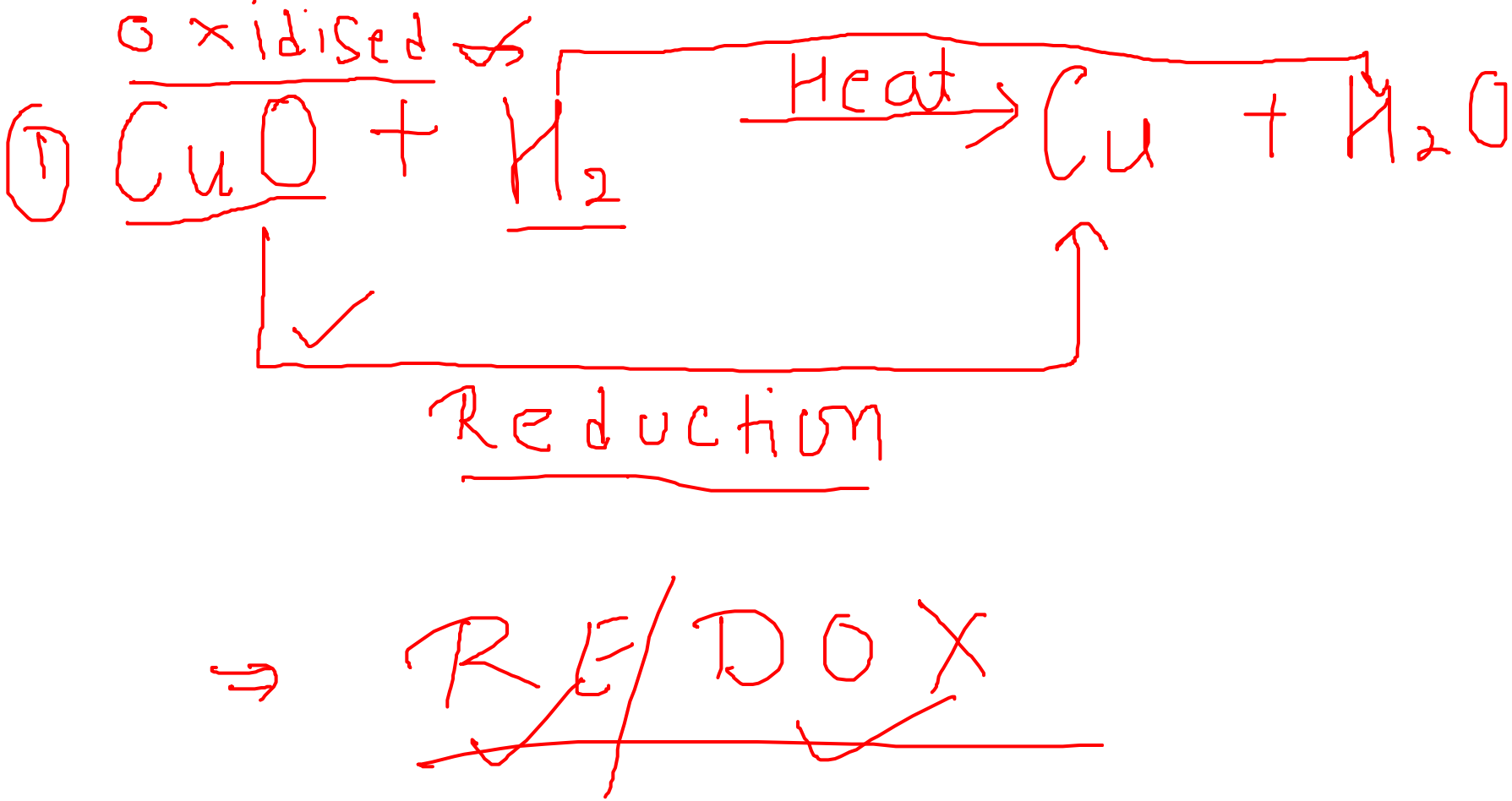
Oxidation-Reduction Reactions

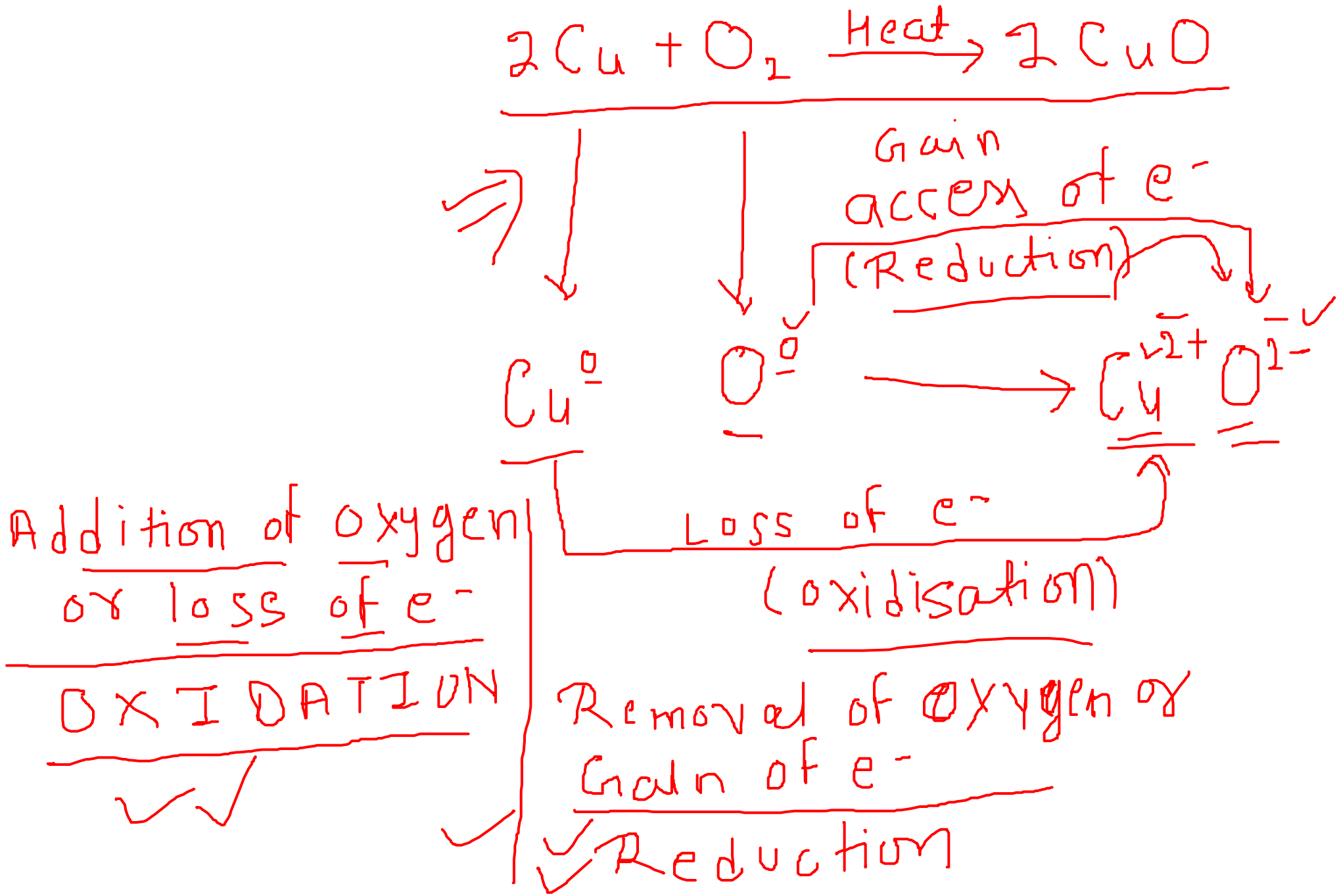

2Cu + O2
Heat
2CuO
oxygen adden in Coppey
Coppey
oxidised

Oxygen is removed from Copper.

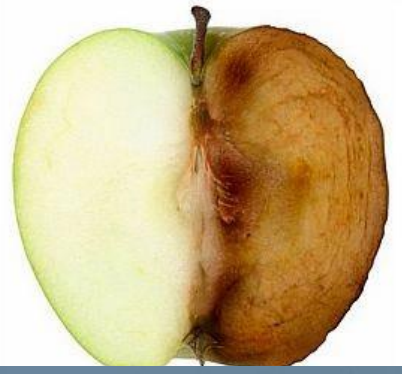


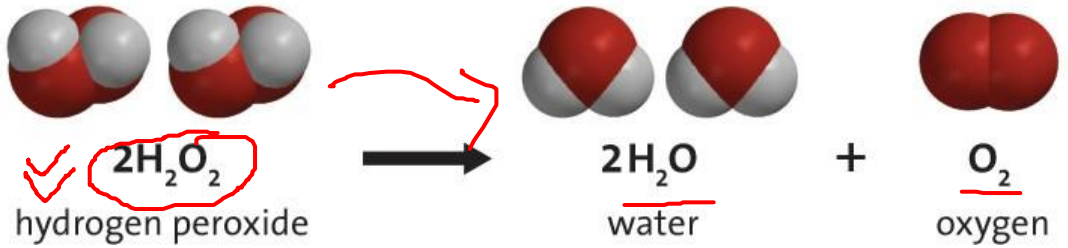


⇒ REDOX


2Cu + O2 Heat 2CuO
Gain access of e⁻ (Reduction)
Cu⁰ O⁰ Cu²⁺ O²⁻
Loss of e⁻ (oxidisation)
Addition of oxygen or loss of e⁻
OXIDATION
Removal of oxygen or Gain of e⁻
Reduction

What do these have in common?

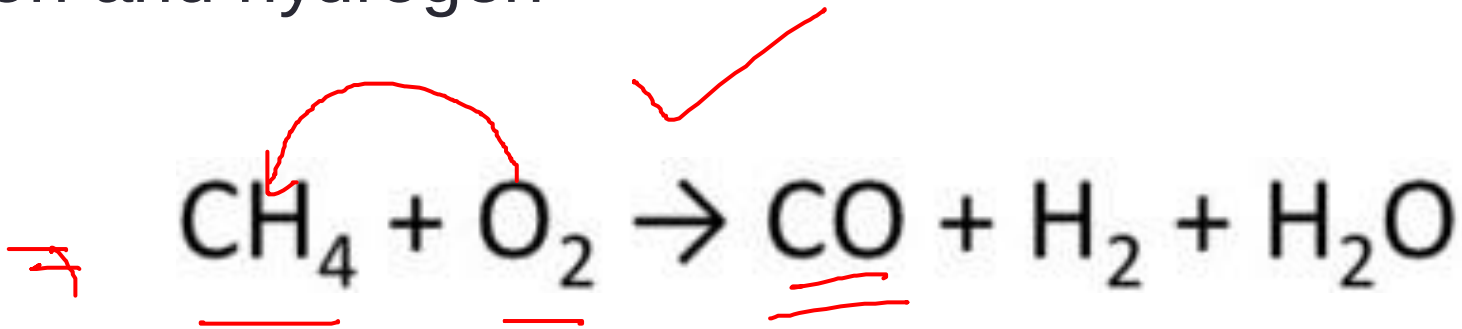




OXIDATION

- Originally, scientists described “oxidation” reactions as simply a substance combining with oxygen to form an oxide

- **EXAMPLE:** Burning of methane—methane oxidizes to form oxides of carbon and hydrogen



Opposite of oxidation…

- REDUCTION is the OPPOSITE of oxidation
  - Originally believed to only involve loss of oxygen from a compound
- **OXIDATION and REDUCTION** always occur simultaneously!!!
- OXIDIZED substance gains oxygen OR loses electrons
- REDUCED substance loses oxygen OR gains electrons

Early definition of OXIDATION

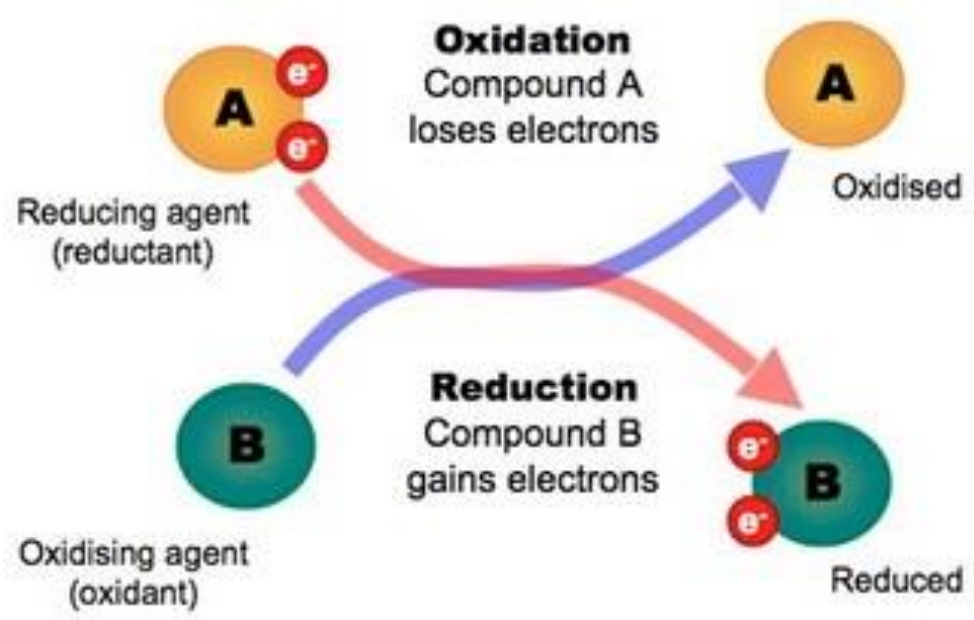
- Originally, scientists described “oxidation” reactions as simply a substance combining with oxygen to form an oxide

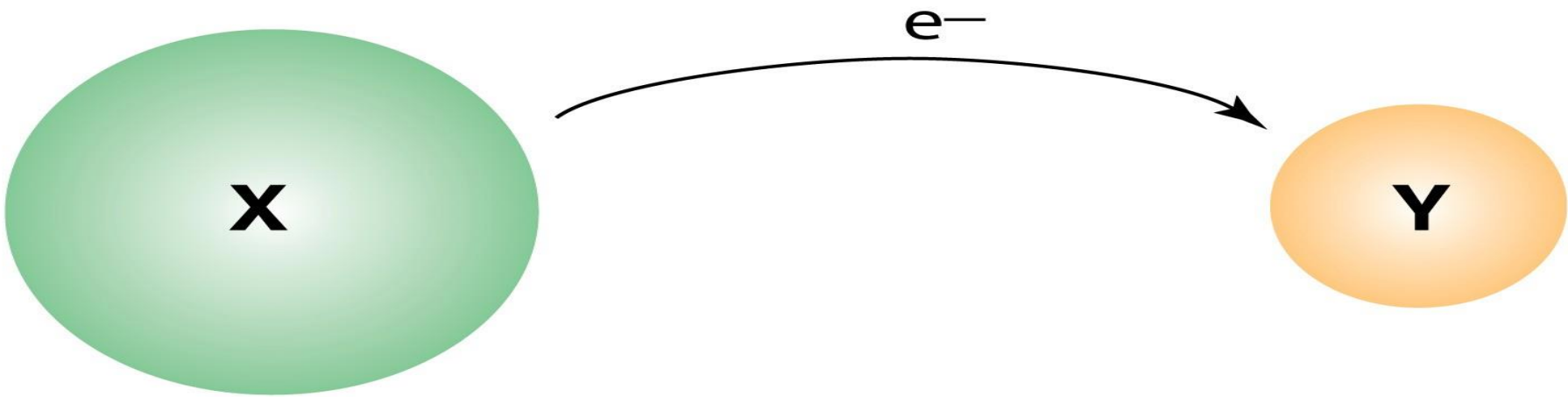
- **EXAMPLE:** Burning of methane—methane oxidizes to form oxides of carbon and hydrogen

$$CH_4 + O_2 \rightarrow CO + H_2 + H_2O$$

Learning the LINGO…

- Substance that is oxidized is the REDUCING agent
- Substance that is reduced is the OXIDIZING agent





Reducing agent	Oxidizing agent
X loses electrons	Y gains electrons
X is oxidized by Y (becomes more positive)	Y is reduced by X (becomes more negative)

When oxygen is NOTinvolved…

- Oxidation-Reduction reactions (“redox”) do not always involve oxygen
- **In redox reactions, <u>electrons are transferred</u> between the reactants**

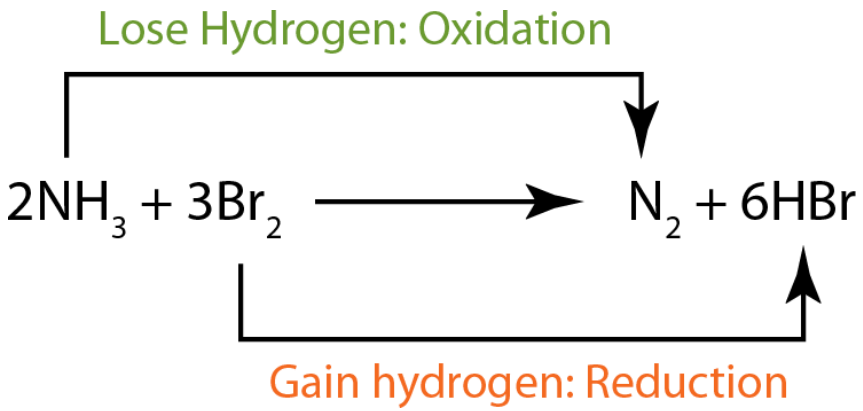
$$Mg + S \rightarrow Mg^{2+} + S^{2-} \quad (MgS)$$

- **Mg** (with 0 charge) loses 2 electrons = OXIDIZED to $\mathbf{Mg^{2+}}$
- **S** atom (no charge) gains 2 electrons = REDUCED to $\mathbf{S^{2-}}$

When oxygen is NOTinvolved

- Oxidation also considered LOSS of HYDROGEN
- Reduction also considered GAIN of HYDROGEN

- REMEMBER they are <u>OPPOSITE PROCESSES</u>!!



How do you remember?

- **O**xidation is **L**osing **E**lectrons
- **R**eduction is **G**aining **E**lectrons

Lose	**G**ain
Electrons	**E**lectrons
Oxidation	**R**eduction

How do you remember?

- **O**xidation is **L**osing **E**lectrons
- **R**eduction is **G**aining **E**lectrons

HALF REACTIONS

- Oxidation-Reduction reactions are often looked at using half-reactions, isolating the oxidation and reduction

$$Fe^{2+} \rightarrow Fe^{3+} + e^- \quad \textbf{(oxidation half-reaction)}$$

$$Ce^{4+} + e^- \rightarrow Ce^{3+} \quad \textbf{(reduction half-reaction)}$$

$$Fe^{2+} + Ce^{4+} \rightarrow Fe^{3+} + Ce^{3+}$$

Examples

Lose Electrons = Oxidation

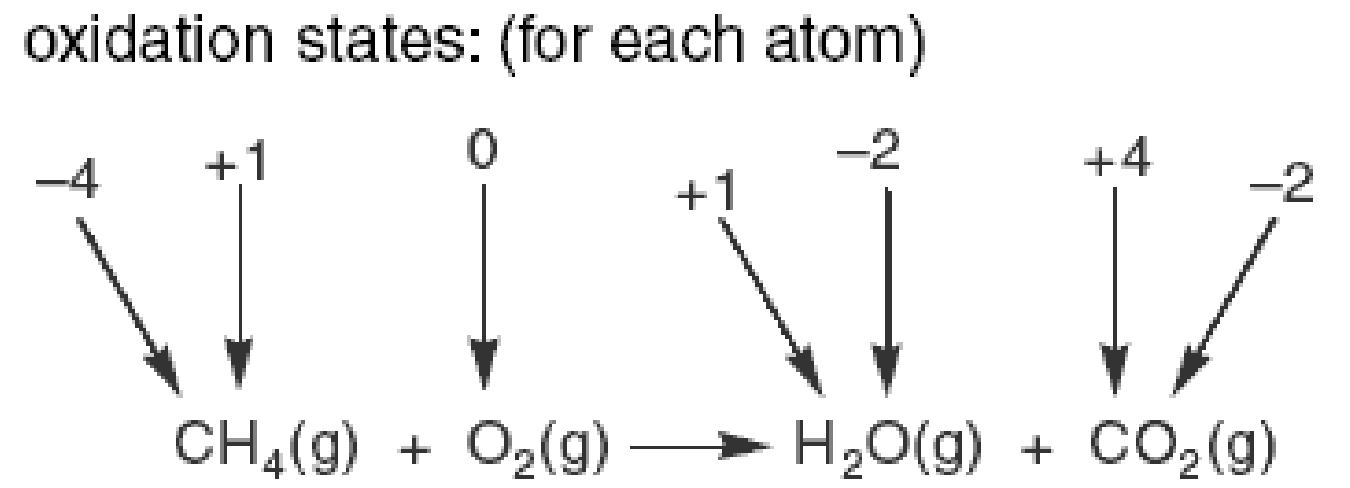
$$\overset{0}{Na} \rightarrow \overset{+1}{Na} + e^-$$ Sodium is oxidized

Gain Electrons = Reduction

$$\overset{0}{Cl} + e^- \rightarrow \overset{-1}{Cl}$$ Chlorine is reduced

What do the numbersmean?

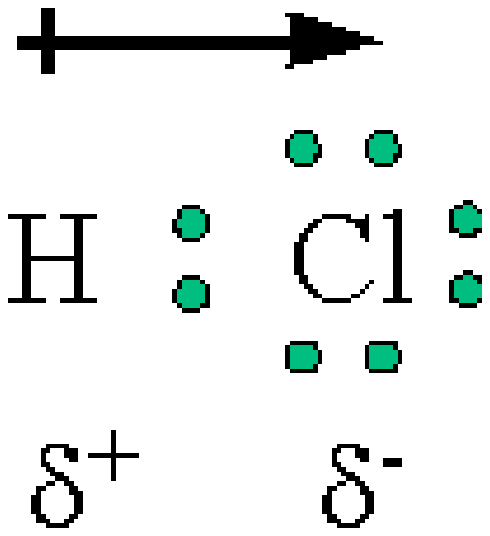
- **OXIDATION NUMBERS** = Charges that represent transfer of electrons – used for 'bookkeeping' when balancing the equations



The overall charges of each molecule is 0. The change in oxidation states come from changes in how atoms share electrons, a function of electronegativity differences

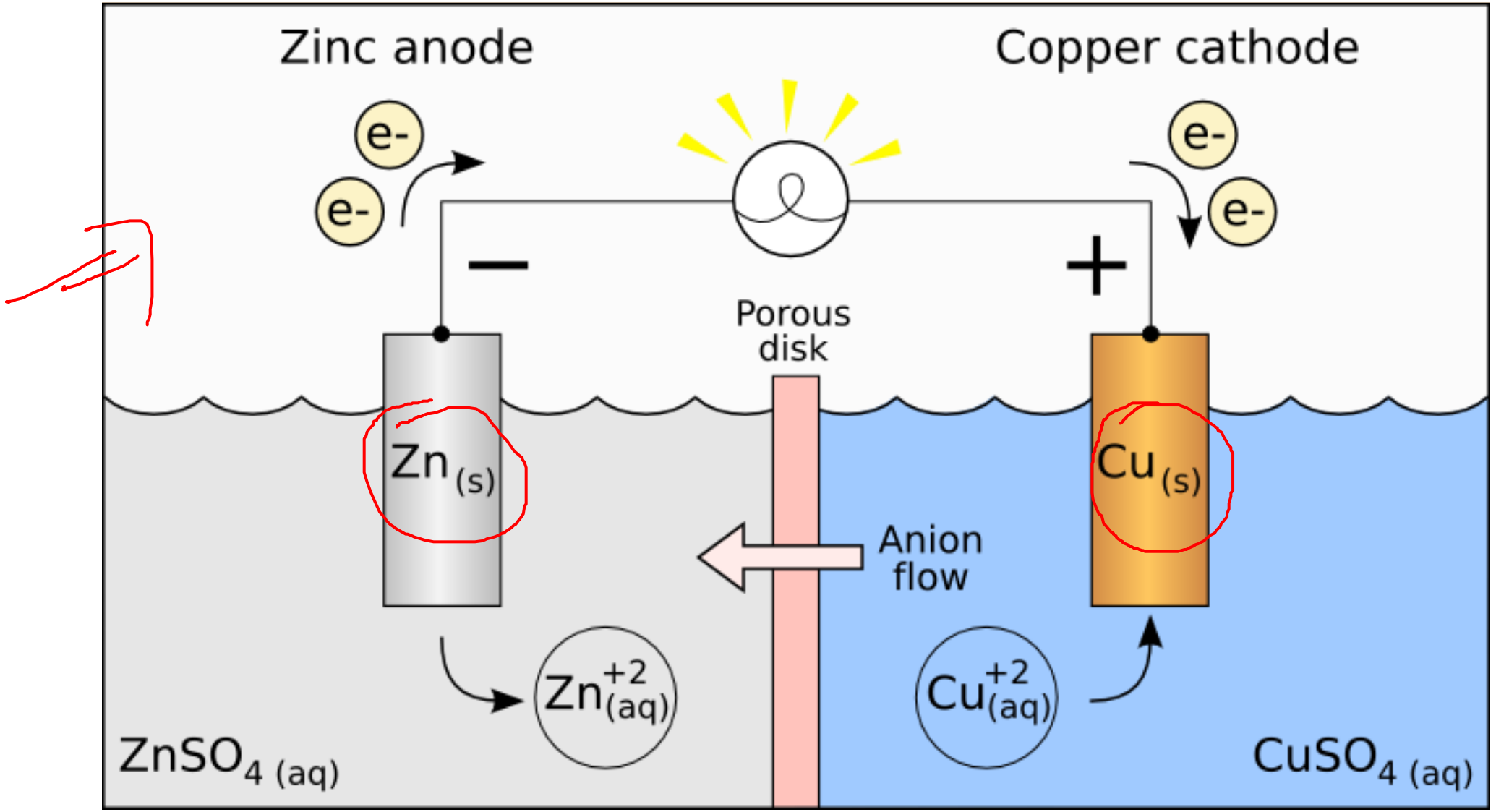
Oxidation-Reduction - COVALENT

- NO actual transfer of electrons
- COVALENT = sharing of electrons
- Oxidation – Reduction when sharing is NOT EQUAL

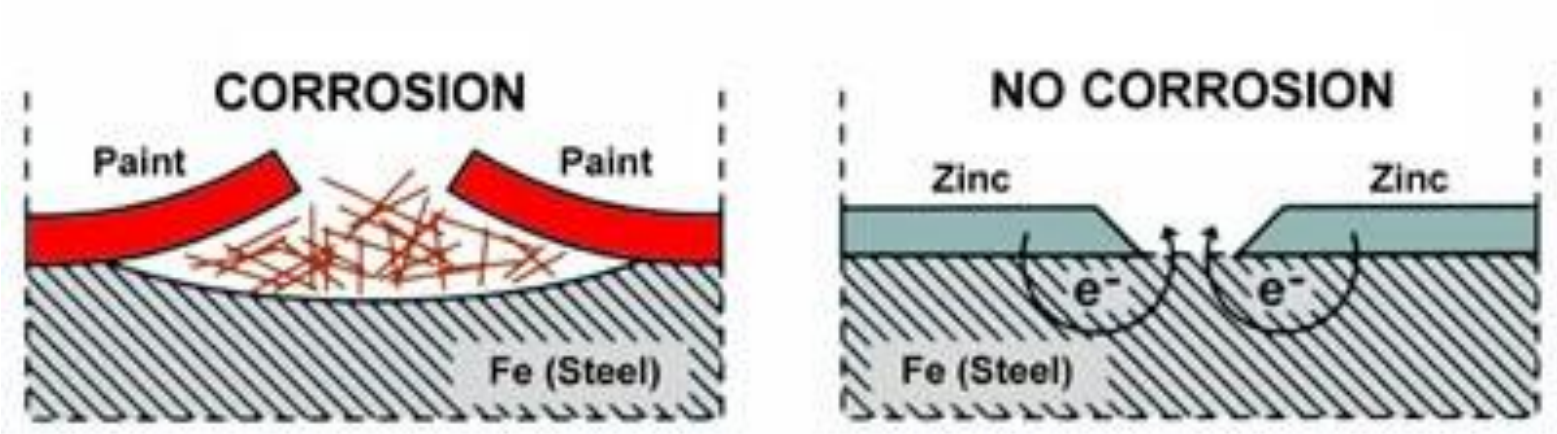


In this covalent compound, CHLORINE pulls the electrons toward it more strongly than HYDROGEN

Electrochemical Cell



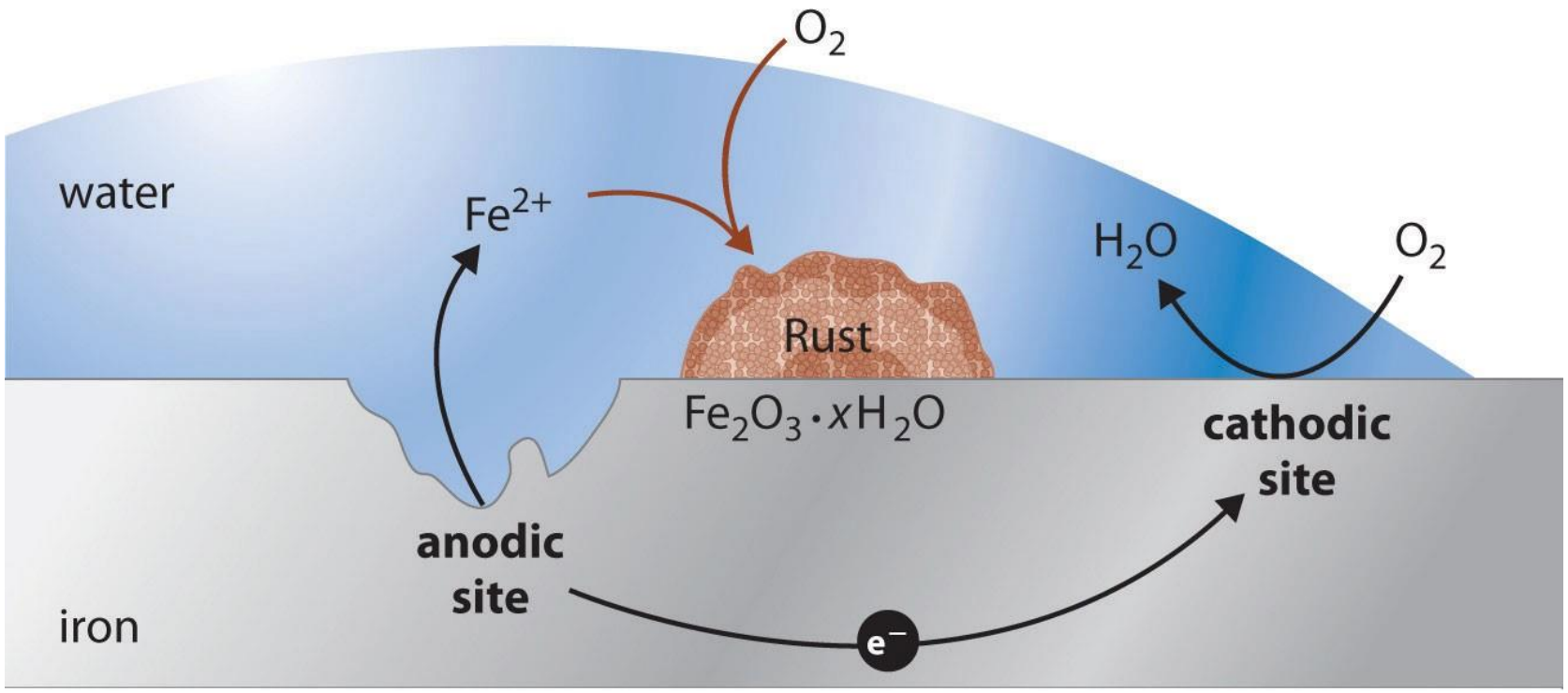
CORROSION~ REDOXREACTION



Drinking water pipes:

Which one had corrosion control?

Corrosion

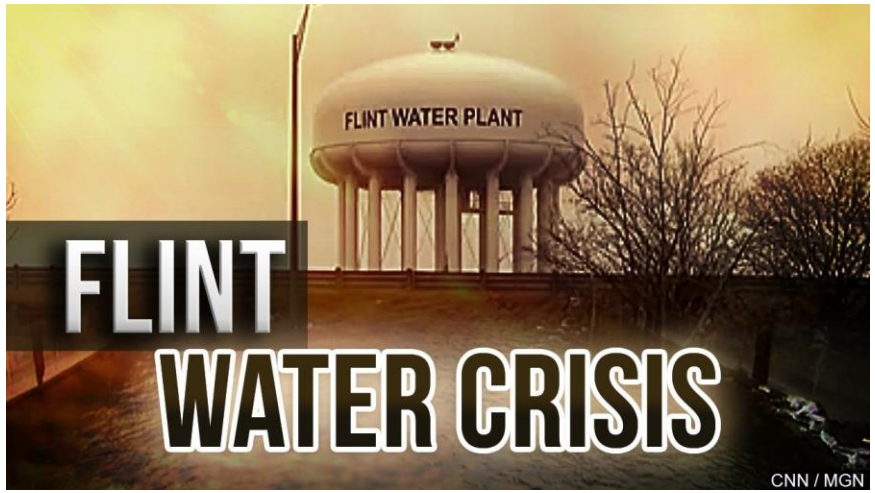


$$Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$$

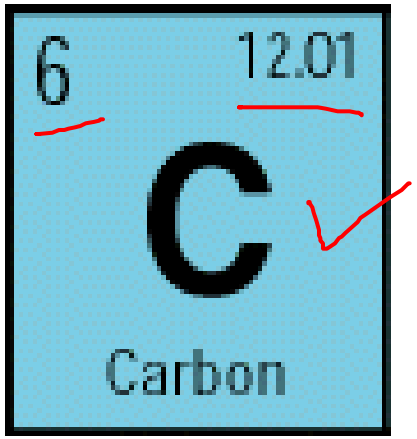
$$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$$

Flint Water Crisis

- Corrosion of pipes lead to contaminated water
- Lead poisoning in children

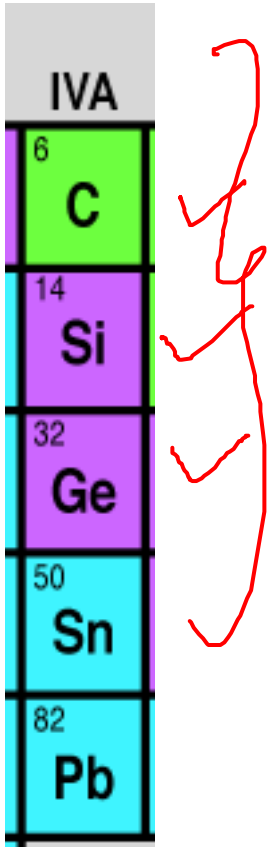


CARBON AND ITS COMPOUNDS



CARBON

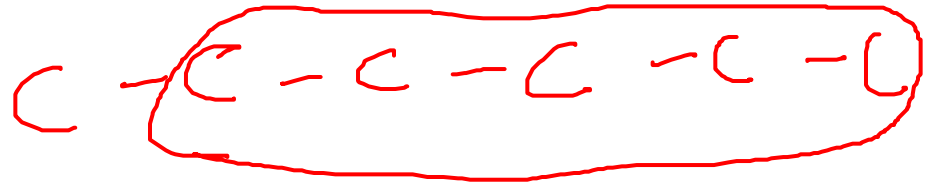
- Carbon belongs to the group IV of the periodic table.
- It has four electrons in its outermost orbit, so its valency is four.
- Carbon is a non-metal.

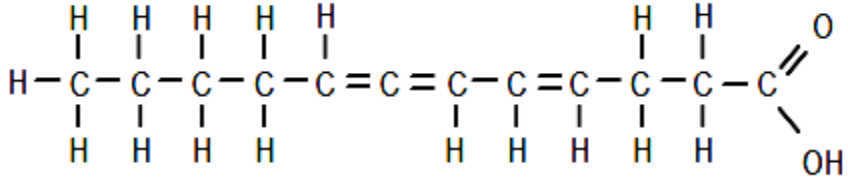


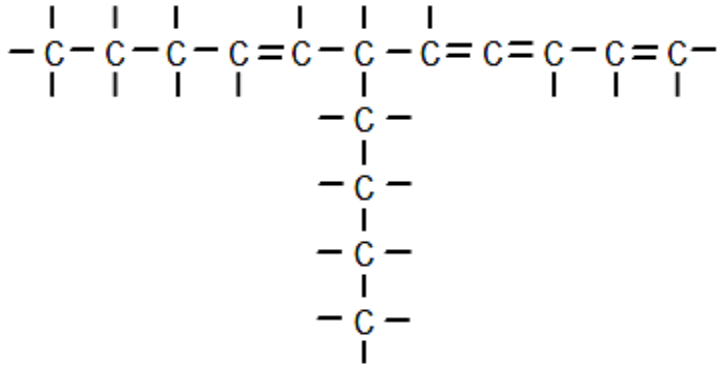
4 e⁻

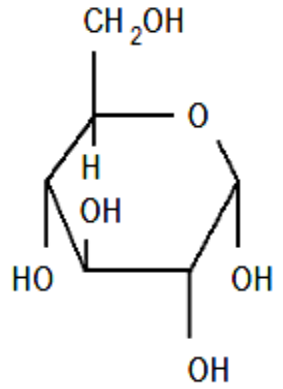
Why so many Carbon Compounds in nature?

- Because carbon is chemically unique.
- Only carbon atoms have the ability to combine with themselves to form long chains







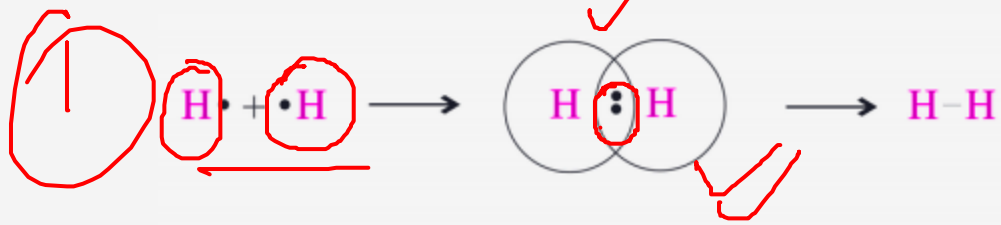


< 4e⁻

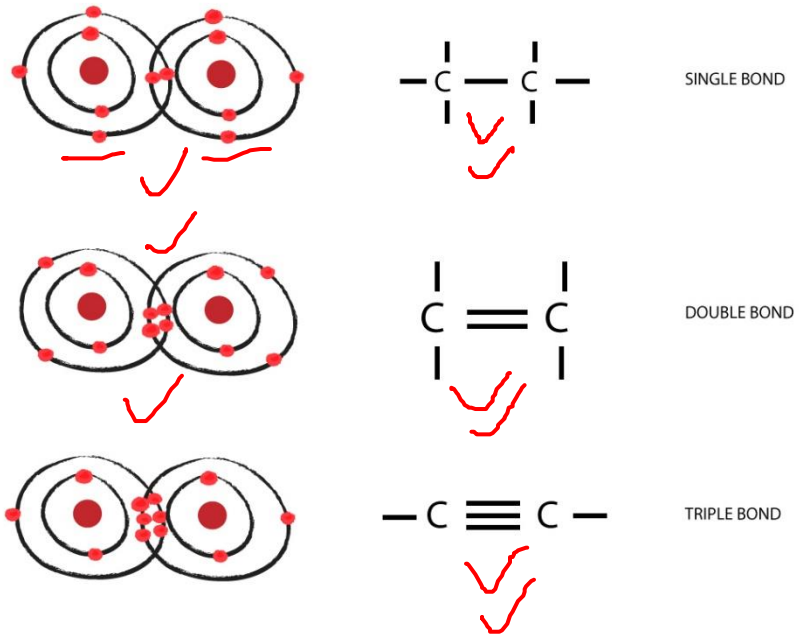
> 4e⁻

= 4

CARBON FORM COVALANT BOND

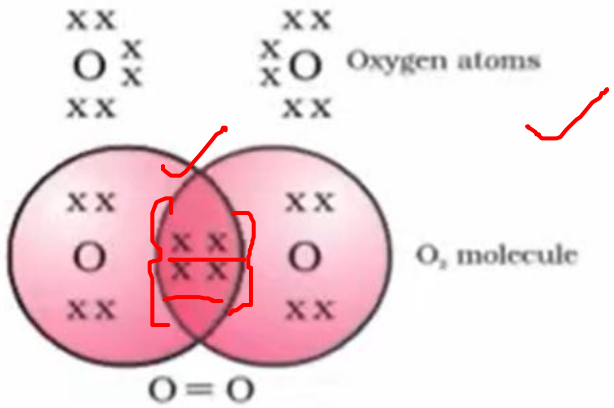


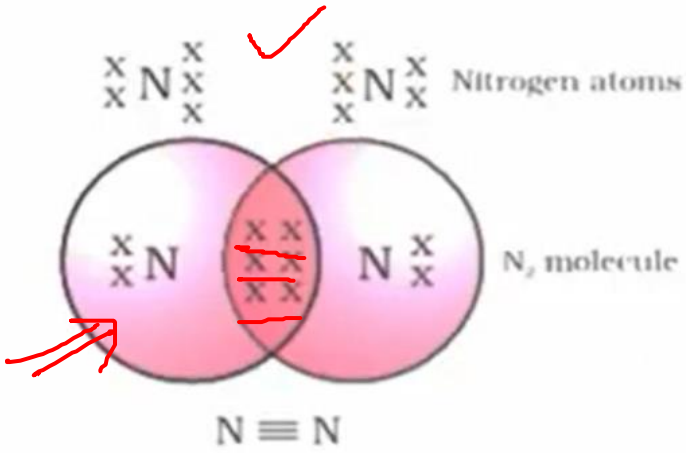
e⁻ pair



ionic → e⁻ loss / gain

6e⁻





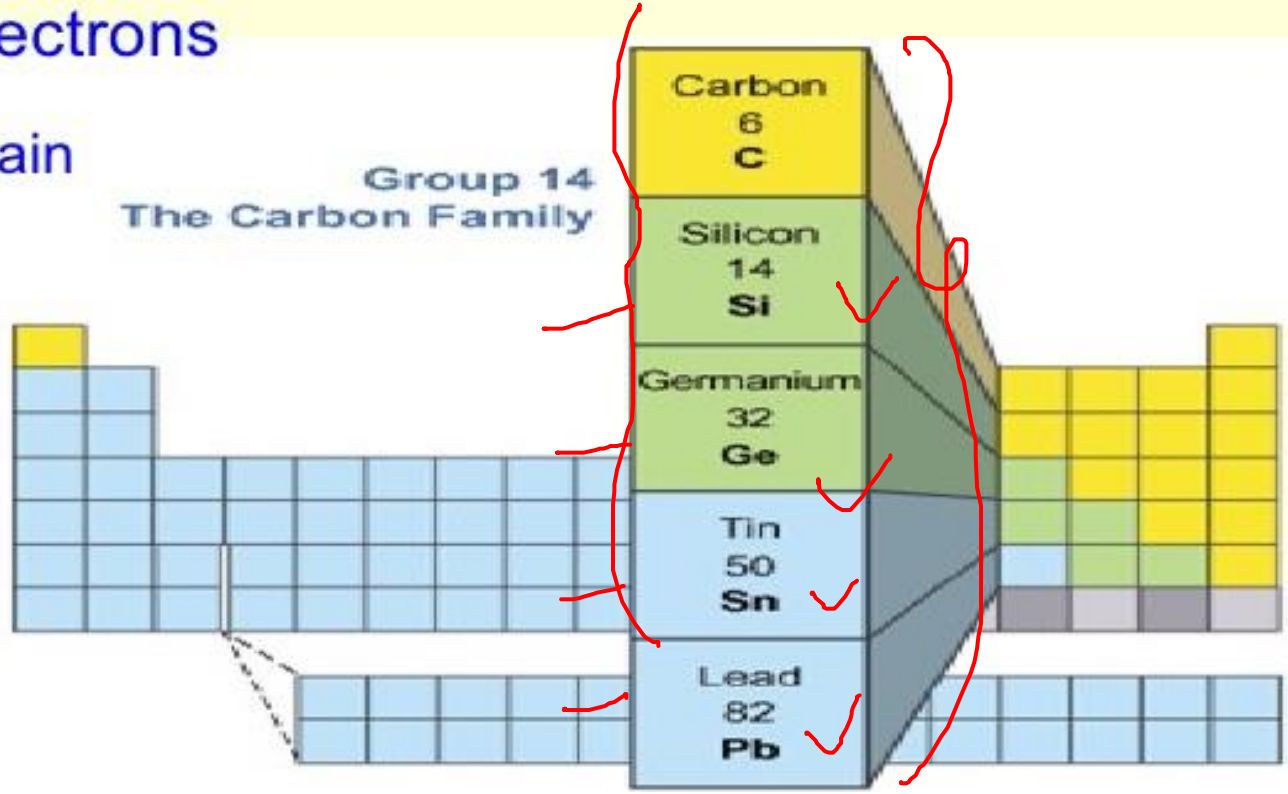
Single bond	Double bond	Triple bond
H–H	O=O	N≡N
H : H	O :: O	N ::: N

8. Carbon Family: Group 14 (4a)

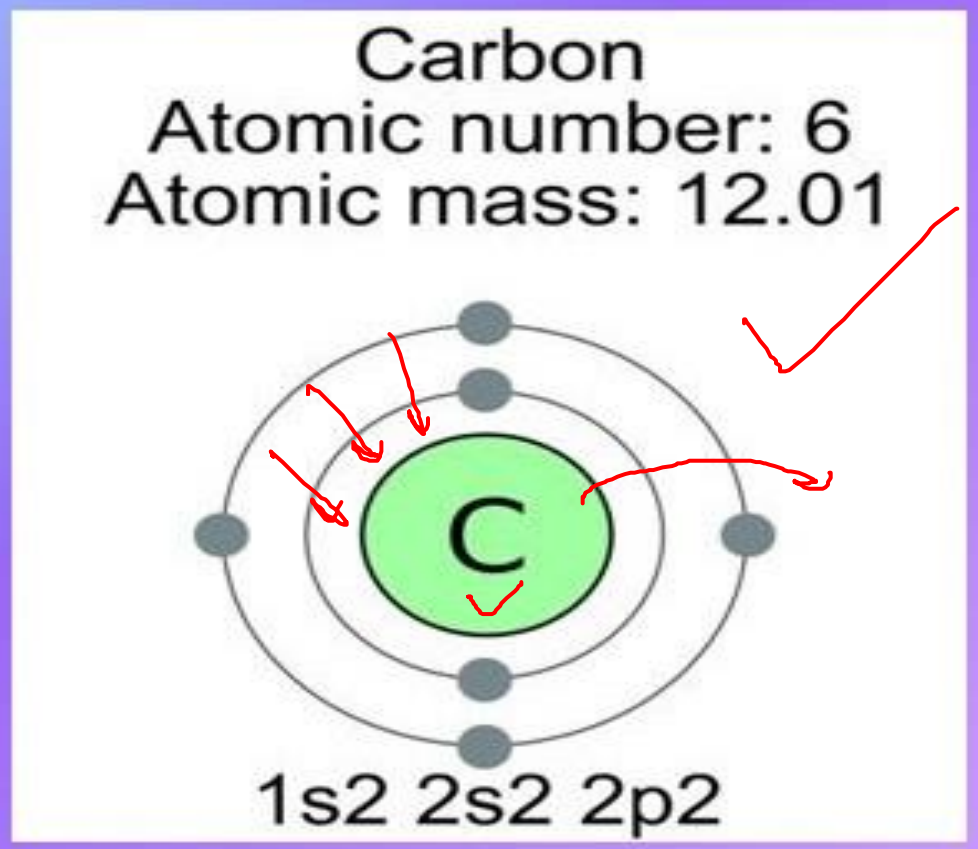
- Metals, nonmetals, and metalloids
- Bond with many elements by sharing electrons
- Silicon is a semiconductor:
  1. Extremely abundant metalloid
  2. Used in computer chip manufacturing – "Silicon Valley"

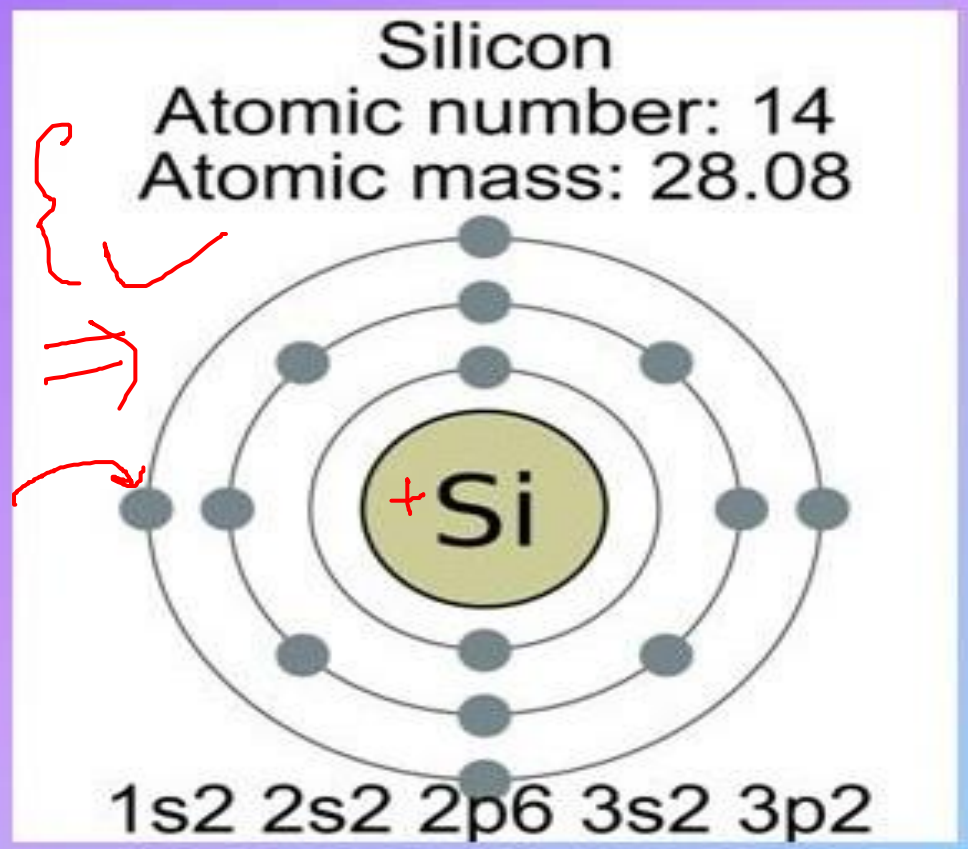
D. 4 valence electrons

- Lose 4 or gain 4; same difference



Long Chain Creation

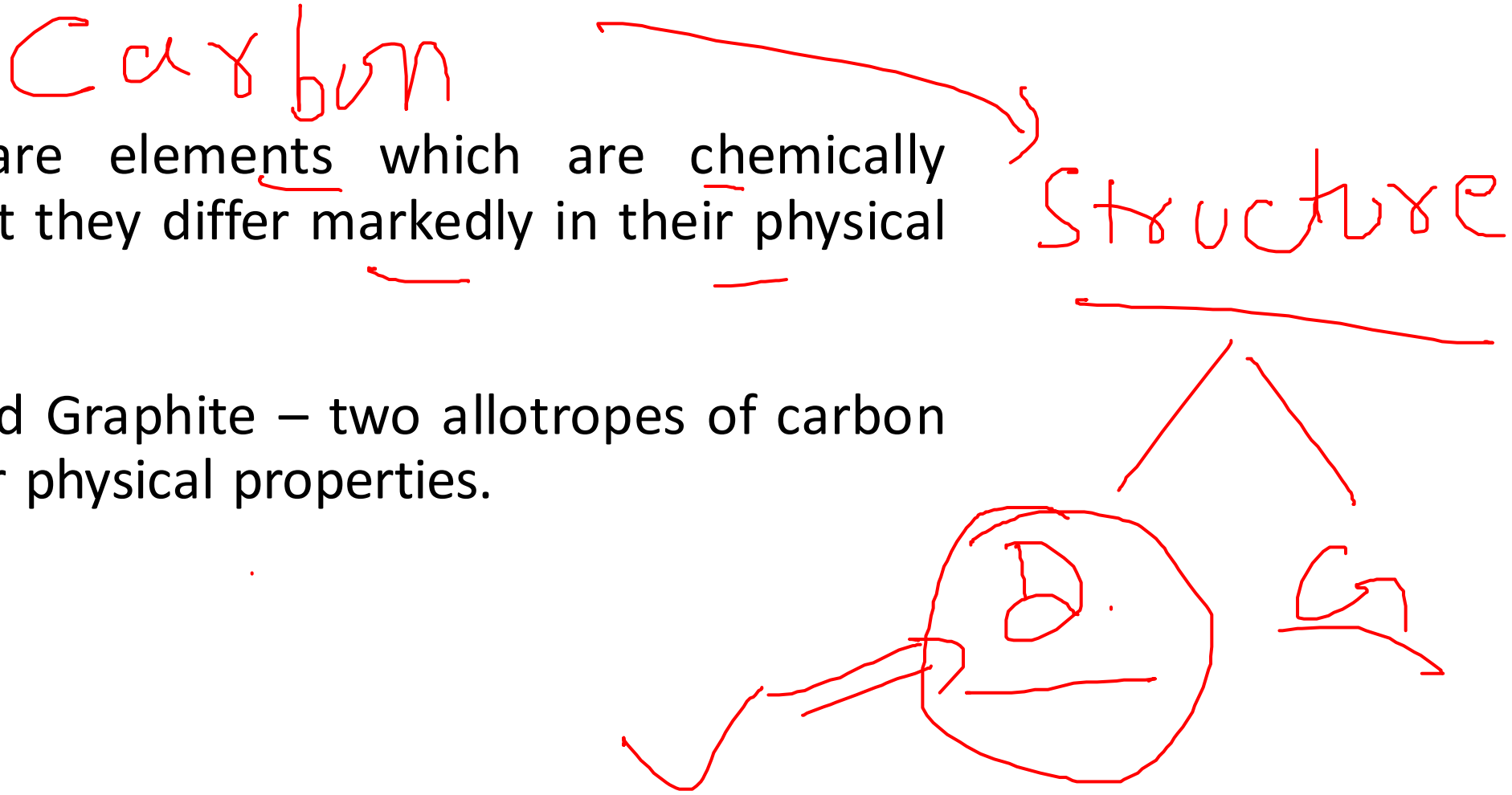




Allotropes of Carbon

- In nature, pure carbon occur in two forms-
- Diamond
- Graphite

What are Allotropes ?



- Allotropes are elements which are chemically identical, but they differ markedly in their physical properties.

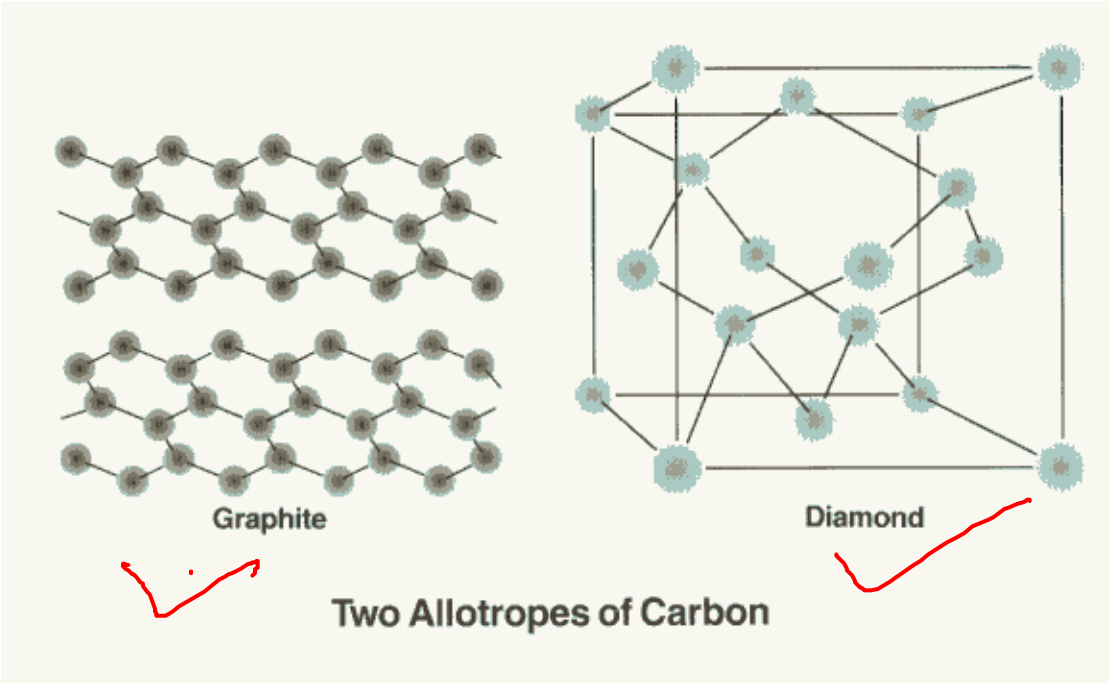
- Diamond and Graphite – two allotropes of carbon differ in their physical properties.

Physical Properties of Diamond and Graphite

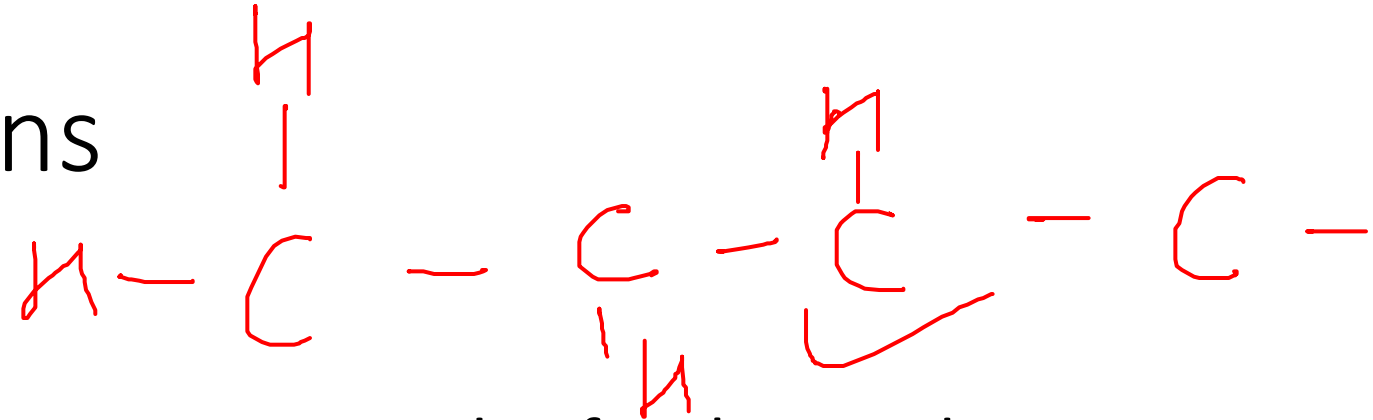
Property	Diamond	Graphite
Appearance	Transparent	Black, Shiny
Hardness	Very Hard	Soft, slippery to touch
Thermal Conductivity	Very poor	moderate
Electrical Conductivity	Poor	Good conductor
Density(kg/m3)	3510	2250
Uses	Jewellery, drilling	Dry cell, electric arc, lubricant, pencil lead

Why the physical properties of diamond and graphite are so different?

- Due to the difference in the arrangement of carbon atoms in diamond and graphite

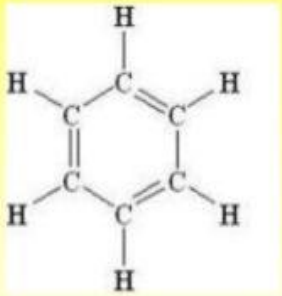
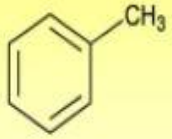


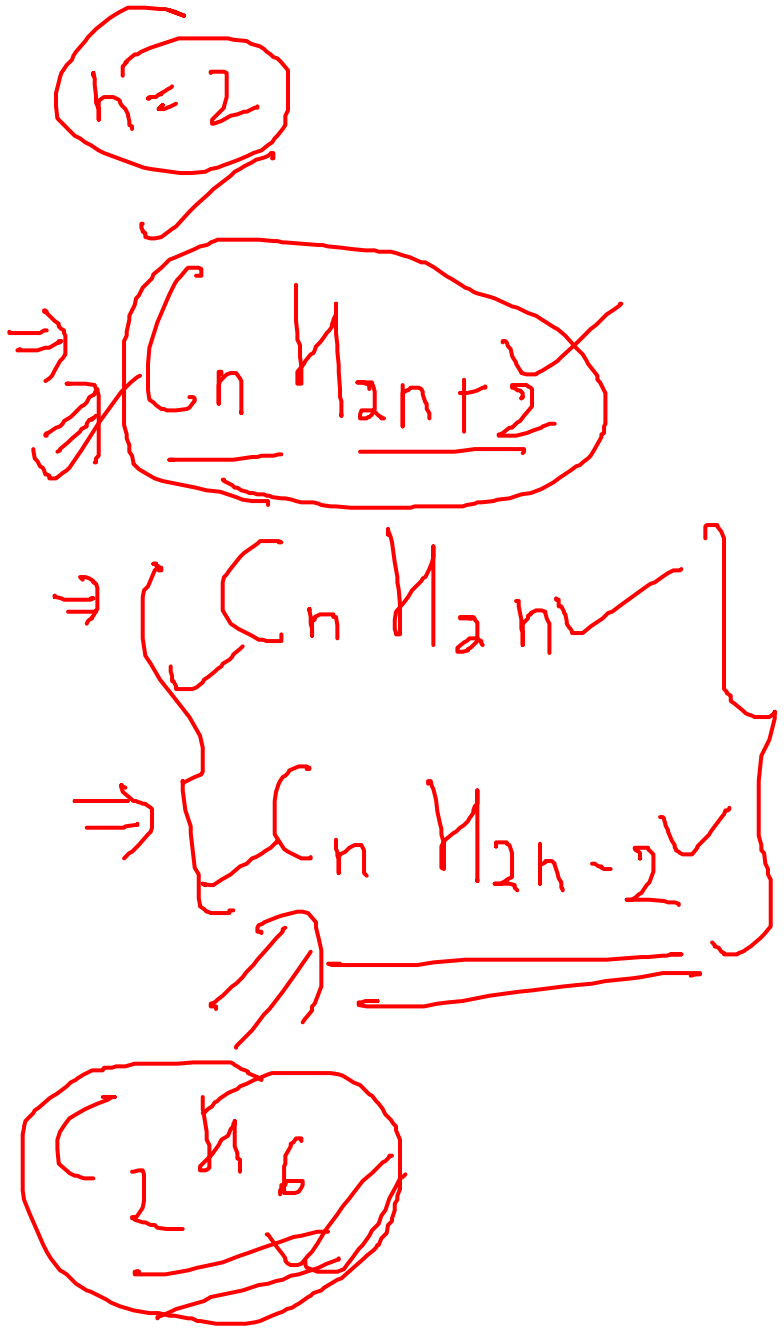
Hydrocarbons



- Hydrocarbons are compounds of carbon and hydrogen.

The natural source of hydrocarbons is petroleum (crude oil)

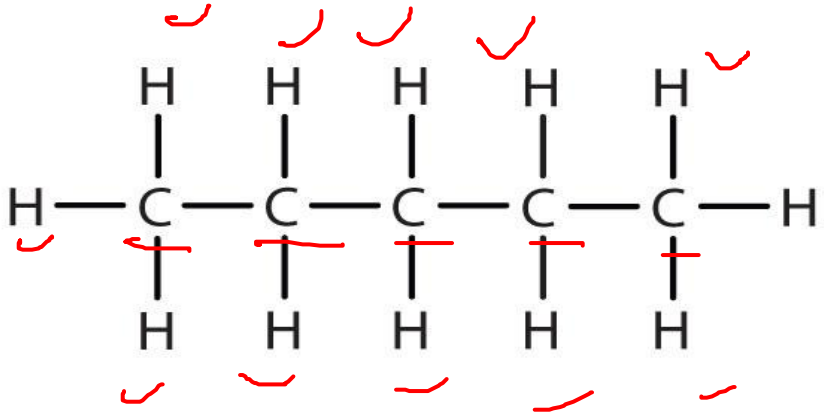
Hydrocarbon Type	Characteristic Group	Example
Saturated Hydrocarbon: *Alkanes*	*No double or Triple Bond*	$CH_3CH_2CH_3$ *Propane*
Unsaturated Hydrocarbon: 1. *Alkenes* 2. *Alkynes*	*Double Bond* *Triple Bond*	$CH_3–CH=CH_2$ *Propene* $CH_3–C\equiv CH$ *Propyne*
Aromatic Hydrocarbons:	*Benzene ring* 	 *Methyl Benzene*



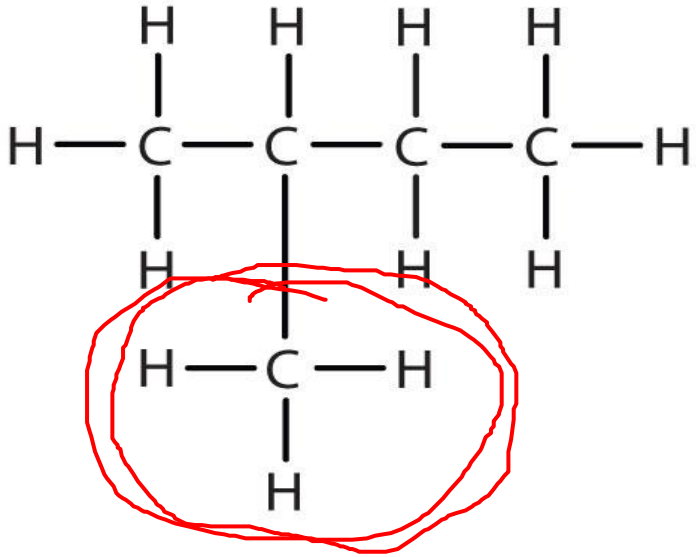
I) Straight (unbranched chain)

- Example : C3H8

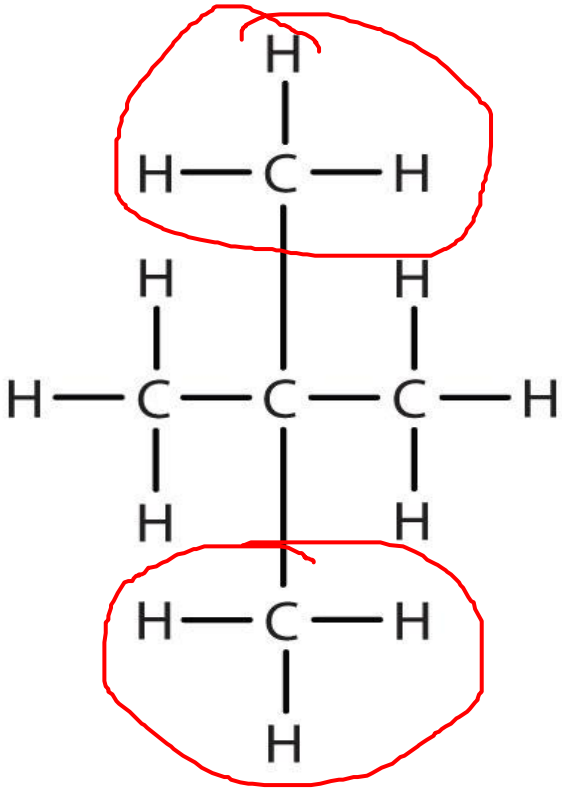
2 BRANCHED



Pentane



Isopentane

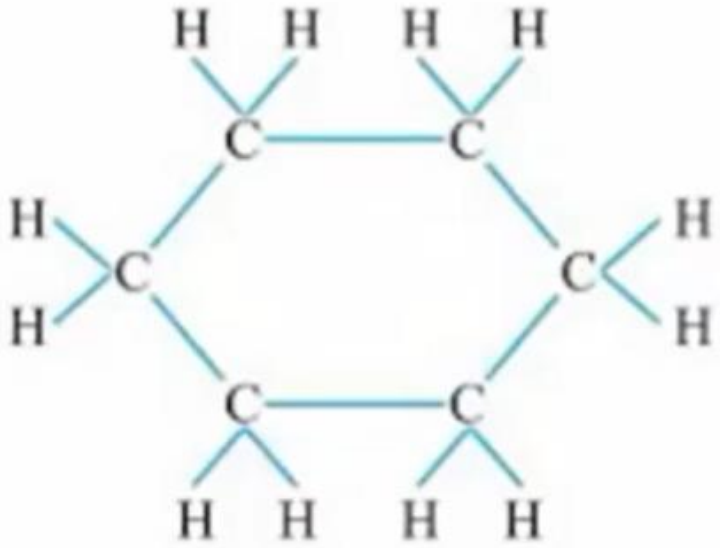


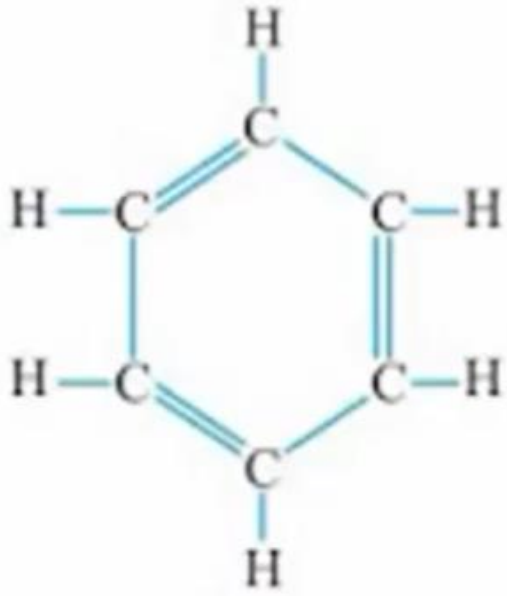
Neopentane

CYCLIC

Cydic soluated

Cyclic unsaluraled
C_6H_6 (Benezene)





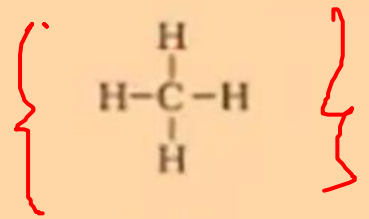
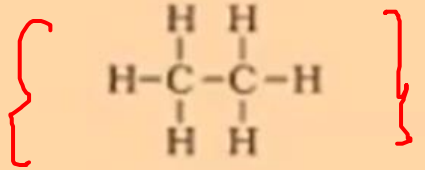
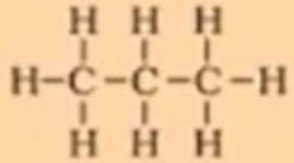
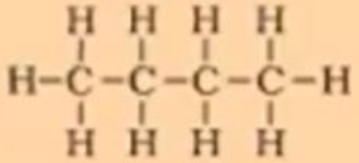
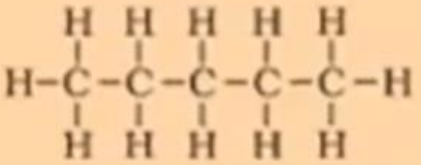
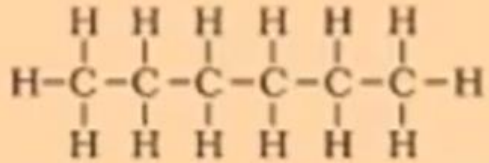
Single B → ane

Double B → ene

Triple B → yne

C - C - C - C - C

C

No. of C atoms	Name	Formula	Structure
1	Methane	CH_4	
2	Ethane	C_2H_6	
3	Propane	C_3H_8	
4	Butane	C_4H_{10}	
5	Pentane	C_5H_{12}	
6	Hexane	C_6H_{14}	

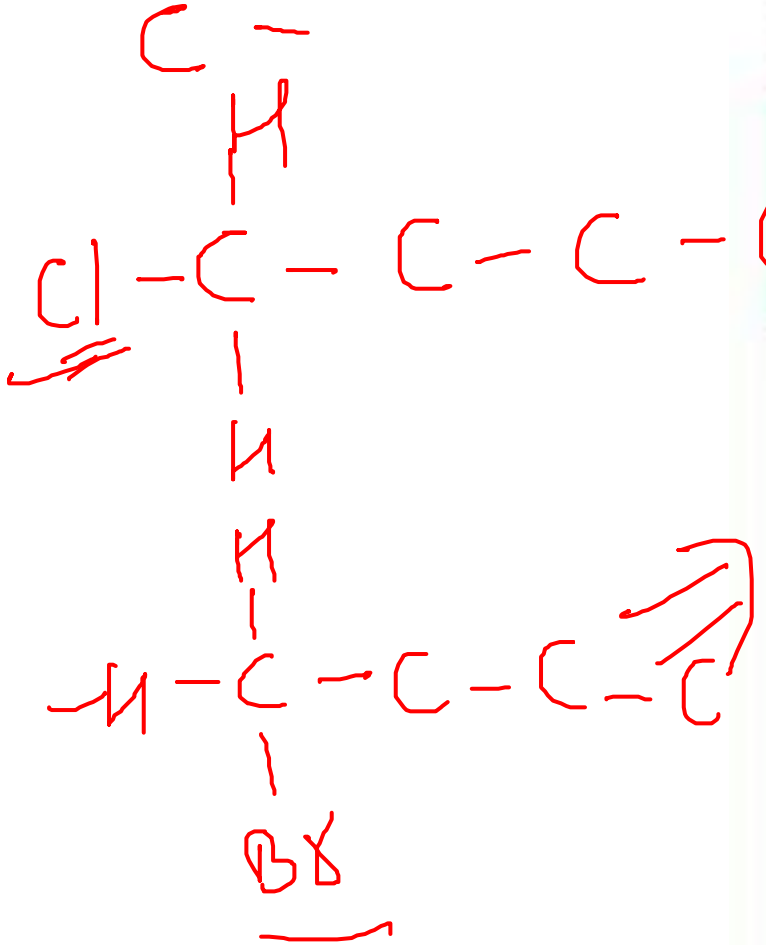
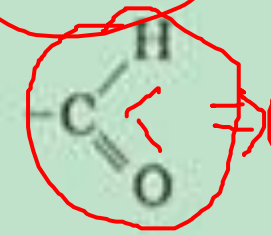
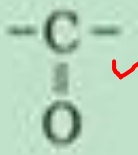
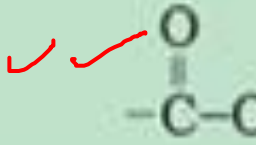
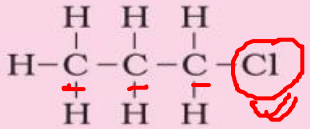
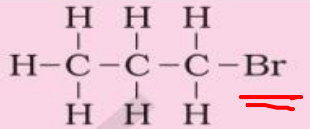
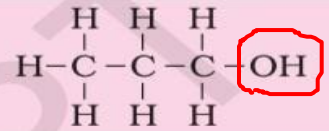
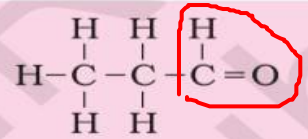
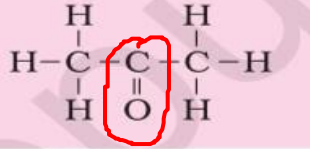
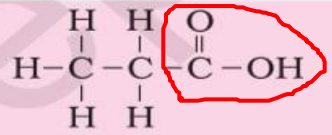
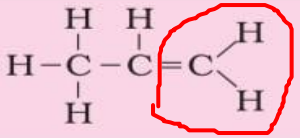
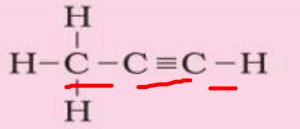
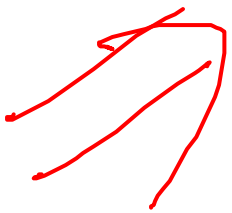


Table 4.3 Some functional groups in carbon compounds

Hetero atom	*Functional group*	*Formula of functional group*
Cl/Br	Halo- (Chloro/bromo)	—Cl, —Br (substitutes for hydrogen atom)
Oxygen	1. Alcohol	—OH
	2. Aldehyde	
	3. Ketone (chain के बीच में)	
	4. Carboxylic acid	

Functional group	Prefix/Suffix	Example
1. Halogen	Prefix-chloro, bromo, etc.	 Chloropropane
		 Bromopropane
2. Alcohol	Suffix - ol	 Propanol
3. Aldehyde	Suffix - al	 Propanal
4. Ketone	Suffix - one	 Propanone
5. Carboxylic acid	Suffix - oic acid	 Propanoic acid
6. Double bond (alkenes)	Suffix - ene	 Propene
7. Triple bond (alkynes)	Suffix - yne	 Propyne

CHEMICAL REACTIONS



COMBUSTION REACTION

(Imp)

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

	C=1		C=1
Balanced	H=4	=	H=4
	O=4		O=4

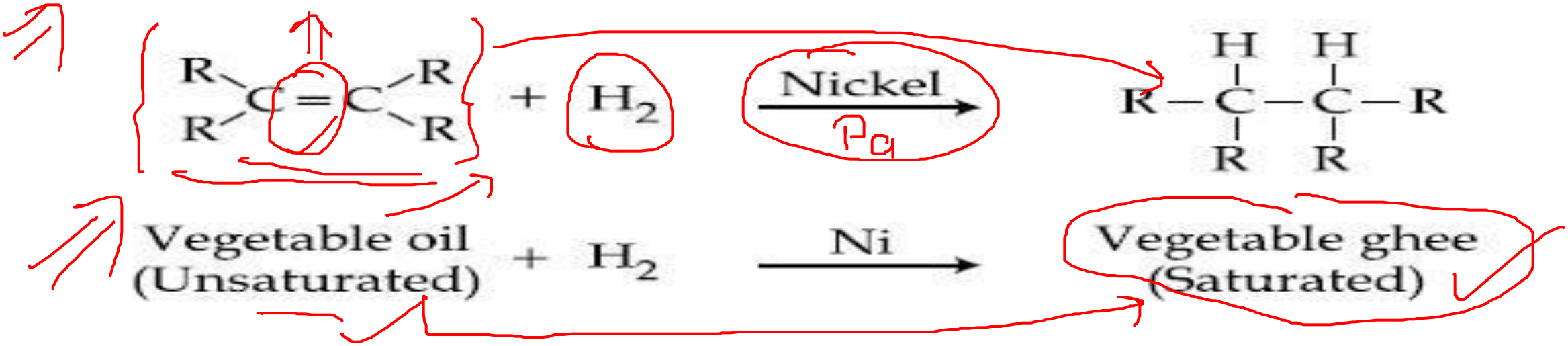
Petrol $\rightarrow CO_2 + H_2O$

- Carbon and its compounds are used as fuels because they burn in air releasing lot of heat energy.
- Saturated hydrocarbon generally burn in air with blue and non-sooty flame.

Imp ⇒ LPG

- Unsaturated hydrocarbon burns in air with yellow sooty flame because percentage of carbon is higher than saturated hydrocarbon which does not get completely oxidized in air.

ADDITION REACTION



- Unsaturated hydrocarbon and hydrogen in the presence of crystals palladium or nickel.
- **HYDROGENATION.**

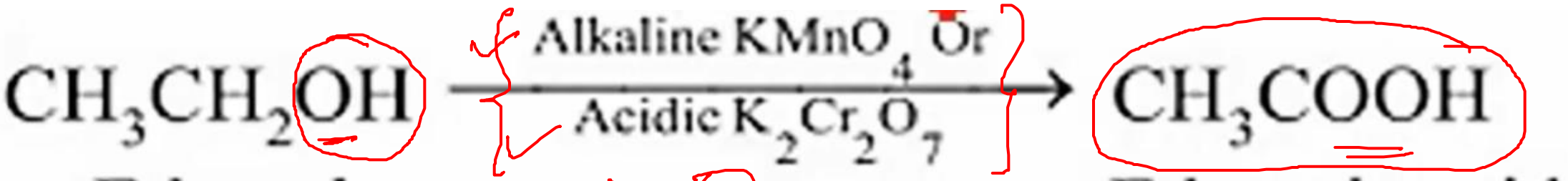
SUBSTITUTION

Substitution reaction:

$$CH_4 + Cl_2 \xrightarrow{\text{Sunlight}} CH_3Cl + HCl$$

Methane — Methyl chloride

OXIDATION REACTION



Alcohol

oxidizing agent

I) PHYSICAL PROPERTIES DIFFERENCES :

- **Ethanol :**

It has specific smell.

It has burning taste.

It does not freeze in winters.

- **Ethanoic Acid :**

It has Vinegar like smell.

It is sour in taste.

It freezes in winters.

Colorless, Soluble in water

Colorless
B.P. ⇒ 391 K

CH_3COOH

II) CHEMICAL PROPERTIES DIFFERENCES :

- **Ethanol :**

It does not react with $NaHCO_3$.

It burns with blue flame.

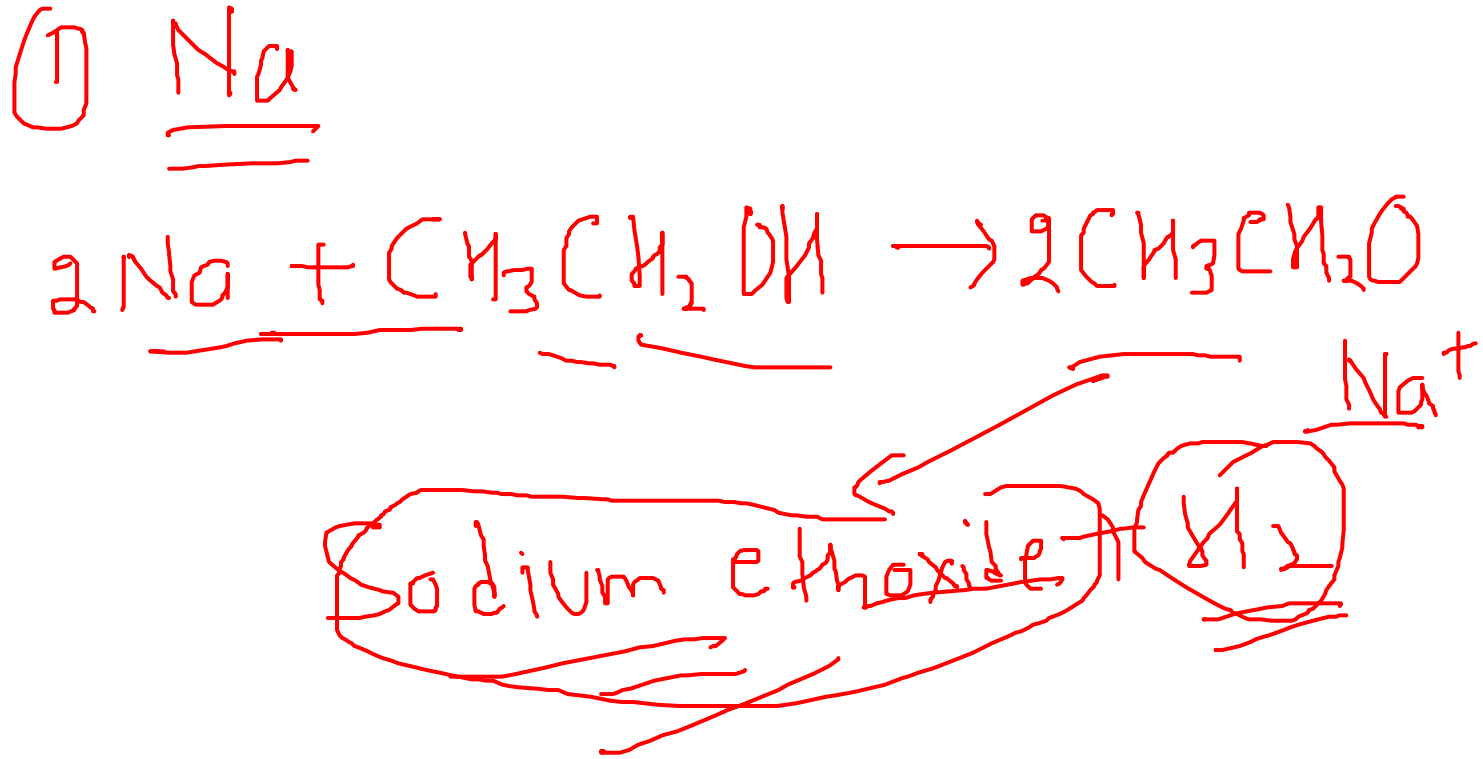
It does not affect blue litmus.

Ethanoic Acid :

It gives CO_2 with $NaHCO_3$

It does not burn with blue flame.

It turns blue litmus red.



* Esterification :-

$CH_3COOH + CH_3CH_2OH$

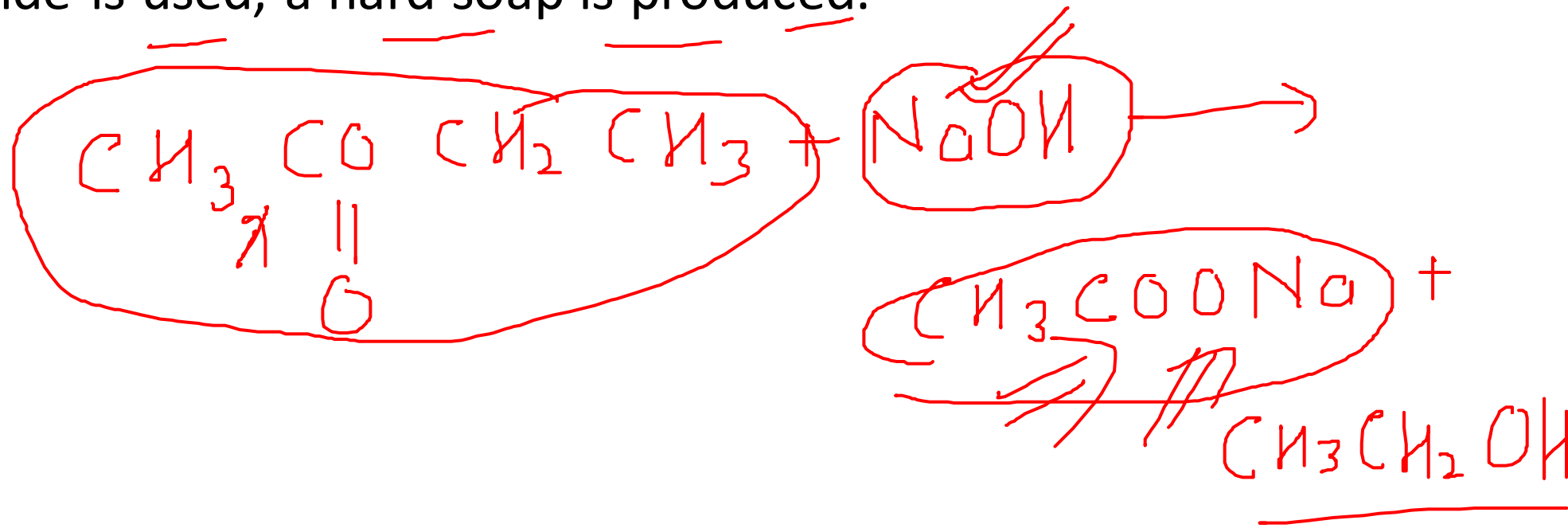
↓

{Sweet smelling ester} ⇒ $CH_3COCH_2CH_3$ (O)

castor

Saponification

- **Saponification** is a process by which triglycerides are reacted with sodium or potassium hydroxide (lye) to produce glycerol and a fatty acid salt called "soap." The triglycerides are most often animal fats or vegetable oils. When sodium hydroxide is used, a hard soap is produced.



(ii) Reaction with base

$$NaOH + CH_3COOH \rightarrow CH_3COONa + H_2O$$

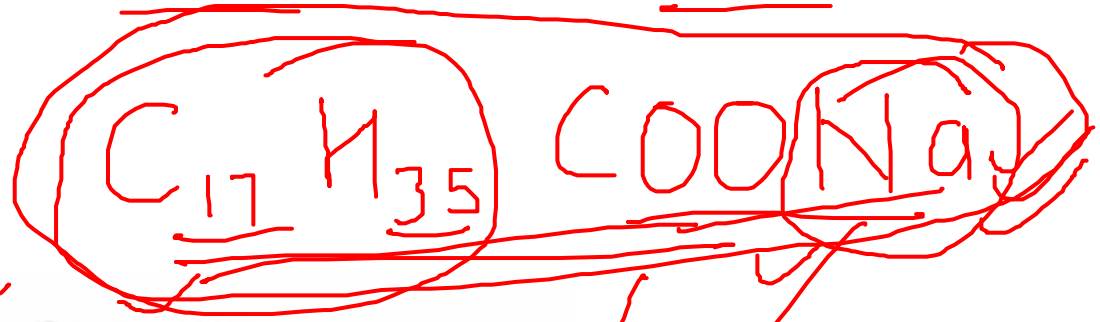
(iii) Reaction with carbonates and hydrogen carbonates :

$$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$$

$$CHH_2COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$$

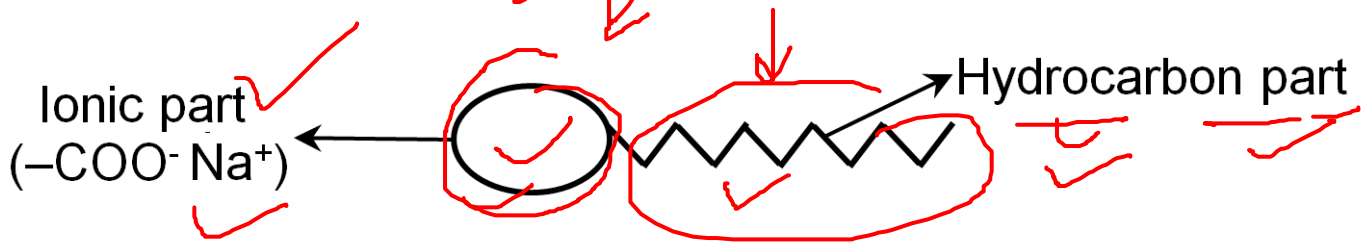
Soaps and Detergents :

- **Soaps :** Soaps are sodium or potassium salts of long chain acid carboxylic acids.
- example: C17H35COONa



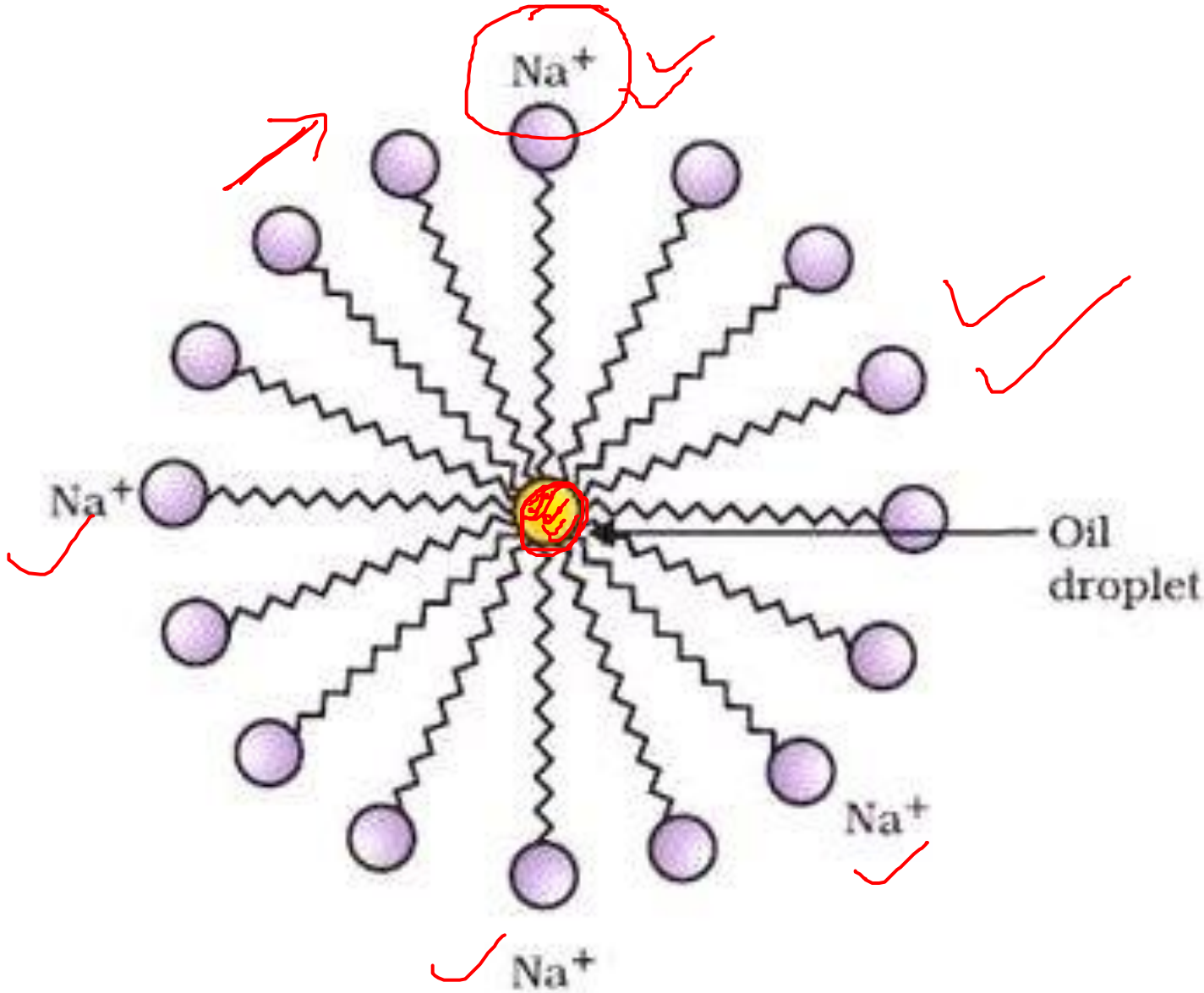
- Soaps are effective only in soft water.

Soap molecule has:



(i) Ionic (hydrophilic) part

(ii) Long hydrocarbon chain (hydrophobic) part



Formation of micelle

DETERGENTS

{ Heavy water }

- Detergents are a class of surfactants with cleaning properties when diluted in water.
- Most detergents are akylbenzenesulfonates.
- Detergents are classified according to the electrical charge they carry as anionic, cationic, or non-ionic.
- While detergents are used for cleaning, they also find use as fuel additives and biological reagents.

{Hard + Soft} → water

⇒ Ammonium or Sulphonate Salt

Carboxylic Acid

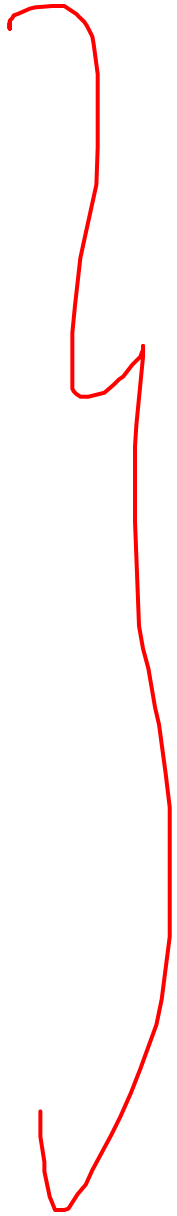
{ Hydrophobic Region } Hydrophilic Region

⇒ Hard → Mg ↓ CaC → Salt

1. How many milligrams is 1 carat of diamond equal to ?
   (a) 100 mg (b) 150 mg
   (c) 200 mg (d) 250 mg *[2006-I]*
2. Which gas is responsible for the swelling of bread ?
   (a) Oxygen (b) Carbon monoxide
   (c) Carbon dioxide (d) Ammonia *[2006-I]*
3. Which one of the following is the correct statement ?
   Graphite can be used as lubricant because it has:
   [2007-I]
   (a) a rigid structure (b) low viscosity
   (c) layered structure (d) low melting point
4. The oxide of which of the following elements is used as a coolant?
   (a) Silicon (b) Nitrogen
   (c) Carbon (d) Phosphorus *[2007-I]*
5. Which one of the following pairs of elements is most essential for building cells in the human body?
   (a) Nitorgen and aluminium
   (b) Carbon and calcium
   (c) Nitrogen and carbon
   (d) Calcium and phosphorus *[2007-II]*
6. Which one of the following is **not** an allotrope of carbon?
   (a) Soot (b) Graphite
   (c) Diamond (d) Carborundum *[2007-II]*
7. Which of the statements regarding carbon dioxide is /are correct? *[2007-II]*
   1. It is prepared on large scale by the action of water on lime.
   2. In the solid form it can be used as a refrigerant.

   Select the correct answer using the code given below:
   (a) 1 only (b) 2 only
   (c) Both 1 and 2 (d) Neither 1 nor 2
8. Vinegar is the trade name of *[2009-I]*
   (a) acetic acid (b) chloroform
   (c) carbon tetrachloride (d) ethyl alcohol
9. Consider the following statements regarding diamond:
   [2009-I]
   1. It is an allotrope of silicon.
   2. It is a bad conductor of heat and electricity.
   3. It is the hardest substance.
   4. It burns to produce carbon dioxide.

   Which of the statements given above are correct ?



DIRECTION (Q. 27): *The following item consist of two statements, statement I and statement II. You are to examine these two statements carefully and select the answers to these items using the code given below.*

[2013-II]

Code:

(a) Both the statements are individually true and Statement II is the correct explanation of Statement I
(b) Both the statements are individually true but Statement II is *not* correct explanation of Statement I
(c) Statement I is true but Statement II is false.
(d) Statement I is false but Statement II is true.

27. **Statement I:**
Limestone decomposes when it is heated in air.
Statement II:
Increase in the content of CO_2 in the atmosphere in recent years is mainly due to the using of limestone in the manufacture of cement.

28. Biogas consists of mainly *[2013-II]*
(a) Methane (b) Ethane
(c) Butane (d) Carbon dioxide

29. The most stable form of carbon is *[2014-I]*
(a) diamond (b) graphite
(c) fullerene (c) coal

30. Which of the following statements is correct? *[2014-I]*
(a) Fullerenes have only six-membered carbon rings
(b) Fullerenes are cage-like molecules
(c) Diamond is thermodynamically the most stable allotrope of carbon
(d) Graphite is slippery and hard, and is therefore used as a dry lubricant in machines

31. Why is Graphite used in electrolytic cells ? *[2015-I]*
(a) Graphite is soft and can be easily moulded into electrodes
(b) Graphite is made of layers of carbon atoms which can slide
(c) Graphite is inert to most of the chemicals and remains intact in electrolytic cells
(d) Graphite is a good conductor of electricity

32. Graphite is a much better conductor of heat and electricity than diamond. This is due to the fact that each carbon atom in graphite: *[2015-II]*
(a) undergoes sp^2 hybridization and forms three sigma bonds with three neighbouring carbon atoms
(b) undergoes sp^3 hybridization
(c) is tetrahedrally bonded
(d) is free from van der Waals force

16. Which one among the following statements is not correct about graphite? *[2010-II]*
(a) It is the most stable allotrope of carbon
(b) It is an electrically conducting material
(c) Crystalline spherical beads of graphite have very good lubricating property under dry conditions
(d) It is the higher grade of coal

17. A bee-sting leaves an acid which causes pain and irritation. The injected acid is *[2011-I]*
(a) acetic acid (b) sulphuric acid
(c) citric acid (d) methanoic acid

18. A student by chance mixed acetone with alcohol. This mixture of acetone and alcohol can be separated by *[2011-I]*
(a) filtration (b) separating funnel
(c) fractional crystallisation (d) fractional distillation

19. Which of the following statements about diamond are correct?
1. It is used as a gem in jewellery because of its ability to reflect light.
2. It is good conductor of electricity.
3. It is used for cutting glass, marble stones and other hard materials.
4. It is used for drilling of rocks. *[2011-I]*
Select the correct answer using the codes given below
(a) 1, 3 and 4 (b) 2, 3 and 4
(c) 1, 2 and 3 (d) 2 and 4

20. The main constituent of vinegar is *[2011-II]*
(a) Citric acid (b) Acetic acid
(c) Ascorbic acid (d) Tartaric acid

21. Consider the following statements :
1. Diamond is hard and graphite is soft.
2. Diamond is soft and graphite is hard.
3. Diamond is a bad conductor but graphite is a good conductor.
4. Diamond is a good conductor but graphite is a bad conductor. *[2012-II]*
Which of the statements given above is/are correct ?
(a) 1 and 3 (b) 1 only
(c) 2 and 3 (d) 1 and 4

22. The pure form of carbon is *[2013-I]*
(a) diamond (b) graphite
(c) charcoal (d) fullerene

23. The acid contained in vinegar is *[2013-I]*
(a) acetic acid (b) ascorbic acid
(c) citric acid (d) tartaric acid

34. Which one of the following elements forms highest number of compounds? *[2017-I]*
(a) Oxygen (b) Hydrogen
(c) Chlorine (d) Carbon

35. Which one of the following elements is used in pencil-lead? *[2017-I]*
(a) Zinc (b) Lead
(c) Carbon (Graphite) (d) Tin

36. How much CO_2 is produced on heating of 1 kg of carbon? *[2017-II]*
(a) $\frac{11}{3}$kg (b) $\frac{3}{11}$kg
(c) $\frac{4}{3}$kg (d) $\frac{3}{4}$kg

37. Consider the following reaction: *[2017-II]*

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

Which of the following about the reaction given above is/are correct?
1. Carbon is oxidized.
2. Hydrogen is oxidized.
3. Hydrogen is reduced.
4. Carbon is reduced.

Select the correct answer using the code given below:
(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 2 and 4 only

(a) 1, 2, 3 and 4 (b) 2, 3, and 4
(c) 1 and 2 (d) 1, 3 and 4

10. The major combustible component of gobar (cow-dung) gas is *[2009-II]*
(a) methane (b) carbon dioxide
(c) hydrogen (d) propane

11. Dry ice is used for making cold-baths in laboratories by mixing with volatile organic solvents. Identify the form of dry ice from the following. *[2009-II]*
(a) Gaseous carbon dioxide
(b) Liquid carbon dioxide
(c) Solid carbon dioxide
(d) Solid hydrogen oxide

12. Diamond is a *[2009-II]*
(a) good conductor and soft
(b) non-conductor and soft
(c) non-conductor and hard
(d) good conductor and hard

13. Following statements are made in connection with carbon dioxide (CO_2) *[2009-II]*
1. CO_2 is a poisonous gas.
2. CO_2 is an acidic oxide.
3. CO_2 turns limewater milky.

Which of the statements given above is/are correct?
(a) 1 and 2 (b) 2 and 3
(c) 3 only (d) 1 and 3

14. Vinegar is produced from *[2010-I]*
(a) ethanoic acid (b) valeric acid
(c) methanoic acid (d) butanoic acid

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