Preface

The Government of Punjab has a strong desire to improve the quality of teaching and learning in the classroom. Various initiatives have been undertaken for provision of quality education to students in the Province. Provision of quality education at secondary level is an important step towards building an education system meant to contribute meaningfully towards development of our society. To achieve the desired goal, activity oriented training for secondary school teachers based on modern teaching methodologies has been considered imperative and crucial.

Directorate of Staff Development (DSD) has been training in-service and pre-service public school teachers and developing educational material since its inception. Considering the quality work produced over the years, the task of development of the Teachers' Guides for secondary school teachers in the subjects of English, Physics, Chemistry, Biology and Mathematics was assigned to the Directorate of Staff Development by the Provincial Government.

DSD worked in collaboration with over three hundred professionals i.e. Teachers, Book Writers and Teacher Trainers from both public and private educational institutions in the subject of English, Physics, Chemistry, Biology and Mathematics who worked in groups to develop these comprehensive Teachers' Guides. These Teachers' Guides with textbooks are aimed to achieve Students' Learning Outcomes (SLOs) through the teaching materials and methodologies which suit varying teaching and learning contexts of Punjab. These Teachers' Guides will help secondary school teachers to deliver and further plan their content lessons, seek basic information on given concepts and topics, and assess students' understanding of the taught concepts.

The DSD team acknowledges the cooperation extended by various public & private, national and international organizations in the preparation of Teachers' Guides. DSD recognizes the contribution made by all developers and reviewers belonging to following organizations including German International Cooperation Agency (GIZ), Institute of Education and Research (IER) Punjab University, Government Science College, International School of Choueifat, Crescent Model Higher Secondary School, Punjab Textbook Board, Lahore Grammar School, Himayat-e-Islam Degree College, SAHE, PEAS, NEEC, HELP Foundation, Ali Institute of Education, Beaconhouse School System, ALBBS, The Educators, Divisional Public School, The City School, AFAQ, Portal, LACAS, Children's Library Complex (CLC) and GICW Lahore, Govt. Higher Secondary Schools and Govt. Colleges for Elementary Teachers in Punjab.

(Nadeem Irshad Kayani)
Programme Director
Directorate of Staff Development, Punjab

UNIT

1

TOPIC

Lesson Plan 1

Avogadro's Number and Mole

Fundamentals of chemistry

Grade IX

One mole quantities of (from left to right) the elements copper, aluminum, sulfur and the compounds potassium dichromate, water, and copper(II) chloride dihydrate

Students' Learning Outcomes

Students will be able to:

- relate gram atomic mass ,gram molecular mass and gram formula mass to mole (applying)
- describe how Avogadro's number is related to a mole of any substance (understanding).
- calculate the number of moles in a given mass of a substance (applying)
- explain the size of the mole by creating an analogy (creating)

Information for Teacher

- Mole is defined as atomic mass, molecular mass or formula mass expressed in grams
- One mole of any substance always contains a fixed number of particles just like one dozen of eggs will always has 12 eggs.
- The number of particles in one mole of a substance is 6.02×10^{23} and is called Avogadro's numbers.

$$\text{Number of moles} = \frac{\text{Mass in Grams}}{\text{Atomic Molecular or formula } \text{Ă}\ell}$$

Introduction

- For brainstorming ask following questions:
  i. What is an atom? (Expected answer: The smallest particle of matter)
  ii. Can you see an atom with naked eye? (Expected answer: No)
  iii. How will you measure such a substance which you cannot see?
  (Expected answer: No reply)

On the basis of last question, explain students that they will learn how to measure number of particles in various substances e.g elements, compounds etc.

Duration/Number of Periods

80 min / 2 period

Material/Resources Required

Sodium chloride (common salt),Copper

Development

Activity 1 (Calculating number of moles)

- Divide students in pair or groups.
- Give each group samples of copper, sodium chloride
- Ask them to weigh them on a spring balance or on a digital balance and note mass.
- Now with the help of periodic table, ask them to write the atomic mass and then find out molecular or formula mass of given samples (Help them in finding atomic mass from periodic table. Students sometimes select Atomic number instead of atomic mass)

Atomic Mass of copper = 64 a.m.u
Molecular mass of NaCl=58.5 a.m.u

- Now ask them to calculate number of moles by using following formula:

No of moles =

$$\frac{\text{mass in grams of given sampls}}{\text{atomic, molecular, or formula}}$$

Activity 2

- Concept of Mole and Avogadro's Number
- Ask students to name following number of items

12 Iron nails	1 dozen
60 seconds	1 minute
10 years	Decade
2 socks	1 pair

- Ask how can you name following number of particles).Now write the number 6.02×10^{23} on board. (Expected response: No reply)
- Conclude the activity by telling them that $6.02 \times 10^{23} = 1$ mole.
- Explain that 1 mole of a substance contains 6.02×10^{23} particles. Now write the following information on board.

1. Gram Atomic mass of H = 1 gram = 1 mole or we can say
   1 gms of H has 6.02×10^{23} atoms of H
2. Gram Atomic mass of Cu = 64 gms = 1 mole
   or
   64 gms of Cu has 6.02×10^{23} atoms of Cu
3. Gram Formula mass of NaCl = 58.5 gms
   or

58.5 gms of NaCl has 6.02×10^{23} formula units of NaCl.

4. Gram Molecular mass of water = 18 gms = 1 mole or
   1 mole of water has 6.02×10^{23} molecules of water

Activity 3

- Draw the following table on board to clear their concept about atomic, molecular and formula mass.

Substance	At/ formula/ Mol. Mass Tell children atmoic mass is expressed in a.m.u)	Mass of 1 mole (Tell children mole is expressed in gms)
Aluminum	Atomic mass = 27. a.m.u	27 gms
NaCl (Sodium Chloride)	Formula mass = 58.5 a.m.u	58.5 gms
SO_2	Molecular mass= 64 a.m.u	64 gms

Conclusion/Sum up

Conclude by telling children

1 mole of any substance contain 6.02×10^{23} particles

- Mole is a quantity as well as a number
- It is a number as its is always equal to 6.02×10^{23}
- It is a quantity as it is expressed in grams

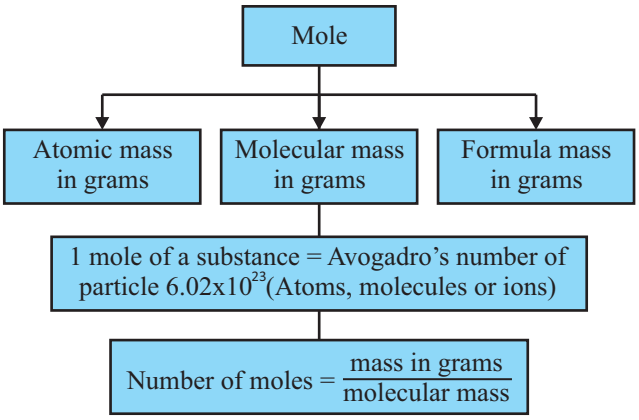
Assessment

- Assess student's knowledge by working following questions.

1. What is a mole
2. What is Avogadro's number?
3. How can you relate mole and Avogadro's number?
4. How can you relate atomic mass,molecular mass and formula mass with mole?
5. Calculate number of moles in following by using formula.

i. 68 gms of Al (At mass = 27 gms/mole)
ii. 26 gms of H2SO4 (Mole mass = 98 gms/mole)
iii. 73 gms of Nacl (Formula mass = 58.5 gms/ mole)

Note: Conclude the lesson by drawing following concept map.



Follow-up

- Find the number of moles in 2 kg of sodium metal (Hint: Convert KG into gms and then use formula).
- 49 g of pure sulphuric acid (H_2SO_4)
- 64 g of methane (CH4)
- 585 gms of sodium chloride (NaCl)

Note: Make students calculate the molecular mass by providing them with atomic mass from periodic table)

- Guide the students to solve the exercise problems given at the end of each unit / chapter of textbook.

UNIT 2

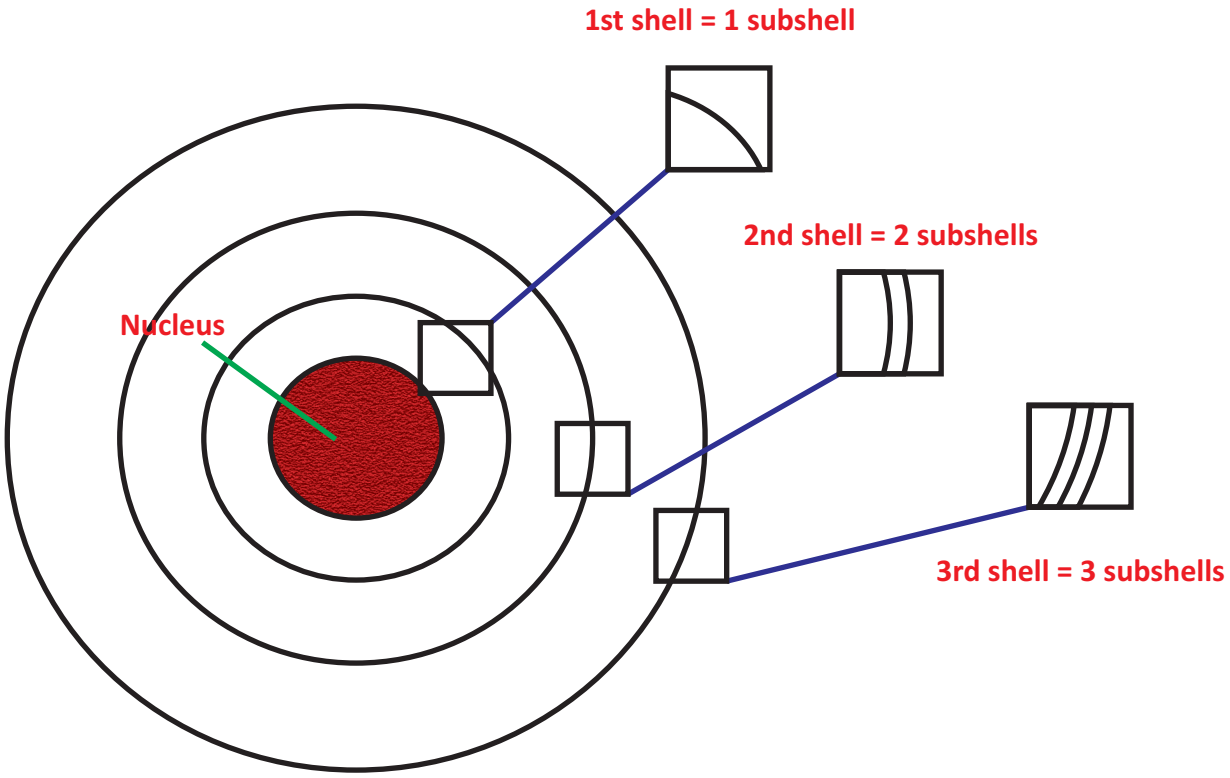
Lesson Plan 2

TOPIC

Shells and Subshells

Structure of Atoms

Grade IX



Students' Learning Outcomes

Students will be able to:

- describe the presence sub shells in a shell. (understanding)
- distinguish between shell and sub shells. (understanding)

Information for Teachers

- Electrons are organized within the atom into shells, sub-shells and orbitals
- Electrons revolve around the nucleus on fixed certain paths which are termed as shells.
- Shells are represented by numbers (1, 2, 3, ---- --- n) that specifies the energy level, or energy state of the shell.
- Energy Levels with in the shell is referred as subshell. These are identified by the lower case letters s, p, d and f.
- Electronic configuration shows the number of electrons in each energy level.

Duration/Number of Periods

80 mins / 2 period

Material/Resources Required

Routine classroom resources

Introduction

- Clarify students concepts about shell and subshell by giving them following examples:
- Shell is the home of electron
- The home has several storeys or floors called shells. Shells are represented by numbers (1, 2, 3, ------- n) that specifies the energy level.
- Explain them that the subshells are the rooms of the storey of the building. Energy Levels with in the shell is referred as subshell. These are identified by the lower case letters s, p, d and f.
- The numbers of subshells are equal to the shell number. If it is the first shell it has only one subshell that is 1s.
- The second shell has two subshells 2s and 2p.

Development

Activity 1

(Number of subshells in Shells)

Note:Carry on next activity only after making sure that students have well understood the concepts explained in Activity 1.Repeat the activity if they are confused.

- Bring out 4 students from the class. Classify them as shell 1,2,3,4 and ask
- How many subshells exist in the 1st shell?(1)
- How many subshells exist in the 2nd shell?(2)
- How many subshells exist in the 3rd shell?(3)
- How many subshells would you expect to exist in the 5th energy level?(Tell students that Shells even more than 4 can only have maximium of 4 subshells).
- In case they answer wrong, give chance to some other student to answer.
- After getting their responses, draw the following table on board and ask them to copy on their notebooks:

Shell Number/ Energy Level	Number of subshells	Subshell names
1	1	1s
2	2	2s,2p
3	3	3s,3p,3d
4	4	4s,4p,4d,4f

Activity 2

(Number of subshells in Shells)

Note:Carry on next activity only after making sure that students have well understood the concepts explained in Activity 1.Repeat the activity if they are confused.

- Bring out 4 students from the class. Classify them as shell 1,2,3,4 and ask
- How many subshells exist in the 1st shell?(1)
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- How many subshells would you expect to exist in the 5th energy level?(Tell students that Shells even more than 4 can only have maximium of 4 subshells).
- In case they answer wrong, give chance to some other student to answer.

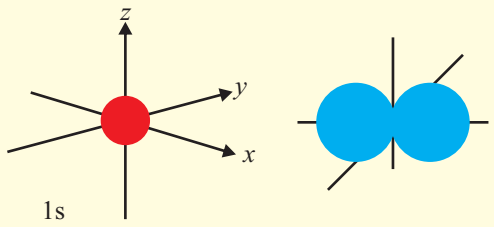
- After getting their responses, draw the following table on board and ask them to copy on their notebooks:

Shell Number/ Energy Level	Number of subshells	Subshell names
1	1	1s
2	2	2s, 2p
3	3	3s, 3p, 3d
4	4	4s, 4p, 4d, 4f

Explain them that the 4 subshells s,p,d,f can have following number of electrons

's' subshell can have maximum of **2** electrons
'p' subshell can have maximum of **6** electrons
'd' subshell can have maximum of **10** electrons
'f' subshell can have maximum of **14** electrons

- Explain them the Shapes of '*s*' and '*p*' subshells.
- Tell that s orbital is a sphere around the nucleus and p orbitals are shaped like a figure 8 or dumbbell.



Activity 3

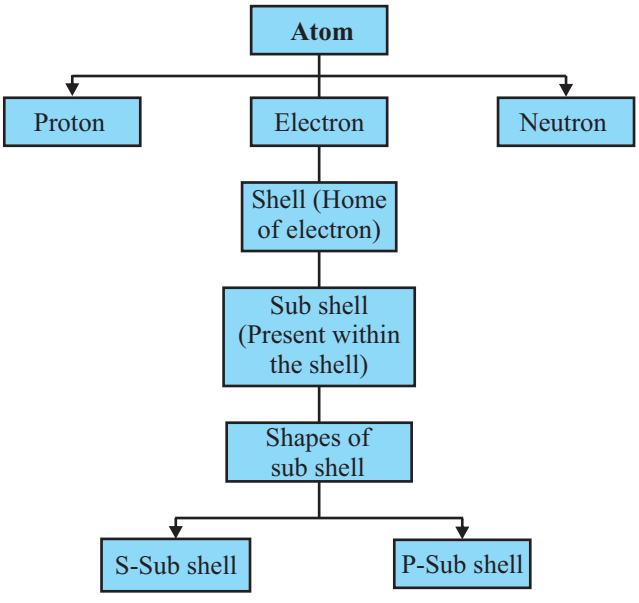
(Finding number of electrons in each shell

- Tell students that in the shells electrons are filled on the basis of $2n^2$ rule where 'n' is the shell number.
- Give only shell number and ask them to find out number of electrons in that shell by putting shell number in $2n^2$.
- After getting their responses, ask them to draw this table in notebooks:

Shell Number	Number of electrons according to $2n^2$ rule
1	$2 \times 1^2 = 2 \times 1 = 2$
2	$2 \times 2^2 = 2 \times 4 = 8$
4	$2 \times 3^2 = 2 \times 9 = 18$
3	$2 \times 4^2 = 2 \times 16 = 32$

Conclusion/Sum up

Teacher will draw the following concept map on board to sum up the lesson:



Assessment

Ask students following questions to assess their learning:

- What are shells?
- What are subshells?
- How many subshells exist in the 1st shell?(1)
- How many subshells exist in the 2nd shell?(2)
- How can you find out number of electrons in each shell?(by using $2n^2$ rule)

Follow-up

- Draw the shapes of s and p subshells?
- Write the number of electrons in 2nd and 3rd shell?
- How many electrons can s subshell hold?
- Guide the students to solve the exercise problems given at the end of each unit / chapter of textbook.

UNIT

3

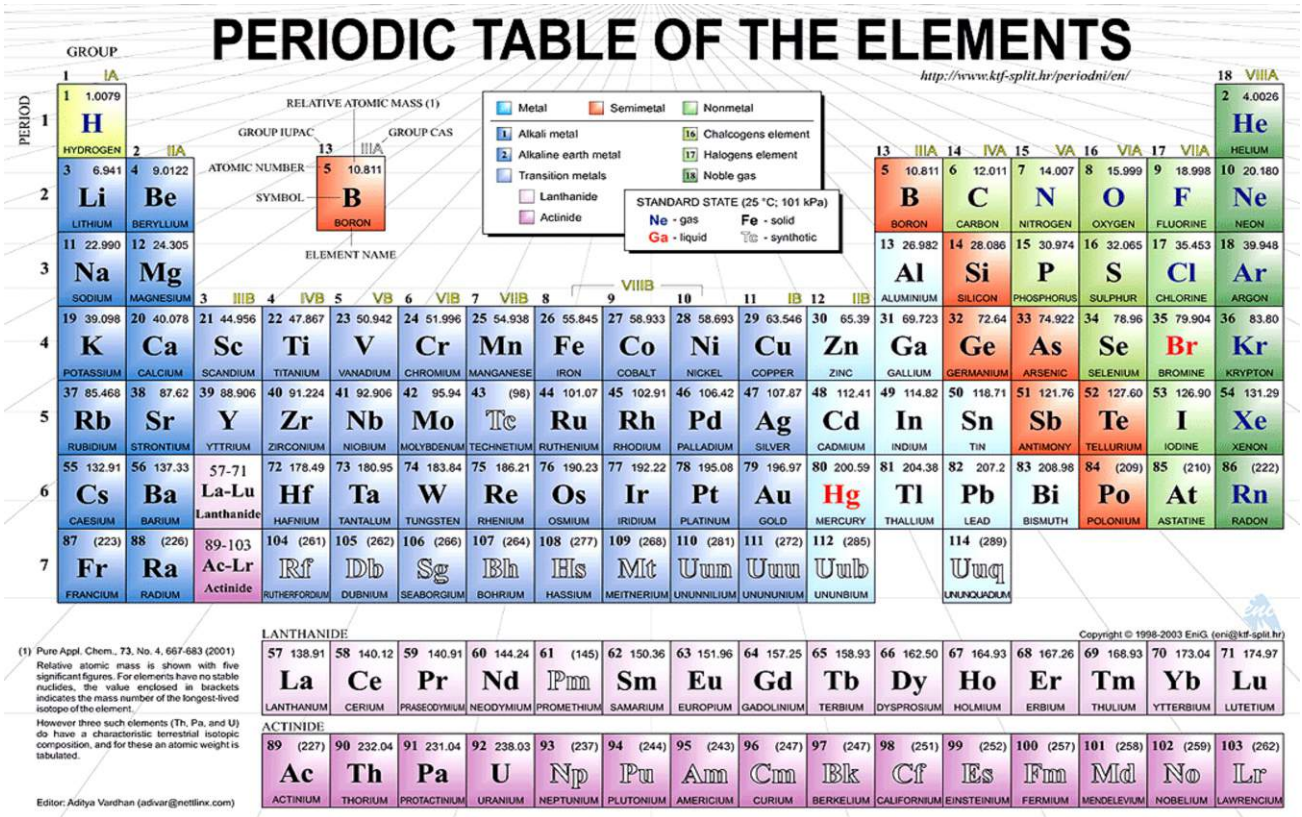
Lesson Plan 3

TOPIC

Periodic Table

Periodic table and periodicity of properties

Grade IX



Students' Learning Outcomes

Students will be able to:

- distinguish between a period and group in the periodic table. (Understanding)
- state the periodic law. (Remembering)
- determine the demarcation of the periodic table into an s block and p block. (Remembering)
- explain the shape of the periodic table,(Analyzing)

Information for Teachers

- Elements are arranged in increasing orders of atomic numbers (proton No.)
- Horizontal rows are called period. There are seven period in periodic table and no. of period indicates the shell being filled
- Vertical columns are called groups, arranged in s block, p block, d block and f block elements
- s block elements are on left side i.e. group no.

1 and 2

- P block elements are on the right side i.e. group no 3 to 8
- Between s and p block elements there are transition elements which belong to d and f block elements
- Normally f block elements are given below the periodic table in two rows
- In 1913 Mosley gave concept of atomic number. Periodic Table was modified and elements were arranged according to their atomic number.

Duration/Number of Periods

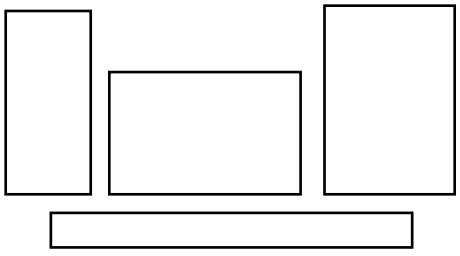
80 mins/2 period

Material/Resources Required

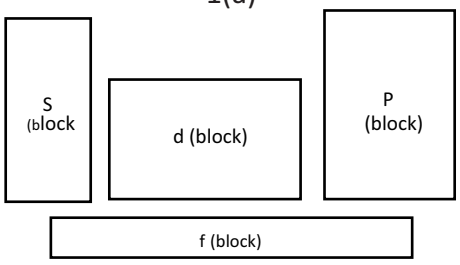
A4 sheets, ruler, pencils, colored markers or pencils, atomic model, periodic table

Introduction

- Tell the students that the elements are arranged in different block according to the sub shell being filled
- The elements in which s sub shell is being filled are called s block element
- Elements in which p sub shell is being filled are p block elements
- D block and f block elements are called transition elements
- Draw 1(a) on board and ask students to name different blocks
- After getting their responses, fill it according to 1(b)



1(a)



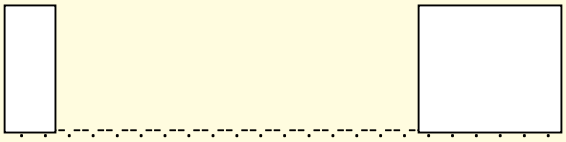
1(b)

Development

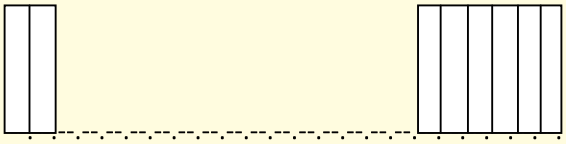
Activity 1

(Shape of periodic table and demarcation into Blocks)

- Ask students to take out A4 sheets or any sheet of paper
- Tell the students to draw a line of 18cm length and divide into 18 parts
- Tell the students to make a vertical rectangle on the left side 2cm x 6cm and one on extreme right 6cm x 6cm as shown in the diagram

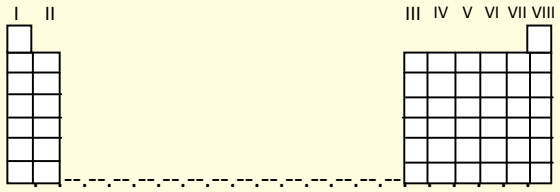


Divide column (A) into two parts vertically and rectangle (B) into six vertical parts

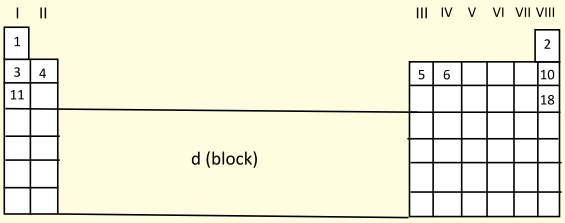


- Draw a small rectangle above column 1 and column 8 and Start numbering from

extreme left from 1 to 8



- Divide column (A) and (B) in six parts horizontally



- Start filling symbols for the elements according atomic numbers

Activity 2

(Periodic Law)

- Select 18 boxes for first 18 elements.
- Start filling elements according to atomic number i.e. number of protons in the nucleus H, He, Li, Be, in box # 1, 2, 3, 4 respectively.
- Now tell students that similarly elements are arranged in periodic table in order of increasing atomic number.

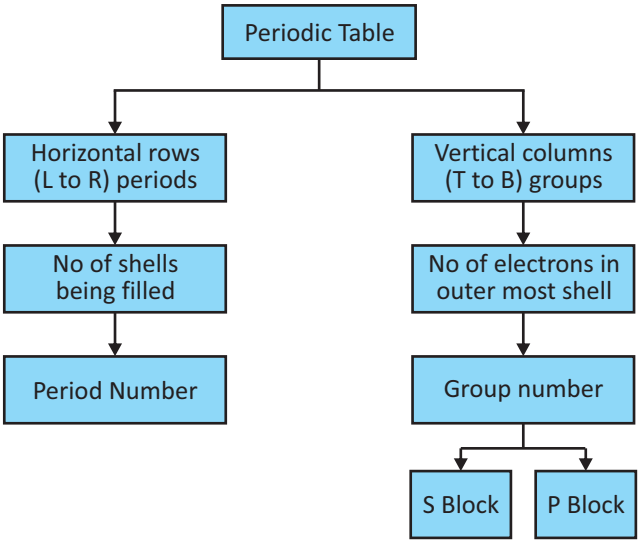
Activity 3

(Concept of Group and Periods)

- Teacher will explain the group and periods with the help of seating arrangement of students in the classroom.
- Students in 1st vertical row will be asked to stand up (group).
- Students in the 1st horizontal row will be asked to stand up(period)
- Teacher will then repeat activity with Group2 and Period 2and students will stand accordingly.
- Atomic model will be displayed in the classroom to explain shells.

Conclusion/Sum up

Draw the following concept map to conclude the lesson:



Assessment

Ask the following questions from students to assess their learning:

- How elements are arranged in the periodic table?
- Define the modern periodic law.
- Differentiate between group & period.
- Differentiate between S & P block elements.

Follow-up

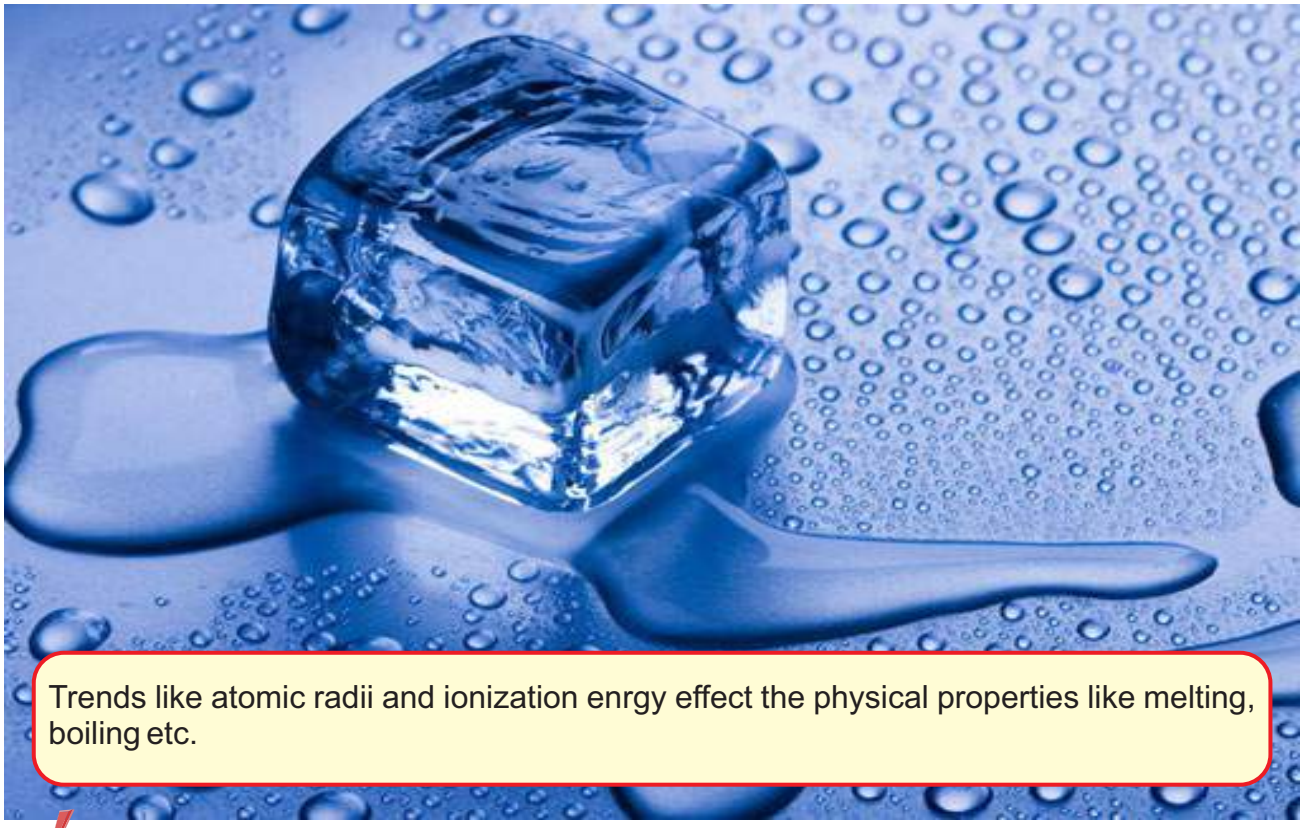
- A, B and C are three elements in the same period of the periodic table. A is a non metal, B a metal and C is a transition metal. What will be correct order of these elements in the periodic table, moving across the period from left to right?
- Find out why hydrogen is placed at the top of group 1 of periodic table?

Lesson Plan 4

TOPIC

Atomic Radii and Ionization Energy

Grade IX



Trends like atomic radii and ionization enrgy effect the physical properties like melting, boiling etc.

Students' Learning Outcomes

Students will be able to:

- describe how the atomic radii vary within a group and within a period of the periodic table.
- describe how ionization energies vary within a group and within a period of the periodic table.

Information for Teachers

- The energy required to remove the outermost electron from a gaseous atom is called ionization energy.
- The outermost electron leaves behind a positively charged ion. That is why it's called ionization.
- The **atomic radius** of an atom is the distance from the nucleus to the boundary of the surrounding cloud of electrons.
- Since the boundary is not a well-defined physical entity, there are various non-equivalent definitions of atomic radius.

Duration/Number of Periods

80 mins/2 period

Material/Resources Required

A4 sheets, glue stick/glue/flip charts, circular magnet, disc magnet/iron disc, small circle disc or magnet, rubber band/spring balance, thread band

Introduction

Activity

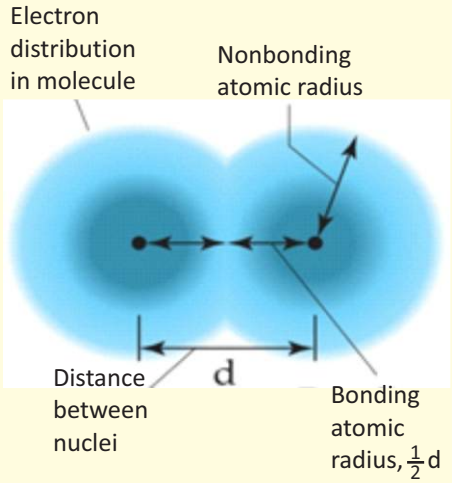
Introduce the topic by asking:

- State and explain periodic law. (The physical and chemical properties of elements are the periodic functions of their atomic numbers).
- Define atomic number and atomic mass. (*Atomic number* of the element is equal to number of protons and *atomic mass* is equal to the total number of protons and neutrons in an element.)
- On which properties of an element does periodic table depends? (Atomic number).
- Ask students to guesswhat would be the size of an atom? Then lead students to the next activity.

Development

Activity 1 (Concept of Atomic Radii)

- Ask students about the methods to measure the radius of a circle and its units.
- After listening to their response, ask how would we measure the size of an atom?
- Explain that the radius of an atom is also measurable with the help of some other means.
- Then write the definition of atomic radius on board and its units.
- **Atomic radius** is generally stated as being the total distance from an atom's nucleus to the outermost orbital of electron.
  OR
- The bonding atomic radius is defined as one-half of the distance between covalently bonded nuclei.



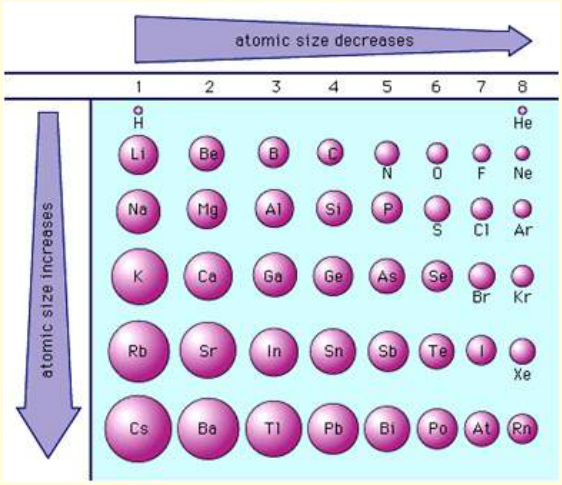
Units of Atomic Radii

The atoms sizes are measured in *Angstrom* Å.= 1 millimicron or picometers (pm = 10-12 m).

Activity 2

(Trends of Atomic Radii)

- Divide students in two groups.
- Ask group 1 to draw the atomic structure of Li, Na, K (with help of the periodic table given in books) on A4 sheets/note book page and paste it on one side of the board.
- Ask group 2 to draw the structure of Be, B and N (with help of the periodic table



given in books) on A4 sheets/note book page and paste it on writing board.

- Ask students to compare the atomic radii of elements in a group and in the period then ask the following questions.

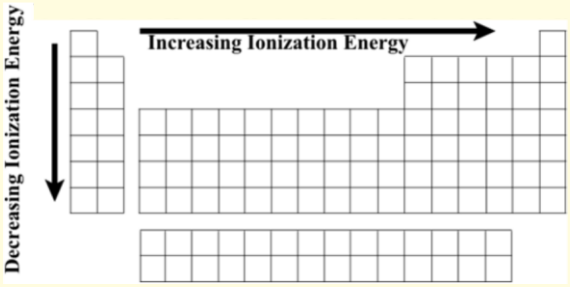
Q1. What is the trend of atomic radius in a group from top to bottom? (Increases)

Q2. What is the trend of atomic radius in a period? (Decreases)

Activity 3

(Concept of Ionization Energy)

- Take two magnets. Place magnet No. 1 on a paper and fix it on the table.
- Draw circles around it at a distance of 2 inches approximately.
- Place another magnet No. 2/iron disc. Tie it to a rubber band/spring balance.
- First place the iron disc in circle 1 and try to pull it away from magnet. Note the increase in length of rubber band/spring balance.
- Keep the magnet in circle 2 and repeat the above procedure. You will note that change in length is greater in circle 1 as compared to circle 2. Assume that magnet No. 1 is nucleus and the other is an electron.
- After this activity, explain students that greater expansion in length showed that more energy was applied to pull the magnet away from the central magnet.
- Thus nucleus which acts like a central magnet keeps electrons attracted towards it so it is difficult to remove electrons.
- If we want to remove an electron then we should provide enough energy to overcome the attraction between a nucleus and an electron. This energy is called ionization energy and it is measured in kJ/mol.
- The first ionization energy is the energy required to remove one electron from the parent atom.
- The second ionization energy is the energy required to remove a second valence electron from the univalent ion to form the divalent ion, and so on.
- Ionization energies increase moving from left to right across a period (decreasing atomic radius). Ionization energy decreases moving down a group (increasing atomic radius).



Conclusion/Sum up

i. Generally, the atomic radius decreases across a period from left to right and increases down

a given group.

ii. Ionization energies increase moving from left to right across a period (decreasing atomic radius). Ionization energy decreases moving down a group (increasing atomic radius).

Assessment

Ask following questions to recap the lesson and also to assess students understanding of the taught concepts.

Q1. Atomic radius **decreases** as you go from left to right across a period. Why?

Ans: Stronger attractive forces in atoms (as you go from left to right) between the opposite charges in the nucleus and electron cloud cause the atom to be 'sucked' together a little tighter.

Q2. Atomic radius increases as you go down a group. Why?

Ans: Addition of a new energy levels of electron clouds to the atom as you move from period to period down a group, making the each atom significantly more massive, both is mass and volume.

Q3. Define ionization energy.

Ans: The ionization energy, or ionization potential, is the energy required to completely remove an electron from a gaseous atom or ion.

Ask following MCQs:

1. I.E is measured in _____ units.
   a. KJ
   b. J
   c. kJ/mol
   d. All of the above
2. I.E decreases along:
   a. Groups
   b. Periods
   c. Both of the above
   d. None of the above
3. Atomic radius of an atom is measured in:
   a. Millimeters
   b. Centimeters
   c. Picometers
   d. All of the above

Ans: c, b, c,

Follow-up

- Explain the trends of atomic radii and ionization energy in periodic table.
- What are units of Ionization energy and atomic radii?
- Give reasons Why ionization energy increases from left to right in a period?
- Guide the students to solve the exercise problems given at the end of each unit/ chapter of textbook.

UNIT 5

Lesson Plan 5

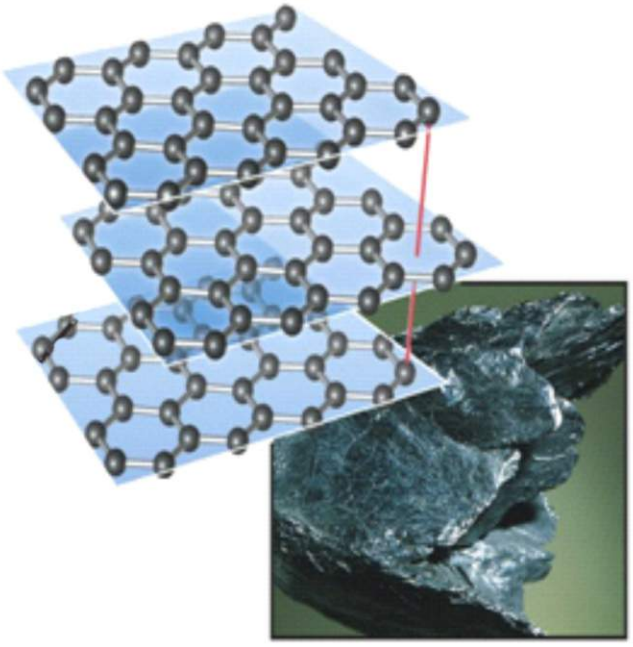
TOPIC

Allotropy of Solids

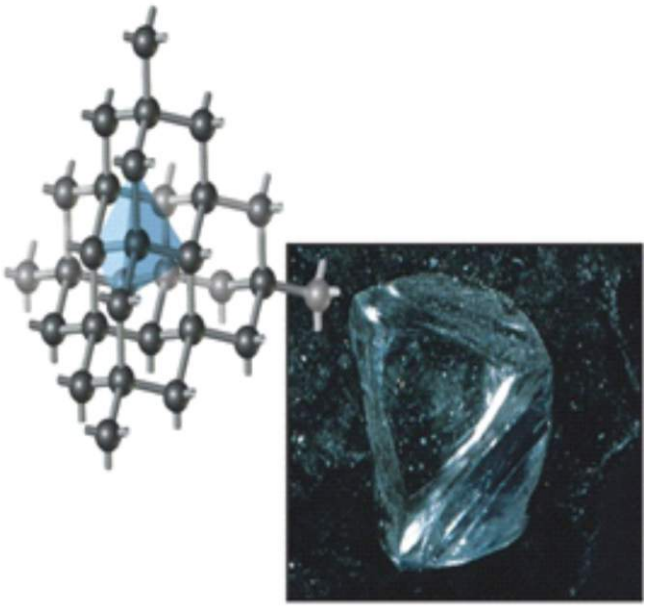
Physical States of Matter

Grade IX

ALLOTROPES OF CARBON



Graphite



Diamond

Students' Learning Outcomes

Students will be able to:

- explain the allotropic forms of solids (Understanding)
- differentiate between amorphous and crystalline solids (Analyzing)

Information for Teachers

- Allotropy is the existence of an element in more than one crystalline forms and these forms of the element are called allotropes or allotropic forms. Sulphur, carbon, tin and phosphorous are some of the important examples of elements which show allotropy.
- Those solids in which atoms, ions or molecules are arranged in a definite three-dimensional pattern are called crystalline solids.
- Amorphous substances are those whose constituent atoms, ions, or molecules do not posses a regular orderly arrangement. The best examples are plastics, glass, rubber, glue etc.

Duration/Number of Period

40 mins/1period

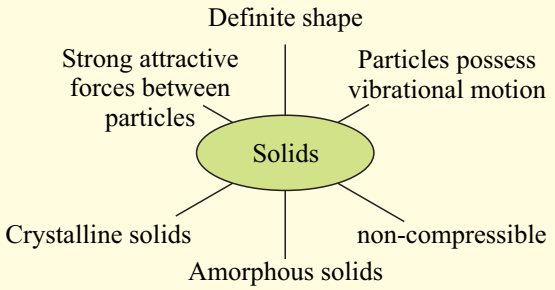
Material/Resources Required

Sodium chloride (Common Salt), Flour/Starch, Sugar, Charts, Markers, Board, Chalk, Glue

Introduction

Activity

- Write the word solids on the board and ask students to brainstorm about it. The students may give ideas as shown below:



Development

Activity 1

(Concept of crystalline and Amorphous Forms)

- Teacher will show few crystalline solids like, sodium chloride, sugar and some amorphous solids like starch & flour etc to the students.

- Ask how do these three differ from each other?
- Ask students to touch and feel the texture of these solids
- Explain them that sodium chloride, and sugar are crystalline solids. They have regular arrangement of atoms or molecules within the structure. But amorphous solids like flour do not.
- The word amorphous means shapeless.
- Conclude the activity by telling the definitions of amorphous and crystalline solids,.
- Explain the two forms in detail by sharing properties e.g Crystalline solids have a sharp melting point, but amorphous solids don't.

Activity 2

(crystalline and amorphous forms Of carbon)

Show them the picture of diamond and coal

- Ask them how are they different?(They will explain the physical characteristics

e.g diamond is shiny and coal is dark and dull)

- Explain them that diamond is crystalline form of carbon and coal is amorphous form .They both are made up of carbon atoms.
- Diamonds are found in coal mines.
- Share with them the following motivational poem

The promise of our dreams comes true
When patience minds our goal
Remember that the diamond once
Was just a piece of coal

- Explain them that in crystalline solids, there is a repeating unit, which makes up the entire structure, but for amorphous solids, a repeating unit cannot be specified.
- When amorphous solids are heated and cooled slowly, they can become crystalline at some point.
- Teacher will further elaborate that allotropic forms are the crystalline forms of solids.

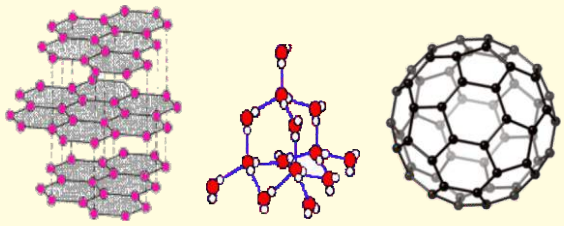
Activity 3

(Allotropes of carbon and sulphur)

Divide the class into two groups.

- First group will be asked to discuss properties and uses of allotropes of carbon i.e diamond graphite and buck balls.
- The second group would be asked to discuss about the allotropic forms of sulphur.
- Ask both groups to write important points on chart and give presentation.
- Teacher will facilitate students while discussion.

Different Allotropic forms of Carbon



Graphite Diamond Buckyball

Conclusion/Sum up

Conclude the lesson by telling children that:

- Solids exist in crystalline and amorphous forms.
- Diamond, graphite and bucky balls are allotropes of carbon.
- Coal, charcoal and carbon black are amorphous forms of carbon.

Assessment

Ask following questions to assess students's learning:

- What is the difference between amorphous and crystalline forms of a solid?
- Can you define allotropy?
- Name few elements that show allotropy?
- Which of the following is a crystalline allotrope of carbon:
  a) Carbon black
  b) Bucky balls
  c) Coaltar
  d) Coke

Follow-up

- Why tyres are usually black in colour?
- Separate the uses of diamond and graphite from the list given below:
  1. Lubricant
  2. Dry cell
  3. Ornament
  4. Drilling of rocks
  5. Glass cutting
  6. Lead pencil
- Guide the students to solve the exercise problems given at the end of each unit/chapter of text book.

UNIT

5

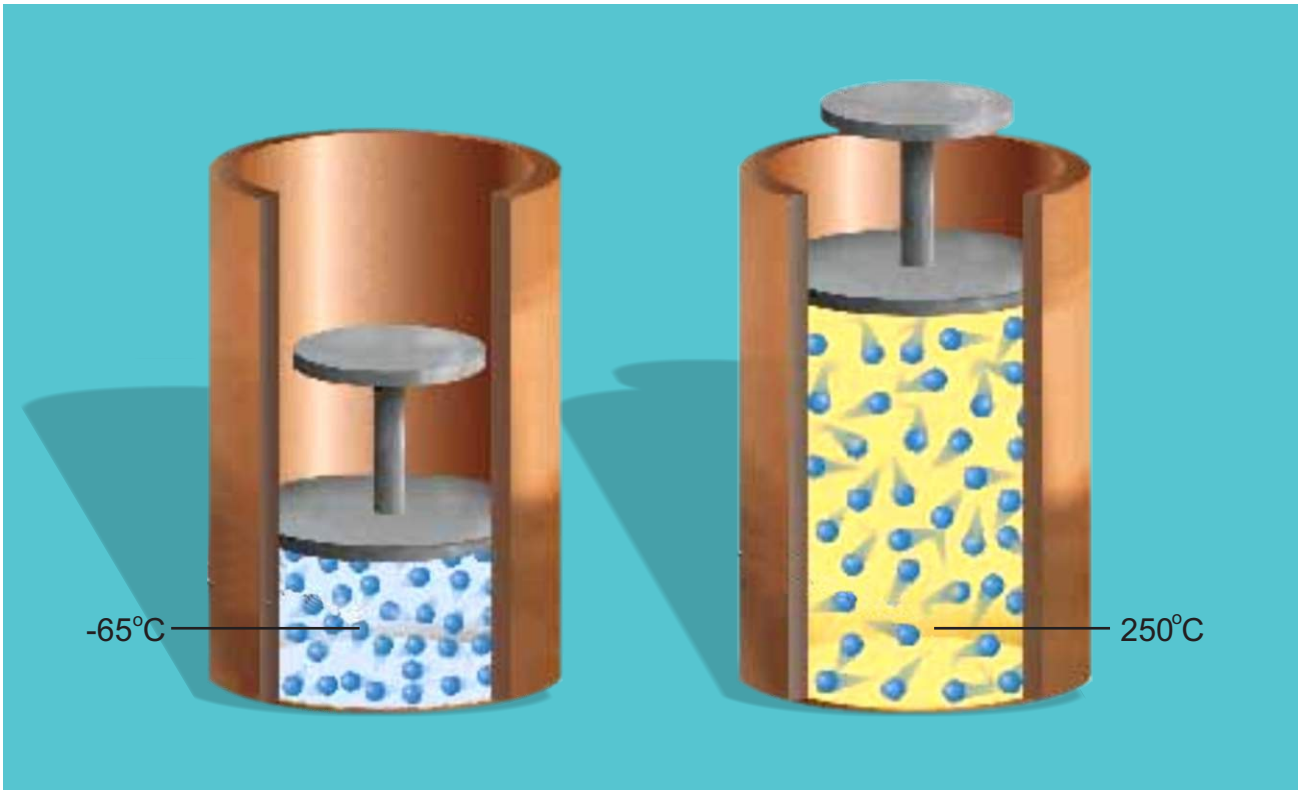
Lesson Plan 6

TOPIC

Charle's Law

Physical States of Matter

Grade IX



Students' Learning Outcomes

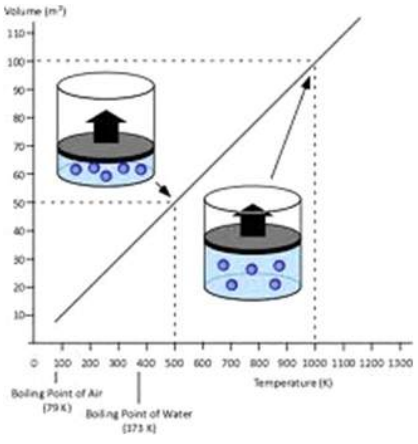
Students will be able to:

- explain effect on the pressure of a gas by a change in the a. volume b. temperature. (understanding)
- account for temperature-volume changes in a gas using charle's law. (analyzing)

Duration/Number of Periods

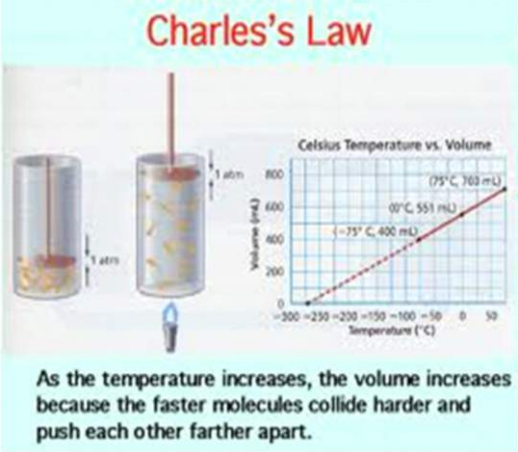
80 mins/2 period

Information for Teachers



- Charles's law states that if a given quantity of gas is held at a constant pressure, its volume is directly proportional to the absolute temperature.
- As the temperature of the gas increases, the gas molecules will begin to move around more quickly and hit the walls of their container with more force.
- Thus the volume will increase.

Only the Kelvin temperature scale is used when working with temperature in all gas law formulas. Celsius temperature can be converted in to Kelvin by adding 273.15



Material/Resources Required

You need this material for each group.

Table tennis balls, water bath, Round bottom flask with its mouth wrapped up with a shopping/polyethene bag.

Introduction

Ask the following questions from the students:

1. What is pressure? (Pressure is the force per unit area applied in a direction perpendicular to the surface of an object.)
2. What happens to the volume of the given mass of a gas when temperature is increased? (Volume Increases).

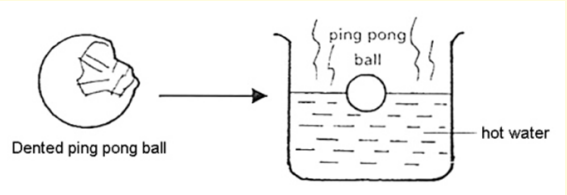
Development

Activity 1

Divide students in small groups; give the material (dented ping pong balls, water, burner) and instruct them to:

- Pour water in a pot or large beaker and heat it gently.
- Put the dented ping pong ball in the warm water.

- Write your observations and group leader will tell group answer to the teacher. (Dents will be removed due to increased volume)



- Introduce the relation between volume and temperature when pressure of a

gas is kept constant. Under condition of constant pressure, there is direct relation between volume and temperature

Statement

- "The volume of a given mass of a gas at constant pressure is directly proportional to absolute temperature"

Activity 2

- Take a round bottom flask with its mouth wrapped up with a polyethene bag.
- Place it on warm water bath.
- Wait for few minutes and ask students to observe what happens.

Result: Shopping bag will inflate as the volume of gas is increased.

Explain the students following mathematical presentation of Charles law:

Let the volume of a gas at T Kelvin =V

$$V \propto T$$

$$V = (\text{constant})\ T$$

$$V/T = \text{constant}$$

At T_1 k

$$V_1/T_1 = k \text{ ----------(1)}$$

At T_2 k

$$V_2/T_2 = k \text{ ----------(2)}$$

Thus

$$V_1/T_1 = V_2/T_2$$

By using above equation, Charles's law can also be stated as:

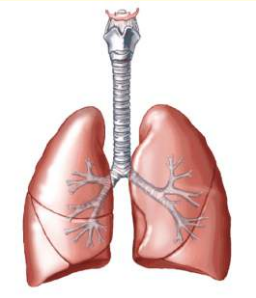
"The ratio of volume to absolute temperature of given mass of a gas at constant pressure is always a constant"

Activity 3

Explain students following example with explanation of all steps:

Example:

An average adult inhales a volume of 0.50 dm^3 of air into the lungs with each breath. If the air is warmed from room temperature (25 ^{0}C) to body temperature (37 ^{0}C). What is the volume of air exhaled?



Data Given

Room temperature = 25 + 273 = 298 K

Body temperature = 37+ 273 = 310 K

Volume of inhaled air V_1=0.50 dm^3

Room temperature T_1=298 K

Body temperature T_2= 310 K

Data Required

Volume of exhaled air = ?

Formula

$V_1/T_1 = V_2/T_2$

$V2=V_1T_2/T_1$

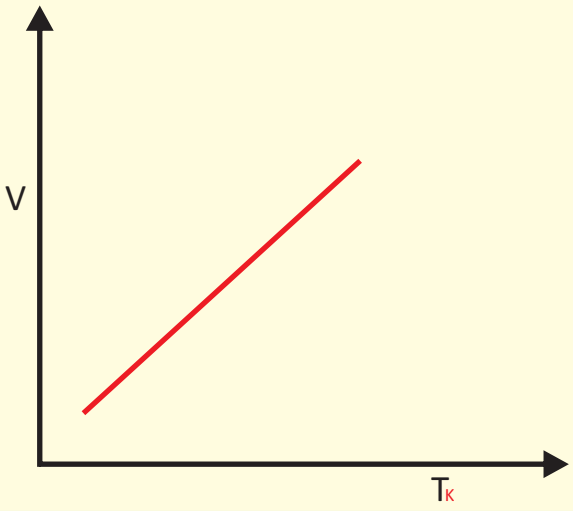
0.50 dm^3 x 310 K/298 K

Ans: 0.53 dm^3

Conclusion: Explain students that as the temperature of air increases from 25 ^{0}C to 37^{0}C,the volume of the air exhaled also increases from 0.50 dm^3 to 0.53 dm^3

Graphical representation

Graph between Volume and absolute temperature of a gas at constant pressure is a "straight line"



Conclusion/Sum up

Explain students that they have learnt

- The ratio of volume to temperature is a constant quantity.This is called Charles Law.
- Charles law must be used with Kelvin temperature scale.
- The formula used for solving numerical problems willbe $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Assessment

Ask following questions to recap the lesson and also to assess students understanding of the taught concepts.

Q1: Define Charle's law.

Q2: Ask the following MCQs

1. Pressure is held constant in:

a. Boyle's law
b. Charles's law
c. Both of the above
d. None of the above

2. $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

a. Charles's law
b. Boyle's law
c. Avogadro's No.
d. None of the above

3. T_1 stands for:

a. Initial temperature
b. Final temperature
c. Middle pressure
d. All of the above

4. Temperature is measured in:

a. Pascal
b. Newton
c. Kelvin
d. Centimeter

e. Answers: 1. b 2. a 3. a 4. c

Follow-up

Solve the following problems.

A sample of gas at 15°C and 1 atm has a volume of 2.50 dm^3. What volume will this gas occupy at 30°C and 1 atm?

Data Given

T_1= 15C +273=288K

T_2 =30C +273=303K

V_1=2.50 dm^3

Data Required

V_2= ?

Formula Used

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Solution

$\frac{2.50}{288} = \frac{V_2}{303}$ V_2=2.63dm^3

As the temperature is increasing slightly, so the volume should increase slightly. Ask student to be careful in questions like these and first convert celsius in Kelvin temperature (by adding 273) to get the correct relationships!

UNIT 6

Solutions

Lesson Plan 7

TOPIC

"Comparison of Solutions, Suspension and Colloids"

Grade IX

Fizzy drinks are a solution of carbon dioxide in liquid.

Students' Learning Outcomes

Students will be able to:

- define solution, aqueous solution, solute and solvent
- explain the difference between saturated, unsaturated and dilute solution.
- differentiate between solution, suspension and colloids.

Duration/Number of Period

40 mins/1period

Information for Teachers

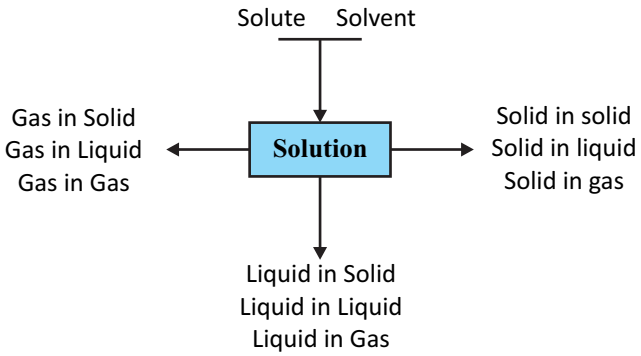
- True solution colloids and suspension differ in their particle size.
- True solution has ions or molecules dispersed in solvent.
- Colloids have particles bigger than true solution and smaller than suspension.
- Particles of a suspension are bigger and cannot pass through filter and settle down.

Material/Resources Required

Test Tubes, Sodium chloride, Milk (Powdered milk can be used or Fe $(OH)_3$), stainless steel spoon and fizzy drink.

Introduction

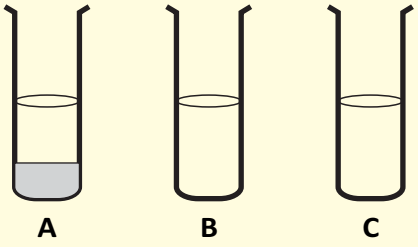
Write the word solution on the board and ask student to give their ideas about it. Write ideas on the board.



Development

Activity 1

Place 3 test tubes half filled with water labeled as A, B, C on the table



- Add one table spoon full of NaCl in test tube A.
- Add a pinch of NaCl in tube B and C. Shake well and observe.
- Test tube A has undissolved NaCl therefore it is a saturated solution of NaCl at room temperature.
- Test tubes B and C have no solid salt therefore they contain unsaturated solution. Add again a pinch of salt and shake. The salt dissolves which confirm unsaturation.
- Add some more water in test tube C and ask the students what is difference between solution in test tube B and C.

  (C is dilute solution as compared to B)

Result:

Test tube A contains saturated solution while B and C contain unsaturated solution.

Now, ask student:

- In the above solution which is solvent **(Water)**
- How you name a solution having water as solvent. **(Aqueous Solution)**
- Give example of a Saturated solution?(To develop their concepts more, explain students that thick syrup of Gulab Jaman (Sheera) is a saturated solution of Sugar.

Activity 1

Place on the table a stainless steel spoon, a fizzy drink and empty glass.

Stainless Steel Fizzy Drink Empty Glass

- Tell the students that stainless steel spoon is a solution of chromium in steel.

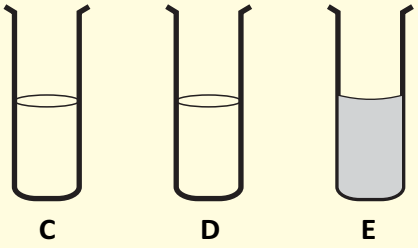
(Solid in Solid)

- Fizzy drink is a solution of CO_2 in water **(gas in liquid)**
- Empty glass contains air which is a solution of **(gas in gas)**

Activity 3

Effect of gravity on particles of solution, colloids and suspension.

Take test tubes C,D and E. C contains dilute solution of NaCl. Add some milk in test tube D and small amount of clay in test tube E. Shake and observe.



- Contents of tube C are clear and nothing settles down. **(True Solution)**
- Contents of tube D are not clear but nothing settles down. **(Milk is colloid)**
- Contents of tube E are cloudy and particles start settling down. **(Suspension)**

  Filter contents of all 5 test tubes and observe.
- Only tube E leaves a residue on the filter paper. **(particle of suspension can be separated by filtration)**

Conclusion/Sum up

- Solution and colloids can be between any two state of matter .i.e. solid, liquid and gas.
- Solution is always clear (may be coloured) while colloids may or may not be cleared to naked eye.
- particles of colloids and solution does not settle down while those of suspension settle down and can be filtered.

Assessment

Tell the student that pure gold which is 24 karats is soft metal. Goldsmith makes it harder by adding 22 parts gold and 2 parts copper called 22 karats gold. What type of solution it is?

Assess their learning by asking following questions:

1) **Air is homogenous mixture i.e. solution of N_2, O_2, other gases. Which of the following is a solvent?**

   (a) O2 (b) N2

   (c) Water vapours (d) No solvent

2) **We cannot see through blue ink yet, nothing settle down and it passes through filter paper unchanged, it is**

   (a) solution (b) colloids

   (c) Suspension (d) amalgam

3) **Hydrochloric acid in the reagent bottle is**

   (a) Compound

   (b) solution of gas in water

   (c) Solution of liquid in liquid

   (d) solution of solid in liquid

4) **A solution in which solid Solute is in equilbrium with its solution is called**

   (a) saturated (b) unsaturated

   (c) super saturated (d) dilute

Follow-up

Tell the students to look around for solution of

Gas	in	Gas
Solid	in	Solid
Solid	in	Gas
Liquid	in	Gas

UNIT 7

TOPIC

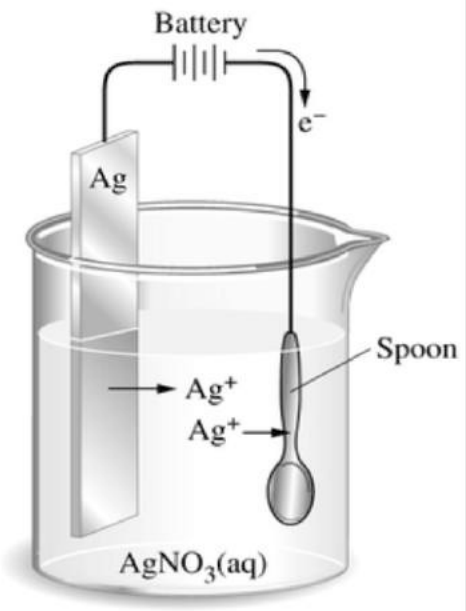
Electrochemical Cells

Lesson Plan 8

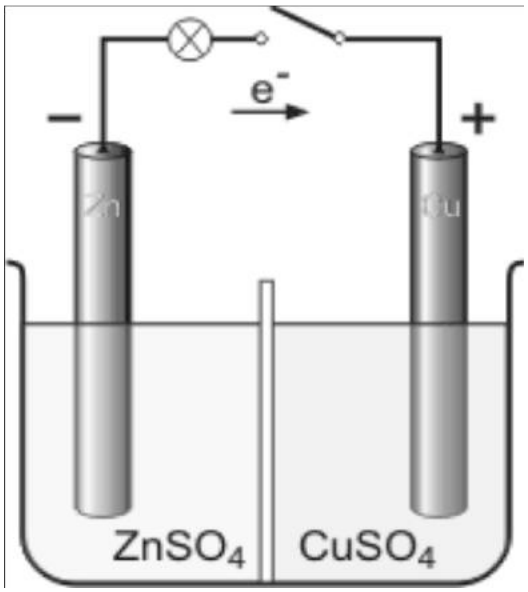
Electrochemistry

Grade IX

Electroplating



Galvanic Cell



Students' Learning Outcomes

Students will be able to:

- define oxidation and reduction (Understanding)
- describe the nature of electro chemical process (Understanding)
- sketch an electrolytic cell, label cathode anode (Understanding)
- distinguish between electrolytic and voltaic cell (Analyzing)
- to identify the half cell in which oxidation and half cell in which reduction take place. (Applying)

Information for Teacher

- Loss of Electron is oxidation (metal to cation)
- Gain of electron is reduction (non metal to an ion)
- Redox mean oxidation and reduction always take place at the same time
- In electro chemical cell inter conversion of electrical and chemical energy take place.
- Electro chemical reactions are always redox reactions.
- Oxidation takes place at anode.
- Reduction takes place at cathode

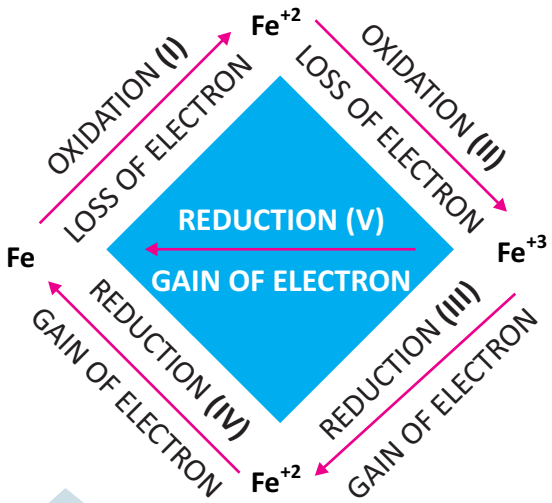
- In electrolytic cell anode is positively charged in galvanic cell anode carries negative charge.

Duration/Number of Periods

80 mins / 2 periods

Introduction

Write different oxidation states of iron and ask the students to name step I to V in terms of oxidation, reduction and (gain or loss of electron).After their responses, the picture will be like this:



Material/Resources Required

Beakers, copper and zinc electrodes, copper sulphate, zinc sulphate, stainless steel spoon, battery cell.

Development

Activity 1

- Place 2 beakers A + B containing dilute copper sulphate Solution. Dip iron strip (or knife) in beaker labeled A and take it out after sometime and show to the students (the strip gets coated with copper metal)
- Put some iron nails or filling in beakers B and shake with a glass rod and show

to the students. The blue colour of copper sulphate solution disappears.

- Tell the students that the following redox reaction has taken place.

$$CuSO_4 \xrightarrow{\text{ionization}} Cu^{+2} + SO_4$$

$$Fe \xrightarrow{\text{Oxidation}} Fe^{+2} + 2e^-$$

$$Fe^{+2} + 2e^- \xrightarrow{\text{Reduction}} Cu$$

- Tell the students that metal ions (cations) are reduced to their metallic form.

Activity 2

- Dissolve approximately ten grams of copper sulphate in 200 Cm^3 water containing few drops of dilute sulphuric acid.
- Attach clean copper wire to the spoon

and another to clean copper electrode.

- Dip the spoon and the copper electrode in the solution of copper sulphate.
- Connect to a cell such that negative end is attached to the spoon and positive end to the copper plate for five to ten minutes. Take out the spoon and observe. (It is coated with copper)

This indicates the following

- The cell is example of electrolytic cell
- Positive ion that is CU^{+2} move towards oppositely charged (-ve) electrode .i.e. cathode and gets deposited on the spoon as copper metal (Electro plating)
- At anode oxygen is released in the form of small bubbles which are not clearly visible.

Break a dry battery cell. It will provide you with

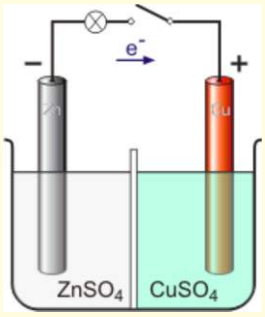
- Steel cathode from its covering
- Open and cut the cell cup. It will provide zinc electrode
- The carbon rod provides carbon electrode

Tell the students in same manner we can electroplate Ni and Cr metal on iron to avoid corrosion.

Activity 3 GALVANIC CELL

- Dissolve 30 grams of $ZnSO_4$ in 200 Cm^3 of water in a beaker
- Dissolve 50 grams of $CuSO_4$ in 200 Cm^3 of water in a beaker
- Dip a zinc electrode in zinc sulphate solution and copper plate in copper sulphate solution
- Attach with the copper wire to volt meter as shown in the diagram

The volt meter will indicate a potential difference



Conclusion/Sum up

Oxidation is loss of electron and reduction is gain of electrons. Electro chemical cells are of two types.

I. Electrolytic Cell

ii. Galvanic Cell

Electrolytic cells are used for extraction of metals, purification of metals, electro plating of metals etc. where as galvanic cells are used fro production of electric current.

Assessment

Ask the students the battery of mobile phone or a car battery act both as electrolytic cell as well as galvanic cell, how? (It acts as both. When recharged as electrolytic cell and when used it acts as galvanic cell.)

Follow-up

Ask the student to open a dry battery cell and find out its cathode and anode.

- Guide the students to solve the exercise problems given at the end of each unit /chapter of textbook.

UNIT 8

Lesson Plan 9

TOPIC

Chemical Reactivity of Metals

Chemical Reactivity

Grade IX

Students' Learning Outcomes

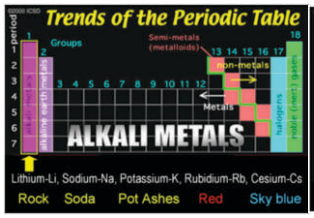
Students will be able to:

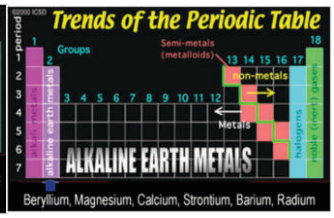
- Identify elements as an alkali metal or an alkaline earth metal. (Applying).
- Explain the differences in ionization energies of alkali and alkaline earth metals. (Understanding).

Duration/Number of Period

80 mins/2 period

Information for Teachers





- Alkali Metals are very reactive and their reactivity increases as we go down the group.
- Caesium in group 1 is the most reactive of all metals.

- This is because the atoms become larger as we go down the group.
- As we go down the group, ionization energy decreases The attractive force between the nucleus and outermost electron weakens and it becomes easier for the outermost electron to escape.
- The minimum energy required to remove outermost electron from an atom is called ionization energy.
- Pure sodium is used in sodium-vapor lamps, which produces very efficient light. Sodium is also used in soap as salts of fatty acids.

Material/Resources Required

Mg ribbon, cold water, beakers,

Introduction

Activity

Divide students in groups and instruct them to:

- Take a small quantity of cold water in a beaker and dip Mg ribbon in it compeletly. Observe the reaction.
- Ask what did you observe.(very slow reaction)
- Now hold a piece of Mg ribbon by a pair of tongs and ignite it.
- Ask students to observe the chemical reaction..What type of rection did they observe? (Very fast reaction).

- Now show the following figure of sodium reaction with cold water.
- Ask students which metals are more reactive with cold water, alkali or alkaline earth metals?
  Ans: Alkali metals

Reason: Alkali metals are more reactive because they have less ionization energies as compared to alkaline Earth metals.

Development

Activity 1

Comparison of ionization energy of Alkali and Alkaline Earth Metals

- Divide students in two groups. Give charts and board makers.
- It is very important that they have clear concept of ionization energy, group and period before the lesson is started.
- To group ONE give the following table and ask them to write this on chart for class display.

Metals	1st Ionization energies kJ mol^{-1}	Reaction with water
Li	520	Vigorous reaction with lots of heat evolved
Na	495	
K	420	
Rb	400	
Cs	380	

- To the second group, give the following table
- Ask which alkaline metal has greatest ionization energy? (Be)
- Is ionization energy increasing or decreasing down the group? (Decreasing)
- Which element has the lowest ionization energy.(Caesium that is why it is the most reactive metal)

	1st Ionization energies kJ mol^{-1}	Reaction with water
Be	899	Less violent exothermic reaction than alkali metals
Mg	737	
Ca	590	
Sr	549	
Ba	503	

Activity 2

Comparison of reactivity of Alkali and Alkaline Earth Metals

- Show students following picture to compare the reactivity of alkali and alkaline Earth metals.Ask students
- What does the picture tell you about the density of sodium? Lesser then water.
- Is this reaction an exothermic reaction? Why?(Yes! Because heat is evolved in this reaction)
- When we put red litmus paper into it,it turns blue. Explain this fact.(Because NaOH (an alkali) is formed which turns red litmus blue)
- What difference would you expect in the above reaction if

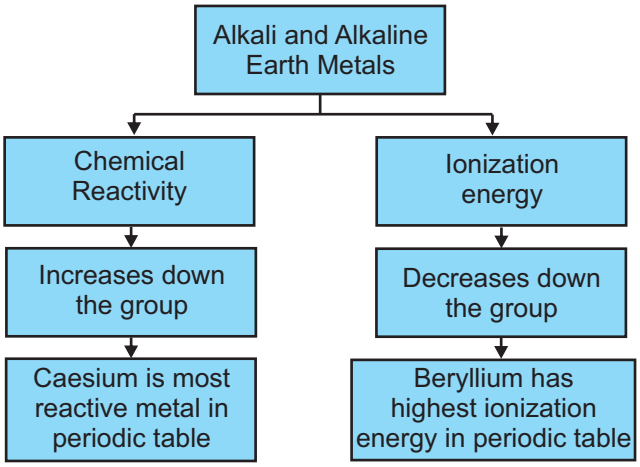
a. A piece of Li were used in place of sodium? (Slow reaction)

b. A piece of Cs were used in place of sodium?
(Very vigorous reaction)

Check their answers and give feedback if required.

Conclusion/Sum up

Conclude the lesson by drawing following concept map on board:



Assessment

Ask following questions to assess students understanding of the taught concepts.

Q1. Which one of the following is more reactive?

Na or Mg (Na)

Q2. Which one of the following has more I.E?

Be or Ca (Be)

Q3.Which one of the following has high melting point? Be or Rb (Be)

Follow-up

Q. Find out the flame colour of lithium, sodium and potassium?

(lithium-red-sodium: yellow, potassium lilac)

Q. Make a table and write one use of all alkali & alkaline Earth metals.

UNIT 9

Lesson Plan 10

TOPIC

Law of Mass Action

Chemical Equilibrium

Grade X

The Haber process is used in the manufacture of ammonia, which is used in fertilizer and explosive industry. This process is an application of chemical equilibrium.

Students' Learning Outcomes

Students will be able to:

- define law of mass action (understanding)
- derive an expression for the equilibrium constants & its units (applying)
- write the equilibrium constant expression of a reaction.

Information for Teachers

- Reactants react to give products, but in some cases product start reacting to give reactants again, such reactions are called reversible reactions.
- Such reactions never go to completion.
- Rate of reaction depends upon concentration of reactants.

$$A+B \underset{K_r}{\overset{K^f}{\rightleftharpoons}} C+D$$

- In the beginning reactants (A & B) have higher concentration therefore rate of forward reaction (R_f) is fast.
- When products (C&D) are formed reverse reaction starts and its rate (R_r) begin to increase, because with the passage of time

concentration of products goes on increasing.

- After some time a stage is reached when rate of forward reaction becomes equal to rate of backward reaction
  $R_f = R_r$
  Therefore, concentration of reactants and products become constant and thus equilibrium is established.
- It is not necessary that at the time of equilibrium concentration of reactants and products are same, they may be in any ratio.

Duration/Number of Periods

80 mins/2 period

Material/Resources Required

2 vessels (or 1000ml beakers), 250ml beaker, 100ml beaker, water

Introduction

- Put a beaker half-full of water in front of the class.
- Ask them what would happen if I place it here for 2 -3 months. (The expected responses: it will evaporate)
- Ask students what if I cover it with another large size beaker? (The H_2O molecules will still be evaporating and accumulating in the space between two beakers. Increase in vapour pressure will make them to return into the beaker again.
- Tell students that we can say that an equilibrium established here between the water molecules.
- It means that the rate at which the molecules are coming out of the water is equal to the rate at which they are going back into the beaker.
- State that its an example of dynamic equilibrium.
- Water molecules coming off the water vapours returning back into the water.
- Help them to learn the statement of the law. It states that "the rate of a chemical reaction is directly proportional to the product of the molar concentrations of the reactants at a given temperature.

  A +B ---> C+ D

  R_f [A] [B]

  $R_f = k_f$ [A] [B]

  Rr [C] [D]

  $Rr = k_r$ [A] [B]

At equilibrium state

The rate of forward reaction= rate of reverse reaction

$R_f = R_r$

k_f [A] [B] = k_r [A] [B]

k_f / k_r = [C] [D] / [A] [B]

k_c = [C] [D] / [A] [B]

where k is equilibrium constant and c means equilibrium constant in terms of molar concentrations

- Students can ask why we call equilibrium constant a constant?
- Explain them that if the concentration of any reactant or product is changed, equilibrium of reaction will be disturbed for the time being. But after sometime the equilibrium is again established and we will get the same value of Kc. That's why it is called equilibrium constant.

Development

Activity 1

- Take potassium dichromate solution in a beaker.
- Note its colour (bright orange)
- Now add small amount of base in it.
- It will convert into potassium chromate. The change can be seen by the change

of colour from orange to yellow.

- After some time, equilibrium will be attained where colour of solution is in between orange and yellow.

  $K_2Cr_2O_7 + OH^- ----> 2K_2CrO_4 + H^+$

  Orange yellow
- Now if we add few drops of acids equilibrium will shift to left that is conversion of dichromate to chromate.
- If we add few drops of base solution will become yellow (equilibrium shifts to right).

Activity 2

- Dissolve small amount of $BiCl_3$ in HCl in a test tube.
- This will give clear transparent solution of bismuth salt.
- Now add few drops of water in this solution.
- The reaction will go in backward direction and then turn milky according to the following equation.
- Now add few drops of HCl in the test tube and observe the change occurring in the test tube. Solution will become clear.
- Ask students In which direction the equilibrium has shifted?
- Ans. Backward direction.
- Add few drops of water in the test tube and observe the change. Also suggest the direction of equilibrium.
- Solution will become milky. The equilibrium will shift to forward direction.

Conclusion/Sum up

- Law of mass action provides relationship among the concentration of reactants and products of a system at equilibrium stage.
- The value of equilibrium constant can predict the direction and extent of a chemical reaction.

Assessment

Ask following questions from students to assess their learning

- What is dynamic equilibrium?
- How is equilibrium constant expression expressed?
- Why at equilibrium state reaction does not stop?

Follow-up

1. Write the equilibrium constant expressions for the following reactions:

a) $CH_3COOH_{(aq)} + C_2H_5OH$ <--> $CH_3COOC_2H_5 + H_2O$

b) $N_2 + 3H_2$ <--> $2NH_3$

c) $H_2 + I_2$ <--> $2HI$

UNIT 10

Lesson Plan 11

TOPIC

pH Scale

Acids, Bases and Salts

Grade X

Preservatives are used to prevent food spoilage and maintain pH. They are harmful as they can destroy nutrients and can cause allergies & cancer.

Students' Learning Outcomes

Students will be able to:

- given the hydrogen ion or hydroxyl ion concentration, Classify a solution as neutral, acidic or basic(applying).
- write the equation for the self ionization of water.(Remembring)

Duration/Number of Periods

60 mins/1.5 period

Information for Teachers

- pH is defined as the negative logarithm of the hydrogen ion concentration
- pH scale is a set of numbers used to indicate whether a solution is acidic or basic
- Alkaline foods include:
  All green vegetables
- Acidic foods include:
  Coffee, tea, soft drinks, burgers

Material/Resources Required

Beakers, pH paper

Introduction

Warm up Activity

- Draw '3' beakers on the board.

HCl solution Water NaOH solution

- Now, ask following questions.
- Can you tell which one of the solutions in the beakers have the greatest, least and medium concentration of H^+ ions?
- The discussion will be concluded by the facts that HCl has the highest concentration of hydrogen ions.It ionizes completely i.e

$HCl_{(aq)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$

The basic solution has the least concentration of hydrogen ions and the water has the medium concentration of hydrogen ions.

Explain children that substances which ionize incompletely are called weak electrolytes. Give them example of water and write equation for its autoionization on board:

$H_2O \rightleftharpoons H^+ + OH^-$

BOARDWORK + DISCUSSION

Q. Do you know the concentration of hydrogen ions in water?

Q. How can we express this concentration?

Tell students that

- Pure water has a hydrogen ion concentration of 0.000,000,1 moles/liter. Concentration is expressed with brackets $[H^+]$

So, $[H^+]$ of water = 0.000,0001 M or in scientific notation,

$[H^+]$ of water $= 1 \times 10^{-7}$ M 1

- Tell students that it was difficult even for the scientists to work with these small numbers. So, they developed a scale called pH scale to represent $[H^+]$
- Tell the definition of pH and write mathematical expression for it i.e.

$pH = -\log[H^+]$ -----2

- Put value of $[H^+] = 1 \times 10^{-7}$ from 1 into 2

$pH = -\log 1 \times 10^{-7}$

$pH = -(-7)$

$pH = 7$

Thus the pH of water= 7

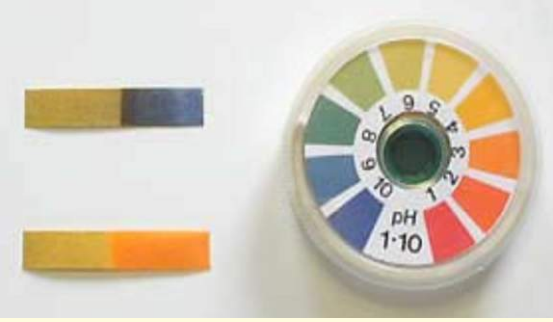
- Since pH is the negative logarithm, an increase in pH means decrease in $[H^+]$ and vice versa.
- Since its scientific notation is in base ten, a change in one of the pH represents a ten times change in $[H^+]$

Development

Activity 1 (pH-Scale)

- Show pH paper & pH scale to the students and tell the pH values of neutral, acidic and basic solutions.
- Draw pH scale and tell its definition.
- Ask students to classify the given list of

chemicals as acidic, basic and neutral.

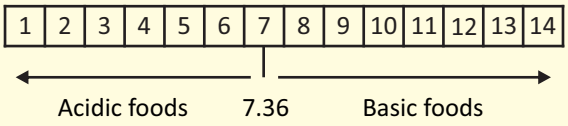


Chemicals	Ph	Nature
Battery acid	1	
Lemon juice	2	
Vinegar	3	
Beer	4	
Coffee	5	
Egg yolks	6	
Water	7	
Sea–water	8	
Detergents	9	
Soapy water	10	
House hold Ammonia	11	
Oven cleaner	13	
Drain cleaner	14	

Activity 2

(Importance of pH and pH dependent foods.)

- Draw pH scale on the board and write the pH value of human body in the middle of the scale.



Ask following questions:

Q. What is the importance of pH in our bodies?(An acidic body pH is like a magnet for all kinds of illnesses. **Explain them** that the body fluids, such as blood, spinal and saliva, of the healthy are alkaline (high pH), whereas the body fluids of sick are acidic .so pH is very important for a healthy body.)

Q. What should be the ratio of acid and alkaline foods to maintain pH. (In order to maintain suitable pH balance, nutritionists suggest 80% of our diet should be alkaline and 20% acidic.

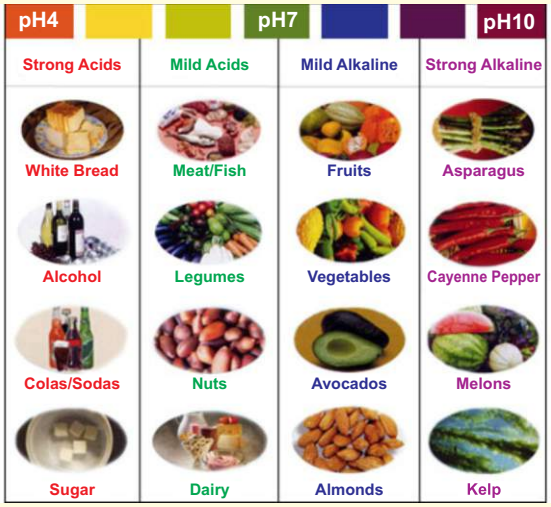
what is the pH value of our bodies?(The perfect pH balance for the human body is 7.3 to 7.4)

Q. How can we maintain the pH value of our bodies?(By drinking plenty of water, eating fresh vegetables and fruits)

- Tell them the importance of acid/base balance in the bodies.
- Describe them how different foods disturb this balance.
- Hold a discussion about the healthy & junk foods.(Tell them fast foods and fizzy drinks are acidic in nature.
- Give examples of Acids & Basic foods (as shown in the chart below)
- Ask them how can they measure pH Of their bodies?(pH test strips can determine saliva pH, which is generally a good indicator of how acid or alkaline your total body pH is. When saliva pH is continuously between 7.0 and 7.5 it means body is functioning in a healthy

range)

- Ask students to list down different food items they take in a day.
- Ask them to analyze and give suggestions to further improve their eating habits.
- Ask students to plan a well-balanced pH diet for you based on the information given in the chart above.



Activity 3

(determining pH-level)

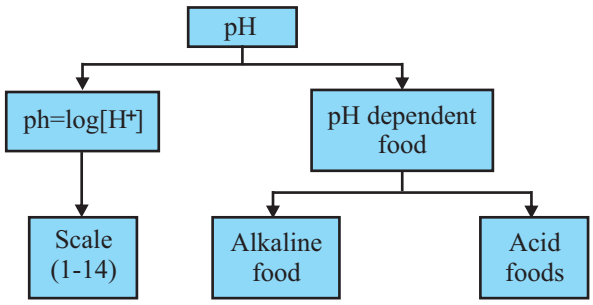
- Give students pH paper and ask them to check the pH value of their saliva.
- Match your pH strip with the pH color chart.
- What is your pH level?
- How will you improve the pH level of your body?

pH Chart

Conclusion/Sum up

- pH scale is used to describe the hydrogen ion concentration of a solution by taking the negative logarithm of the actual $[H^+]$
- pH 7 is arbitrary described as neutral
- Solutions with pH below 7 have a higher $[H^+]$ & are therefore acidic.
- Solutions with pH, above 7 have a lower $[H^+]$ & are therefore basic.

CONCEPT MAP



Assessment

Ask the students following questions to assess their learning:

1. If a solution has too many hydrogen ions, it is called
   a. basic
   b. acidic
   c. neutral
   d. None of the above
2. The pH of Battery acid is
   a. 1
   b. 2
   c. 3
   d. 4
3. The pH of human body is
   a. 7.365
   b. 7.568

c. 8.50

d. 3.205

4. What is the pH of a 0.00001 molar HCl solution?
   a. 1
   b. 9
   c. 5
   d. 4
5. An acidic solution could have a pH of
   a. 7
   b. 10
   c. 3
   d. 14

Follow-up

1. Lemon juice has a $[H^+]$ of 1×10^{-3}M. What is the pH of lemon juice?
2. House hold bleach has a pH of 13. What is the $[H^+]$ of house hold bleach?
3. Stomach acid has a $[H^+]$ of .01M. What is the pH of stomach acid?

Answers:

1. pH=3
2. 1×10^{-13}M .0000000000001M
3. 0.01M or 1×10^{-2}M, pH=2

UNIT 10

Lesson Plan 12

TOPIC

Acids and Bases

Acids, Bases and Salts

Grade X

Students' Learning Outcomes

Students will be able to:

- define and give examples of Arrhenius acid and bases.(Understanding)
- use the Bronsted-Lowry theory to classify substances as acids or bases, or as proton donors or proton acceptors.(Applying)

Information for Teachers

- According to Arrhenius concept acids donate hydrogen ions in aqueous solution and bases donate hydroxyl ions in aqueous solution
- According to Bronsted and Lowry concept: acids are proton donor while bases are proton acceptor groups. This concept is independent of nature of the solvent.
- Those groups which have greater tendency to accept a proton are strong bases and those groups which have greater tendency to lose a proton are strong acids.
- Every Bronsted acid has a conjugate base which differ from its acid by one proton.

Duration/Number of Period

80 mins/2period

Material/Resources Required

Test tubes sodium sulphide, copper sulphate, ammonia solution, sodium chloride and sulphuric acid

Introduction

- Explain students that will learn about conceptual definition of acids and bases.
- Explain the students there are three concepts of acids and bases
  1. Arrhenius concept of Acid and Bases.
  2. Bronsted concept of Acid and Bases.
  3. Lewis concept of Acid and Bases

Development

Activity 1

(Arrhenius concept of Acid and Bases)

Tell them the concept of acid and base according to Arrhenius

- An acid is a compound which dissociates in water to give hydrogen ions: H^+
- A base is a compound which dissociates in water to give hydroxide ions: OH^-
- Write formulas of these compounds on the board H_2SO_4, and NH_3
- Ask students to sort out into acids and bases according to Arrhenius concept.
- Explain them that H_2SO_4 is Arrhenius acid and is known as sulphuric acid .When dissolved in water gives hydrogen H^{1+} ion

$H_2SO_{4aq} \rightarrow H^{1+}_{aq} + HSO_4^{1-}{}_{aq}$

- Explain about ammonia that it reacts with water to produce ammonium ions and hydroxide ions:

$NH_{3(aq)} + H_2O_{(1)} \rightarrow NH_4{}_{+(aq)} + OH^{2-}{}_{(aq)}$

- Explain them the limitation of Arrhenius theory that it is restricted to solutions in water only and did not extend to other solvents.

Activity 2

(Bronsted – Lowry Concept)

- Tell Students the concept of acid and base according to Bronsted–Lowry
- An acid is a proton (hydrogen ion) donor and a base is a proton (hydrogen ion) acceptor.
- Give the concept of conjugate acid formed by accepting a proton by a base.
- Give the concept of conjugate base formed by donating a proton by an acid.
- Elaborate concept by these activities:
- Ask students to take few crystal of NaCl in a test tube add few drops of concentrated H^2SO^4.
- A gas is evolved. Test the gas with a rod dipped in ammonia solution.
- Dense white fumes of NH4Cl show the presence of HCl.

$NaCl \rightarrow Na^+ + Cl^-$

$Cl^- + H_2SO_4 \rightarrow Hcl + HSO_4^-$

Base Acid Conjugate Acid Conjugate Base

- In this case Cl^- has accepted a proton from H_2SO_4.
- Therefore it is a Bronsted base.
- In the product HCl is conjugate acid and HSO_4 is conjugate base of H_2SO_4

Activity 3

- Ask students to add few crystal of sodium sulphide in a test tube.
- Then add dilute H_2SO_4.
- A gas which smells like rotten eggs is given out according to following reaction.

$Na_2S \rightarrow Na^+ + S^{-2}$

$S^{-2} + H_2SO_4 \rightarrow H_2S + HSO_4^-$

Base Acid Conjugate Acid Conjugate Base

Activity 4

- Explain students that strong Acid have weak conjugate bases while weak acids have strong conjugate bases.
- Explain that in this activity they will compare the strength of conjugate acid and base.
- Take solution of sodium chloride and sodium sulphide in a test tube
- Add few drops dilute sulphuric acid.
- H_2S gas is given out
- The following reaction takes place.

$Na_2S \text{ --> } Na^+ + S^{-2}$

$NaCl \text{ --> } Na^+ + Cl^-$

$S^{-2} + H_2SO_4 + Cl^- \text{ --> } H_2S + HSO_4^- + Cl$

- The above reaction shows that sulphide ion has greater tendency to accept a proton as compared to chloride ions.
- Therefore according to Bronsted concept sulphide ions are stronger base than chloride ions
- Remember that sulphide ions are conjugate base of weak acid and chloride ion is a conjugate base of a strong acid.

Conclusion/Sum up

- According to Arrhenius concept, acids donate hydrogen ions in aqueous solution
- Bases donate hydroxyl ions in aqueous solution
- According to Bronsted and Lowry concept. Acids are proton donating while bases are proton acceptor. This concept is independent of nature of the solvent.
- Every Bronsted acid has a conjugate base which differ from its acid by one proton

Assessment

Ask following questions to assess students learning

$HA + H_2O = H_3O^+ + A^{1-}$

- Which substance is donating a proton
- Which substance is accepting proton?
- What do you think about H_3O^+? Can H_3O^+ donate proton?
- What do you think about A^{1-}? Can A^{1-} accept proton? What is your answer?

Answers

- HA is donating proton
- H_2O is accepting proton
- H_3O^+ is Bronsted acid because it can donate proton
- A^{1-} is Bronsted base because it can accept a proton. A^{1-} is the conjugate base of an acid HA

Follow-up

Make the acid base conjugate pairs of the following substances

H_3PO_4, CH_3COO^{1-}, HCO_3^{1-}, $H_2PO_4^{1-}$, CH_3COOH, CO_3^{2-}

ANSWER ACID- BASE CONJUGATE PAIRS

ACID	BASE
H_3PO_4	$H_2PO_4^{1-}$
CH_3COOH	CH_3COO^{1-}
HCO_3^{1-}	CO_3^{2-}

UNIT 11

Lesson Plan 13

TOPIC

Functional groups

Organic Chemistry

Grade X

Fruits contain natural esters. Sweet smell from bananas,pineapples and other fruits is due to presence of esters.

Students' Learning Outcomes

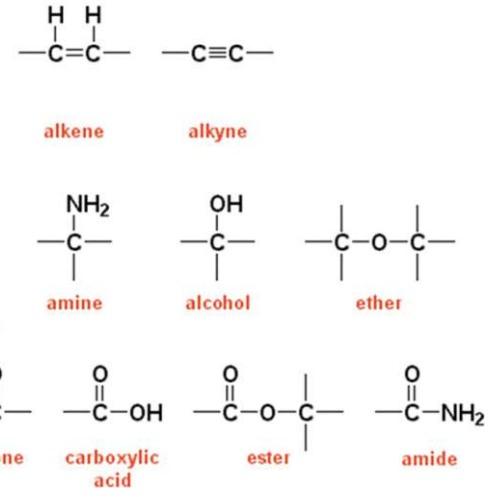
Students will be able to:

1. define functional group (Remembering)
2. differentiate different organic compounds on the basis of their functional group. (Analyzing)
3. recognize and identify a molecule's functional group.

Duration/Number of Periods

80 mins/2 periods

Information for Teacher



- Atoms or group of atoms that determines the chemical properties of whole organic molecule.
- We single out carbon for special study because of the ability of carbons atoms to form strong covalent with one another.
- Carbon atoms may join together into straight chains, branched chains and rings.
- For systematic study of Organic compounds, functional group plays key role.
- Generally an organic compound consists of two parts:

a) Hydrocarbon Part

b) Remaining part of the compound other than functional group is generally represented by R. (The alkyl group)

Material/Resources Required

Duster, a piece of wood with cutter, pencil with a rubber, pencil with an inserted nail, 3 plastic bottles/gas jars/titration flasks containing lemon juice/orange juice, glucose solution and spirit which are all covered.

Introduction

Activity

Check students' prior knowledge about organic chemistry by asking:

1. Define organic chemistry ?

Ans: Branch of Chemistry which deals with the carbon compounds, hydrocarbons and its derivatives is called organic chemistry.

2. Name some organic compounds. (Petrol, diesel, medicines etc.)

Show students the following material and ask:

- Show duster to the students and ask them about its use. (Cleaning). If we remove the cloth attached to it, can it be used as a duster? (No). Tell them that it is the presence of cloth which makes the piece of wood a duster.
- Also show a pencil with a rubber attached to it. Ask them about the function of rubber when it is attached to the pencil and when it is not attached. Explain that the uses and properties (functions) are changed due to the addition/removal of certain things.
- So we can say these substances/things impart certain characteristics to the observed substances. Tell them the definition of functional groups.
- Also mention other examples. Write some functional groups on board (ethane, ethene, ethyne, ethanol, ethanoic acid, ethyl amine etc) and explain how the name changes with respect to functional groups.

Development

Activity 1

- On smooth table, put the beakers/ bottles having lemon juice/orange juice, glucose/sugar solution in the 2nd, and methylated spirit in third one. Ask the following questions.

1. Tell the taste of lemon/orange juice? (Sour)
2. You have tasted sugar/glucose solution so many times. What is its taste? (Sweet).
3. Spirit is to be handled very carefully.

Why? (Dangerous and flammable).

4. Are these all organic compounds? (Yes)
5. If they are all organic compounds, why they are different? (Due to functional groups).

- Tell them that carboxylic acid is present in lemon/orange juice, aldehyde group is in glucose, and alcohol in spirit.
- Ask: Name the functional group is in nail polish? (Ketone).
- Give the following handout to the students and tell that how the name of an organic compound changes.

Chemical class	Group	Suffix	Example
Alkene	Double bond (alkenyl-)	-ene	Ethene
Alkyne	Triple bond (alkynyl-)	-yne	Ethyne
Alcohol	Hydroxyl	-ol	Ethanol
Ketone	Carbonyl	-one	Ethanone
Aldehyde	Aldehyde	-al	Ethanal
Carboxylic acid	Carboxyl-	-oic acid	Ethanoic acid
Amine	Amine	-amine	Methyl amine

Activity 2

Draw the following table on board and ask students to write formulae of the given organic compound.

- Check their structures and give feedback if required.
- Ans: $CH_2 = CH_2$, $CH_3CH_2NH_2$ C_2H_5OH CH_3COCH_3 CH_3COOH

S.NO	Examples	Formulae
1	Ethene	
2	Ethyl amine	
4	Ethanol	
5	Propanone	
6	Ethanoic acid	

Conclusion/Sum up

In organic chemistry, functional groups are specific groups of atoms within molecules that are responsible for the characteristic chemical reactions of those molecules.

Assessment

Ask following questions to recap the lesson and also to assess students understanding of the taught concepts.

Q1: Define alkenes. (Organic compounds with double bonded carbon atoms).

Q2: Encircle and name the functional groups in the following:

a) $CH_3\text{-}\overset{\overset{H}{|}}{C}\text{-}H$

b) $CH_3\text{-}\overset{\overset{H}{|}}{C}\text{-}CH_3$

Follow-up

Name the functional groups present in:

Polythene (Ethene)
1-propanol (alcohol)
1-pentanoic acid (carboxylic acid)

- Guide the students to solve the exercise problems given at the end of each unit / chapter of textbook.

UNIT 13

Biochemistry

Lesson Plan 14

TOPIC

Lipids

Grade X

Vegetable oils containing lipids are used to make Bio diesel. It produces about 60% less carbon dioxide and is non-toxic and biodegradable.

Students' Learning Outcomes

Students will be able to:

- differentiate between fats and oil. (Applying)
- explain the sources and uses of lipids. (understanding)

Information for Teachers

- A heterogeneous group of naturally occurring organic compounds that do not dissolve in water. Lipids include oils, fats and waxes.
- The group also includes sterols, triglyceride and phospholipids.
- Fats are solid and semi-solids, where as oils are liquid at room temperature.
- Lipids are esters of fatty acids and glycerol.
- Saturated fatty acids (e.g present in ghee) are long chain organic acids in which, there are single covalent bonds between carbon-carbon chains.
- Unsaturated fatty acids (present in oil) are those in which there are one or more than one double covalent bonds.

Duration/Number of Periods

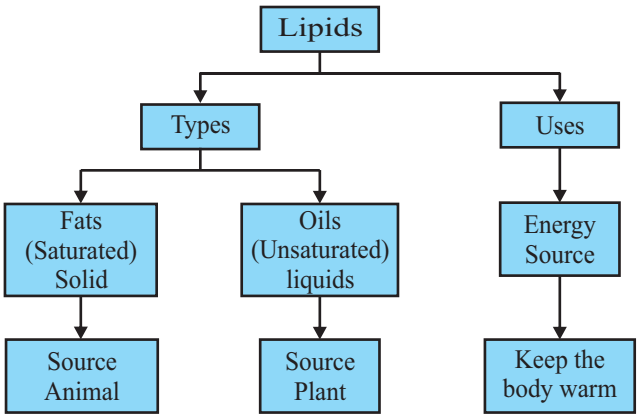
40 mins/1 period

Material/Resources Required

Samples of fats and oils, butter and margarine, corn, peanuts and sunflowers or their seeds

Introduction

- Draw the following concept map on board and explain students that they will learn about lipids



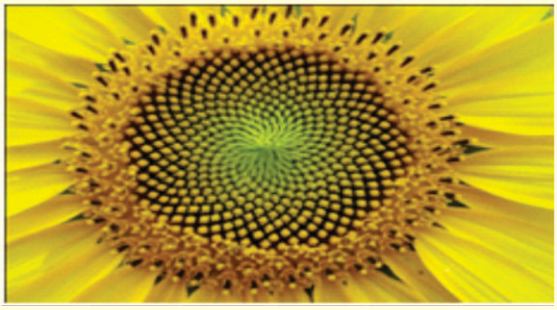
Development

Activity 1

- Paste the following pictures on the chart and ask the following questions.
- What information do you get from these picture?(A woman is churning the curd to get butter.)
- What is butter? (Butter is a fat from milk).
- What is its physical state?(Solid)
- Teacher may conclude by saying that as its solid at room temperature and obtained from animal source, it is classified as "Fat"

Activity 2

Paste the following picture on another chart and show this to the students, or bring corn, sunflowers seeds or peanuts in the class and show them to the students.



Now Ask the following questions

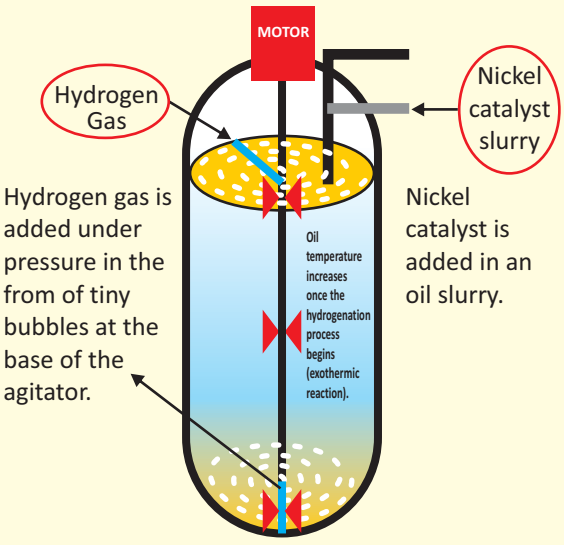
- When these seeds are pressed what do we get?(Oils)
- Explain that from corn, sun flowers seed and peanuts we get oils used in cooking
- What is the physical state of oil? (Expected answer: Liquid)
- Explain students that lipids which are mostly liquids at room temperature are called "Oils". They are usually obtained from plant sources.

Activity 3

- Show students samples of margarine and ghee

  Ask them
- Can we convert oil into margarine? (Yes by a process called hydrogenation in which hydrogen is added)
- Show them picture to elaborate the concept.
- What types of fatty acids are present in fats?
- (Answer: Saturated fatty acid).
- What types of fatty acids are present in oil? (Expected Answer: Unsaturated fatty acids).

general Hydrogenation Process



Conclusion/Sum up

Conclude lesson by telling students

- Lipids are naturally occurring organic compounds of animal and plant origin.
- They are soluble in organic solvents and insoluble in water.
- Fats are solids and oils are liquids at room temperature.

Assessment

Assess student's learning by asking

- Which functional group is present in fatty acids? (Expected answer: Carboxylic acid)
- Are fats soluble or insoluble in water? (Expected answer: Insoluble in water, soluble in ether)
- Which functional group is present in fats? (Expected answer: Ester)
- Olive oil contains saturated or unsaturated fatty acids.(Unsaturated fatty acids)
- What does hardening of oils mean?(Addition of hydrogen)
- Plants are source of oil. Justify?

Follow-up

- Draw a table to show differences between fats and oils. Give examples.
- Make a chart and show important uses of lipids?

UNIT 14

TOPIC

Lesson Plan 15

Air Pollutants

Ozone Depletion and its Effects

Environmental Chemistry

Grade X

Students' Learning Outcomes

Students will be able to:

- describe sources and effects of air pollutants (understanding)
- describe ozone depletion and its effects
- describe global warming (understanding)

Information for Teachers

- A Primary air pollutant is a chemical that directly enters the air e.g. SO_2
- A secondary pollutant is a chemical compound formed as a result of reaction between a primary pollutant and some other compound in the air. e.g., SO_2 reacts with O_2 in the air to produce SO_3 a Secondary air pollutant. The SO_3 then reacts with water vapours in the air to form H_2SO_4 which is also another Secondary pollutant.
- Acid rain is the mixture of Sulphuric and Nitric acids. pH value of acid rain is less than 5.6
- Global warming is caused due to the accumulation of excessive heat energy under

the thick layer of atmosphere. The thickness of atmospheric layer is caused due to accumulation of CO_2 gas a primary air pollutant and Chloro fluoro Carbons (CFS's) under the surface of atmosphere.

- Green house gases include, CO_2, CFC's, CH_4 and water vapours.
- The average earth temperature is 58^0F.
- Ozone is a pale blue gas and absorbs 99% of U.V radiation.

Duration/Number of Periods

120 mins/3 period

Material/Resources Required

Material/resources: Pictures of sources of pollution & Green House Effect

Introduction

Warm up Activity

- Paste the picture of Coughing Earth on the board and then initiate discussion about pollution.

- Write the word pollution on board and collect students ideas about it.
- Explain students that they will focus in detail about them.

Development

Activity 1

- Divide the class into small groups and distribute photocopies of following photographs. Ask them what is wrong with the following pictures:

- Explain students that most paints give off fumes that evaporate in the air causing a variety of symptoms from headache to trouble breathing.
- Children may ask that should we stop painting our homes?
- Explain them that being chemistry students they should read paint labels and make sure that they don't have mercury or lead component in them.

- Ask students that they must have seen the statement written over Garbage collecting containers?
- Why trash should not be burned?
- Explain them that Pollutants in trash when burned in the open air release many toxic materials which are harmful for health and environment.

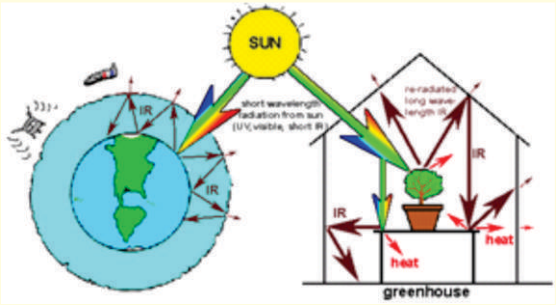
- Explain children that air pollution is increasing in urban areas and the major source of this problem is transport sector.
- Maintenance of vehicles and monitoring systems are relatively unsatisfactory,
- Making people aware about proper maintenance of vehicles and
- Explain that quality of fuel should help overcome this problem.
- Inspection on road and air quality monitoring programmes should be launched by the government.
- Now ask students to think of all activities that they do or see people doing that cause damage to the environment.
- Tell students to list down all those activities.
- Ask them how can such practices be minimized?
- Ask what alternative ways could be followed to prevent environment from further damage?
- Once the students have discussed it among themselves in groups. They will share it with the rest of the class.
- Conclude and facilitate discussion by elaborating about sources, and effects of various pollutants through the following pictures.

Activity 2

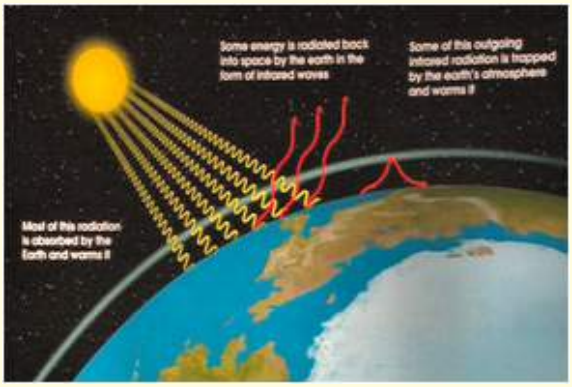
- Paste the following pictures of Earth on the board to initiate discussion about Global warming.

- Now ask, what is causing global warming?
- What is the mechanism of global warming?
- Ask, why do gardeners place plants in a green house?

- Show pictures of a green house and compare it with the mechanism of heat trapping by Earth shown in the picture below:



- Explain, just as the green house increases the inner temperature, by trapping sun's heat, the pollutants in air (mainly CFC's, methane, the CO_2 and water vapours) absorb and re-emit the sun's radiations. This results in increasing the overall temperature of earth and thus causes global warming. This effect is known as green house effect. Draw picture on the board to further elaborate the concept.



Activity 3 (Role Play)

- Teacher will ask 12 volunteers from the class to participate in the role-play
- One of the students will be asked to stand in the middle to act as an earth

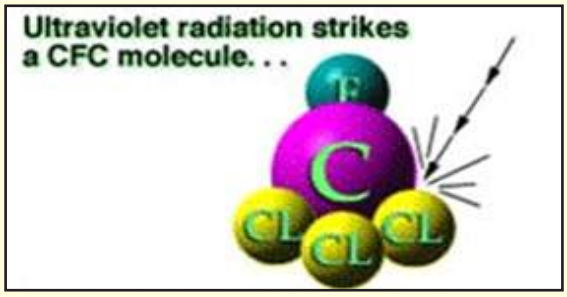
  (as shown in figure)

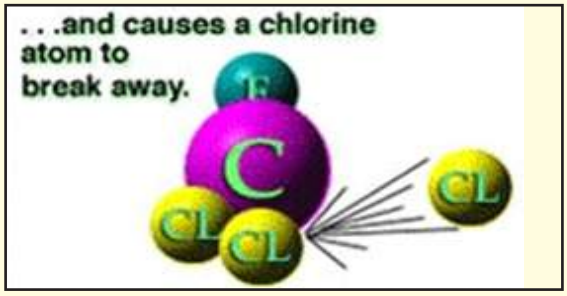
- Ask 5-6 students to make a circle around the earth to represent green house gases

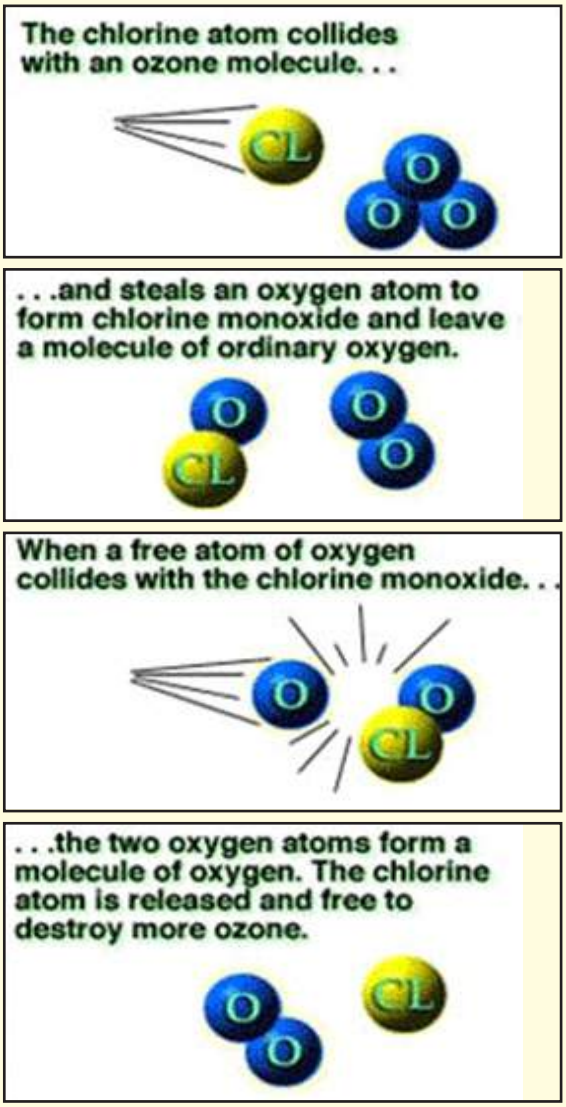
  (as shown in fig)
- Now ask 4-5 students acting as u.v radiations will reach the earth from the sun and when they want to go out, they will be trapped by green houses gases.
- Explain that as the number of trapped u.v radiations increases the temperature of earth also increases.
- Earth would say that my temperature is increasing that causes my glaciers to melt. I am facing big hurricanes and tornadoes. My sea level is rising. Please do not produce green house gases. Please protect me.

Activity 4 (Ozone layer depletion)

- Explain the depletion of ozone layer by drawing this diagram on the board.







- Explain the mechanism of ozone layer formation and depletion by writing these reactions on the board.

Formation of Ozone

a) $O_2 + h\upsilon$ (u.v) ---> $O^{\cdot} + O^{\cdot}$

b) $O^{\cdot} + O_2$ ---> O_3

Destruction of Ozone

a) $O_3 + h\upsilon$ (u.v) ---> $O_2 + O^{\cdot}$

- Explain that the rates of formation and destruction result in a steady state concentration of Ozone in the stratosphere, but this natural destruction rate is increased by chemical reactions with pollutants in the stratosphere (e.g, NO, CH_4 and CFCs)

Destruction of Ozone with CFC's

$CFCl_3$ + UV Light -----> $CFCl_2$ + Cl

Cl + O_3 -----> ClO + O_2

ClO + O -----> Cl + O_2

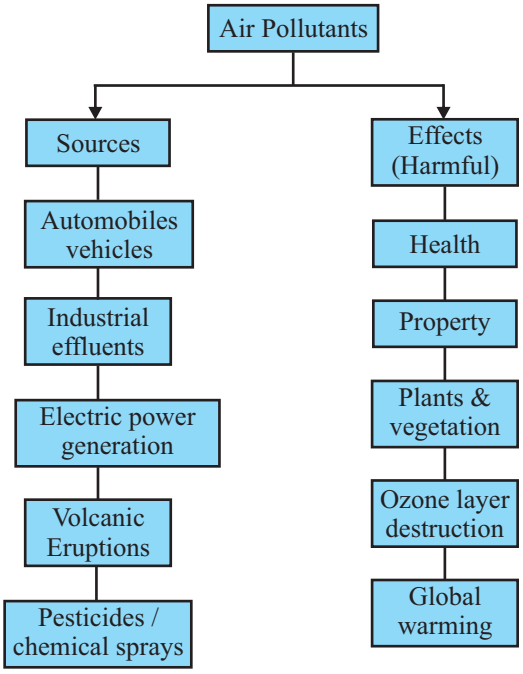
Destruction of Ozone with Nitrous oxide

$O_3 + NO$ -----> $O_2 + NO_2$

The reactions above lower the concentration of Ozone.

Conclusion/Sum up

Teacher will recap the lesson by making the concept map on the board



Assessment

Assess student learning by asking these questions:

1. Which of the following is an example of

secondary pollutant?

a) SO_2
b) CO_2
c) H_2SO_4
d) NO

2. Acid rain is the mixture of the two acids
   a) $H_2SO_4 + HNO_3$
   b) $HCl + HNO_3$
   c) $H_2SO_4 + HCl$
   d) $H_2SO_4 + H_2CO_3$
3. Most of the Ozone formation takes place in this layer
   a) Thermosphere
   b) Mesosphere
   c) Stratosphere
   d) Troposphere

Answers:

1. b
2. a
3. c

Follow-up

Write a letter to the local government explaining about the harmful effects of air pollution caused by transportation and Industries / any other in your city. Give suggestions to improve the saturation.

UNIT

16

Lesson Plan 16

TOPIC

Solvay's Process

Chemical industries

Grade X

Students' Learning Outcomes

Students will be able to:

- make a list of raw materials for Solvay process(Applying)
- outline the basic reactions of Solvay process.(Applying)
- develop a flow sheet diagram of Solvay process.(Creating)

Information for Teachers

- It was invented by the Belgian chemist Ernest Solvay (1838–1922).
- It is an industrial process, also known as the ammonia-soda process, for the manufacture of sodium carbonate.
- Sodium chloride (common salt), ammonia, carbon dioxide, and water react to give precipitated sodium bicarbonate, which on heating gives sodium carbonate also called Soda Ash.

- The word "soda" originally referred to certain plants that grow in salt marshes; it was discovered that the ashes of these plants yielded the useful alkali "soda ash."

Duration/Number of Periods

80 mins/2 period

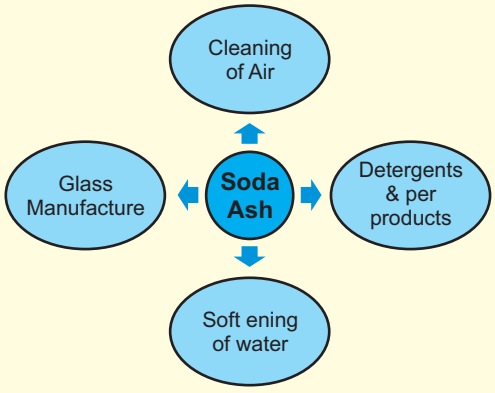
Material/Resources Required

A4 sheets, glue stick/glue/ charts, black/white board

Introduction

Activity

- Explain students that Sodium carbonate is also called as Soda ash and its formula is Na_2CO_3.
- It is called soda ash as it was extracted from the ash of different plants. The solution of ash in hot water was used for cloth washing
- Explain students that why are they Studying Solvay process.
- Write the word Soda Ash on board and ask students about its Uses
- Explain students that Solvay process is the cheapest method to form soda ash.



Development

Activity 1

(Explanation of Raw Materials)

- Explain Students that Raw materials used in the process are cheap and in abundant.
- Tell them the names of Raw materials and their use in the process.

Raw Materials

1. **Sodium Chloride:** A saturated solution of sodium chloride is prepared which is also known "BRINE".
2. **Lime Stone ($CaCO_3$):**it is heated to produce Carbon dioxide. Quick lime(CaO) is also produced which is converted to Slaked Lime for use Ammonia recovery step.
3. **Ammonia**

Activity 2

(Steps of preparation)

- First Write just names of all steps and give students a summary of the process.
- If you will try to teach them all the details at once, they would not be able to absorb and understand it well.
- Once they have learnt names of all steps and raw materials ,direct them to detailed explanation
- Ask them to open the text book and practice equations related to each step

Step I–Preperation of ammonical Brine

In first step, ammonia gas is mixed with brine. This process is carried in Ammoniation Tower.

Step II-carbonation of ammoniated Brine

In this step, ammoniated brine is mixed with carbon dioxide in a tower called

carbonating tower.

- Ammoniated Brine is fed from the top where as carbon dioxide ascends from the bottom.
- Tell Students that by the end of this step Sodium bicarbonate will be formed.
- Ask students to open text book and study reactions involved
- Call Students on board and ask them to write the reaction at each step.

Step III - Production of Soda Ash

Sodium bicarbonate is heated in a long iron tube to obtain anhydrous sodium carbonate or Soda Ash.

This carbon dioxide is recycled to the Solvay tower. This hydrated sodium carbonate is also called washing soda.

Recovery of Ammonia

Ammonia gas is recovered from the remaining solution by treating it with Calcium Hydroxide.

$2NH_4Cl + Ca(OH)_2 \text{----> } CaCl_2 + 2H_2O + NH_3$

Ask the following questions

1. How can Ammonia be recovered in this process in Solvay's process?

   (Ammonia Recovery Tower)
2. How is sodium carbonate obtained from sodium bicarbonate?(Decomposition)

Activity 3

(Development of Flow sheet diagram)

- Explain students that solvay process is a cheap process as carbondioxide and ammonia are recovered and can be used again and again
- Now ask them to draw a Flow sheet diagram. Tell that its just a summary of all steps or a recap of the process
- Ask them to draw four boxes first. They will represent Lime kiln ,Carbonating tower, Ammonia Recovery tower and Ammoniating tower.
- Now ask them to write the reactions that occur in each tower.
- Let them draw it themselves. Guide them but don't ask them to learn it from the book.
- After they have developed the flow sheet diagram, draw it on the board and make students do the corrections.

Conclusion/Sum up

Conclude the lesson by telling students that they have learnt

- Solvay's Process is a process to produce sodium carbonate. The steps in the Solvay's process are:
- Brine Purification
- Sodium Hydrogen Carbonate Formation
- Sodium Carbonate Formation
- Ammonia Recovery

Assessment

Ask following questions to recap the lesson and also to assess their understanding of the taught concepts.

- What is meant by ammoniated brine? (Brine solution saturated with ammonia gas
- Name two chemicals that are re-used in Solvay's process.(NH_3 and CO_2gasses)
- What is the formula for sodium carbonate?(Na_2CO_3)
- What is the commercial name of sodium carbonate?(Soda ash/washing soda)
- Explain the uses of soda ash

- What is the use of slaked lime in the process(To recover ammonia)

Follow-up

Arrange a Solvay Contest

- Ask students to demonstrate the main steps and reactions of Solvay process with the help of charts and give presentation.
- Whole class could be made a part of it by making it a group task. All members of group will take part in the presentation by explaining one step each
- Guide the students to solve the question at the end of exercise.

Glossary

Words	Meaning
Acid Rains	The rain containing acids produced by human activity and natural phenomena give rise to acid precipitation also known as acid deposition or acid rain
Air Pollution	Addition of unwanted substances in the atmosphere is called air pollution
Alkanes	Alkanes are saturated hydrocarbons and have single bond in them. They are also called paraffin means least reactive. Their general formula is C_nH_{2n+2}.
Alkenes	The compounds which have double covalent bonds between carbon atoms are called
Alkynes	The compounds which have double covalent bonds between carbon atoms are called alkynes. Their general formula is C_nH_{2n-2} where 'n' is number of carbon.
Alloys	Mixtures of metals are called alloys.
Amino acids	Amino acids are the compounds containing an amino group ($-NH_2$), and a carboxylic group (COOH).
Arrhenius Acid	A chemical compound which gives proton (H^+(in water.
Atmosphere	A layer of gases surrounding the earth is called atmosphere.
Bronsted Acid	A compound which can donate proton
Bronsted Base	A compound which can accept proton
Concentration	The finely crushed ore is concentrated by **Forth-Floatation process.**
Environmental chemistry	The branch of chemistry is which we study about the various chemical phenomena taking place in the environment is called environmental chemistry
Fats	Fats consist of a wide range of compounds that are generally soluble in organic solvents and largely insoluble in water
Functional group	An atom or a group of atoms in a molecule that imparts characteristic chemical properties to the molecule is called a functional group.
Hydrocarbons	The compounds which contain only carbon and hydrogen in them are called hydrocarbons.
Irreversible Reaction	The reactions which only carbon and hydrogen in them are called hydrocarbons.
Irreversible Reaction	The reactions which only proceed in the forward direction to give the products are called irreversible reactions.
IUPAC	IUPAC stands for International Union of Pure and Applied Chemistry called IUPAC system of nomenclature.
Law of Mass Action	This law states that the rate at which the reaction proceeds is directly proportional to the product of the active masses of the reactants.

Lawis Acid	A substance which can accept an electron pair
Lew is Base	An acid which ionizes completely in water
Neutralization	Acids and bases react together to form salts and water, this process is called neutralization reaction
Organic Chemistry	It is the branch of chemistry in which we study about hydrocarbons and their compounds
Ozone Depletion	The destroying of ozone layer over Antarctic region is called ozone depletion.
Ozone Hole	The hole formed due to the depletion of ozone is called ozone hole.
pH Scale	The negative log of hydrogen ion (H^+) concentration present in a solution.
Pollutant	Sometimes unwanted substances are added in the environment by the human or natural activities. These unwanted things are called pollutants.
Pollutant	The unwanted gases put adverse effects on the environment and are called pollutants.
Primary Pollutants	The pollutants which are directly emitted in the atmosphere such as CO, NO_2 and SO_2 etc are called primary pollutants.
Reversible Reaction	The reactions which go in the forward and the backward direction simultaneously, under the similar conditions are called as reversible reactions
Saturated Hydrocarbons	Hydrocarbons with single bonds between carbon atoms are known as saturated hydrocarbons.
Secondary Pollutants	These are the pollutants which are derived from the primary pollutants such as ozone and photochemical smog etc.
Solvay's process:	Solvay's process is an industrial process for producing sodium carbonate from brine, ammonia and carbon dioxide.
Smelting	Roasted ore is melted in the blast furnace along with mixture of cal and sand.
States of Equilibrium	A state of reversible reaction which two opposing reactions occur at the same rate and the concentration of reactants and products don't change with time is called as state of chemical equilibrium or dynamic equilibrium.
Stratosphere	The region above the troposphere is called stratosphere.
Strong Acid	An acid which ionizes partially in water
Strong base	A base which can ionize completely in water giving excess of hydroxide ions
Unsaturated Hydrocarbons	The hydrocarbons which have multiple bonds (double or triple) in them are called unsaturated hydrocarbons.
Weak Acid	An acid which ionizes partially in water
Weak Base	A base which ionizes partially in water.