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Q(a) Define ceramic and nano-ceramic materials. Why the nano-ceramics show better properties than their ceramic counterparts? Write the applications of ceramic materials? (5marks)

CERAMIC:

The term 'ceramic' is a greek word meaning 'pottery'. However, pottery is just one part of the ceramic world. In fact, ceramic is an inorganic non-metallic solid made up of clay that have been shaped and then hardened by heating them to high temperatures. They are hard, brittle and resistant to corrosion and heat.

For Example:

- Tiles
- Bricks
- Watches
- Toilets
- Plates
- Glass, etc.

NANO - CERAMICS:

Nano-ceramics are ultrafine particles composed of ceramics with particles size less than 100 nm. Physically, they are harder and more rigid than macro-ceramics and have comparatively high

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heat resistance.

For Example:

- Silica (SiO_2)
- Titania (TiO_2)
- Alumina (Al_2O_3)
- Zinc oxide (ZnO)
- Iron Oxide (Fe_3O_4, Fe_2O_3)

Why the nano-ceramics show ↑ (better) properties than their ceramic counterparts?

In the modern era, nano-ceramics play a significant role in society and show better properties like low cost, improved mechanical properties, thermal stability and fire resistance, strength like steel, and substantial resistance against compression and bending than their ceramic counterparts due to exceptionally grounded small particle size that gives them a non-porous structure and a high surface area.

Applications of Ceramic Materials:

Ceramics material display a wide range of applications.

Aerospace:

Ceramics are used in parts of space shuttle, rockets and space stations.

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Consumer Usage:

Ceramics have great usage in our homes like glassware, pottery, dineware and home electronics.

Medical (Bio-ceramics):

Ceramics are used in medical fields especially in dental and bone fillings and bone implants.

Military Equipment:

Structural components in ground, naval and air vehicles of military are made from ceramics.

Building and Construction:

Ceramics are used by manufacturers to make bricks, tiles, piping and other construction materials.

Q: Write two applications of each of the following electromagnetic radiations: (5 marks)

1) Ultraviolet
2) Infra-red
3) Microwaves
4) Radiowaves
5) X-rays

ELECTROMAGNETIC RADIATIONS:

Electromagnetic radiations are transverse waves in which the electric and

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magnetic fields are perpendicular to each other and to the direction of propagation of the wave.

Depending upon the frequency of oscillation, different wavelengths of the electromagnetic spectrum, from gamma rays to radio waves, are produced.

Application of Different Electromagnetic Waves:

1: Ultraviolet Radiations:

1: Ultraviolet radiations are used in energy-efficient lights, in which flourescent substances absorb UV light produced inside the lamp and re-emit the energy as visible light.

2: UV radiations are also used on: bank notes to detect forgeries and allow investigators and forensic researchers to examine clues and recover evidence.

2: Infrared:

1: In homes, infra-red radiation is used by electric heaters, cookers for cooking food, remote controls, optical fibers, security systems and thermal imaging security cameras that detect people in dark.

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2: In medicine, infra-red radiations can promote local blood circulation and reduce muscle tensions.

3: Microwaves:

1: The operation and working of Global Positioning Systems (GPS), WiFi and Bluetooth are based on microwaves.

2: One of the major applications of microwaves in home is in the kitchen, i.e. the microwave oven.

4: Radio waves:

1: Radio waves are used by cellular mobile phones to transmit voice communication.

2: Radio waves, with their longest wavelength, are used to transmit data from radios, televisions, satellites, and RADAR.

5: X-rays:

1: In medicine, X-rays are used in the diagnosis of fractures of bones, foreign bodies like bullets and stones in the body, and dental pathologies.

2: In industry, X-rays are used to test homogenity of welded joints and to detect the structural defects of parts of machinery.

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Q: What is wildfire? Explain its types, causes, spread and preventions. (5 marks)

WILDFIRE:

Wildfire is an uncontrolled fire that burns in a natural area of combustible vegetation, such as grasslands and forests and wipes out large fields and areas of land.

Example:

The recent fires in Los Angeles, Southern California is an example of wild fires which caused a huge destruction.

Types of Wildfires:

There are three types of wildfires.

1: Ground fires:

Ground fires burn mostly in decayed roots below the ground and in the duff layer. The duff layer is made up of compacted, dead plant materials such as leaves, bark, needles and twigs. Ground fires are sustained by glowing combustion (without flames) and can go undetected for a long time because they produce little to no smoke and spread slowly.

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2: Surface Fires:

Surface fires occur within the lower level of the forest and burns loose needles, harbaceous vegetation, lichens, shrubs, and small trees that are at or near the surface of the ground. Surface fires are common; however, their intensity is low.

3: Crown Fires:

Crown fires is a fast-moving fire involving burning in the upper canopy of vegetation, which includes live and dead branches, lichens in trees, and tall shrubs that lie well above the surface. Since, the influence of wind is greater in the canopy, and the canopy is composed of interconnected vegetation, these fires can spread quickly.

Causes of Wildfire:

1: Natural Causes of Wildfire:

- Lightening
- Heat waves
- Volcanic Lava

2: Anthropogenic Causes of Wildfire:

- Smoking
- Fireworks
- Industrial activity
- Arson

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Spread of Wildfire:

According to the National Interagency Coordination Center (NICC) Wildland fire Annual Report for 2022, "68,988 wildfires were reported in 2022 that have consumed 7,577,183 acres, compared to 58,985 wildfires in 2021 having consumed 7,125,643 acres.

Wild fires spread in intensity to scorch the forest canopy depends on:

1: The amount of fuel
2: Fuel moisture content
3: Wind speed
4: The height from the base of trees.
5: The density of tree crowns

Ways to Prevent Wildfire:

1: Used matches: while smoking must be discarded in a closed container or cup of water.
2: Yard waste or rubbish must be burned in a 50-gallon drum or fire pit only if allowed by the relevant municipality.
3: Any hot car or another machine must not be parked in dry grass.
4: Burning fires, if necessary to be kept burning, must never be left unattended.

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Q: What are pesticides? Classify pesticides with examples. How do they enhance the water pollution? (10 marks)

PESTICIDES:

A pesticide is any substance or mixture of substances intended for destroying, preventing, repelling or mitigating any pest.

Pest:

Pest can be defined as any organism that causes economic losses to mankind. These includes insects, weeds, rodents and worms etc.

CLASSIFICATION OF PESTICIDES:

Pesticide Classification Based on Pest Target:

This is also called Agronomic classification.

1: Fungicides: They kill fungi including blights, mildews, moulds and rusts.

2: Fumigants: These produce gas or vapours intended to kill pests in buildings or soil.

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3: Herbicides: They kill weeds and other plants that grow where they are not wanted.

4: Insecticides: These kill insects and other arthropods.

5: Molluscicides: These kill snails and slugs.

6: Miticides: These kill mites that feed on plants and animals.

7: Repellents: These repell pests, including insects such as mosquitoes.

8: Nematicides: These kill nematodes (micro-scopic, warm-like organisms that feed on plant roots).

9: Rodenticides: These control mice and other rodents.

10: Aracnicides: These control spiders.

Insecticide Classification Based on Chemical Nature:

1: Organic Pesticides:

They are based on chemicals having carbon as the basis of their molecular structure.

They can be subdivided into two additional groups:

(i) Natural Organics:

They are derived from plants for Example: Rotenone

Insecticide

- Organic Pesticides
  - natural organic (Roterone)
  - synthetic organics (DDT, glyphosphate)
- Inorganic Pesticides (CuSO4, sulphur)

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(ii) Synthetic organics:

They are produced artificially by chemical synthesis.

for Example: DDT and glyphosphate.

2: Inorganic Pesticides:

They are simpler compounds, having a crystalline, salt-like appearance.

Example: Copper sulphate, ferrous sulphate and sulphur.

Pesticide Classification Based on Mode of Entery:

1: Stomach Poison: insecticide enters the body through mouth of the pest and acts in the stomach.

2: Contact Poison: insecticide enters the body through the integument into the blood and into the respiratory system through the spiracles.

3: Fumigant Poison: these are volatile poisons that enter the body through the respiratory system.

ROLE OF PESTICIDE IN ENHANCING WATER POLLUTION:

Runoff and Contamination:

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1: Agricultural runoff: Pesticides applied to crops can wash into nearby water bodies through rainfall or irrigation.

2: Contamination of water resources: Pesticides can leach into groundwater or flow into surface water, polluting drinking water sources.

Environmental Impact:

1: Harm to aquatic life: Pesticides can accumulate in aquatic organisms, affecting their health and reproduction.

2: Disruption of Ecosystems: Pesticides can alter the balance of aquatic ecosystems, leading to changes in species compositions.

Human Health Concerns:

1: Water-borne diseases: Exposure to pesticide-contaminated water can increase the risk of various health problems.

2: Long-term health effects: Chronic exposure to pesticides in water has been linked to various issues ranging from short-term impacts such as headaches and nausea to chronic impacts like cancer, reproductive problems and endocrine disruption.