Introduction

In this chapter the student finds the importance of chemistry in everyday life. It also provides a general awareness of scientific principles and methods used in Chemistry. The student gets an idea about the microscopic as well as macroscopic nature of particles and substances. The fundamental numerical calculations are also discussed in detail. A thorough discussion enables the students to get an idea about the nature of chemistry and makes the study of the subject easy so that he can pursue the studies with enthusiasm.
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<td>and very small numbers</td>
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<td></td>
<td>Problem solving based on scientific notations.</td>
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</table>

**Explains the importance of chemistry in different spheres of life.**

**Explains the characteristics of three states of matter.**

**Classifies different substances into elements, compounds and mixtures.**

**Identifies pure substances.**

**Defines SI base units and lists some commonly used prefixes.**

**Identifies derived prefixes like volume and density.**

**Uses scientific notations and performs simple mathematical operations on numbers.**
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<td>understanding communication of others</td>
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<td>General discussion followed by small group discussion based on Laws of chemical combinations. Problem solving Assessment • Participation in discussion(process) • Solving numerical problems(process) • Activity log(Portfolio)</td>
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<td>General discussion of Daltons atomic theory. Assessment • Participation in discussion (process)</td>
<td>Explains Daltons Atomic Theory</td>
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<td>General discussion leading to the importance of atomic mass, molecular mass and mole concept Problem solving based on atomic mass, molecular mass and mole concept</td>
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</tr>
<tr>
<td>Concepts/ Ideas</td>
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</tbody>
</table>
| **Assessment** | • Participation in discussion(process)  
• Solving numerical problems(process)  
• Activity log(Portfolio)  
**Percentage composition.**  
• Using number relationships  
• Interpreting data | Calculates the mass percent of different elements constituting a compound |
| **General discussion by citing common examples like water, carbon dioxide etc. Problem solving based on Percentage composition** | **Assessment**  
• Participation in discussion(process)  
• Solving numerical problems(process)  
• Activity log(Portfolio)  
**Empirical formula and molecular formula.**  
• Using number relationships  
• Interpreting data | Determines empirical formula and molecular formula for a compound from the given experimental data |
| **General discussion by taking an example Problem solving based on empirical formula** | **Assessment**  
• Participation in discussion(process)  
• Solving numerical problems(process)  
• Activity log(Portfolio)  
**Stoichiometric calculations.**  
• Using number relationships  
• Interpreting data | Solves numerical problems based on stoichiometric equations. |
| **General discussion by giving examples of balanced chemical equations, Limiting reagent and reactions in solutions. Problem solving** | **Assessment**  
• Participation in discussion(process)  
• Solving numerical problems(process)  
• Activity log(Portfolio) | |
**Towards the Unit......**

Total 8 Periods

**Concept: Importance of chemistry in different spheres of life**

**Suggested Activity 1.1 (1 period)**

Teacher initiates a discussion on the topic ‘importance of chemistry in different spheres of life’. Students are encouraged to participate in the discussion.

**The following points can be used to ensure students participation.**

- What are the basic constituents of matter?
- What are the areas in which chemical principles are applied?
- Importance of chemistry in food preparation, medicines and industry.
- What is the need of a good chemist in the present day world?

The students prepare a chart of the importance of Chemistry.

**Consolidation:**

Importance of chemistry in different spheres of life

**Concept: Three states of matter and their characteristics.**

**Suggested Activity 1.2 (1 period)**

The teacher invites the attention of students by showing common objects available in class room like chalk, water, etc, and starts a discussion which leads to the idea of matter and its three forms.

**Discussion points**

- What are these substances?
- Which physical state they have?
- What are the different physical states of matter?
- What are the properties of three physical states?

The properties of three states of matter are elicited from students and it is listed on the board or chart.

**Consolidation: Three states of matter and its characteristics**

**Concept: Classification of different substances into elements, compounds and mixtures.**

**Suggested Activity 1.3 (½ period)**

Teacher shows a metal piece of copper or aluminum, water or benzene or naphthalene and a mixture of substances like sand and water, sugar and
sand, sugar in water and asks the students to classify them according to the fundamental building units of matter contained in it.

The following questions can be used to lead them.

- What are these substances?
- What are the constituent particles of these substances?
- .................................................................?
- .................................................................?

Teacher should point out that copper contains only atoms, water contains only molecules and others contain more than one substances.

Teacher elicits from students the terms mixtures, pure substances and the types of mixtures. Teacher lists the classification on a board or chart.

**Consolidation:**

Classification of different substances into elements, compounds and mixtures

**Concept: Different units and its measurements**

**Suggested Activity 1.4 (½ period)**

- Teacher initiates a discussion on measurable properties of matter like mass, volume, pressure, temperature etc.
- Discussion is directed to two systems of measurement i.e. English and Metric.
- Teacher introduces the SI system of measurements, its origin and necessity (mention CGPM).
- Teacher lists some of the units of measurement on the board or chart by eliciting responses from students and the remaining units, if any, are introduced to students.
- Teacher introduces the basic difference between mass and weight, followed by the concept of volume, temperature and density.
- Simple mathematical problems are solved.

**Consolidation:**

Different units and its measurements

**Concept: Scientific notations and simple mathematical operations**

**Suggested Activity 1.5 (½ period)**

- Teacher introduces the difficulty of scientists in expressing large number of particles and very small amount of mass.
- For that Teacher can use Avogadro number and the mass of a hydrogen atom without using scientific notation.
• Teacher now explains the convenience of using scientific notation and solves numerical problems.
• Teacher can create small groups of students for solving the problems.

Consolidation:
Scientific notations and simple mathematical operations

Concept: Precision and accuracy

Suggested Activity 1.6 (½ period)
• Teacher introduces data of measurements taken by different persons and explains the terms accuracy and precision.

Consolidation:
Precision and accuracy

Concept: Significant figures

Suggested Activity 1.7 (½ period)
In continuation of the above discussion, teacher explains the importance of significant figures and lists the rules and illustrates it.
Simple mathematical operations are done using significant figures.

Consolidation:
Significant figures

Concept: Dimensional analysis

Suggested Activity 1.8 (½ period)
• Teacher introduces the concept by asking students to measure the length of an object like a chalk or pen in inches.
• Then He/She asks to convert the unit to centimeter. (They are not supposed to measure it with scale).
• Then teacher introduces the Unit factor method or Factor label method.

Consolidation:
Dimensional analysis

Concept: Laws of chemical combinations

Suggested Activity 1.9 (1 period)
Teacher checks the previous knowledge of students regarding elements and compounds. He/She develops a curiosity among students by asking how the elements are converted to compounds. The following prompting questions can be used.
• What do you mean by a chemical reaction?
• What about the mass of reactants and products?
• Is there any relation between mass of reactants and products?
• What about the elements present in a compound?
• What about the ratio of the masses of elements in the compound?
• What is the mass ratio if two elements combine to form more than one compound?

Teacher introduces five laws of chemical combinations and illustrate with examples.
• Simple problems are solved.

Consolidation: Laws of chemical combinations

Concept: Daltons Atomic Theory

Suggested Activity 1.10 (½ period)

Teacher initiates a discussion by using the following prompting question.
• What are the basic constituents of matter?
• Why is there a definite ratio between masses of elements in a compound?

Discussion should direct the attention of students to the fundamental particle, atoms.

Teacher consolidates the discussion by introducing the points of Dalton's atomic theory and charting it.

Consolidation: Daltons Atomic Theory (Total 1 Period )

ASSESSMENT
• Participation in discussion (process)

Concept: atomic mass, average atomic mass, molecular mass and formula mass

Suggested Activity 1.11 (½ period)

Teacher discusses with students the idea of weighing an atom in a conventional balance just like weighing common substances. Students share the difficulty in the process of weighing an atom in a physical balance.

Then teacher draws the attention of students to the fact that how peoples compared the weight of substances in ancient times, where no modern
weighing systems were available.

Discussion points are;
- How can we weigh common substances like rice, sugar, etc?
- What about weighing an atom in a physical balance?
- Why is it difficult?
- How we can measure the weight of an atom if atoms of elements only are available?

Teacher concludes with the idea that mass of atoms can be measured by comparing the mass of a particular atom, say, hydrogen with other atoms and the mass of atoms can be expressed as numbers which indicates how many times it is heavier than a particular atom.

Teacher introduces the use of C-12 atoms as a standard for measuring atomic mass of elements and the reason for this choice.
- Unit of atomic mass is introduced.
- Numerical problems are solved.
- The concepts of molecular and formula mass are also introduced.

Consolidation:
atomic mass, average atomic mass, molecular mass and formula mass.

Concept:
Mole and Molar mass

Suggested Activity 1.12 (½ period)
Teacher initiates a discussion on the problem of counting atoms in chemical reactions. Teacher can ask interesting questions related to daily life situations like;
- Can you buy 10000 green grams from a grocery shop just by counting?
- What is the difficulty in it?
- What is the easy method of buying the same thing from the shop?
- How you will buy 10000 green grams, if one weighs exactly 500mg, assuming all the grains have the same mass?
- .................................................................
- .................................................................

Teacher then compares the mass of different substances like grapes, lemons, oranges etc to make the students understand the idea that for the same number of different objects, they will have different masses. Teacher can ask the following type of questions
• What is the mass of 1 dozen each of grapes, lemons, oranges, etc.?
• If they have different masses, what is common regarding their number?
• .................................................................?
• .................................................................?

Teacher now extend this idea to atoms of different elements and introduces the concept of mole and Avogadro number. Further He/She introduces the concept of molecular mass and molar mass of atoms and molecules.
• The concept of formula unit mass of ionic compounds is also introduced.
• Numerical problems are solved.

Consolidation:
Mole and Molar mass

Concept:
Percentage composition

Suggested Activity 1.13 (1 period)
The teacher shows the students a sample of substance like water or sugar or any substance commonly used and interacts with the following type of questions.
• What is this substance?
If they say the correct answer or they are doubtful about the substance, Teacher can ask;
• How will you make sure that it is ........... ?
• If you are doubtful, how will you confirm it?
• How will you identify the elements present in it?
• How will you determine the mass of each element present?

( Teacher can now give a rough information of detection of elements and determination of its mass In the chapter 12 part 2 )

Teacher explains the fact that, in such situations you can compare the given substance with a known one and confirms its percentage composition.

Teacher clarifies the expression for calculation of percentage composition and explains it with examples.

Consolidation:
Percentage Composition
**Concept:**
Empirical formula and Molecular formula

**Suggested Activity 1.14 (2 period)**
Teacher continues from the concept percentage composition and introduces the concept of empirical formula which is obtained from percentage composition.

The method of calculating molecular formula from empirical formula is also discussed.

- How can percentage composition be used to calculate number of moles?
- How the knowledge of number of moles can be converted to ratio of atoms?

Teacher explains with suitable examples.

**Consolidation:**
Empirical formula and molecular formula

**Topic:**
Stoichiometric calculations

**Concept:**
Limiting Reagent

**Suggested Activity 1.15 (1 period)**
Teacher writes a balanced chemical equation in board and asks students;

- What information can be obtained from the balanced equation?
- What are the amount of reactants and products in terms of number of atoms, number of moles, grams, Avogadro number, etc.
- Teacher also introduces the concept of limiting reagent with an example.

Consolidation: Limiting reagent and other calculations based on chemical equations.

**Concept:**
Reactions in solutions
**Suggested Activity 1.16 (2 period)**

Teacher introduces the terms mass percentage, mole fraction, molarity and molality by the demonstration of dissolution of suitable solutes in suitable solvents.

For example, molarity and molality can be demonstrated to students by dissolving a suitable amount of solute in water and making upto one litre and one kilogram water.

**Consolidation:**

Mass percentage, Mole Fraction, Molarity and Molality

**Unit wise TE Questions**

1. The importance of Chemistry in everyday life is significant. Considering the above fact, match the following items appropriately.

   1. Cisplatin  
   2. $\text{CO}_2$  
   3. CFC  
   4. Ceramics  
   5. Cancer therapy  
   6. Green house effect  
   7. Polymers

2. The measurement of mass of a substance by two students is reported below.

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student A</td>
<td>1.99g</td>
<td>2.01g</td>
</tr>
<tr>
<td>Student B</td>
<td>1.85g</td>
<td>1.91g</td>
</tr>
</tbody>
</table>

   (i) If the true mass of the object is 2g. Which of the following is correct?
   a.) A is both precise and accurate
   b.) B is both precise and accurate
   c.) Both A and B is precise and accurate
   d.) Neither A nor B is precise and accurate.

   (ii) Justify your answer.

3. Multiplication of two significant figures 2.5 and 1.25, four students reported the result in four different ways as

   a.) 3.125  
   b.) 3.1  
   c.) 3.12  
   d.) 3

   (i) Identify the correct one

   (ii) Represent the result if the above two numbers are added.
4. Unit factor method or dimensional analysis is used to convert one unit to another.

(i) In converting 1 inch to centimeter, a student used the unit factor \( \frac{1\text{ inch}}{2.54\text{ cm}} = 1 \) and another student used the unit factor \( \frac{2.54\text{ cm}}{1\text{ inch}} = 1 \). Which will yield the correct answer?

a.) \( \frac{1\text{ inch}}{2.54\text{ cm}} = 1 \)

b.) \( \frac{2.54\text{ cm}}{1\text{ inch}} = 1 \)

c.) Both a and b

d.) Neither a nor b

(ii) Prove that there are 172800 seconds in 2 days, using unit factor method.

5. A raindrop contains about 0.05 grams of water.

a. How many molecules of water are there in a raindrop?

b. How many hydrogen atoms are there in a raindrop?

c. How many oxygen atoms are there in a raindrop?

6. Mole is the fundamental unit of amount of substance. It is defined as the amount of substance that contain \( 6.022 \times 10^{23} \) particles.

(a) Which of the following pairs have the same number of atoms.

(i) 16 g of \( \text{O}_2\) and 4 g of \( \text{H}_2\)

(ii) 16 g of \( \text{O}_2\) and 44 g of \( \text{O}_2\)

(iii) 28 g of \( \text{N}_2\) and 32 g of \( \text{O}_2\)

(iv) 12 g of \( \text{C}_6\) and 23 g of \( \text{Na}_3\)

(b) In the reaction \( 2\text{A} + 4\text{B} \rightarrow 3\text{C} + 4\text{D} \), when 5 moles of A react with 6 moles of B, then

(i) Which is the limiting Reagent

(ii) Calculate the amount of C formed.

7. 4.54 L of dinitrogen reacts with 22.7 L of dioxygen and 45.4 L of nitrous oxide was formed. The reaction is given below.

\[ 2\text{N}_2(g) + \text{O}_2(g) \rightarrow 2\text{N}_2\text{O}(g) \]

What are the laws being obeyed in this experiment. Write the statement of the laws?

8. Hydrogen gas is prepared in the laboratory by reacting dilute HCl with granulated Zinc. Following reactions takes place.

\[ \text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2 \]

Calculate the volume of hydrogen gas liberated at STP when 32.65 g of Zinc reacts with HCl. (1 mol of a gas occupied 22.4 L volume at STP, atomic mass of Zn = 65.34).

Molarity and molality are used to express concentration of solutions. One litre of 1 molal and 1 molar solution are given. Justify the following statements.
(i) Both the solutions contain same number of moles of solute
(ii) 1 molal solution contain more amount of solvent than 1 molar solution.
(iii) 1 molal solution undergo change in concentration if it expands.
(iv) Molarity does not vary with temperature.

Data regarding isotopes of carbon are given below.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Relative abundance (percentage)</th>
<th>Atomic mass (amu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{12}\text{C}$</td>
<td>89.892</td>
<td>12</td>
</tr>
<tr>
<td>$^{13}\text{C}$</td>
<td>1.108</td>
<td>13.00335</td>
</tr>
<tr>
<td>$^{14}\text{C}$</td>
<td>$2 \times 10^{-10}$</td>
<td>14.00317</td>
</tr>
</tbody>
</table>

(i) Calculate the average atomic mass of carbon
(ii) Express the mass of carbon-13 ($^{13}\text{C}$) atom grams.

**REPOSITORY OF CE ACTIVITIES**

**For process assessment**

- General discussion (Individual participation, Clarity of concept and views, etc.)
- Small group discussion (Group involvements, Sharing of ideas, Attitude to accept other’s opinion, etc.)
- Completion of work sheets (Accuracy of results, Levels attained, Sequencing of concepts, etc.)
- Presentation of multimedia animations (Observation skill, Correct interpretation of concepts, etc.)
- Problem solving (Skill in manipulating numbers, Speed in computing data, Accuracy of results, etc.)

**Portfolio assessment**

- Suggested Activity Log (Clarity, Systematic approach, etc.)
- Work sheets (Clarity, Proper sequencing, etc.)
- Charts (Clarity, Authenticity of data, Appearance, etc.)

**Unit based assessment**

- Oral assessment
- Preparation of Text items and their indicators (both MCQs and Descriptive)
1. Given 58 grams of butane ($C_4H_{10}$) molecules:
   (a) What is the molecular mass of butane?
   (b) How many moles of molecules of $C_4H_{10}$ are present?
   (c) How many molecules of $C_4H_{10}$ are present?
   (d) What is the total number of atoms in each molecule of $C_4H_{10}$?
   (e) What is the total number of moles of atoms in each mole of $C_4H_{10}$ molecules?
   (f) What is the total number of moles of atoms in the sample?
   (g) What is the total number of atoms in the sample?

2. $CH_4(g) + 2 Cl_2(g) \rightarrow CH_2Cl_2(g) + 2 HCl(g)$
   Methane gas reacts with chlorine gas to form dichloromethane and hydrogen chloride, as represented by the equation above. A 25.0 g sample of methane gas is placed in a reaction vessel containing 2.58 mol of $Cl_2(g)$.
   (a) Identify the limiting reactant when the methane and chlorine gases are combined. Justify your answer with a calculation.
   (b) Calculate the total number of moles of $CH_2Cl_2(g)$ in the container after the limiting reactant has been totally consumed.

3. Decomposition of $CaCO_3$ is given as $CaCO_3 \rightarrow CaO + CO_2$
   1. What is the mass of $CaO$ obtained if we take 100 kg of $CaCO_3$?
   2. If the $CO_2$ formed is reduced to STP, What is the volume of $CO_2$ obtained from 100 g $CaCO_3$?
   3. What is the molar ratio of $CaO$ and $CO_2$ formed?
   4. To get 11.2 mL of $CO_2$ at STP, What should be the amount of $CaCO_3$ to be taken?

4. 60 g of Urea is added to 500 g water to form a solution.
   1. Find the molality of the solution.
   2. What is the mass percentage of the solution?
   3. Find the mole fraction of Urea in solution.
Appendix 1.1

Avogadro's number = 6.02 x 10^{23} \text{ atoms/mol}

mol of a gas at STP occupies 22.4 L.

1. How many atoms of oxygen are there in 18g of water?

2. How many atoms of hydrogen are there in 18g of water?

3. How many molecules of \( \text{H}_2\text{O} \) are there in 18g of water?

4. What is the mass of 1 mol of \( \text{O}_2 \)?

5. What is the mass of 1 molecule of \( \text{O}_2 \)?

6. What is the mass of 2 mol of \( \text{H}_2\text{SO}_4 \)?

7. What is the density of \( \text{O}_2 \) at STP?

8. 3 L of a gas at STP weighs 2 g. What is the molecular mass?

9. What volume does 22g of \( \text{CO}_2 \) at STP occupy?

10. How many atoms of hydrogen are present in 67.2 L of \( \text{H}_2 \) at STP?

Appendix 1.2.

Comparing sugar (\( \text{C}_{12}\text{H}_{22}\text{O}_{11} \)) & \( \text{H}_2\text{O} \)

<table>
<thead>
<tr>
<th>Same/different</th>
<th>1 gram each</th>
<th>1 mol each</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of moles?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of molecules?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of atoms?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 1.3.
Converting between grams and moles
  o If we are given the number of grams of a compound we can determine the number of moles, & vise-versa
  o In order to convert from one to the other you must first calculate molar mass
    \[ g = (\text{mol} \times g) \text{ mol} \]
    \[ \text{mol} = g \div (g/\text{mol}) \]
  o This can be represented in an "equation triangle"

\[
\begin{array}{c}
\text{mass} \\
\downarrow \\
\text{g} \\
\downarrow \\
\text{mol} \\
\downarrow \\
\text{g/mol}
\end{array}
\]

<table>
<thead>
<tr>
<th>Formula</th>
<th>Gram/mol</th>
<th>Gram</th>
<th>Mol (n)</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCl</td>
<td></td>
<td></td>
<td>0.25</td>
<td>[ g = (g/\text{mol}) \times \text{mol} ]</td>
</tr>
<tr>
<td>( \text{H}_2\text{SO}_4 )</td>
<td>53.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NaCl</td>
<td></td>
<td>3.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cu</td>
<td>1.27</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

References
1. NCERT Chemistry text books of class XI books
3. http://www.rsc.org/learn-chemistry
5. http://www.chemistryexplained.com/Ma-Na/Mole-Concept.html
Introduction

This unit deals with the experiments leading to the discovery of electron, proton and neutron. It also comprises the model of atom proposed by Thomson, Rutherford and Bohr. Merits and demerits of different models of atom are also given. Some basic aspects of quantum mechanical model of atom are also introduced.

Basic concepts regarding atomic structure is necessary for the proper conceptualization of advanced chemistry topics.
<table>
<thead>
<tr>
<th>Concepts/Ideas</th>
<th>Process/Activity with Assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
</table>
| Discovery of fundamental particles and their characteristics.  
  - Communicating and understanding communication of others  
  - Observing  
  - Inferring | General discussion on earlier concepts of atomic structure  
  Multimedia presentation of animated video of discovery of fundamental particles  
  Preparation of short notes on properties of fundamental particles.  
  **Assessment**  
  - Participation in discussion (Process)  
  - Short Note (Portfolio) | Explains the discovery of electron, proton, neutron and their characteristics. |
| Thomson model of atom  
  - Communicating and understanding communication of others  
  - Observing  
  - Measuring and charting | General discussion on Thomson model of atom  
  Chart of schematic representation of Thomson model of atom  
  **Assessment**  
  - Participation in discussion (Process)  
  - Chart (Portfolio) | Describes Thomson model of atom. |
| Rutherford's alpha ray scattering experiment and Rutherford model of atom  
  - Communicating and understanding communication of others  
  - Observing  
  - Measuring and charting  
  - Using space – time relationship | General discussion on gold foil experiment  
  Multimedia animation of Rutherford's gold foil experiment  
  Sketching schematic molecular view of gold foil  
  General discussion on Rutherford model of atom  
  **Assessment**  
  - Participation in discussion (Process)  
  - Chart (Portfolio) | Explains Rutherford's alpha ray scattering experiment and Rutherford's atom model |
| Electromagnetic radiation and electromagnetic spectrum  
  - Communicating and understanding communication of others  
  - Observing  
  - Using number relationship | General discussion on electromagnetic radiation and electromagnetic spectrum.  
  Multimedia presentation on electromagnetic spectrum and spectrum of visible light.  
  Problem solving on characteristics of electromagnetic radiation.  
  **Assessment**  
  - Participation in discussion (Process)  
  - Skill in problem solving (Process and Portfolio)  
  - Activity log (Portfolio) | Identifies the characteristics of electromagnetic radiation and electromagnetic spectrum. |
<table>
<thead>
<tr>
<th>Concepts/ Ideas</th>
<th>Process/Activity with Assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
</table>
| Planck's quantum theory, Black body radiation and Photoelectric effect  
- Communicating and understanding communication of others  
- Measuring and Charting  
- Using number relationship  
- Observing | General discussion on Planck's quantum theory, Black body radiation and photoelectric effect  
Multimedia presentation of photoelectric effect  
Assessment  
- Participation in discussion (Process)  
- Chart (Portfolio) | Explains Planck's quantum theory, Black body radiation and photoelectric effect. |
| Hydrogen spectrum  
- Communicating and understanding communication of others  
- Observing  
- Using number relationship | General discussion on Hydrogen spectrum  
Multimedia presentation of origin of line spectrum of hydrogen  
Problem solving based on hydrogen spectrum  
Assessment  
- Participation in discussion (Process)  
- Problem solving (Process and Portfolio) | Identifies different regions of hydrogen spectrum, its origin and solves numerical problems. |
| Bohr model of atom  
- Communicating and understanding communication of others  
- Observing  
- Inferring  
- Using number relationships | General discussion on Bohr model of atom  
Multimedia presentation on Bohr's model of atom  
Charting of features of Bohr's atom model  
Problem solving based on Bohr model of atom  
Assessment  
- Participation in discussion (Process)  
- Problem solving (Process and Portfolio)  
- Chart (Portfolio) | Explains Bohr model of atom and solves numerical problems. |
| Dual nature of matter-de Broglie's equation  
- Communicating and understanding communication of others  
- Using number relationships | Group discussion on dual nature of matter  
Derivation of de Broglie's relation  
Problem solving based on de- Broglie's equation.  
Assessment  
- Participation in discussion (process)  
- Problem solving (Process and portfolio) | Explains dual behavior of matter and de Broglie's equation, solves numerical problems. |
<table>
<thead>
<tr>
<th>Concepts/ Ideas</th>
<th>Process/Activity with Assessment</th>
<th>Learning outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heisenberg’s Uncertainty principle.</td>
<td>Group discussion on uncertainty principle Data analysis of uncertainties in position and momentum Problem solving based on uncertainty principle <strong>Assessment</strong> • Participation in discussion (Process) • Short note (Portfolio)</td>
<td>Explains Heisenberg’s uncertainty principle and solves numerical problems.</td>
</tr>
<tr>
<td>• Communicating and understanding</td>
<td>General discussion on quantum mechanical model of atom and Schrodinger wave equation. Charting of features of quantum mechanical model <strong>Assessment</strong> • Participation in discussion (Process) • Chart (Portfolio)</td>
<td>Summarises the important features of quantum mechanical model of atom.</td>
</tr>
<tr>
<td>communication of others</td>
<td></td>
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<tr>
<td>• Using number - relationships</td>
<td>General discussion on quantum numbers Charting of each quantum number, its significance and values Problem solving based on quantum numbers <strong>Assessment</strong> • Participation in discussion (Process) • Chart (Portfolio) • Problem solving (Process and Portfolio)</td>
<td>Explains the significance of quantum numbers.</td>
</tr>
<tr>
<td>Quantum number</td>
<td>General discussion on probability density curves and shapes of atomic orbitals Charting on probability distribution curves and shapes of orbitals Multimedia animation on shape of orbitals <strong>Assessment</strong> • Participation in discussion (process) • Chart (Portfolio)</td>
<td>Sketches the probability distribution curve and boundary surface diagrams of s, p, and d orbitals.</td>
</tr>
<tr>
<td>• Communicating and understanding</td>
<td></td>
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<tr>
<td>communication of others</td>
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<td></td>
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<tr>
<td>Quantum mechanical model of atom</td>
<td></td>
<td></td>
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<tr>
<td>• Measuring and charting</td>
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<tr>
<td>Probability density curves and shapes of</td>
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<tr>
<td>atomic orbitals</td>
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<tr>
<td>• Observing</td>
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<tr>
<td>• Inferring</td>
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<tr>
<td>• Using space-time relationships</td>
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<tr>
<td>principle, Hund’s rule of maximum</td>
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<tr>
<td>multiplicity</td>
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</tbody>
</table>
### Concepts/ Ideas
- Communicating and understanding communication of others
- Inferring
- Using number relationships
- Predicting
- Measuring and charting

### Process/Activity with Assessment
**Assessment**
- Participation in discussion (Process)
- Problem solving (Process and Portfolio)

### Learning outcome

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**Towards the Unit......**

**Content:** Rutherford alpha ray scattering experiment and Rutherford's model of atom

**Suggested activity 2.1 -**

General discussion with the aid of multimedia animation on alpha ray scattering experiment (1 period)

Multimedia animation of Rutherford’s alpha ray scattering experiment is shown in the class and afterwards a general discussion is conducted based on the following discussion points

→ Observations regarding the path of alpha particles
→ Conclusions arrived from the above observations
→ Features of Rutherford's model of atom
→ Demerits of Rutherford's model of atom

**Consolidation**

- Rutherford's gold foil experiment
- Rutherford’s model of atom and its demerits

**Content: Quantum numbers**

**Suggested activity 2.2 Small group discussion (1 period)**

Learners are grouped benchwise and given a handout comprising the features of any one quantum number and allowed to conduct a small group discussion based on the handout. Representative of each group is allowed to present it generally.
Model of handout

**Principal quantum number**

Designation: \( n \)

What it denotes: The main energy level or shell to which an electron belongs

Values: '\( n \)' can have any integral values, \( n=1,2,3,4,... \)

\( n=1 \) denotes K shell, \( n=2 \) denotes L shell, ...

**Suggested activity 2.3- General discussion (1 period)**

A general discussion is done in the class based on quantum numbers

**Suggested activity 2.4- Problem solving (1 period)**

Problems based on quantum numbers are given to learners and allowed to solve them.

**Consolidation**

Quantum of numbers

**Repository of CE works**

**Process assessment**

- General discussion and small group discussion
- Chart making
- Problem solving
- Presentation of multimedia animation
- Preparation of short notes

**Portfolio assessment**

- Activity log
- Chart

**Unit based assessment**

**Unit test**

- Open book assessment
- Quiz

**ICT Possibilities**

Multimedia presentation or animated video of

- Discovery of fundamental particles
- Rutherford's gold foil experiment
Sample TE Questions

1. The minimum energy needed to eject an electron from potassium metal is $3.83 \times 10^{-19}$ J.

   (i) Identify the lights which can trigger photo electric effect. (Their wavelengths are given along with them)
   
   (a) Violet (400nm)   (b) Orange (650 nm)
   (c) red (750 nm)     (d) Green (550nm)

   (ii) Calculate the maximum kinetic energy of these ejected electrons

2. Some electromagnetic radiations are given below. Their wavelengths or frequency is given along with them. Construct a line spectrum of these. Identify the radiation which has an energy of $7.95 \times 10^{-20}$ J

   [ X-rays (2 x $10^{15}$kHz), IR (40000 nm), FM radio waves (108Hz), AM radio waves (102m), UV (10$^{16}$Hz), Green (550nm)]

3. Write all the possible quantum numbers for the electrons belonging to 3s, 4s and 4p and construct the following table as instructed.

<table>
<thead>
<tr>
<th>Principal quantum number</th>
<th>3s</th>
<th>4s</th>
<th>4p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azimuthal quantum number/s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnetic quantum number/s</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Spin quantum number/s</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Quantum numbers common in 3s &amp; 4s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantum numbers common in 3s and 4p</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantum numbers common in 4s and 4p</td>
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</tbody>
</table>
4. Some facts or statements are given below. Find out the rules or principle related to them. State the rules/ principles you identified.
   (i) Electronic configuration of Nitrogen is 1s\(^2\), 2s\(^2\), 2p\(_x\)\(^1\),2p\(_y\)\(^1\),2p\(_z\)\(^1\)
   (ii) An orbital can accommodate only two electrons
   (iii) Electrons fill in 4s orbital before it enters 3d

5. Select the odd one out regarding electronic configuration in the following groups and justify
   (i) (a) Carbon (b) Nitrogen (c) Oxygen
   (ii) (a) Cobalt (Z=28) (b) Copper (Z=29) (c) Zinc (Z=30)

6. Solve the following problems, Name the proponents of the equation you used for solving the problems and clearly state the concept/principle related to the equations
   (i) Find out the wavelength of an electron moving with a speed of 4 km/s (h=6.626 \times 10^{-34}\text{Js})
   (ii) A ball of mass 50 g is moving with a speed of 50 m/s. If the speed can be measured only with in an accuracy of 10%. Calculate the uncertainty in position.

7. Analyse the following data

<table>
<thead>
<tr>
<th>Mass number</th>
<th>Number of neutrons more than that of proton (in percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>206</td>
<td>51.21</td>
</tr>
<tr>
<td>207</td>
<td>49.39</td>
</tr>
</tbody>
</table>

   (i) Assign atomic symbol
   (ii) Identify the relationship between them (isotope, isobar or isotone). Justify.

8. Reason for origin of different lines in hydrogen spectra is schematically represented below. The names of series are represented wrongly
   (i) Redraw it representing the correct series
   (ii) Calculate the wave number corresponding to missing lines in the diagram of each series. (R\(_{11}\) = 109677 cm\(^{-1}\))
9. Analyse the following diagram

(i) Give the scientific observations from the diagram

(ii) Also write the conclusions arrived from the above observations

10. "Orbit and orbital differs in many aspects" Substantiate this statement. Also draw the boundary surface diagrams of 3d orbitals.

References
1. Castellan, Physical chemistry, 3rd Edition
2. Puri, Sharma, Pathania, Principles of physical chemistry
3. Puri, Sharma, Pathania, Principles of Inorganic chemistry
4. Olmsted & Williams, Chemistry
5. Huheey, Keiter, Inorganic chemistry
6. Manaschanda , Atomic structure and the chemical bond