Ministry of Higher Education & Scientific Research
Foundation of Technical Education
Technical Collage of Basrah
Environmental & Pollution Department
Water Pollution.

NO.	Lesson	Week
1	Water a precious natural resource	1
2	Water resources	2
3	The role of engineers and scientists	3-4
4	Characteristics of waters and waste water	5-7
5	Sampling and analysis	8-12
6	Aquatic microbiology and ecology	13
7	Water quality and health	14-16
8	Biological oxidation of organic matter	17-18
9	Oxygen demand in aerobic oxidation	19-21
10	Water pollution and its control	22-24
11	Ground water pollution& pollution of tidal water	25-26
12	Control of pollution	27
13	Introduction to treatment processes	28-30
	Water pollution laboratory	
NO.	Lesson	Week
1	Hardness in water	1-2
2	PH to water	3-4
3	Alkalinity to water	5
4	Acidity to water	6
5	Dissolve oxygen in water	7
6	BOD to water	8-9
7	Determination of chloride in water	10
8	Determination of microorganisms in water	11-13
9	Biodegradation of oil in water by microorganisms	14-16

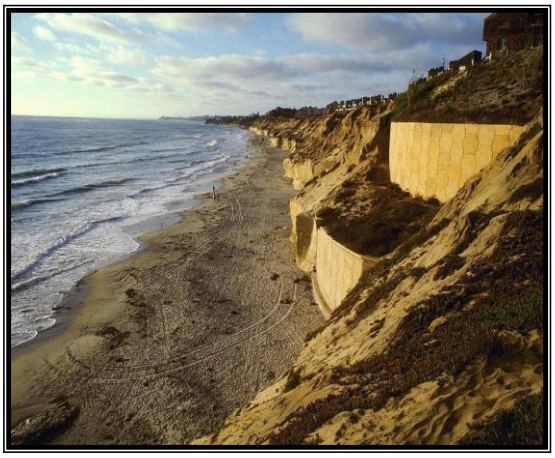
Ministry of high Education and Scientific Research
Foundation of Technical Education
Technical Collage / Al-Basrah

Training package
in

WATER POLLUTION

For

Students of third class
Environmental & Pollution Department



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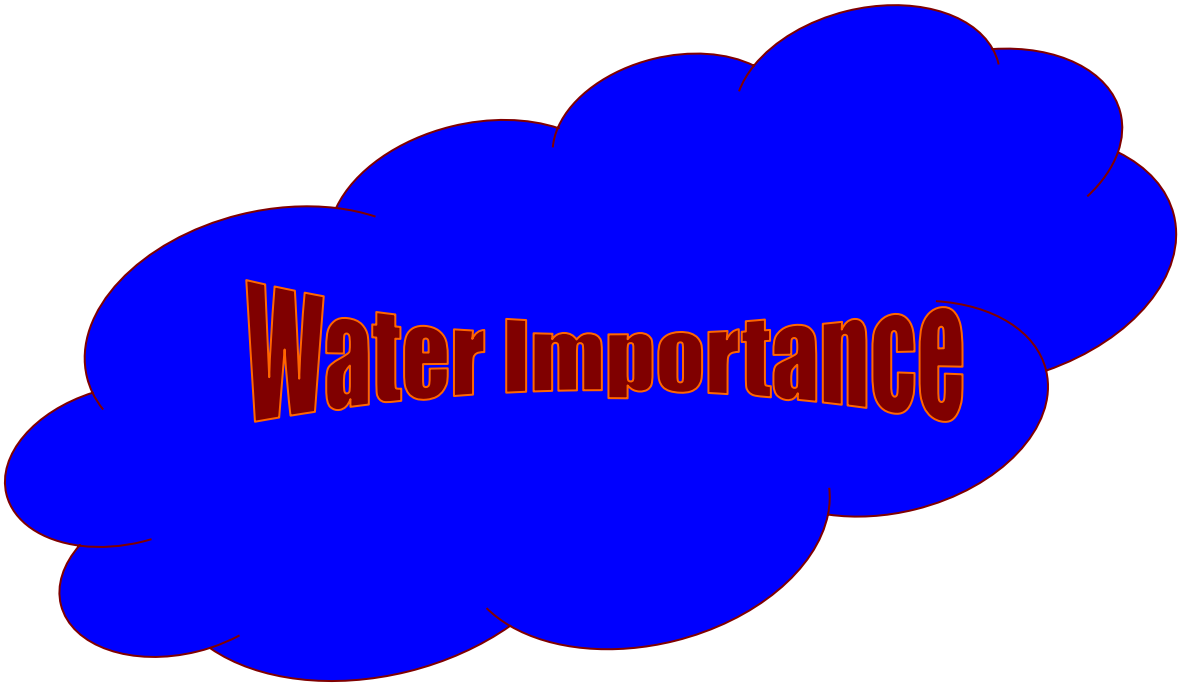

Water Importance


First modular unit

1/ Over view

1 / A –Target population :-

For students of third class
Technical collage
Department of environmental & pollution

1 / B –Rationale :-

Water is the most important natural resource in the world since without it, life cannot exist and most industries could not operate. The presence of a safe and reliable source of water is thus an essential prerequisite for the establishment of a stable community. In the absence of such a source, a nomadic life style becomes necessary and communities must move from one area to another as demands for water exceed its availability.

1 / C –Central Idea :-

1 – Water resources.
2 –Water of engineers and scientists.
3- Water supply & wastewater disposal systems.
4- Characteristic of water & wastewaters.

a- Physical characteristics.
b- Chemical characteristics.
c- Biological characteristics.

5- Typical characteristics.

1 / D –Instructions:-

1. Study over view thoroughly.
2. Identify the goal of this modular unit.
3. Do the pre test and if you :-
    - Get 9 or more you do not need to proceed.
    - Get less than 9 you have to study this modular unit well.
4. After studying the text of this modular unit ,do the post test , and if you :-
    - Get 9 or more, so go on studying modular unit second.
    - Get less than 9, go back and study the first modular unit; or any part of it; again and then do the post test again.

2/ Performance Objectives

After studying the first modular unit, the student will be able to-

1. Define water resources.
2. Know the water importance.
3. Determine the characteristics of waters.
4. Determine the typical characteristics of waters.

3/ Pre test:-

Circle the correct answer:-

1. **Water pollution means :-**

a- change in environment conditions. b- Enter strange matter.

c- Change in water characteristics. c- all of them.

2. **Hydrological cycle assess :-**

a- quality & quantity of water b- quality of water

c- quantity of water d- balance of water

3. **Characteristics of water include :**

a- Chemical & physical b- Physical, chemical and biological

c- Typical properties d- just biological

4. **Temperature is a :**

a- Chemical properties b- physical properties

c- Biological properties d- typical properties

5. **Odor in water may be caused by :**

a- suspended solid b-inorganic ions

c- organic matters d- inorganic & organic matter

6. **PH means :**

a- intensity of acidity b- intensity of alkalinity

c- intensity of water d- intensity of acidity & alkalinity

7. Oxygen is a :

a- chemical properties b- physical properties

c- biological properties c- typical properties

8. Chloride is a salts of :

a- chlorine b- hydrochloric acid

c- hydrocarbons d-organic compounds

9. Biological characteristics important in :

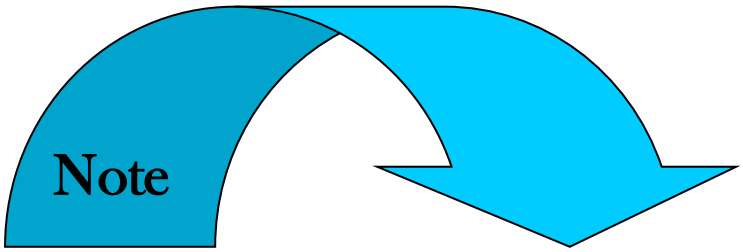
a-water quantity control b- water pollution

c- water quality control d- water management

10- Typical characteristics of water divided in to:

a- three group b- four group

c- six group d- five group



- Check your answers in key answer page 19.

- (1) degree for each .

4/ The text :-

Water a precious natural resource:

Water is the most important natural resource in the world since without it life can not exist and most industries could not operate. Although human life can exist for many days without food, the absence of water for only a few days has fatal consequences. The presence of a safe and reliable source of water is thus an essential prerequisite for the establishment of a stable community. In the absence of such a source a nomadic life style becomes necessary and communities must move from one area to another as demands for water exceed its availability.

Water resources:-

The science of hydrology is concerned with the assessment of water resources in the hydrological cycle, and their management for the optimum results. It will be appreciated that in any management plan for water resources it is vital to assess both the quality and quantity of the available supplies. {Fig. 1}

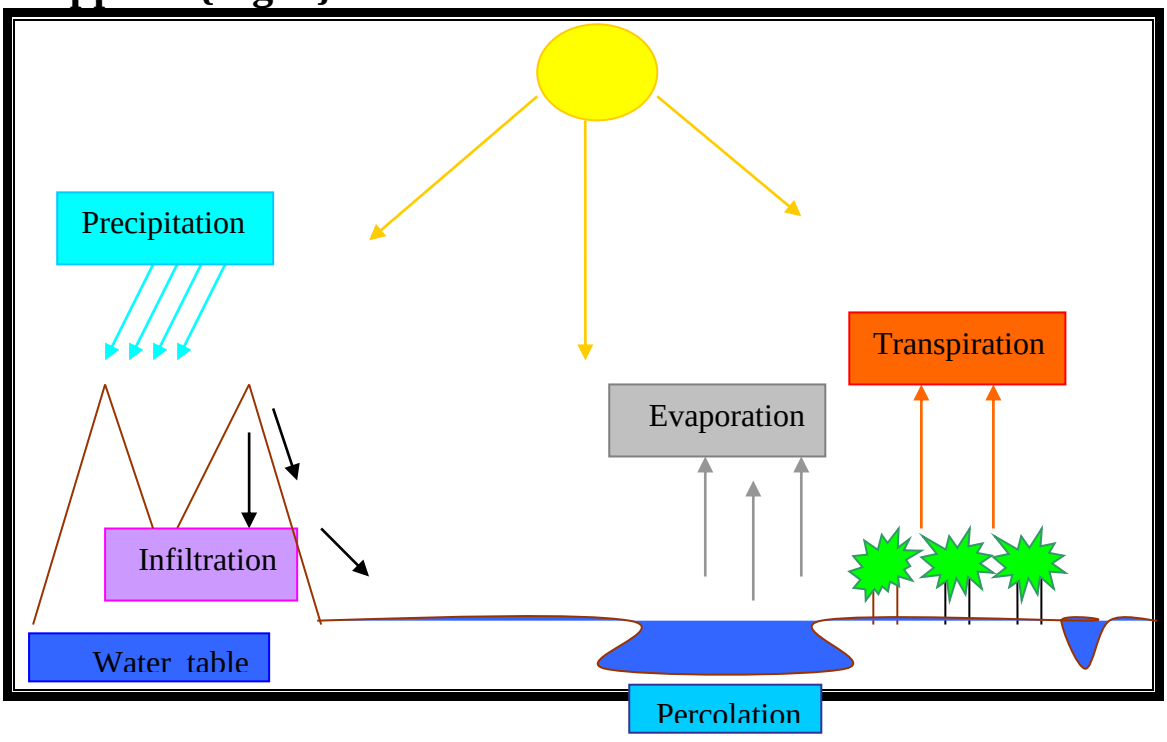


Fig. 1: The hydrological cycle...

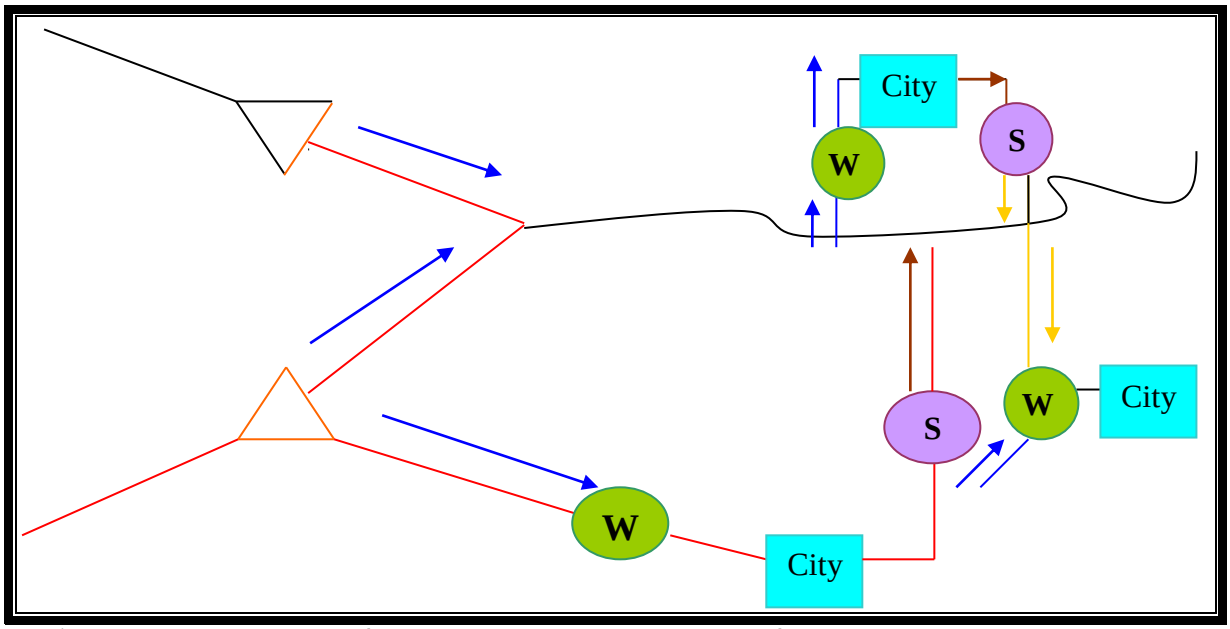
The role of engineers and scientists:-

Public works such as water supply and sewage disposal schemes have traditionally been seen as civil engineering activities and water engineering is probably the largest single branch of the civil engineering profession. The connection with civil engineering is due to the fact that most water engineering works involve large structures and require a good understanding of hydraulics .water science and technology is, however, an interdisciplinary subject involving the application of biological, chemical and physical principles in association with engineering techniques. A major objective in water quality control work is to reduce the incidence of water – related diseases. This objective depends on the ability to develop water sources to provide an ample supply of water of wholesome quality.

i.e.: a water free from:-

*** Visible suspended matter.**
*** Excessive colour, taste and odour.**
*** Objectionable dissolved matter.**
*** Aggressive constituents.**
*** Bacteria indicative of faecal pollution.**

In many situations treated wastewaters provide a significant proportion of the water resources for other users. {Fig. 2} illustrates in diagrammatic form typical water supply and wastewater disposal systems.



W: water treatment plant, S: sewage treatment plant

Fig.2:-Water supply and wastewater disposal systems

Characteristics of waters and wastewaters:-

The chemical formula for water, H_2O, is widely recognized, but un fortunately it is somewhat of a simplification since water has several properties which cannot be explained by such a simple structure. At low temperature, particularly, water behaves as if its molecular form was H_6O_3 or H_8O_4 held together by hydrogen bridges. As the temperature approaches freezing, these structural linkages become more important than the thermal agitation which encourages a looser association of molecules. this interaction of the two molecular forces results in the effect that ice is less than water and the fact that the density of water increases as the temperature rises from 0° C to 4° C and then decreases with further increases in temperature because of the greater effect of thermal agitation at higher temperatures . Two consequences of this density effect are the bursting of pipes during freezing conditions and the thermal stratification of lakes.

Because of its molecular structure and its electrical properties of a very high dielectric constant and a low conductivity, water is capable of dissolving many substances, so that the chemistry of natural water is very complex. All natural waters contain varying a mount of other materials in concentrations ranging from minute traces at the ng/L level of trace organics in rain water, to a round 35.000mg/L in sea water. Wastewaters usually contain most of the dissolved constituents of the water supply to the area with additional impurities arising from the waste – producing processes.

To gain a true under-standing of the nature of a particular sample its thus usually necessary to measure several different properties by undertaking analyses under the board headings of physical, chemical and biological characteristics:

1- Physical characteristics: -

Physical properties are in many cases relatively easy to measure and some may readily be observable by the layman.

1- Temperature: basically important for its effect on other properties.

2- Taste and odour: due to dissolved impurities, often organic in nature.

3- Colour: even pure water is not colourless; it has a pale green –blue tint in large volumes. it is necessary to differentiate between true colour due to materials in solution and a apparent colour due to suspended matter .

4 – Turbidity: the presence of colloidal solids gives liquid a cloudy appearance which is aesthetically un attractive and may be harmful.
5 – Solids: these may be present in suspension and / or in solution and they may be divided into organic matter and inorganic matter
6 – Total dissolved solids (TDS): are due to soluble materials whereas suspended solids (SS) are discrete particles which can be measured by filtering a sample through a fine paper.
7 – Electrical conductivity: the conductivity of a solution depends on the quantity of dissolved salts present and for dilute solutions it's approximately proportional to the (TDS) content, given by:

$$K = \frac{\text{Conductivity (S / m)}}{\text{TDS (mg / L)}}$$

Value of K = a particular water.
8 – Radioactivity: measurements of gross B and ɣ activity are routine quality checks. Naturally occurring radon can be a possible long –term health hazard with some ground waters.

2- Chemical characteristics: -

Chemical characteristics tend to be more specific in nature than some of the physical parameters and are thus more immediately useful in assessing the properties of a sample. Its useful at this points to setout some basic chemical definitions.

- ***Atomic weight – weight*** (mass) of an atom of an element referred to a standard based on the carbon isotope ^{12}C, also, relative atomic mass.
- ***Molecular weight*** – total atomic weight of all atoms in a molecule.
- ***Molar solution*** – solution containing the gram molecular weight (mole) of the substance in 1 litter, signified by M.

- ***Valence*** – property of an element measured by the number of atoms of hydrogen that one atom of the element can hold in combination or displace.
- ***Equivalent weight*** – the quantity of substance which reacts with a given amount of a standard , given :

$$\text{Equivalent weight} = \frac{\text{Molecular weight}}{Z}$$

where :
For acids ,Z = the number of moles of H obtainable from 1 mole of acid.
For bases, Z = the number of moles of H with 1 mole of base will react.
Some important chemical characteristics are described below:

1- PH :

The intensity of acidity or alkalinity of a sample is measured on the PH scale which actually indicates the concentration of H^+ ions present , water is only weakly ionized , as shown by the equilibrium :-

$$H2O \longrightarrow H^+ + OH^-$$

Since only about 10^{-7} molar concentration of H^+ and OH^- are present at equilibrium. This is conveniently expressed by the function PH, given by: $PH = -\log_{10}[H^+]$.

2- Oxidation – reduction potential (ORP):

In any system undergoing oxidation there is a continual change in the ratio between the material in the reduced form and those in the oxidized form. In such a situation the potential required to transfer electrons from the oxidant to the reductant is approximated by:

$$ORP = E^\circ - \frac{0.509}{Z} \log_{10} \frac{[\text{products}]}{[\text{reactants}]}$$

E° = cell oxidation potential referred to H =0.
Z = number of electrons in the reaction.
*** Aerobic reactions show ORP values of > + 200 mv.**
*** An aerobic reactions occur below + 50 mv.**

3- Alkalinity:

Due to the presence of bicarbonate, HCO^{-}_{3}, carbonate, CO^{-2}_{3}, or hydroxide OH^{-} , most of the natural alkalinity in water is due to HCO^{-}_{3} produced by the action of ground water on limestone or chalk

$$Caco_3 + H_2O + Co_2 \longrightarrow Ca(Hco3)_2$$

In soluble — from soil Organisms — soluble

Alkalinity is useful in waters and wastes in that it provides buffering to resist changes in PH.

4 – Acidity:

most natural waters and domestic sewage are buffered by a CO_2 , HCO_3 system , carbonic acid , H_2CO_3 , is not fully neutralized until PH 8.2 and will not depress the PH below 4.5 . Thus CO_2 acidity is in the PH range 8.2 to 4.2; mineral acidity (usually due to industrial wastes) occurs below PH 4.

5- Hardness:

This is the property of water which prevents lather formation with soap and produces scale in hot water systems; hardness is expressed in terms of $Caco_3$ and is divided into two forms:

1- **Carbonate hardness:** metals associated with HCO^{-}_{3}.
2- **Non – carbonate hardness:** metals associated with SO^{-2}_{4}, CL^{-}, and NO^{-}_{3}.

6 – Dissolved oxygen (DO):

Oxygen is most important element in water quality control , its presence is essential to maintain the higher forms of biological life and the effect of waste discharge on a river is largely determined by the oxygen balance of the system .

Temp (C°)	0	10	20	30
DO (mg / L)	14.6	11.3	9.1	7.6

7 – Oxygen demand:

Organic compounds are generally un stable and may be oxidized biologically or chemically to stable, relatively inert, end products such as CO_2, NO_3, and H2O. An indication of the organic content of a waste can be obtained by measuring the amount of oxygen required for its stabilization using: BOD, COD, TOC, UV, VOC, and AOC.

8 – Nitrogen:

This is an important element since biological reactions can only proceed in the presence of sufficient nitrogen. Nitrogen exists in four main forms in the water cycle:

1- **Organic nitrogen.**
2- **Ammonia (NH3) nitrogen.**
3- **Nitrite (NO2) nitrogen.**
4- **Nitrate (NO3) nitrogen.**

Oxidation of nitrogen compounds, termed nitrification, proceeds thus: $\text{Organic nitrogen} + O_2 \longrightarrow \text{ammonia nitrogen} + O_2 \longrightarrow NO_2 + O_2 \longrightarrow NO_3$

Redaction of nitrogen, termed de-nitrification, may reverse the process: $NO_3 \longrightarrow NO_2 \longrightarrow NH_3$ or N_2

9- Chloride:

chlorides are salts of hydrochloric acid or metals combined directly with chlorine, the threshold level for chloride taste is 250 – 500 mg /L , although up to 1500 mg /L is un likely to be harmful to healthy consumers .

10 – Trace organic:

Over 600 organic compounds have been detected in raw water sources and most of them are due to human activity or industrial operations. substances which have been found include benzene , chlorophenols , oestrogens , pesticides , polynuclear , aromatic hydrocarbons (PAH) and trihalomethanes (THM) .

When dealing with industrial wastewaters or their effects on water courses and aquatic life many others specialized chemical characteristics may be important, including: heavy metals, cyanides, oils and greases.

3 - Biological characteristics:-

Living organisms play major roles in many aspects of water quality control and thus the assessment of biological characteristics of water are often of great significance. It will suffice here to note that the bacteriological analysis of drinking water supplies usually provides the most sensitive quality assessment. raw sewage contains millions of bacteria per milliliter and many organic waste waters have large populations of bacteria , but the actual numbers are rarely determined conventional treatment methods for sewage and organic wastewaters rely on the ability of microorganisms to stabilize organic matter so that very large numbers of microorganisms are found in wastewater treatment plants and in their effluents .

Typical characteristics:

Since waters and wastewaters vary widely in their characters it is not desirable to give specification for what might be termed (Normal) samples. In this context it is useful to classify constituents of water into five groups: -

1- Organoleptic parameters:

Characterized by being readily observable by the consumer but usually having little health significance; typical examples are colour, suspended matters, tastes and odors.

2 – Natural physical – chemical parameters:

Including normal characteristics of waters such as PH, conductivity, dissolved solids, alkalinity, hardness, dissolved oxygen.

3 – Substances undesirable in excessive amounts:

This group includes a wide variety of substances, some of which may be directly harmful in high concentrations; other may produce undesirable tastes and odours.

4 – Toxic substances:

A considerable number of inorganic and organic chemicals can have toxic effects on consumers of water containing them, the severity of the effects depending for a particular substance on the dose received, the period of consumption, and other dietary and other environmental factors.

5 – Microbiological parameters:

In most parts of the world these parameters are by far the most important in determining the safety of drinking water.

5/ Post test :-

Circle the correct answer:-

1- Human life can exist for many days with out :

a- food b- water

c- oxygen d- temperature

2- Natural water resources depended on :

a- safe water b- hydrological cycle

c- water treatment plant d- quality & quantity of water

3- Colour is a :

a-biological properties b- chemical properties

c-physical properties d- typical properties

4- Electricity conductivity of solution depends on:

a- DS b- SS

c- VSS d- TDS

5- Hardness in water divided in to:

a- two type b- three type

c- four type d- five type

6- THM in water is a :

a- organic matter b- trace organic matter

c- inorganic matter d- oil pollutants

7-Nitrifection is oxidation to :

a- organic compound b- ammonia compound

c- organic nitrogen d-in organic nitrogen

8- BOD is used for:

a- determine oxygen demand b- oxidation organic matter

c- microorganisms growth d- all of them

9- Toxic substances in water are a:

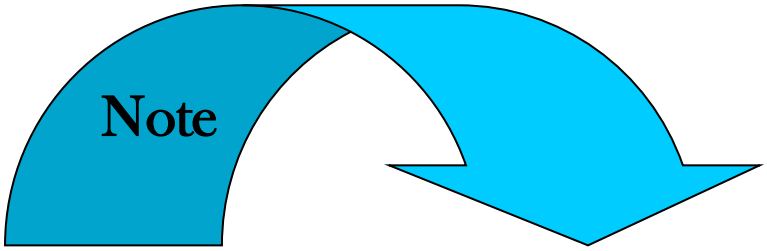
a- inorganic & organic matter b- chemical material

c- biological product d- industrial wastes

10- Microbiological parameter used to determine:

a- water resources b- safety of drinking water

c- typical properties of water d- water supply



- Check your answers in key answer page 19 .

- (1) degree for each .

6/ key answer:-

1- Pre test :-

1. **c**
2. **a**
3. **b**
4. **b**
5. **c**
6. **d**
7. **a**
8. **b**
9. **c**
10. **d**

If you :-

- got 9 or more you do not need to proceed .
- got less than 9 you have to study this modular unit well .

2- Post test :-

1. **a**
2. **b**
3. **c**
4. **d**
5. **a**
6. **b**
7. **c**
8. **d**
9. **a**
10. **b**

If you:-

- Got 9 or more, so congratulation your performance, go on studying modular unit second.
- Got less than 9, go back and study the first unit;

or any part of it; again, and then do the post test again.

7/Sources:-

1- Chatterjee, A.K. (1994). Water supply, Waste disposal and environmental pollution engineering (including odour, noise and air pollution and its control). 5th ed. Khanna publishers. 2- B Nath Market, Nai sarak, Delhi.

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Sampling & Analysis

Second modular unit

1/ Over view

1 / A –Target population :-

For students of third class
Technical collage
Department of environmental & pollution

1 / B –Rationale :-

To obtain an accurate representation of the composition and nature of a water or wastewater its first essential to ensure that the sample analyzed is truly representative of the source.

1 / C –Central Idea :-

1 – Collection of samples.
2 –Analysis of samples.
3- Types of analysis.
4- Relation ship in ecosystem.

1 / D –Instructions:-

1. Study over view thoroughly.
2. Identify the goal of this modular unit.
3. Do the pre test and if you :-
    - Get 9 or more you do not need to proceed.
    - Get less than 9 you have to study this modular unit well.
4. After studying the text of this modular unit ,do the post test , and if you :-
    - Get 9 or more, so go on studying modular unit three.
    - Get less than 9, go back and study the second modular unit; or any part of it; again and then do the post test again.

2/ Performance Objectives

After studying the second modular unit, the student will be able to-

1. Collect sample.
2. Analysis & storage sample.
3. Determine the methods of analysis.
4. Determine the type of particles pollutants.

3/ Pre test:-

Circle the correct answer:-

1. **After collect samples if cant analysis must be storage at :-**

a- 4^0C b- 3^0C

c- 2^0C d-1^0C

2. **Gravimetric analysis depended on :-**

a- volume b- weight

c- colour d- concentration

3. **Visual methods include :**

a- spectrophotometer& colorimeter b- PH& ORP electrode

c- comparison tube& colour disc d- beers& lamberts laws

4. **Colorimetric analysis depend on :**

a- volume b- weight

c- colour d- concentration

5. **Electrode technique include :**

a- spectrophotometer& colorimeter b- PH& ORP electrode

c- comparison tube& colour disc d- beers& lamberts laws

6. **By colorimetric analysis can determine :**

a- optical density b- sulphate

c- density of light path in solution d- all of them

7. Gravimetric analysis is used to determine :

a- TDS b- SS

c- Sulphate d- all of them

8. Volumetric analysis is used to determine :

a- heavy metals b- hardness

c-alkalinity& acidity d- nitrogen compounds

9. microorganisms keep the :

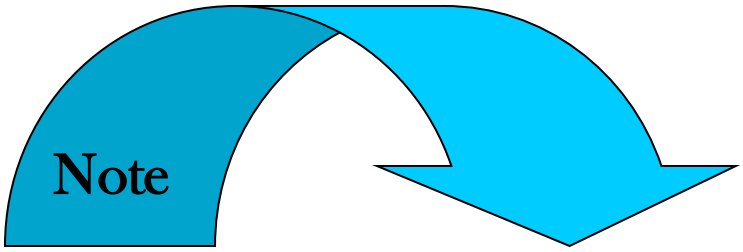
a- environmental balance b- organic oxidation

c- variety of diseases in water d- all of them

10- A biological community& environment forms:

a- ecology b- ecosystem

c- productivity d- tropic relationship



- Check your answers in key answer page 14.

- (1) degree for each .

4/ The text :-

1 - Sampling: -

The collection of a representative sample from a source of uniform quality poses few problems and a single grab sample will be satisfactory. To obtain an accurate assessment in this situation it's necessary to produce a composite sample by collecting individual samples at known time intervals throughout the period and measuring the flow at the same time. By bulking the individual samples in proportion to the appropriate flows an integrated composite sample is obtained. Various automatic devise are available to collect composite samples and these may operate on either a time basis or on a flow – proportional basis. all analyses should be carried out on the sample immediately after collection , with characteristics which are likely to be un stable such as dissolved gases , oxidizable or reducible constituents change in the composition of a sample with time can be retarded by storage at low temperature (4° C) and the exclusion of light is also advisable .

2- Analytical methods:

Because of its solvent properties water could contain one or many of the thousands of inorganic and organic substances found in the environment. Physical and chemical analyses are carried out using arrange of gravimetric, volumetric and colorimetric or by using sensing electrodes and specialized instrumental methods.

* *Gravimetric analysis:-*

This form of analysis depends upon weighing solids obtained from the sample by evaporation, filtration or precipitation. Because of the small weights involved, a balance accurate to (0.0001 g) is required together with a drying oven to remove all moisture from the sample. Gravimetric analysis is thus not suited for field testing. Its main uses are for the measurement of:-

1- ***Total and volatile solids :*** a known volume of sample in pre weighed nickel dish is evaporated to dryness on a water bath , dried at 103̊ C (for waste waters) or 108̊ C (for potable waters) and weighed , the increase in weight is due to the total solids , the loss in weight on firing at 500̊ C represents the volatile solids .
2- ***Suspended solids (SS):*** a known volume of sample is filtered under vacuum through a pre weighed glass- fiber paper, with a pore size of 0.45 or 1.2 µm. total (SS) are given by the increases in weight after drying at 103̊ C and volatile (SS) (VSS) are those lost on firing at 500̊ C .
3- ***Sulphate:*** for concentrations above 10mg /L it possible to determine sulphate by precipitating barium sulphate after the addition of barium chloride, the precipitate is filtered out of the sample, dried and weighed.

* *Volumetric analysis:-*

Many determinations in water quality control can be carried out rapidly and accurately by volumetric analysis, a technique which depends on the measurement of volumes of liquid reagent of known strength. The requirements for volumetric analysis are relatively simple and are listed below:-

*** A pipette to transfer a known volume of the sample to a conical flask.**
*** A standard solution of the appropriate reagent.**
*** An indicator to show when the end point of the reaction has been reached. Various types of indicator are available e.g.: electrometric, acid-base, precipitation, adsorption and oxidation – reduction.**
*** A graduated burette for accurate measurement of the volume of standard solution necessary to reach the end point.**

An example of the use of volumetric analysis is found in the determination of alkalinity and acidity.

* *Colorimetric analysis:-*

when dealing with low concentrations , colorimetric analysis are often particularly appropriate and there are many determinations in water quality control which can be quickly and easily carried out by this form of analysis . To be of quantitative use a colorimetric method must be based on the formation of a completely soluble product with a stable colour. The coloured solution must conform to the following relationships.

1- ***Beer's law:*** light absorption increases exponentially with the concentration of the absorbing solution.

2- ***Lambert's law:*** light absorption increases exponentially with the length of the light path.

These laws apply to all homogeneous solutions and can be combined as:-

$$OD = \frac{I_0}{I} = a\ b\ c$$

Where:-

OD: optical density.

I_0:intensity of light entering sample.

I: intensity of light leaving sample.

a: constant characteristic of particular solution .

b: length of light path in solution .

c: concentration of absorbing substance in solution .

* *Visual methods:-*

1- *Comparison tubes (Nessler tubes):* a standard range of concentrations of the substance under analysis is prepared and the appropriate reagent added.

2- *Colour discs:* in this case the standards are in the form of a series of suitably coloured glass filters through which a standard depth of distilled water or sample with out colour forming reagents is viewed. The sample

in a similar tube is compared with the colour disc and the best visual match selected.

* *Instrumental methods:-*

1-*Absorptiometer or colorimeter:* this type of instrument comprises a glass sample cell through which a beam of light from a low – voltage lamp is passed. Light emerging from the sample is detected by a photo electric cell whose out put is displayed on a meter. The sensitivity is enhanced by inserting in the light path a colour filter complementary to the solution colour and the range of measurement can be extended by using sample cells of different length.

2- *Spectrophotometer:* this is more accurate type of instrument using the same basic principle as an absorptiometer but with a prism being employed to give monochromatic light of the desired wave length. The sensitivity is thus increased and on the more expensive instruments measurements can be under taken in the infrared and ultra violet regions as well as in the visible light wave bands.

With both types of instrument a blank of the sample with out the last colour forming reagent is used to set the zero optical density position.

* *Electrode technique:-*

The measurement of such parameters as PH and oxidation – reduction potential (ORP) by electrodes has been wide spread for many years and the technology of such electrodes is thus well established. PH is measured by the potential produced by a glass electrode – an electrode with a special sensitive glass area and an acid electrolyte. Wide range of PH electrodes is available, including combined glass and reference units and special rugged units for field use. ORP is measured using redox probe with a platinum electrode in conjunction with a calomel reference electrode.

Aquatic Microbiology and Ecology:-

A feature of most natural waters is that they contain a wide variety of microorganisms forming a balanced ecological system. The types and numbers of the various groups of microorganism's presents are related to water quality and other environmental factors. In the treatment of organic waste waters, microorganisms play an important role and most of the species found in water and waste water are harmless to humans. However, a number of microorganisms are responsible for a variety of disease and their presence in water creates a major health risk. It is there fore necessary to develop an under standing of the basic principles of microbiology and thus gain an appreciation of the role of microorganisms in water quality control. Because of their small size, observation of microorganisms with the naked eye is impossible and in the case of the simpler microorganisms their physical features do not provide positive identifications.

Ecological Principles:-

In all communities of living organisms the various forms of life are interdependent to a greater or lesser extent. This interdependence is essentially nutritional, described as atrophic relationship, and is exemplified by the cycle of organic productivity and the carbon and nitrogen cycles. A biological community and the environment in which it is found form an ecosystem and the science of such systems is known as *ecology*.

5/ Post test :-

Circle the correct answer:-

1- The collection uniform quality sample from source poses few:

a- problems b- pollutants

c- analysis d- all of them

2- In gravimetric analysis, a balance accurate reach to:

a- 0.001g b- 0.0001g

c- 0.00001g d- 0.01g

3- Potable water dried at:

a- 103^0C b- 104^0C

c- 108^0C d- 105^0C

4- Optical density applied in :

a- volumetric analysis b- visual methods

c- gravimetric analysis d- colorimetric analysis

5- Spectrophotometer more accurate than colorimeter by use:

a- prism b- photocell

c- monochromatic d- low voltage lamp

6- PH measured potential produced by:

a- electrode- an electrode b-special sensitive glass area

c- an acid electrolyte d- all of them

7-Beers & Lamberts laws apply to all:

a- solutions b- homogenous solution

c- heterogeneous solution d-true solution

8- Wide range of PH electrodes is available, including:

a- combined glass b- reference units

c- special rugged units d- all of them

9- The science that deals with ecosystem called:

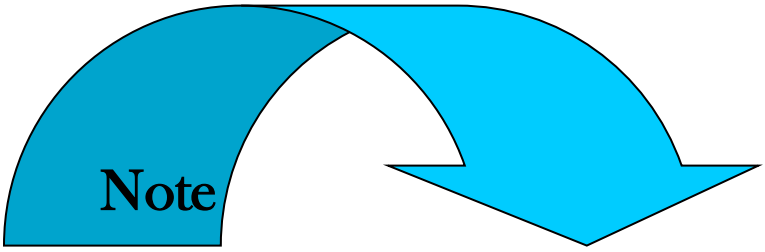
a- biology b- physiology

c- ecology d- cytology

10- In natural water organic matter oxidation by:

a- living and non living organisms b- living organisms

c- non living organisms d- microorganisms



- Check your answers in key answer page 14 .

- (1) degree for each .

6/ key answer :-

1- Pre test :-

1. **a**
2. **b**
3. **c**
4. **d**
5. **b**
6. **a**
7. **d**
8. **b**
9. **d**
10. **b**

If you :-

- got 9 or more you do not need to proceed .
- got less than 9 you have to study this modular unit well

2- Post test :-

1. **a**
2. **b**
3. **c**
4. **d**
5. **a**
6. **d**
7. **b**
8. **d**
9. **c**
10. **d**

If you :-

- got 9 or more , so congratulation your performance , go on studying modular unit three .
- got less than 9 , go back and study the second unit ; or any part of it ; again, and then do the post test again .

7/Sources :-

1- Chatterjee, A.K. (1994). Water supply, Waste disposal and environmental pollution engineering (including odour, noise and air pollution and its control). 5th ed. Khanna publishers. 2- B Nath Market, Nai sarak, Delhi.

2- David, L. R. (2006). Practical Waste Water Treatment. Global Environmental Operation, Inc. Lilburn, Georgia.

3- Gehm, HW, and Bregman, J.I., Handbook of Water Resources and Pollution Control, Van Nostrand- Reinhold, New York, 1976.

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5- Metcalf and Eddy, Inc., Wastewater Engineering, McGraw Hill, New York, 1972.

6- Parker, HW, and Bregman, J.I., Wastewater Systems Engineering, Prentice-Hall, Englewood Cliffs, 1975.

7- Tebbutt, T.H.Y. (1998). Principle of Water Quality Control.5th edition. British library cataloguing in publication data.

8- Winkler, M. Biological Treatment of Wastewater, Halsted Press, 1981.

Watr quality & health

Third modular unit

1/ Over view

1 / A –Target population :-

For students of third class
Technical collage
Department of environmental & pollution

1 / B –Rationale :-

Because of the essential role played by water in supporting human life it also has, if contaminated, great potential for transmitting a wide variety of diseases and illnesses. In the developed world water-related diseases are rare, due essentially to the presence of efficient water supply and waste water disposal systems.

1 / C –Central Idea :-

1 – Importance of water quality.
2 – Characteristics of diseases.
3- Types of diseases sources.

1 / D –Instructions:-

1. Study over view thoroughly.
2. Identify the goal of this modular unit.
3. Do the pre test and if you :-
    - Get 9 or more you do not need to proceed.
    - Get less than 9 you have to study this modular unit well.
4. After studying the text of this modular unit ,do the post test , and if you :-
    - Get 9 or more, so go on studying modular unit four.
    - Get less than 9, go back and study the third modular unit; or any part of it; again and then do the post test again.

2/ Performance Objectives

After studying the third modular unit, the student will be able to-

1. Recognize of water quality.
2. Determine of water diseases.
3. Determine the characteristics of water & control on it.
4. Show the types of sources diseases.

3/ Pre test:-

Circle the correct answer:-

1. **Water is play essential role in:-**

   a- supporting human life b- supporting chemical reaction

   c- dilution environmental pollution d- transported wide of diseases

2. **In the developing world peoples live with out safe water supply reach to:**

   a- 2 thousand million b- 1.3 thousand million

   c- 3.1 thousand million d- 2.3 thousand million

3. **WHO mean:**

   a- water hazard object b- water heat optimum

   c- world health organization d- world hazard object

4. **The main features of communicable diseases :**

   a- source of infection b- transmission rout

   c- exposure of susceptible living organism d- all of them

5. **Control of diseases is based on :**

   a- curing suffer b-breaking transmission rout

   c- protecting susceptible population d- all of them

6. **Endemic take place at:**

   a- low level of disease b- high level of disease

   c- mid level of disease d- all of them

7. Epidemic take place at:

a- low level of disease b- high level of disease

c- mid level of disease d- all of them

8. Water borne faecal- oral diseases classified as :

a- water born diseases b- water washed diseases

c- water based diseases d-water related insect vectors

9. Malaria is caused by:

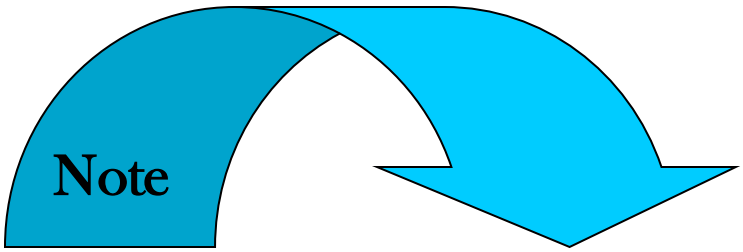
a- Amoebia b-Giardia

c- Tinea d- Mosquitoes

10- Bilharzias classified as:

a- water born diseases b- water washed diseases

c- water based diseases d-water related insect vectors



- Check your answers in key answer page 14.

- (1) degree for each .

4/ The text :-

Water quality and health:

Because of the essential role played by water in supporting human life it also has, if contaminated, great potential for transmitting a wide variety of diseases and illnesses. In the developed world water-related diseases are rare, due essentially to the presence of efficient water supply and waste water disposal systems. However, in the developing world perhaps as many as 1.3 thousand million people are without safe water supply and almost 2 thousand million do not have adequate sanitation. As a result, the toll of water – related disease in these areas is frightening in its extent. Millions of people die each year as the consequence of unsafe water or in adequate sanitation and although exact information is difficult to obtain, WHO data give an indication of the magnitude of the problem:

- **Each year over five million people die from water related diseases.**
- **Two million of the annual deaths are of children.**
- **In developing countries 80% of all illness is water- related.**
- **At any one time half of the population in developing will be suffering from one or more of the main water- related diseases.**
- **A quarter of children born in developing countries will have died before the age of five, the great majority from water-relater diseases.**

Characteristics of diseases:-

Before considering the water-related diseases it is useful to outline briefly the main features of communicable diseases. All diseases require for their spread a source of infection, a transmission rout, and the exposure of a susceptible living organism. Control of disease is thus based on curing suffer, breaking the transmission route and protecting the susceptible

population. Engineering measures in disease control are essentially concerned with breaking the transmission route,

And medical measures are concerned with the other two parts of the infection chain. When a disease is always present in a population at a low level of incidence it is termed endemic. When a disease has widely varying levels of incidence the peak levels are called epidemics and world wide out breaks are termed pandemic.

Water – related diseases:-

There are about two dozen infections diseases, shown in table (1), the incidence of which can be influenced by water. These diseases may be due to viruses, bacteria, protozoa or worms and although their control and detection is based in part on the nature of the causative agent it is often more helpful to consider the water – related aspects of the spread of infection.

No	Diseases	Type of water relationship	Estimated annual deaths
1	Cholera	Water borne	4 million
2	Giardiasis	Water borne	4 million
3	Infections-hepatitis	Water borne	4 million
4	Leptospirosis	Water borne	4 million
5	Paratyphoid	Water borne	4 million
6	Tularemia	Water borne	4 million
7	Typhoid	Water borne	4 million
8	Amoebic dysentery	Water borne or water washed	1 million
9	Bacillary dysentery	Water borne or water washed	1 million
10	Gastroenteritis	Water – washed	1 million
11	Ascariasis	Water – washed	Relative few deaths but large number of cases
12	Conjunctivitis	Water – washed	Relative few deaths but large number of cases
13	Diarrhea dis.	Water – washed	Relative few deaths but large number of cases

14	Leprosy	Water – washed	Relative few deaths but large number of cases
15	Scabies	Water – washed	Relative few deaths but large number of cases
16	Skin sepsis and ulcers	Water – washed	Relative few deaths but large number of cases
17	Tinea	Water – washed	Relative few deaths but large number of cases
18	Trachoma	Water – washed	Relative few deaths but large number of cases
19	Dracunculiasis	Water – based	200 thousand
20	Schistosomiasis	Water – based	200 thousand
21	Malaria	Water – relater insect vector	1 million
22	Onchocerciasis	Water – relater insect vector	1million
23	Sleeping sickness	Water – relater insect vector	1 million
24	Yellow fever	Water – relater insect vector	1 million

*Water borne diseases:

The commonest form of water – related disease and certainly that which causes most harm on a global scale includes those diseases spread by the contamination of water by human faeces or urine. With this type of disease, infection occurs as shown in figure (3), when the pathogenic organism gains access to water which is then consumed by a person who does not have immunity to the disease.

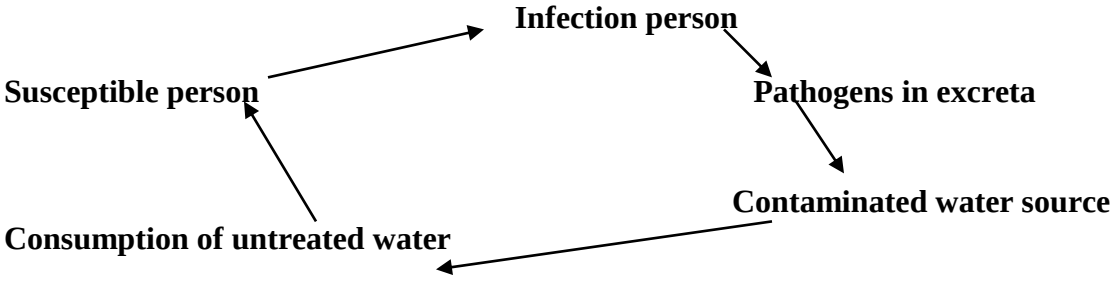


Fig (3): The classical water borne disease infection cycle.

*Water washed diseases:

In the case of poor hygiene, due to inadequate water supply for washing, the spread of infection may be reduced by providing additional water, the quality of which becomes a secondary consideration. Cleary, water borne faecal - oral diseases may be classified as water washed disease and many of the diarrhea infections in tropical climates behave as water washed rather than water – borne diseases. A second group of diseases can also be classified as water washed, these include a number of skin and eye infections which, whilst not normally fatal, have a serious debilitating effect on suffers. The diseases of this type include bacterial ulcers, and trachoma.

*Water based diseases:

A number of diseases depend upon the pathogenic organisms spending part of its life cycle in water or in an intermediate host which lives in water. Thus human infection cannot occur by immediate ingestion of, or contact with, the organism excreted by a suffer. Many of the diseases in this class are caused by worms which infect the sufferer and produce eggs which are discharged in faeces or urine. Infection often occurs by penetration of the skin rather than by consumption of the water.
Schistosomiasis (bilharzias) may be the most important example of this class of disease.

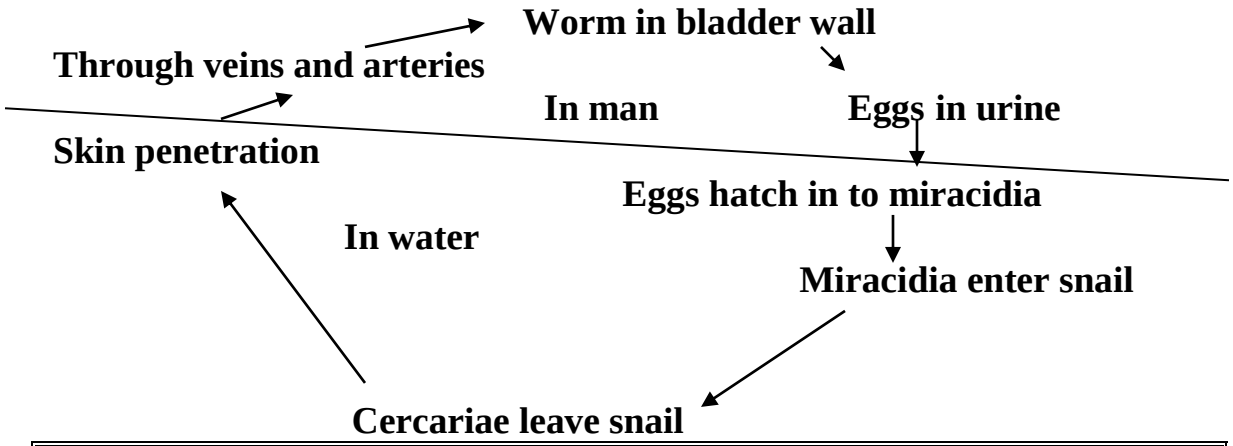


Fig (4): The infection cycle for schistosomiasis

*Water related insect vectors:

There are a number of diseases that are spread by insects which breed or feed near water so that their incidence can be related to the proximity of suitable water sources. Infection with these diseases is in no way connected with human consumption of, or contact with water. Mosquitoes, which transmit malaria and a number of other diseases.

5/ Post test :-

Circle the correct answer :-

1- Million of people die each year as the consequence of:

a- un safe water b- diseases

c- pollutants d- all of them

2- Two million of the annual deaths are of :

a- adults b-children

c- organisms d- microorganisms

3- Infection diseases in water reach to:

a- 30 infections b- 12 infections

c- 24 infections d- 18 infections

4- The common form of water- related diseases is:

a- acute scale b- parallel scale

c- diffusion scale d- global scale

5- Skin and eye infections classified as:

a- water washed diseases b- water born diseases

c- water insect victors d- water based diseases

6- Miracidia of bilharzias when leave snail convert to:

a- worm b- egg

c- cercariae d- all of them

7-Water related insect caused by insects which:

a- breed in water b- feed near water

c- part of life in water d-all of them

8- Cholera classified as:

a- water washed diseases b- water born diseases

c- water insect victors d- water based diseases

9- Water based infection occur when:

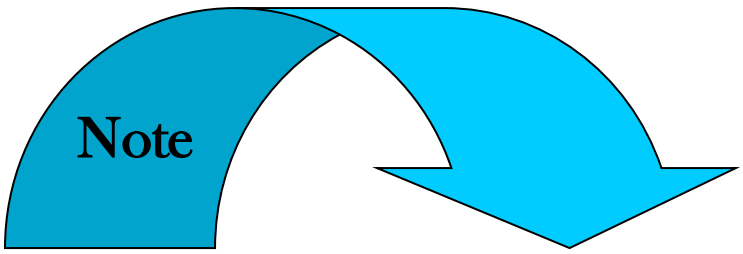
a- worm in water b- worm in blood

c- worm in bladder wall d- all of them

10- Bacterial ulcer and trachoma classified as:

a- water washed diseases b- water born diseases

c- water insect victors d- water based diseases



- Check your answers in key answer page 14.

- (1) degree for each.

6/ key answer :-

1- Pre test :-

1. **a**
2. **b**
3. **c**
4. **d**
5. **d**
6. **a**
7. **b**
8. **b**
9. **d**
10. **c**

If you :-

- got 9 or more you do not need to proceed .
- got less than 9 you have to study this modular unit well

2- Post test :-

1. **a**
2. **b**
3. **c**
4. **d**
5. **a**
6. **c**
7. **d**
8. **b**
9. **c**
10. **a**

If you :-

- got 9 or more , so congratulation your performance , go on studying modular unit four .
- got less than 9 , go back and study the third unit ; or any part of it ; again, and then do the post test again .

7/Sources :-

1- Chatterjee, A.K. (1994). Water supply, Waste disposal and environmental pollution engineering (including odour, noise and air pollution and its control). 5th ed. Khanna publishers. 2- B Nath Market, Nai sarak, Delhi.

2- David, L. R. (2006). Practical Waste Water Treatment. Global Environmental Operation, Inc. Lilburn, Georgia.

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8- Winkler, M. Biological Treatment of Wastewater, Halsted Press, 1981.

Biological oxidation of organic matter

Fourth modular unit

1/ Over view

1 / A –Target population :-

For students of third class
Technical collage
Department of environmental & pollution

1 / B –Rationale :-

Many of the problems associated with water quality control are due to the presence of organic matter from natural sources or from waste water discharges. This organic matter is normally stabilized biologically and the microorganisms involved utilize either aerobic or anaerobic oxidation systems.

1 / C –Central Idea :-

1 – Importance of water quality control.
2 – Types of oxidation.
3- Nature of organic matter in water quality control.
4- Biochemical reaction.
5- Nature of biological growth.

1 / D –Instructions:-

1. Study over view thoroughly.
2. Identify the goal of this modular unit.
3. Do the pre test and if you :-
    - Get 9 or more you do not need to proceed.
    - Get less than 9 you have to study this modular unit well.
4. After studying the text of this modular unit ,do the post test , and if you :-
    - Get 9 or more, so go on studying modular unit five.
    - Get less than 9, go back and study the fourth modular unit; or any part of it; again and then do the post test again.

2/ Performance Objectives

After studying the fifth modular unit, the student will be able to-

1. Stabilize organic matter in water.
2. Show the type of oxidation organic matter in water.
3. Determine the nature of organic matter in water quality control.
4. Determine the important requirements for biological growth.

3/ Pre test:-

Circle the correct answer:-

1. **The organic matter was normally stabilize by:-**

a- oxidation. b- microorganisms.

c- control on sources. d- all of them.

2. **In water quality control there are--------- main types of organic matter :-**

a- one only b- three

c- four d- five

3. **When microorganisms was broken food to release energy this called :**

a- catabolic b- anabolic

c- hydrolysis d- oxidation

4. **The biochemical reaction influenced by :**

a- temperature b- PH & inhibitors

c- substrate concentration d- all of them

5. **For successful biological growth requirements must be found like:**

a-sources of carbon & nitrogen b-energy sources

c- in organic ions d- all of them

6. **When microorganisms utilize energy to build new cells this called:**

a- catabolic b- anabolic

c- hydrolysis d- oxidation

7. **The measure of the sludge producing potential of a substrate this given by:**

a- biomass concentration b- substrate concentration

c- yield coefficient c- catalyses reaction

8. **The chemical formula of carbohydrates:**

a- CHONS b- CHONPS

c- CHO d-CH & little O

9. **Hydrolysis reaction is :**

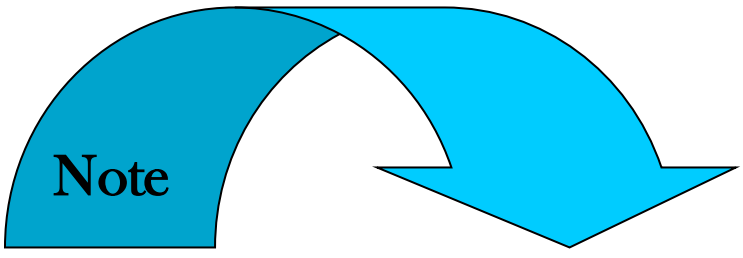
a- addition of water b- removal of water

c- kill the bacteria d- broken of organic matter

10-Microorganisms need energy for :

a- oxidation organic matter b- metabolic activities

c- build new cells d- all of them



- Check your answers in key answer page 12.

- (1) degree for each .

4/ The text :-

Biological oxidation of organic matter:-

Many of the problems associated with water quality control are due to the presence of organic matter from natural sources or from waste water discharges. This organic matter is normally stabilized biologically and the microorganisms involved utilize either aerobic or anaerobic oxidation systems.

Organic matter + Bacteria +O_2 → new cells
CO_2, NO_3, H_2O

Aerobic oxidation

Organic matter + Bacteria → new cells
Alcohols, acids, + Bact. → New cells
CH_4, H_2S, NH_3, CO_2, H_2O

An aerobic oxidation

Fig (5): Modes of biological oxidation.

Nature of organic matter:

There are three main types of organic matter in water quality control:

1- Carbohydrates, containing carbon, hydrogen and oxygen (CHO), typical examples are sugars; e.g glucose, starch, cellulose.

2- Nitrogenous compounds, containing carbon, hydrogen, oxygen, nitrogen and occasionally sulfur (CHONS), the main compounds in this group are proteins, amino acids and urea.

3- Lipids or fats, containing carbon, hydrogen and a little oxygen (CHO). They are only slightly soluble in water but soluble in organic solvents.

Biochemical reactions:

Microorganisms use organic substances as a food source by means of a series of complex reactions. These reactions may be catabolic, in which the food is broken down to release energy, or anabolic, in which energy is utilized by synthesize new microbial cells. A vital link in the biochemical transfer of energy involves the compound adenosine tri phosphate (ATP).

Biochemical reactions are controlled by enzymes which are organic catalysts, produced by living organisms, capable of speeding up the reactions without being consumed in the process. Enzymes are proteins of high molecular weights which are able to catalyses specific biochemical reactions. Their performance is influenced by such factors as temperature, PH, substrate concentration and the presence of inhibitors. There are many different types of enzyme, characterized by names ending in – ase (oxidase, dehydrogenase, etc.), and they are classified by reference to the reaction which they control.

Important enzyme – catalyses reactions in water quality control are:

- **Oxidation: addition of oxygen or removal of hydrogen.**
- **Reduction: addition of hydrogen or removal of oxygen.**
- **Hydrolysis: addition of water.**
- **De hydrolysis: removal of water.**
- **De amination: removal of NH_2 group.**

Reactions which occur mainly outside the microbial cell are catalyses by hydrolytic extra cellular enzymes located on the cell surface. Oxidation reactions occur when the substrate has been broken down by hydrolysis in to units which are able to pass through the cell wall to come under the influence of intra cellular enzymes.

Nature of biological growth:

For successful biological growth certain requirements must be satisfied:

1- **Sources of carbon and nitrogen: an empirical formula for a bacterial cell is $C_{60}H_{87}O_{23}N_{12}P$ and this has implications on the necessary composition of waste water if biological treatment is to be used.**

2- **Energy sources: microorganisms require energy for their metabolic activities and this energy must be made available by releasing the energy of formation bound up in chemical compounds when they were originally formed from their basic constituents.**

3- **In organic ions: many in organic ions, mainly metals such as, calcium, magnesium, potassium, iron, manganese, cobalt, etc. are essential to growth, although they are only required in minute amounts. Such ions are normally present in the water supply and also in sewage.**

4- **Growth factors: like other living organisms, microorganisms need growth factors such as vitamins; these are normally present at the required level in waste water.**

The absence of sufficient amounts of any of the above items can significantly influence the biological treat ability of waste water and in some cases it may be necessary to add the missing compound to the waste water.

It is useful to have some measure of the sludge producing potential of a substrate and this is given by the yield coefficient (Y).

$$Y = \frac{(X_t - X_0)}{(S_0 - S_t)}$$

Where;

S_0 and S_t represent substrate concentration at time 0 and t, respectively with X_0 and X_t being the biomass concentration at these times.

5/ Post test :-

Circle the correct answer :-

1- The best mode to stabilize organic matter is:

a- aerobic reaction b- an aerobic reaction

c- addition water d- addition ammonia group

2- The chemical formula to nitrogenous compound is:

a-CHO b- CHONS

c- CHONPS d- CH & Little O

3- Lipids or Fat soluble in :

a-water b- in organic solvents

c-organic solvents d- milk

4- Oxidation means:

a- addition of oxygen b- removal of hydrogen

c- removal of water d- choice a & b

5- Reaction which occur outside the microbial cell are catalyses by:

a- hydrolytic extra cellular enzymes b- temperature

c- intra cellular enzyme d- inhibitors

6- Yield coefficient depend on :

a- substrate concentrations b- biomass concentrations

c- times d- all of them

7- Oxidation of organic matter depend on :

a- oxygen b- bacteria

c- temperature d-all of them

8- A vital link in the biochemical transfer of energy involves the compound called:

a- ATP b- H_2O

c- NH_2 d- No_3

9- The chemical formula to carbon & nitrogen for a bacterial cell:

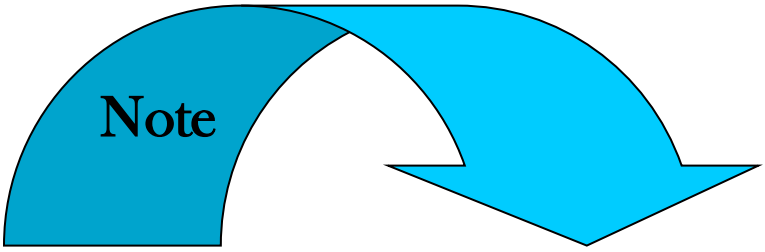
a-CHNOS b- $C_{60}H_{87}O_{23}N_{12}P$

c- CHO d- CH & little O

10- Growth factors to bacterial cell include:

a- in organic ions b- organic ions

c- vitamins d- salts



- Check your answers in key answer page 12.

- (1) degree for each .

6/ key answer :-

1- Pre test :-

1. **d**
2. **b**
3. **a**
4. **d**
5. **d**
6. **b**
7. **c**
8. **c**
9. **a**
10. **b**

If you :-

- got 9 or more you do not need to proceed .
- got less than 9 you have to study this modular unit well

2- Post test :-

1. **a**
2. **b**
3. **c**
4. **d**
5. **a**
6. **d**
7. **d**
8. **a**
9. **b**
10. **c**

If you :-

- got 9 or more , so congratulation your performance , go on studying modular unit five .
- got less than 9 , go back and study the fourth unit ; or any part of it ; again, and then do the post test again .

7/Sources :-

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Oxygen demand in aerobic oxidation

Fifth modular unit

1/ Over view

1 / A –Target population :-

For students of third class
Technical collage
Department of environmental & pollution

1 / B –Rationale :-

It is importance in water quality control that the amount of organic matter present in the system be known and that the quantity of oxygen required for its stabilization be determined.

1 / C –Central Idea :-

1 – Importance of determine demand of oxygen in aerobic oxidation.
2 – Demand and ultimate biological oxygen.
3- An aerobic oxidation.

1 / D –Instructions:-

1. Study over view thoroughly.
2. Identify the goal of this modular unit.
3. Do the pre test and if you :-
    - Get 9 or more you do not need to proceed.
    - Get less than 9 you have to study this modular unit well.
4. After studying the text of this modular unit ,do the post test , and if you :-
    - Get 9 or more, so go on studying modular unit six.
    - Get less than 9, go back and study the fifth modular unit; or any part of it; again and then do the post test again.

2/ Performance Objectives

After studying the sixth modular unit, the student will be able to-

1. Determine of demand and ultimate biological oxygen.
2. Calculate BOD & UOD.
3. Differentiated between aerobic and an aerobic oxidation.

3/ Pre test:-

Circle the correct answer:-

1. **The amount of oxygen required to stabilize a waste water depend on :-**

a- complete chemical analysis b- bacteria activity

c- temperature c- type of waste water

2. **UOD means :-**

a- ultra oxygen demand b- ultimate oxygen demand

c- utilize oxygen demand d- no any one

3. **The "k" in BOD law the :**

a- rate of degradable b- rate of oxygen consumed

c- rate of oxidation d- rate of stabilization

4. **With strong organic waste the best oxidation to degradable :**

a- aerobic oxidation b- aerobic & an aerobic oxidation

c- chemical oxidation d- an aerobic oxidation

5. **UOD calculate theoretically in:**

a- mg/ L b- ng/ L

c- kg/ L d- g/ L

6. **BOD depend on :**

a- amount of oxygen b- bacteria

c- organic matter concentration d- all of them

7. The rate of organic matter oxidation depend on:

a- amount of oxygen b- bacteria

c- organic matter concentration d- organic matter complex

8. The " L" in BOD law means:

a- conc. of organic matter remaining b- BOD remaining at time t

c- constant specific to organic matter d- conc. of organic matter

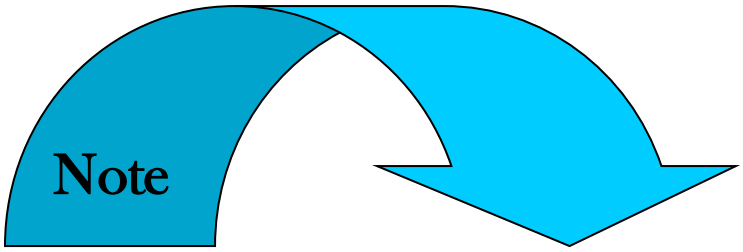
9. The suitable method of treatment organic matter with high efficiency:

a- an aerobic oxidation b- aerobic oxidation
c- chemical oxidation d- aerobic & an aerobic oxidation

10- The "L_t" in BOD law means :

a- conc. of organic matter remaining b- BOD remaining at time t

c- constant specific to organic matter d- conc. of organic matter



- Check your answers in key answer page 12.

- (1) degree for each .

4/ The text :-

Oxygen demand in aerobic oxidation:-

It is importance in water quality control that the amount of organic matter present in the system be known and that the quantity of oxygen required for its stabilization be determined. In the case of a simple compound like glucose it is possible to write down the equation for its complete oxidation:

$$C_6H_{12}O_6 + 6\ O_2 \longrightarrow 6\ CO_2 + 6\ H_2O$$

In the case of the more complex compound found in most samples, e.g. proteins, the reactions become more difficult to understand. In addition to the oxygen required to stabilize carbonaceous matter, there is also a considerable oxygen demand during the nitrification of nitrogen compounds.

$$2NH_3 + 3O_2 + \text{nitrifying bacteria} \longrightarrow 2NO_2 + 2\ H + 2H_2O$$
$$2NO_2 + O_2 + 2H + \text{nitrifying bacteria} \longrightarrow 2NO_3 + 2\ H$$

The amount of oxygen required to stabilize a waste completely could be calculated on the basis of a complete chemical analysis of the sample, but such a determination would be difficult and time consuming. Several methods of calculating the theoretical oxygen demand knowing various characteristics of the sample have been proposed,

Ultimate oxygen demand = 2.67* organic compound (mg/ L) + (UOD) mg/ L
4.57* [organic N + ammonia N (mg/L)] +1.14* nitrite N (mg/L)

The BOD test measures the oxygen consumed by bacteria whilst oxidizing organic matter under aerobic condition.
In the first order reaction the rate of oxidation is proportional to the concentration of oxide able organic matter remaining and once a suitable population of microorganisms has been formed the rate of reactions is controlled only by the amount of food available, i.e.:

$$\frac{dL}{dt} = -KL \quad \text{……. (1)}$$

L: concentration of organic matter remaining, or ultimate BOD
t: time, and K: constant specific to the particular organic substances or substance present.
Integrating (1),

$$\frac{L_t}{L} = e^{-Kt} \quad \text{……. (2)}$$

L_t: is the BOD remaining at time t, it is conventional to use $\log_{10}$ rather than $\log_e$ and this can be achieved by changing the constant,

$$\frac{L_t}{L} = 10^{-Kt} \quad \text{……. (3)}$$

The normal concern is with oxygen taken up, i.e. BOD, rather than with oxygen demand remaining, thus:

$$BOD_t = (L - L_t) = L\,(1 - 10^{-Kt}) \quad \text{……. (4)}$$

The value of K governs the rate of oxidation, and may be used to characterize the biological degradability of a substance. For domestic sewage, K is about (0.17/ day) at a temperature of 20° C. For another temperature T new values can be found from:

$$K_T = K_{20}\,(1.047)^{(T-20)} \quad \ldots\ldots\ldots (5)$$

$$L_T = L_{20}\,[1 + 0.02\,(T - 20)] \quad \ldots\ldots\ldots (6)$$

An aerobic oxidation:-

With certain strong organic waste, e.g. sludge, the oxygen requirement for aerobic stabilization is high and it becomes physically difficult to maintain aerobic conditions in the reaction vessel. In such circum stances anaerobic stabilization of the major part of the organic matter may be a suitable method of treatment in spite of its lower efficiency and slow rate of reaction.

The basic difference between aerobic and anaerobic oxidation

Is that in the aerobic system oxygen is the ultimate hydrogen acceptor with a large release of energy. In the anaerobic system the ultimate hydrogen acceptor may be nitrate, sulphate, or various organic compounds, resulting in a much lower release of energy. Complete stabilization of organic matter can not be achieved an aerobically, and it is normally necessary to treat the anaerobic plant effluent further by aerobic means if it is to be discharged directly to a receiving water.

5/ Post test :-

Circle the correct answer :-

1- UOD depend on:

a- organic compound b- organic nitrogen & ammonia

c- nitrite d- all of them

2- For domestic waste water the "k" value at 20^0 reach to:

a- 0.17/ day b- 0.19/ L

c- 0.2/ L d- 0.3/ L

3- In the aerobic system oxygen is the ultimate to :

a-nitrogen acceptor b- hydrogen acceptor

c-sulphate acceptor d- all of them

4- Energy in aerobic oxidation is:

a- low release b- medium release

c- large release d- no any one

5- Concentration of organic matter remaining means:

a- UOD b- BOD

c- BOD remaining d- ultimate BOD

6- The best time for oxidation in BOD law is :

a- one day b- three day

c- five day d- no any one

7-BOD depend on :

a- amount oxygen b- bacteria

c- organic matter concentration d-all of them

8- Sludge can degradable by:

a- anaerobic oxidation b- aerobic oxidation

c- chemical oxidation d- all of them

9- In the anaerobic system the ultimate hydrogen acceptor may be:

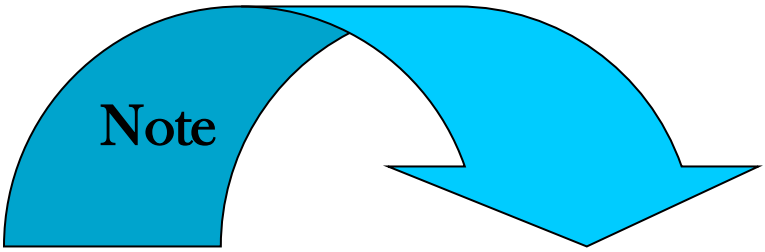
a- nitrate & sulphate b- oxygen

c- inorganic matter d- organic salts

10- With strong organic waste the best oxidation to degradable :

a- aerobic oxidation b- aerobic & an aerobic oxidation

c- chemical oxidation d- an aerobic oxidation



- Check your answers in key answer page 12.

- (1) degree for each .

6/ key answer :-

1- Pre test :-

1. **a**
2. **b**
3. **c**
4. **d**
5. **a**
6. **d**
7. **d**
8. **a**
9. **b**
10. **b**

If you :-

- got 9 or more you do not need to proceed .
- got less than 9 you have to study this modular unit well

2- Post test :-

1. **d**
2. **a**
3. **b**
4. **c**
5. **d**
6. **c**
7. **d**
8. **a**
9. **a**
10. **d**

If you :-

- got 9 or more , so congratulation your performance , go on studying modular unit six .
- got less than 9 , go back and study the fifth unit ; or any part of it ; again, and then do the post test again .

7/Sources :-

1- Chatterjee, A.K. (1994). Water supply, Waste disposal and environmental pollution engineering (including odour, noise and air pollution and its control). 5th ed. Khanna publishers. 2- B Nath Market, Nai sarak, Delhi.

2- David, L. R. (2006). Practical Waste Water Treatment. Global Environmental Operation, Inc. Lilburn, Georgia.

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5- Metcalf and Eddy, Inc., Wastewater Engineering, McGraw Hill, New York, 1972.

6- Parker, HW, and Bregman, J.I., Wastewater Systems Engineering, Prentice-Hall, Englewood Cliffs, 1975.

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8- Winkler, M. Biological Treatment of Wastewater, Halsted Press, 1981.


water pollution & its control


Sixth modular unit

1/ Over view

1 / A –Target population :-

For students of third class
Technical collage
Department of environmental & pollution

1 / B –Rationale :-

It is important to appreciate that all natural water contain a variety of contaminants from erosion, leaching and weathering processes. To this natural contamination is added that arising from domestic and industrial waste waters which may be disposed of in various ways, e.g. in to the sea, on to land, in to under ground strata or most commonly in to surface water.

Any body of water is capable of assimilating a certain amount of pollution with out serious effects because of the dilution and self-purification factors which are present. If additional pollution occurs the nature of the receiving water will be altered and its suitability for various uses may be impaired. An understanding of the effects of pollution and of the control measures which are available is thus of considerable importance to the efficient management of water resources.

1 / C –Central Idea :-

1 – Types of pollutant in water.
2 – Self- purification.
3- Over all effects of pollution.
4- River pollution.
5- Ground water pollution.
6- Pollution of tidal waters.
7- Control of water pollution.

1 / D –Instructions:-

1. Study over view thoroughly.
2. Identify the goal of this modular unit.
3. Do the pre test and if you :-
    - Get 9 or more you do not need to proceed.
    - Get less than 9 you have to study this modular unit well.
4. After studying the text of this modular unit ,do the post test , and if you :-
    - Get 9 or more, so go on studying modular unit seven.
    - Get less than 9, go back and study the sixth modular unit; or any part of it; again and then do the post test again.

2/ Performance Objectives

After studying the seventh modular unit, the student will be able to-

1. Determine types of pollutants in water.
2. Calculate down stream.
3. Define self- purification and processes associated with it.
4. Significant of river pollution.
5. Significant of Ground water pollution.
6. Significant tidal water pollution.
7. Determine way to control of water pollution.

3/ Pre test:-

Circle the correct answer:-

1. **Water pollution means :-**

a- change in environment conditions. b- Enter strange mater.

c- Change in water characteristics. d- all of them.

2. **Any body of water is capable of assimilating a certain amount of pollution with out effects because of :-**

a- self - purification b- dilution

c- choice a & b d- oxidation

3. **All natural water contain a variety of contaminants from**

a- erosion b- leaching

c- weathering d- all of them

4. **Contaminants behave in different ways when added to water include :**

a- non- conservative & conservative b- toxic pollutants

c-inert pollutants d- consume oxygen pollutants

5. **Thermal pollution in water effect on:**

a- water characteristics b- oxygen balance

c- life in water d- oxidation of organic matter

6. **Self- purification is a :**

a- dilution process b- chemical process

c- biological process d- physical process

7. Pollution by waste water effects on the creation of :

a- BOD b- DO

c- UOD d- OD

8. River pollution undesirable for :

a- water supplies b- fish life

c- creation of nuisances d- all of them

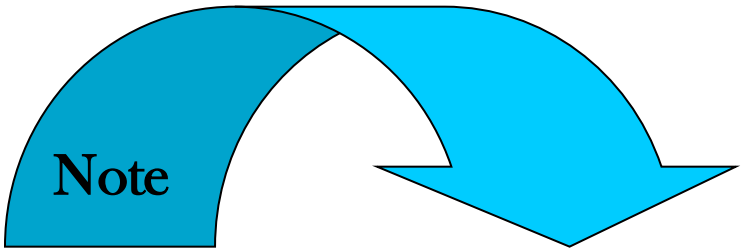
9. The ground water protection policy used identifies zones around ground water abstraction include :

a- inner zone b- outer zone
c- source catchments d- all of them

10- Tidal water is low in pollutants concentration because :

a- exist self- purification b- exist high dilution

c- exist oxidation process d- exist chemical reaction



- Check your answers in key answer page 16.

- (1) degree for each .

4/ The text :-

Water pollution and its control:-

It is important to appreciate that all natural water contain a variety of contaminants from erosion, leaching and weathering processes. To this natural contamination is added that arising from domestic and industrial waste waters which may be disposed of in various ways, e.g. in to the sea, on to land, in to under ground strata or most commonly in to surface water.

Any body of water is capable of assimilating a certain amount of pollution with out serious effects because of the dilution and self-purification factors which are present. If additional pollution occurs the nature of the receiving water will be altered and its suitability for various uses may be impaired. An understanding of the effects of pollution and of the control measures which are available is thus of considerable importance to the efficient management of water resources.

Types of pollutant:

Contaminants behave in different ways when added to water. Non – conservative materials including most organics, some in organics and many microorganisms are degraded by natural self – purification processes so that their concentrations reduce with time. The rate of decay of these materials is a function of the particular pollutant, the receiving water quality, temperature and other environmental factors.

Many inorganic substances are not affected by natural processes so that these conservative pollutants can only have their concentrations reduced by dilution.

The following constituents of pollutants are of importance:

1- Toxic compounds which result in the inhibition or destruction of biological activity in the water. Most of these materials originate from industrial discharges and would include heavy metals, herbicides and pesticides ….etc. some species of algae can release potent toxins and causes have been recorded where cattle have died after drinking water containing algal toxins.

2- Any thing which may affect the oxygen balance of the water, including:

a- Substances which consume oxygen: these may be organic materials which are biochemical oxidized or inorganic reducing agents.

b- Substances which hinder oxygen transfer across the air – water interface. Oils and detergents can form protective films at the interface which reduce the rate of oxygen transfer may thus amplify the effects of oxygen – consuming substances.

c- Thermal pollution, which can upset the oxygen balance because the saturation DO concentration reduces with increasing temperature.

3- Inert suspended or dissolved solids: in high concentrations can cause problems, e.g. clay. The discharge of saline mine drainage water may render a river un suitable for water – supply purposes.

It is obviously important to be able to assess the effect of a particular polluting discharge on receiving water in quantitative terms and a first step is to utilize a mass balance approach.

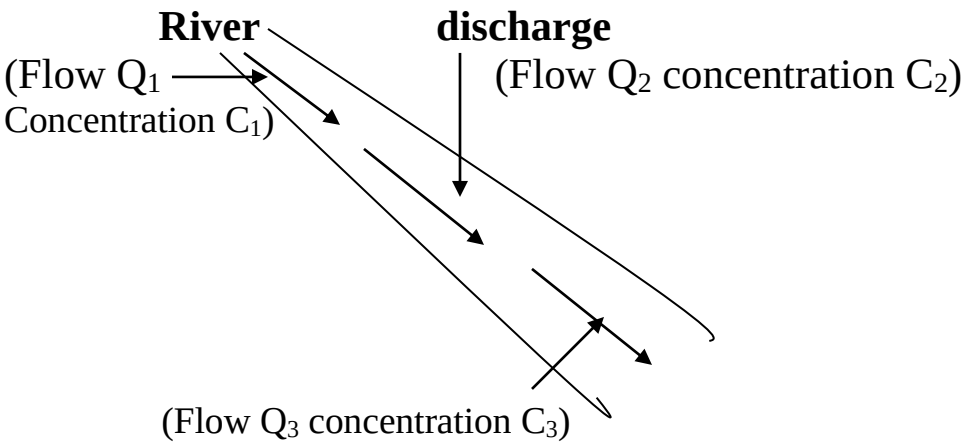


Fig (6): The main balance concept in river pollution.

And it's possible to determine the down stream concentration of the pollutant assuming instantaneous mixing with conservation of mass.

$$Q_1 * C_1 + Q_2 * C_2 = Q_3 * C_3$$

Since the sum of the flows arriving and leaving the discharge point must be equal (i.e. $Q_3 = Q_1 + Q_2$) the down stream concentration C_3 is easily calculated.

Self - purification:-

In natural water, self – purification exists in the form of a biological cycle, which is able to adjust itself, within limits, to changes in the environmental conditions. In a low organic content stream there is little nutrient material to support life so that although many different types of organisms may be present, there are only relatively low numbers of each type.

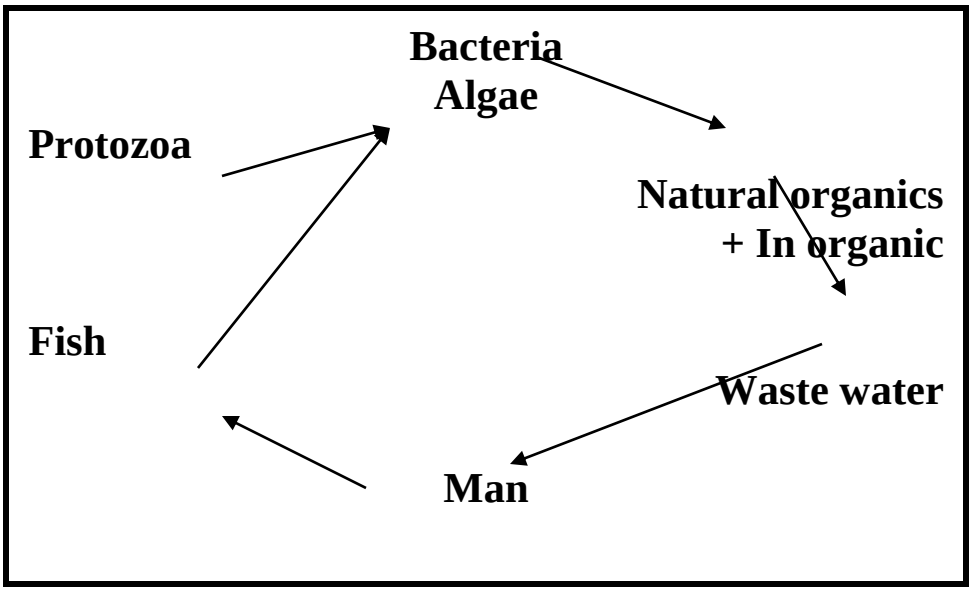


Fig (7): the self – purification cycle.

Self – purification involves one or more of the following processes:

1- **Sedimentation, possibly assisted by biological or mechanical flocculation.**
2- **Chemical oxidation of reducing agents such as sulphides.**
3- **Bacterial decay due to the generally in hospital environment for enteric and pathogenic bacteria in natural waters.**
4- **Biochemical oxidation which is normally by far most important process.**

Overall effects of pollution:-

When considering pollution by waste water there are of course effects other than the creation of DO deficits, depending on the dilution available there may be significant increases in dissolved solids, organic content, nutrients such as nitrogen and phosphorus, colour and turbidity. All of these constituents may give rise to undesirable change in water quality particularly as regards down stream abstraction.

In an industrialized country it becomes economically impossible to prevent all river pollution and it is necessary to take an overall view of water resources and to classify rivers as suitable for particular purposes.

River pollution is clearly undesirable for many resources:

1- Contamination of water supplies – additional load on treatment plants.
2- Restriction of recreational use.
3- Effect on fish life.
4- Creation of nuisances – appearance and odour.
5- Hindrance to navigation by banks of deposited solids.

A typical water use classification might thus be (in decreasing order of quality requirements):

1- Domestic water supply.
2- Industrial water supply.
3- Commercial fishing.
4- Irrigation.
5- Recreation and amenity.
6- Transportation.
7- Waste disposal.

Ground water pollution:-

The straining action of soil and rocks as water percolates through them is normally sufficient to remove suspended impurities from contaminated infiltration flows. It should be noted, that excessive suspended solids can accumulate in the pores and thus eventually block the aquifer, preventing further recharge. Soluble impurities may be removed by the ion – exchange properties of some soils and rocks, but this is by no means the case with all contaminants.

A major problem in some area is the presence of high nitrate levels in ground water due to increased drainage and heavy fertilizer

applications which tend to occur as the result of intensive farming practices.

The ground water protection policy used identifies zones around a ground water abstraction:

1- **Zone I (inner source protection) immediately adjacent to the ground water abstraction and defined as area within a 50 day travel time of the abstraction.**
2- **Zone II (outer source protection) area within 400 day travel time of the abstraction.**
3- **Zone III (source catchments) complete catchments of the source.**

Pollution of tidal waters:-

For many years communities with access tidal waters have utilized such waters as a convenient disposal facility. The potential for dilution and dispersion of pollution in the open sea is considerable and there is a large self – purification capacity. This is does not mean that the seas can be considered as an infinite sink for the disposal of un wanted materials nor does it mean that all tidal waters are suitable for sewage discharges. The upper reaches of a tidal estuary are likely to have pollution assimilating characteristics similar to those of the non – tidal reaches of the river.

Control of pollution:-

Because of the need to reconcile the various demands on the aquatic environment and on water resources most countries have pollution control bodies to maintain and hopefully improve water quality.
The discharge by man of substances in to the aquatic environment the results of which are such as to cause hazards to human health, harm

to living resources and aquatic ecosystems, damage to amenities or interfere with other legitimate uses of water.

The control of pollution can be achieved by:

1- **Water quality management.**
2- **Water quality classifications.**
3- **Discharge consents.**

5/ Post test :-

Circle the correct answer :-

1- Most commonly waste water from domestic or industrial waste disposed of in :

a- surface water b- sea

c- land d- under ground strata

2- Non- conservative pollutants are degraded by:

a- dilution process b- self- purification

c- chemical oxidation d- all of them

3- There are substance hinder oxygen transfer across the air-water interface like :

a- oils b- detergents

c- choice a & b d- reducing agents

4- High concentrations of inert suspended can cause problems in water for example:

a- organic matter b- inorganic matter

c- toxic mater d- clay

5- Self- purification involves processes include:

a- sedimentation b- chemical oxidation

c- bacterial decay d- all of them

6- Conservative pollutants reduced by:

a- dilution b- self- purification

c- chemical oxidation d- all of them

7-DO deficits depending on dilution which increase in :

a- dissolve solids b- organic contents & colour

c- nutrients & turbidity d- all of them

8- The outer source protection need---------- day travel time of the abstraction :

a- 50 b- 400

c- 150 d- 300

9- A major problem in ground water pollution is the presence of high:

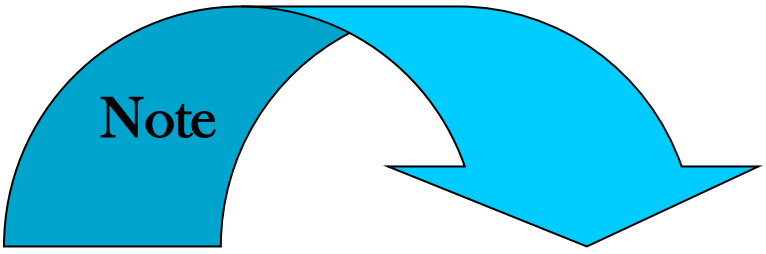
a- sulphate levels b- phosphor levels

c- nitrate levels d- ammonia levels

10- The control of water pollution can be achieved by:

a- water quality managements b- water quality classification

c- discharge consents d- all of them



- Check your answers in key answer page 16.

- (1) degree for each .

6/ key answer :-

1- Pre test :-

1. **d**
2. **c**
3. **d**
4. **a**
5. **b**
6. **c**
7. **b**
8. **d**
9. **d**
10. **a**

If you :-

- got 9 or more you do not need to proceed .
- got less than 9 you have to study this modular unit well

2- Post test :-

1. **a**
2. **b**
3. **c**
4. **d**
5. **d**
6. **a**
7. **d**
8. **b**
9. **c**
10. **d**

If you :-

- got 9 or more , so congratulation your performance , go on studying modular unit seven .
- got less than 9 , go back and study the sixth unit ; or any part of it ; again, and then do the post test again .

7/Sources :-

1- Chatterjee, A.K. (1994). Water supply, Waste disposal and environmental pollution engineering (including odour, noise and air pollution and its control). 5th ed. Khanna publishers. 2- B Nath Market, Nai sarak, Delhi.

2- David, L. R. (2006). Practical Waste Water Treatment. Global Environmental Operation, Inc. Lilburn, Georgia.

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8- Winkler, M. Biological Treatment of Wastewater, Halsted Press, 1981.

Introduction to treatment process

Seventh modular unit

1/ Over view

1 / A –Target population :-

For students of third class
Technical collage
Department of environmental & pollution

1 / B –Rationale :-

It will be apparent from previous modular units that waters and waste waters often highly complex compositions and those modifications to the composition are usually necessary to suit a particular use or to prevent environmental degradation. It follows that a variety of treatment processes will be necessary to deal with the range of contaminants likely to be encountered.

1 / C –Central Idea:-

1 – Types of pollutant in water.
2 – Methods of treatment water pollution.
3- Application of the main treatment processes.
4- The main treatment processes required to produce potable water from various sources.
5- Optimized design.
6- Control and operation.

1 / D –Instructions:-

1. Study over view thoroughly.
2. Identify the goal of this modular unit.
3. Do the pre test and if you :-
    - Get 9 or more you do not need to proceed.
    - Get less than 9 you have to study this modular unit well.
4. After studying the text of this modular unit ,do the post test , and if you :-
    - Get 9 or more, so go on next stage.
    - Get less than 9, go back and study the seventh modular unit; or any part of it; again and then do the post test again.

2/ Performance Objectives

After studying the eighth modular unit, the student will be able to-

1. Determine types of pollutants in water.
2. Explain methods of treatment water.
3. Determine size of pollutants particles.
4. Significant of potable water.
5. Design optical treatment plant.
6. Determine way to control and operation of water treatment plants.

3/ Pre test:-

Circle the correct answer:-

1. **The variety of treatment processes will be necessary to deal with:-**

a- change in environment conditions. b- range of contaminants.

c- highly complex compositions. d- all of them.

2. **Contaminants may be present as :-**

a- floating or large suspended b- dissolve solids & gases

c- small suspended & colloidal solids d- all of them

3. **The main classes of treatment process include:**

a- physical process b- chemical process

c- biological process d- all of them

4. **The particles that have 10^2µm named:**

a- suspended & floating solids b- colloidal solids

c- true solution d- all of them

5. **The probable combination of the main treatment processes required to produce :**

a- clean water b-disinfect water

c- potable water d- natural water

6. **To deep ground water the probable treatment is :**

a- disinfection b- screening

c- filtration d- straining

7. The basic options for a process plant operation & control include:

a- completely manual b- manual operation & automated control

c- fully automated d- all of them

8. Feed back control uses measurement in the :

a- in put b- out put

c- choice a & b d-no any one

9. When the correction signal is proportional to the error that is called:

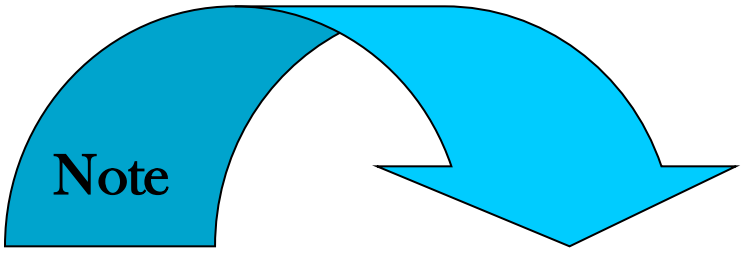
a- integral option b- derivative option

c- proportional option d- all of them

10- Biological oxidation process can treatment :

a- true solution b- colloidal solids

c-suspended & floating solids d- all of them



- Check your answers in key answer page13.

- (1) degree for each .

4/ The text :-

Introduction to treatment processes:-

It will be apparent from previous lectures that waters and waste waters often highly complex compositions and those modifications to the composition are usually necessary to suit a particular use or to prevent environmental degradation. It follows that a variety of treatment processes will be necessary to deal with the range of contaminants likely to be encountered.

Contaminants may be present as:

*** Floating or large suspended solids: in water – branches; in waste water – paper.**
***Small suspended and colloidal solids: in water – clay; in waste water – large organic molecules and microorganisms.**
*** Dissolved solids: in water – alkalinity; in waste water – organic compound, inorganic salts.**
*** Dissolved gases: in water – carbon dioxide; in waste water – hydrogen sulphides.**

Methods of treatment:

There are three main classes of treatment process:

1- Physical processes: which depend essentially on physical properties of the impurity, e.g. particle size, specific gravity, viscosity… etc. typical example of this type of process are screening, sedimentation, filtration, gas transfer.

2- Chemical processes: which depend on the chemical properties of an impurity or which utilize the chemical properties of added reagents, e.g. coagulation, precipitation, ion exchange.
2- Biological processes: which utilize biochemical reactions to remove soluble or colloidal impurities, usually organics.

Aerobic biological processes include biological filtration and activated sludge. An aerobic oxidation processes are used for the stabilization of organic sludge and high strength organic wastes.
Atypical operational ranges of which are shown in fig (8):

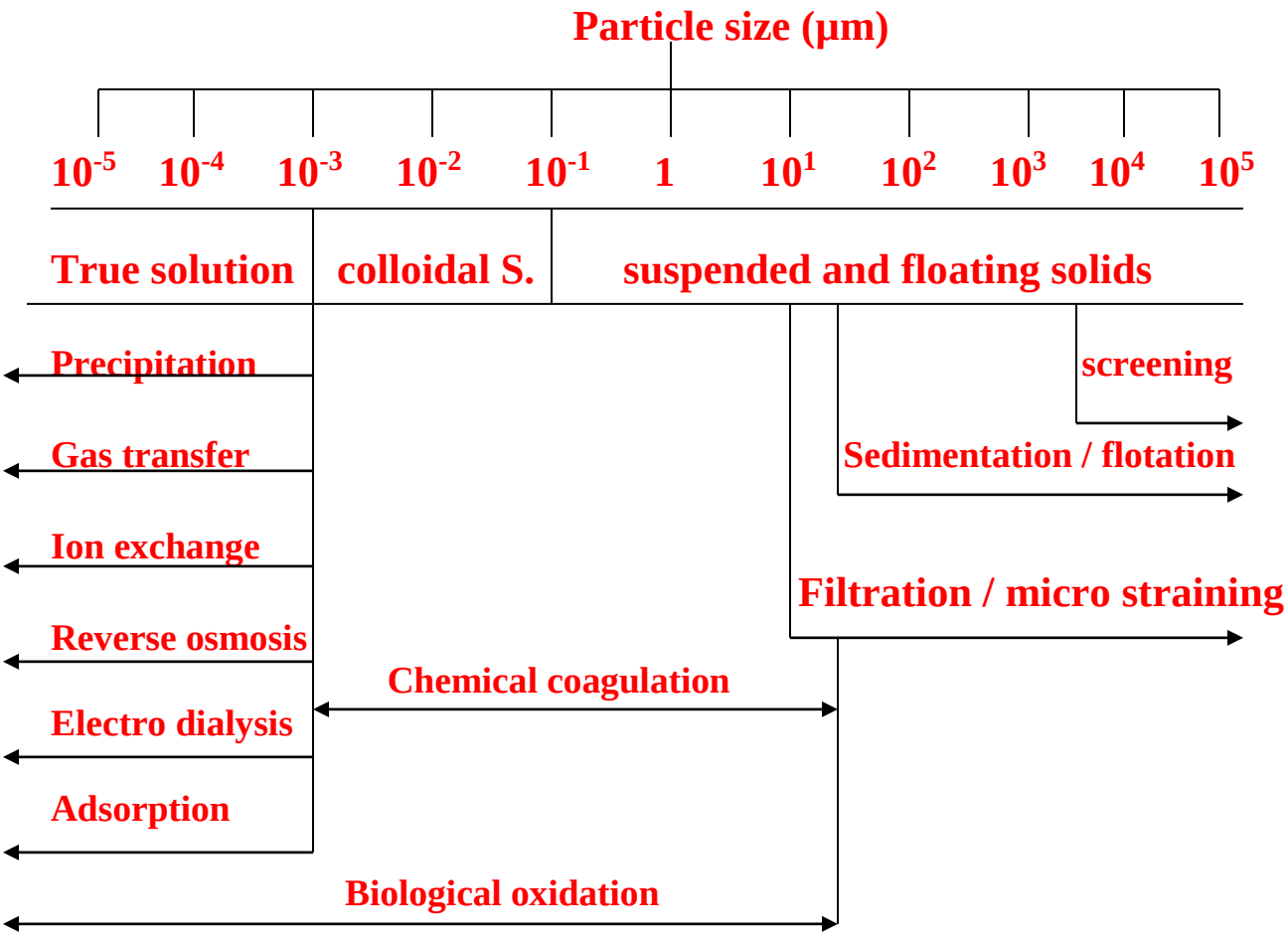


Fig (8): Application of the main treatment processes.

The probable combination of the main treatment processes required to produce potable water from various sources is given in table (2):

No	Source	Probable treatment	Possible addition
1	Up land catchments	• screening or micro straining, disinfection.	Sand filtration stabilization, Colour removal.
2	Low land river	• screening or micro straining, coagulation, rapid filtration, disinfection • screening or micro straining, rapid filtration, Slow filtration, disinfection.	Storage, softening stabilization, adsorption desalination, Nitrate removal.
3	Deep ground water	• Disinfection.	Softening, stabilization, Iron removal, nitrate removal.

Optimized design:

As outlined above, treatment plants usually consist of a number of unit's processes or operations in combination, this shown in figures (9) and (10):

Control and operation:

Water and waste water treatment plants involve a number of inter-related processes and operations which can be carried out manually but which are increasingly being under taken by automatic control systems. There are three basic options for a process plant, described below:

1- **Completely manual operation and control: in which all decisions and adjustments are under taken by human operatives.**
2- **Manual operation with automated control: in which decisions are made by human operatives who manually initiate the operation of valves and other controls from a central location.**
3- **Fully automated operation and control: in which all normal decisions are made and acted upon by local or central programmed logic controllers integrated into an intelligent system.**

5/ Post test :-

Circle the correct answer :-

1- Water highly compositions to suit the :

a- particular use b- prevent environmental degradation

c- variety of treatment process d- all of them

2- Suspended solids contaminants in water include :

a-branches b- paper

c- clay d- large organic molecules

3- Typical example of physical treatment include:

a-ion exchange b- gas transfer

c-precipitation d- coagulation

4- Biological process to treatment water include:

a- aerobic oxidation b- anaerobic oxidation

c- choice a & b d- filtration

5- The particles that have 10^{-2} in size named :

a- true solution b- colloidal

c- suspended d- floating

6- Reverse osmosis process use to treat:

a- true solution b- colloidal

c- suspended d- floating

7- The probable treatment to low land river :

a- disinfection b- screening

c- straining d- all of them

8- Filtration is used for treatment :

a- true solution b- colloidal

c- suspended d- dissolve gas

9- With feed back control the options are available:

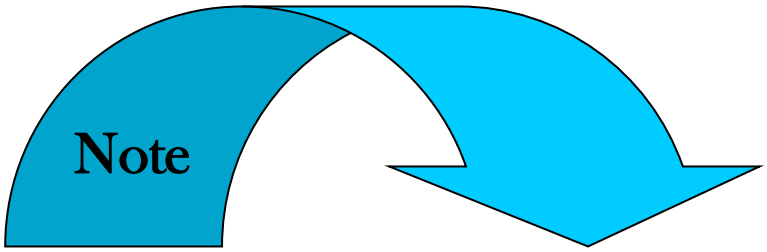
a- proportional b- integral

c- derivative d- all of them

10- When the correction signal is proportional to the rate of change of the error this called :

a- derivative b- integral

c- proportional d- all of them



- Check your answers in key answer page 13.

- (1) degree for each .

6/ key answer :-

1- Pre test :-

1. **b**
2. **d**
3. **d**
4. **a**
5. **c**
6. **a**
7. **d**
8. **b**
9. **c**
10. **d**

If you :-

- got 9 or more you do not need to proceed .
- got less than 9 you have to study this modular unit well

2- Post test :-

1. **d**
2. **a**
3. **b**
4. **c**
5. **b**
6. **a**
7. **d**
8. **c**
9. **d**
10. **a**

If you :-

- got 9 or more , so congratulation your performance , go on studying next stage .
- got less than 9 , go back and study the seventh unit ; or any part of it ; again, and then do the post test again .

7/Sources :-

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