Q2.

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

Ceramics:

A ceramic is a material which is neither organic nor (crystalline) metallic. It may be crystalline or glassy or both crystalline and glassy. They are typically hard and chemically non-reactive and can be formed or densified with heat. They are known for their brittle and hard nature, excellent heat resistance, electrical heat insulation and corrosive resistance.

Nano-Ceramics:

Nano-ceramic materials refers to ceramics that have been engineered at the nanoscale, typically with pasticles ranging from 1 to 100 nanometers. This reduction in pastricle size provides unique properties such as improved mechanical strength, increased surface area, enhanced optical properties and better thermal and electrical conductivity.

Example of Ceramics:

A classic example of Ceramics is Porcelain, which is made from clay at high temperature to create a hard durable and heat-resistant material.

Example of Nano-Ceramics:

One of the examples of nano-ceramics is: nano-structured "Alumina", which is a ceramic compound primarily made of "Aluminium Oxide". When processed at nano-scale, it exhibits enhanced properties like increased hardness and improved thermal and electrical conductivity.

Unveiling Nano-scale Advantages: Why NanoCeramics Outperform Their Ceramics Counterpart

Nano ceramics offer better properties than their ceramic counterparts due to following properties.

i- Reduced Grain Size:

Smaller grain size results in higher density of grain boundaries which enhances mechanical properties like hardness, toughness and strength.

ii- Superior Thermal and Electrical Conductivity:

Some nano-ceramics possess enhanced thermal and electrical conductivity compared to bulk ceramics. This makes them suitable for applications requiring heat transfer or thermal conduction.

iii. Improved Optical Properties:

Nano-ceramics possess better optical properties such as increased transparency or ability to emit light of specific wavelengths of light.

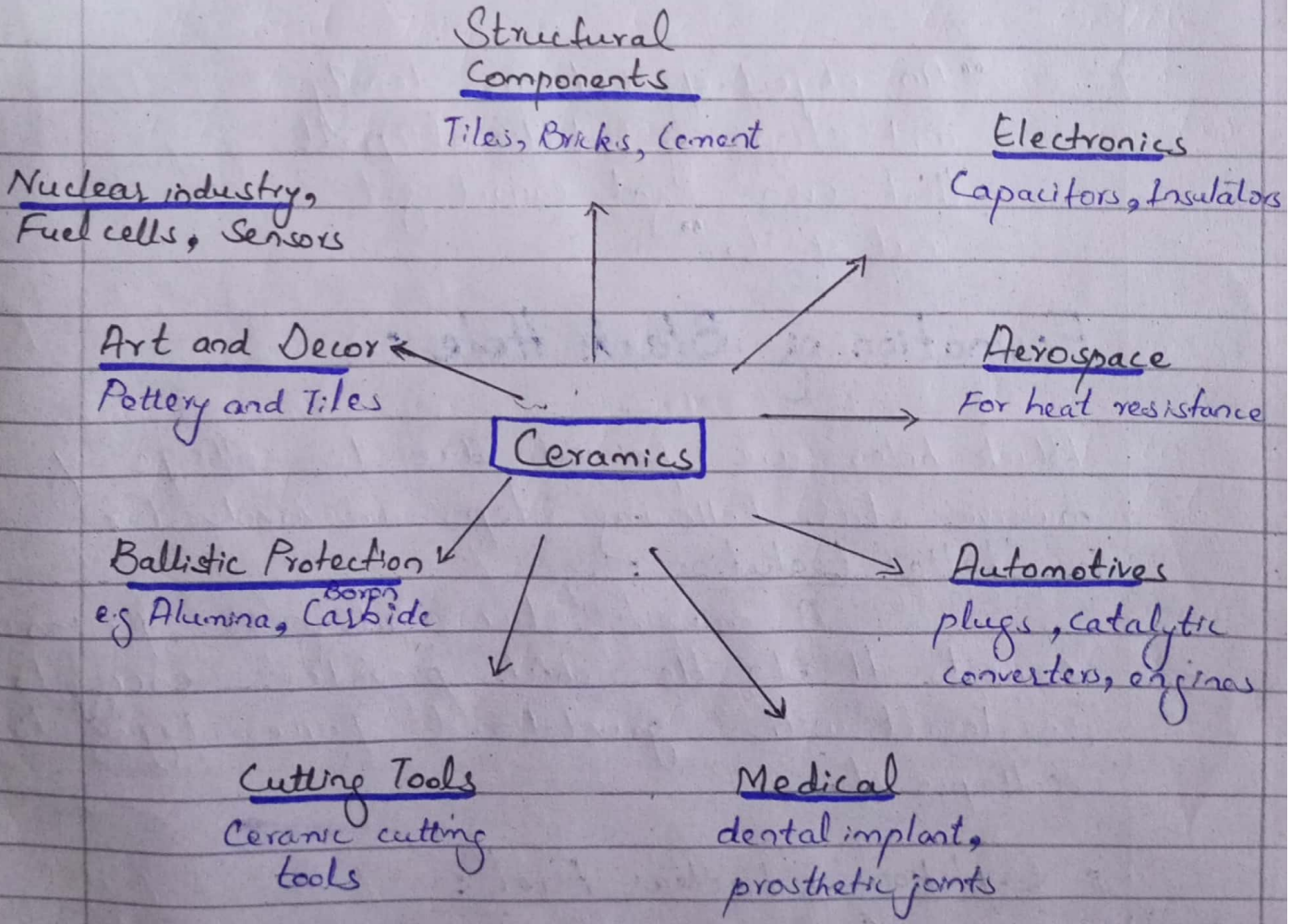
iv. **Enhanced Chemical Reactivity :**

Due to their higher surface volume ratio, nano-ceramics exhibit better chemical reactivity.

v. **Reduced Defects :**

Nano-ceramics have fewer defects, impurities and grain boundaries which lead to improved material purity and consistency than bulk ceramics.

Applications of Ceramics :



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(b)

Q What is black hole. How black holes are formed?

Black Hole:

According to NASA' website:

"Black Hole is a place in space where gravity is so strong that even light cannot escape it. The gravity is intense because the matter has been squeezed into a tiny space. This can happen when a star is dying."

Or

"An object of extreme density and strong gravitational pull that even light cannot get out of it."

Formation of Black Hole:

Black holes are formed due to collaspe of massive star. Following steps are involved:

i- Stellar Evolution:

A massive star undergoes fusion converts H into He, which provides energy to counteract with gravitational forces trying to collapse it.

ii- Depletion of Nuclear Fuel:

Over million of years, when a star runs out of Hydrogen, it progresses to heavier elements through successive stages and reaches Iron, which cannot release energy through fusion.

iv. **Iron Core Collapse:**

The unstable Iron core collapse under its gravity within a fraction of a second.

v- **Super-nova Explosion:**

Core rapaidly collapse and cause a rebound effect. The outer layers of star are expelled outward in a massive explosion known as supernova.

vi- **Formation of Singularity:**

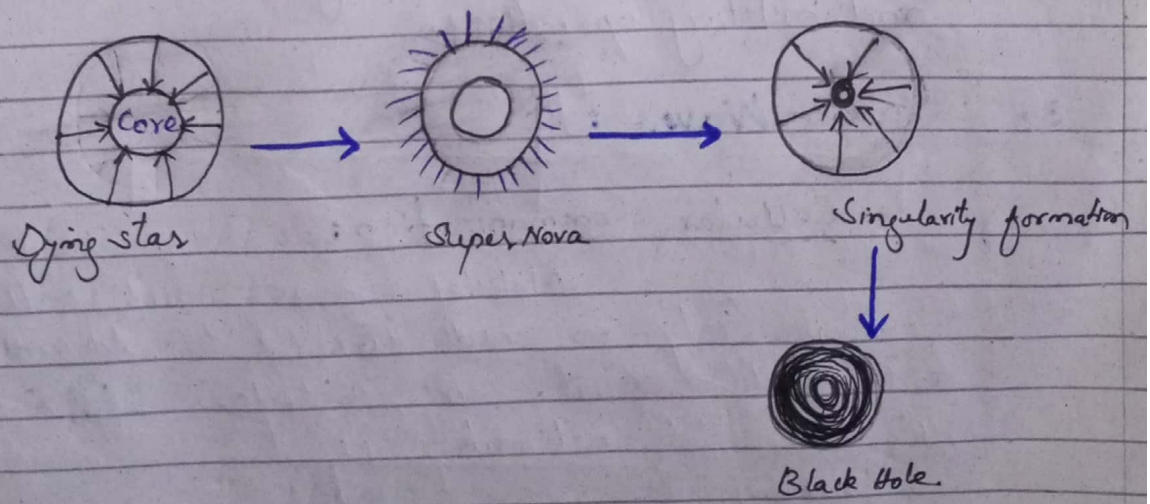
The remaining core will further collapse into singularity - a dense point at center.

vii- **Event Horizon:**

Around the singularity, a boundary is formed through which nothing can escape.

viii- **Black Hole Structure:**

The black hole now consist of singularity at the center, surrounded by event horizon. Outside event horizon is region where space and time are wrapped due to strong gravitational pull.



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(c)

Q- Write two applications of following electromagnetic radiations.

1- Ultra-Voilet : (UV)

a- Sterilization: UV rays are used to sterilize surfaces, air and water by destroying DNA and RNA of microorganisms like bacteria and viruses.

b- Flourescent Lighting: UV radiation is used in flourescent lamps. When UV light hits the phosphate coating inside the bulb, it emits visible light.

2- Infra-red : (IR)

a- Medical Imaging :

Infrared Imaging such as infrared thermography is used in medicine for diagnosing and monitoring conditions like breast cancer, vasular issues and musculoskeletal disorders.

b- Night Vision :

Infrared vision devices amplies ambient IR radiations to enable night time surveillance and military operations.

3- Radio-Waves :

a- Cellular Communication:

Mobile phones and cellular networks rely on radiowaves to transmit voice and data signals. This includes 2G, 3G, 4G and 5G networks.

b- Radar :

Radiowaves are used in radars systems for detecting and tracking objects, including in aviation, weather forecasting and military operations.

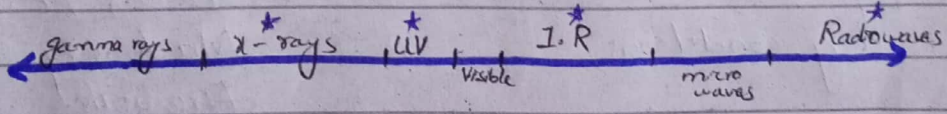
4- X-rays :

a- Medical Imaging :

X-ray is radiography is widely used in medicine for diagnosing and monitoring a variety of conditions. It includes chest X-rays, dental X-rays, skeletal X-rays to visualize bones and tissues.

b- Non-Destructive Testing (NDT) :

In industries, X-rays are used to inspect the integrity of materials and components without causing damage. This is vital in areas like aerospace, automotive and manufacturing.



Higher energy but shorter wavelength

Less energy but higher wavelength.

(d)

Q What is wild fire. Explain its types, causes, spread and prevention?

Wild Fire :

" Wildfire is rapidly spreading

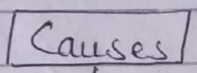
and uncontrollable fire that consumes forests, vegetation, grasslands or other combustible materials."

Wildfire is also referred as "bush fire" or "forest fire".

As per NASA Earth Observatory, August 2023 was called as Fire Season in Northern Hemisphere.

As per research of University of Maryland, 2021 was one of worst years for forest fires caused loss of 9.3 million hectares of tree cover loss globally.

Causes of Wildfire :



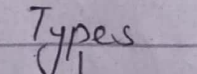
Natural

Lightening strikes
Volcanic Eruptions
Spontaneous Combustions
Dry conditions

Man-made

Camp-fires
Discarded cigrattes
Arsons, Power lines
Machinery Sparks
Fireworks

Types of Wild Fire :



Surface Fire
Fire along the forest floor. Consumes grass, leaves and small vegetation.

Crown Fire
More intense and move to tree tops spread rapidly and quickly.

Ground Fire
These smolder below the surface, often in peat or organic soil.

Spread of Wild Fire:

Wild fire can be spread due to number of factors, few of them are:

1- Weather:

Weather plays a crucial role in spreading of wild fire i.e wind, temperature and humidity. Strong winds can push fires quickly.

2- Fuel:

The availability and dryness of fuel like vegetation and dead leaves influence the intensity of fire.

3- Topography:

The landscapes such as slopes and canyons can channel fires and influence their behaviour.

Prevention of Wild Fire: