**Nalanda Open University**

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**E-CONTENT 5**

for

Part-I Examination, 2020

**SHORT DESCRIPTION OF THE SUGGESTED TOPICS**

**THEORY PAPER**

**PAPER – III**

**(ENVIRONMENTAL CHEMISTRY)**

1. **Meaning and definition of “Strength of Solution”. Different methods for expressing strength of solutions.**

**Strength of Solution:**

A solution is a homogeneous mixture of two or more substances. Usually the smaller component is called ‘Solute’ where as the larger component of the solution is called ‘Solvent’. In the study of different chemical transformations (i.e. chemical reactions) one or more of the reactants and products may be a solid, a liquid or a gas. However, in the study of a large number of chemical reactions (i.e. changes) in laboratories as well as in industries the chemical changes are studied in solutions. For quantitative study of such chemical reactions in solution it is necessary to know the amount (weight or volume) of a solute dissolved/present in a definite amount (weight or volume) of the solution. This knowledge about a solution is known as Strength of that Solution.

Thus,

***Strength of a solution expresses the amount (weight or volume) of a solute present/dissolved in a definite amount (weight or volume) of that solution.***

**Methods of expressing Strength of Solutions:**

Different standard methods for expressing strength of solutions are the following:

1. **In percentage**
2. **In molarity**
3. **In normality**
4. **In molality**
5. **In mole fraction**
6. **In part per million (ppm) and**
7. **In part per billion (ppb)**
8. **In percentage**

It expresses the part of a solute dissolved in 100 parts of a solution. It is studied further under the following three subheadings:

1. Strength as W/W percent (W/W %)
2. Strength as W/V percent (W/V %) and
3. Strength as V/V percent (V/V %)
4. **Strength as W/W percent (W/W %)**

It is the weight of a solute dissolved in 100 parts by weight of the solution. Thus, a 5% (W/W) NaOH solution means that 5g of NaOH is dissolved in 100g of the solution.

1. **Strength as W/V percent (W/V %)**

It is the weight of a solute dissolved in 100 parts by volume of the solution. Thus, a 4% (W/V) solution of NaCl means that 4g of NaCl has been dissolved in 100 ml of the solution.

1. **Strength as V/V percent (V/V %)**

It is the volume of a solute dissolved in 100 parts by volume of the solution. Thus, a 6% (V/V) aqueous solution of ethyl alcohol means that 6 ml of pure ethyl alcohol has been dissolved in 100 ml of its aqueous solution.

**Note:** In describing the strength of solution C.G.S. system of measurement has been used. Other units of measurement can also be used.

1. **In molarity**

Molarity of a solution is the number of moles (i.e. gm molecules) of a solute dissolved in one litre of the solution.

 Molar Solution is defined as a solution having one mole (i.e. molecular weight in gram) of a solute dissolved in 1 litre of the solution. Thus molar solution of NaOH means that 1 mole of NaOH which is equal to (23+16+1) gm = 40 gm is dissolved in 1 litre of the solution.

1. **In normality**

Let us first define Normal solution. It is defined as a solution having one gram equivalent (i.e. equivalent weight in gram) of a solute dissolved in 1 litre of the solution. It is represented as N-solution. Thus N-solution of H2SO4 means that one gram equivalent of H2SO4 which is equal to $\frac{2+32+64}{2}$ gm = 49 gm is dissolved in 1 litre of the solution.

 **Normality** is a solution is the number of gm-equivalents of a solute dissolved in 1 litre of the solution.

1. **In molality**

Let us first define Molal Solution. It is defined as a solution having one mole (i.e. molecular weight in gram) of a solute dissolved in 1 Kg of the solvent.

 **Molality** of a solution is defined as the number of moles of a solute dissolved in 1 Kg of the solvent.

1. **In mole fraction**

Mole fraction of solute (or solvent) in a solution is the ratio of number of moles of the solute (or solvent) to the total number of moles of all the components – Solute (s) and Solvent – present in the solution.

Thus,

Mole fraction of solute in solution,

 Xsolute **=** $\frac{No. of moles of solute (n)}{No. of moles of solute \left(n\right)+No. of moles of solvent (N) }$

i.e. Xsolute = $\frac{n}{n+N}$

Similarly, Xsolvent = $\frac{N}{n+N}$

1. **In part per million (in ppm):**

When very small amount of a solute is dissolved/present in large amount of a solution it is convenient to express the strength of that solution in parts per million (ppm). It is the amount (weight or volume) of a solute dissolved/present in 106 parts of the solution (by weight or volume; 1 million = 106)

1. **In part per billion (in ppb):**

This method of expressing strength of a solution is used when very minute quality of a solute is dissolved/present in large amount of a solution. It is the amount (weight or volume) of a solute dissolved in 109 parts of the solution (by weight or volume; 1 billion = 109)

**Note:** Further elaboration through numerical examples and numerical problems on different methods of expressing strength of solutions is required.

1. **Elaboration of the statement that “Oxygen plays a key role in the troposphere, while Ozone in the stratosphere”.**

Air is the most important natural resource essential for survival of plants, animals and human beings. There is life on the earth because there is air to breathe. We cannot see air, we cannot smell air but it is all around us. Air around the earth forms an invisible thick cover which is called atmosphere. The atmosphere may be broadly divided into four regions: Troposphere, Stratosphere, Mesosphere and Thermosphere.

**Troposphere:**

This is the lowest part of the atmosphere closest to the surface of the earth. It is where man and other organisms live. It extends upto nearly 14 km above the surface of the earth. It contains the largest percentage (70 -90 percent) of the total mass of atmosphere. The air which consists largely of Nitrogen (about 78 % by volume) and Oxygen (about 21 % by volume) and which is the lifeline of all living things, is mainly packed into the Troposphere.

 Oxygen which is present largely in the troposphere is the essential component of air as it is the basis of life. All living beings breathe in oxygen for their survival. Oxygen is essential for burning (combustion) of fuels. We burn fuels for energy required for domestic, industrial and transportation purposes. Without oxygen burning of fuels which is an inevitable natural process for survival of human beings and other life forms on the earth, is not possible. Dissolved oxygen in water bodies (rivers, lakes, ponds, seas and oceans) is used by aquatic animals and plants for breathing. A number of other vital natural processes (such as aerobic biodegradation of organic wastes etc.) require the presence of atmospheric oxygen. Thus it is fully justified to say that oxygen plays key role in the troposphere.

**Stratosphere:**

Above the troposphere is the stratosphere which lies between 14 km to 50 km above the surface of the earth. This region of the atmosphere has almost no water vapor, no clouds and no dust and the density of the air is very low. The temperature of this region increases with increase in altitude. However, the most important gas present in this region of the atmosphere is Ozone (O3) gas. The presence of Ozone in the stratosphere which forms a well-marked Ozone layer is of vital importance to humans and other life forms. The Ozone layer serves as a protective shield for life on earth by absorbing most of the harmful ultraviolet rays of the sun. The ultraviolet rays if not screened (i.e. absorbed) properly may reach the earth’s surface and can cause skin cancer, cataract and inflammatory diseases. This harmful radiation can damage and destroy micro-organisms and animal tissues.

 It is therefore fully justified to state that ozone (O3) present in stratosphere plays a vital role in protecting the life of human beings and other life forms of our planet.

 **Note :** Further elaboration, addition and/or substation may be done.

1. **Green House Gases and Green House Effect. Consequences of increasing Green House Effect.**

**Greenhouse gases and Greenhouse Effect:**

Before taking up the main topic for description one should know first what is a Green House and how does the earth work as giant greenhouse?

A greenhouse is a house with roof and wall made of transparent glass. Greenhouses are built in cold regions to grow plants, vegetables and flowers which would otherwise not survive in the cold. Sunlight enters through the glass and warm up the soil and plants inside. The warm soil emits radiation of longer wavelength (i.e. lesser energy) than it receives. This emitted radiation is mainly infrared radiation and has less energy than the incident radiation. Glass is opaque to the emitted radiation, so the greenhouse retains a part of infrared radiation and the inside of the greenhouse stays warmer than outside.

 As early as in 1827, the French Scientist J.B.J. Fourier envisaged the earth as a giant greenhouse whose atmosphere traps radiant heat from the sun thus warming the planet and giving life to every plant and animal. Today, it is well established that the atmosphere consists of such gases as carbon dioxide, Water vapor, Methane, Nitrous oxides etc. which comprise 1 to 2 percent of the atmosphere. These gases absorb some of the solar radiation and help warm the planet to a comfortable, livable temperature. These gases present in the atmosphere which are responsible for warming the planet to a comfortable temperature are collectively called Greenhouse Gases and the effect thus experienced has been given the name Greenhouse effect. Without this natural greenhouse effect the average temperature on the earth’s surface would be approximately -200C, far too cold to sustain our present ecosystem.

**Common Greenhouse Gases in present time:**

Carbon dioxide is the main greenhouse gas and is responsible for about half of the atmospheric gases and also for 50% of the greenhouse effect. Other greenhouse gases include methane, nitrous oxide, water vapor and ozone. Moreover, human activities have added chlorofluorocarbons as a highly potent greenhouse gases.

**Consequences of increasing Greenhouse effect:**

In 1896, the Swedish chemist S. Arrhenius painted out that industrial pollutants, particularly carbon dioxide were accumulating in the earth’s atmosphere and that their build up would cause a gradual rise in temperature. In recent years the world has observed and experienced that the planet is warming more rapidly than expected due to massive industrialization, burning of fossils fuels, deforestation, modern agricultural practices etc. Now, the greenhouse effect has rapidly emerged as a global environmental issue. To emphasis the potential danger of the greenhouse effect on the life on the earth, the United Nations Environment Programme (UNEP) coined the term “Global Warming” (on World Environment, 5 June, 1989) to alert the people of the world against the possible impact of global warming.

**Possible impact of Global Warming:**

 In international scientific circles, a consensus is growing that the buildup of CO2 and other greenhouse gases in the atmosphere may have a number of adverse effects on earth’s climate and may lead to major environmental problems. The major problems that may occur are as noted below:

1. Sea level rise
2. Agricultural shift and lesser crop yield
3. Adverse effect on global water balance
4. Loss of ecosystems and biodiversity
5. Adverse effect on human health
6. Erratic climate conditions etc.

**Note:** Short description of the major problems due to Global Warming as noted above required to be included here. Study learning material provided by Nalanda Open University, Patna may be of help while preparing the answer. Other texts may also be consulted.

1. **Sea water as a source of drinking water in future. Description of effective and efficient methods for conversion of sea water into portable water.**

Seas and oceans which cover approximately 70 percent of earth’s surface are the ultimate repository of many materials eroded or dissolved from the land surface. Common salt (i.e. sodium chloride, NaCl) is the most common salt (chemical) present in seas and ocean water. The 3 – 3.5 percent salt content in ocean water (called saline water) makes it unusable for most of human needs.

Due to huge and disproportionate with drawl of water from rivers, lakes and ground aquifers for various purposes (domestic, agricultural, industrial, recreational etc.) land based freshwater resources are becoming scarce. Due to the reasons mentioned above we are heading towards a global water crisis. Non availability of freshwater and health problems associated with poor quality of water are the twin problems which are among the major global issues demanding immediate attention. Under this background of ensuring freshwater crisis there is greater emphasis now on the extraction of freshwater from ocean water through the process called ‘Desalination’.

According to the International Desalination Association, in June 2015, 18426 desalination plants operated worldwide, producing 86.8 million cubic meters per days, providing water for 300 million people. The most important users of desalinated water are in the Middle East mainly Saudi Arabia, Kuwait, the United Arab Emirates, Qatar and Bahram which uses about 70 % of worldwide capacity.

**Desalination of Sea-water:**

Desalination or Desalting is the process of removing (partially or completely as per the need) the salt content present naturally in sea water. Partial desalination is applied to lowering of the saline contents to a degree which renders the water suitable for the drinking and other domestic purposes. For this purpose the salt content of the sea water is lowered down to a value of 500 ppm or less. Complete desalination is applied mainly to furnishing water suitable for use in high pressure boilers and for certain other industrial uses. There are several methods for desalination. Each method has its own advantages and disadvantages, but all are useful. Today, there are three main types of desalination techniques. They are:

1. Membrane based techniques.
2. Thermal techniques and
3. Electrical Techniques.

Of these techniques the following two techniques (i.e. methods) which are more commonly used are:

1. Electrodialysis Method and
2. Reverse Osmosis Method

**Note:** For description of these methods, Study Learning Material (SLM) provided by Nalanda Open University, Patna may be consulted. Other available resource/study materials may also be consulted if so felt.