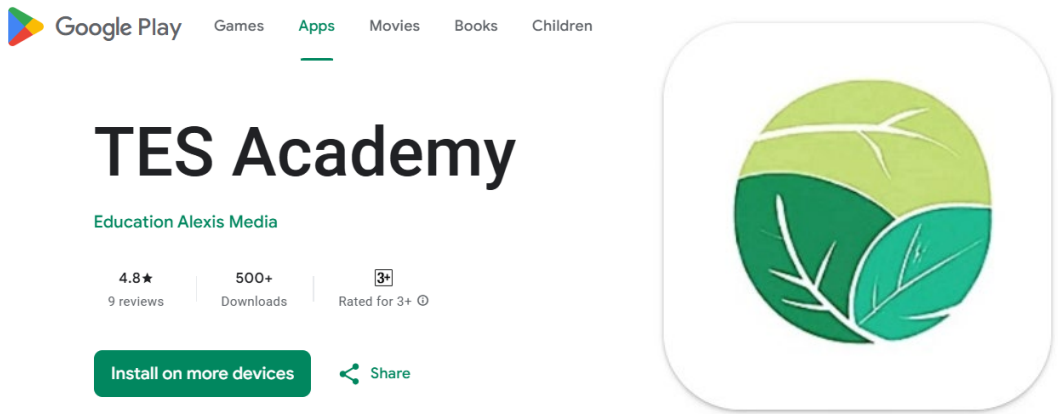


Detailed Solution:

UGC NET Environmental Science (January 2025 Examination)

Q.51

Shannon - Weaver Diversity Index takes in account.

(A) Richness of all species

(B) Richness of only endemic species

(C) Richness of only invasive species

(D) Equitability

(E) Genetic diversity

Choose the **correct** answer from the options given below :

(1) (B) and (C) Only

(2) (B) and (E) Only

(3) (A) and (D) Only

(4) (C), (D) and (E) Only

The Shannon-Weaver Index is calculated as:

✅ : 3

$$H' = -\sum (p_i \ln p_i)$$

Where:

- p_i = Proportion of individuals of species *i* relative to the total individuals in the community.
- It considers **both species richness (number of species)** and **evenness (distribution of individuals among species).**

✅ **(A) Richness of all species** – It considers the total number of species present in a community.

✅ **(D) Equitability (Evenness)** – It measures how evenly the individuals are distributed among the species.

Q.52 In which component of Life Cycle Analysis, is the 'flows of materials' quantified ?

(1) Waste mining
(2) Impact analysis
(3) Inventory analysis
(4) Improvement analysis

Options 1. 1
2. 2
3. 3
4. 4

✅ (3) Inventory Analysis

Inventory Analysis: This phase involves collecting data on all inputs and outputs of a product system. Here, the focus is on quantifying the flows of materials, energy, and waste streams throughout the entire life cycle of the product, from raw material extraction through to disposal or recycling. This includes: Inputs such as raw materials, energy, and water. Outputs like products, co-products, emissions to air, water, and soil, and waste. The goal is to build a comprehensive inventory of all these flows, often using mass and energy balances, to ensure that all inputs can be accounted for in outputs, thereby quantifying the environmental exchanges associated with each life cycle stage.

Q.53 Match **List - I** with **List - II**.

	List - I (Process)		**List - II (Outcome)**
(A)	Biological nitrogen fixation	(I)	Conversion of ammonium to nitrate
(B)	Nitrification	(II)	Conversion of elements from organic to inorganic form
(C)	Immobilization	(III)	Conversion of nitrogen gas to ammonium
(D)	Mineralization	(IV)	Incorporation of inorganic nutrient elements into organic forms

Choose the **correct** answer from the options given below :

(1) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)

(2) (A)-(I), (B)-(III), (C)-(II), (D)-(IV)

(3) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

(4) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

Column 1	Process	Outcome	Match
A	Biological nitrogen fixation		III
B	Nitrification		I
C	Immobilization		IV
D	Mineralization		II
I		Conversion of ammonium to nitrate	B
II		Conversion of elements from organic to inorganic form	D
III		Conversion of nitrogen gas to ammonium	A
IV		Incorporation of inorganic nutrient elements into organic forms	C

✅ : 3

•**Biological nitrogen fixation (A → III):** Certain bacteria (e.g., Rhizobium, Azotobacter) convert atmospheric nitrogen (N_2) into **ammonium (NH_4^+)**.

•**Nitrification (B → I):** The conversion of **ammonium (NH_4^+) to nitrate (NO_3^-)** by nitrifying bacteria (e.g., Nitrosomonas, Nitrobacter).

•**Immobilization (C → IV):** Inorganic nitrogen (**NH_4^+, NO_3^-**) is absorbed by microbes and converted into **organic forms**.

•**Mineralization (D → II):** Organic nitrogen from dead organisms or waste is broken down into **inorganic forms** like ammonium (**NH_4^+**).

Q.54 Ratio between the concentration of a substance in animal tissue and its daily dietary intake of a terrestrial animal, is expressed as :

(1) Bioconcentration factor
(2) Biotransfer factor
(3) Partition coefficient
(4) Toxicant concentration

✅ (2) Biotransfer Factor

The **Biotransfer Factor (BTF)** is the ratio between the **concentration of a substance in an animal's tissue** and its **daily dietary intake**. It represents how efficiently a substance (e.g., heavy metals, pesticides) transfers from food to an animal's body in a terrestrial ecosystem.

Bioconcentration Factor (BCF) – This refers to the accumulation of a substance from **water** into an organism, mainly in aquatic systems, rather than from diet.

Partition Coefficient (K_a/w or K_o/w) – This measures how a substance distributes between two phases (e.g., water and lipid) and is not related to dietary intake.

Toxicant Concentration – This is a general term for the amount of a toxic substance but does not define its relationship with dietary intake.

Q.55 Match **List - I** with **List - II**.

	List - I (Terms in Epidemiology)		**List - II (Description)**
(A)	Vehicle	(I)	Living agent that transfers pathogen
(B)	Carrier	(II)	Pathogen-contaminated inanimate object
(C)	Fomite	(III)	Non living source which transmits pathogens to large number of individuals
(D)	Vector	(IV)	Sub-clinically infected individual

Choose the **correct** answer from the options given below :

(1) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

(2) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

(3) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

(4) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

Term	Match
A. Vehicle	III
B. Carrier	IV
C. Fomite	II
D. Vector	I
I. Living agent that transfers pathogen	D
II. Pathogen-contaminated inanimate object	C
III. Non-living source which transmits pathogens to a large number of individuals	A
IV. Sub-clinically infected individual	B

✅ **(2)**

(A → III) Vehicle: A non-living medium (e.g., water, food, air) that spreads pathogens to many individuals. Example: Contaminated water spreading cholera.

(B → IV) Carrier: A person or animal that harbors a pathogen **without showing symptoms** but can spread the infection. Example: Typhoid Mary.

(C → II) Fomite: A **non-living object** that transmits pathogens. Example: Contaminated door handles, towels, medical instruments.

(D → I) Vector: A **living organism** that transmits pathogens. Example: Mosquitoes (malaria, dengue), Ticks (Lyme disease).

Q.56 For a set of observations $X=[1, 2, 4, 8, 16, 32]$, the relationship among arithmetic mean (A. M.), geometric mean (G. M.) and harmonic mean (H. M.) will be represented as :

(1) $\text{G. M.}=\left(\frac{\text{A. M.}}{\text{H. M.}}\right)^2$

(2) $\text{A. M.}=\left(\frac{\text{G. M.}}{\text{H. M.}}\right)^2$

(3) $\text{G. M.}=(\text{A.M.}\times\text{H.M.})^{\frac{1}{2}}$

(4) $\text{A. M.}=(\text{G.M.}\times\text{H.M.})^{\frac{1}{2}}$

✅ : 3

For any dataset, the general relationship among **Arithmetic Mean (A.M.), Geometric Mean (G.M.), and Harmonic Mean (H.M.)** follows:

$$H.M. \leq G.M. \leq A.M.$$

Additionally, an important mathematical identity holds:

$$G.M. = \sqrt{A.M. \times H.M.} \quad = \quad G.M. = (A.M. \times H.M.)^{\frac{1}{2}}$$

Q.57 According to Stoke's law, the terminal velocity of a particle in a medium depends on :

(A) Gravitational acceleration
(B) Density of the particle
(C) Density of the medium
(D) Size of the particle
(E) Viscosity of the medium

Choose the **correct** answer from the options given below :

(1) (B), (D) and (E) Only
(2) (A), (D) and (E) Only
(3) (A), (B), (C), (D) and (E)
(4) (A), (B), (C) and (E) Only

According to **Stoke's Law**, the **terminal velocity (vt)** of a spherical particle settling in a viscous medium is given by:

$$v_t = \frac{2}{9} \cdot \frac{(r^2)(\rho_p - \rho_m)g}{\eta}$$

- r = **Radius of the particle**
- ρ_p = **Density of the particle**
- ρ_m = **Density of the medium**
- g= **Gravitational acceleration**
- η = **Viscosity of the medium**

✅ : **3**

Correct Options:

✅ **(A) Gravitational acceleration**

✅ **(B) Density of the particle**

✅ **(C) Density of the medium** – Higher medium density reduces terminal velocity.

✅ **(D) Size of the particle**– Since terminal velocity depends on r^2, larger particles settle faster.

✅ **(E) Viscosity of the medium**– Higher viscosity reduces terminal velocity.

Q.58 Arrange the following substances in the **increasing order** of their heat capacity at standard temperature and pressure.

(A) Ice
(B) Water
(C) Air
(D) Dry Sand

Choose the **correct** answer from the options given below :

(1) (B), (A), (D), (C)
(2) (A), (B), (C), (D)
(3) (C), (D), (A), (B)
(4) (D), (C), (B), (A)

✅ : 3

The **heat capacity** of a substance is the amount of heat required to raise its temperature by **1°C (or 1 K)**. At **standard temperature and pressure (STP)**, the **specific heat capacity (Cp)** values for the given substances are approximately:

(C) Air: 1.005 kJ/kg°C
Air has a relatively low heat capacity.

(D) Dry Sand: 0.8-1.3 kJ/kg°C (average: 1.05 kJ/kg°C)
Dry sand has a slightly higher heat capacity than air.

(A) Ice: 2.05 kJ/kg°C
Ice has a higher heat capacity than air and dry sand.

(B) Water: 4.184 kJ/kg°C
Water has the highest heat capacity among the given substances.

(C) Air < (D) Dry Sand < (A) Ice < (B) Water.

Q.59 In the northern hemisphere, the gradient wind around a high pressure is characterized by :

(1) Supergeostrophic and clockwise flow
(2) Subgeostrophic and clockwise flow
(3) Supergeostrophic and anti-clockwise flow
(4) Subgeostrophic and anti-clockwise flow

(1) Supergeostrophic and clockwise flow

•**High-pressure systems (anticyclones)** in the northern hemisphere have **clockwise flow** due to the Coriolis effect.

•The gradient wind around a high-pressure system is **supergeostrophic**, meaning it is faster than the geostrophic wind. This is because the centrifugal force (outward force due to curvature) acts in the same direction as the pressure gradient force, requiring a stronger Coriolis force to balance the forces, resulting in faster winds.

Q.60 Which of the following factor(s) is/are used to calculate global warming potential of greenhouse gases ?

(A) Concentration
(B) Spectral window
(C) Atmospheric lifetime
(D) Absorption efficiency

Choose the **correct** answer from the options given below :

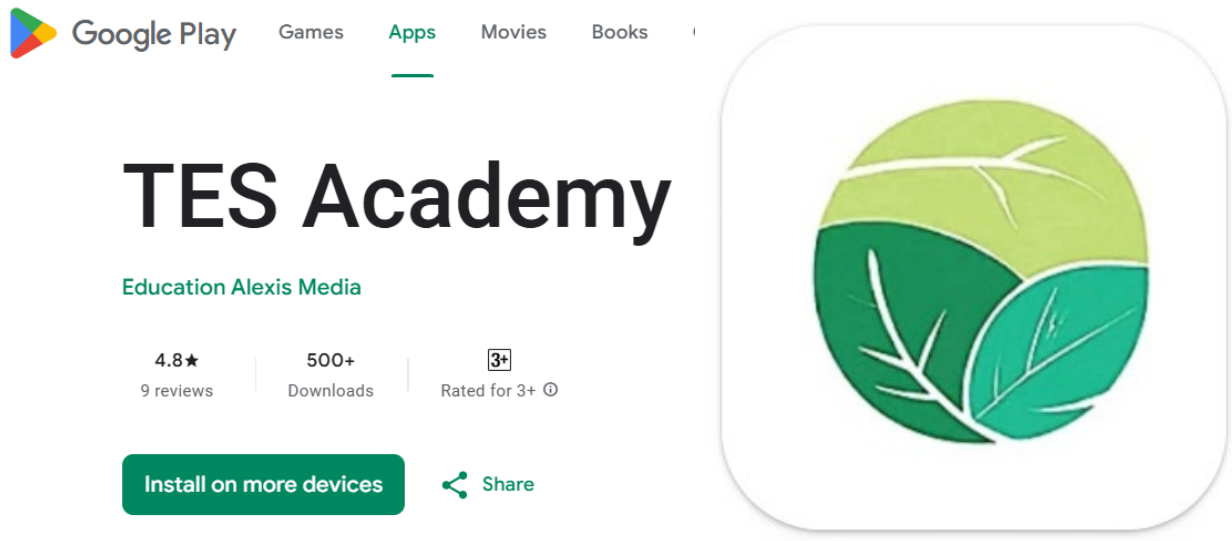
(1) (A) Only
(2) (C) Only
(3) (A), (C), (D) Only
(4) (A), (B), (C), (D)

(3) (A), (C), (D) Only

The Global Warming Potential (GWP) of greenhouse gases is calculated based on the following factors:
(A) Concentration: The amount of the gas present in the atmosphere.
(C) Atmospheric lifetime: How long the gas remains in the atmosphere before being removed or broken down.
(D) Absorption efficiency: The ability of the gas to absorb infrared radiation (heat) in the atmosphere.

The spectral window (B) is not directly used to calculate GWP. It refers to the range of wavelengths in the infrared spectrum where greenhouse gases absorb radiation, but it is not a factor in the GWP calculation itself.

<u>As per UGC Key (4) All option are correct</u>



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61 Global atmospheric circulation tends to produce arid areas at :

(1) 30° Latitude
(2) 10° Latitude
(3) 60° Latitude
(4) The equator

(1) Global circulation patterns, specifically the descending air of the Hadley, Ferrel, and Polar cells, contribute to the creation of arid regions. The most significant arid zones are typically found around **30° latitude**, both north and south of the equator.
At these latitudes, air that rises near the equator (in the Hadley cells) cools and descends, causing high-pressure systems. This descending air prevents cloud formation, leading to clear skies and dry conditions—common characteristics of deserts. The world's largest deserts, like the Sahara and the Arabian Desert in the Northern Hemisphere and the Atacama in the Southern Hemisphere, are located around these latitudes.

62 As per EIA Notification 2006, which of the following projects or activities is/are categorized as category A ?

(A) Nuclear Power Projects

(B) Cement Plants (<1 million tonnes/annum production capacity)

(C) Rayon Fibres Manufacturing

(D) Common Municipal Solid Waste Management Facility

Choose the **correct** answer from the options given below :

(1) (A) and (B) Only

(2) (A) and (C) Only

(3) (A) and (D) Only

(4) (B) and (C) Only

A. Nuclear Plant: Category A
B. Cement manufacturing more than 1 million ton/ year = Category A, Under this limit Category B
C. Rayon Manufacturing: Category A
D. Common Waste Management facility: Category B

Answer: **(2)** (A) & (C),

63. Substances that catch fire spontaneously in air without an ignition source, are called :
(1) Flammable solids
(2) Combustible liquids
(3) Flammable liquids
(4) Pyrophoric

(4) Pyrophoric materials are a subset of reactive materials that ignite spontaneously in the presence of air. The most well-known pyrophoric material is elemental phosphorus, which is used in flares and other incendiary devices. Other examples include: Sulfur.

A substance is pyrophoric if it ignites spontaneously in air at or below 54 °C (129 °F) (for gases) or within 5 minutes after coming into contact with air (for liquids and solids).[1] Examples are organolithium compounds and triethylborane. Pyrophoric materials are often water-reactive as well and will ignite when they contact water or humid air. They can be handled safely in atmospheres of argon or (with a few exceptions) nitrogen. Class D fire extinguishers are designated for use in fires involving metals but not pyrophoric materials in general. A related concept is hypergolicity, in which two compounds spontaneously ignite when mixed

64. Which of the following is true if gasoline is burnt in perfect air/fuel stoichiometric ratio in internal combustion engines ?

(A) Fuel consumption decreases.

(B) Power of engine remains optimum.

(C) NO_x emission remains high compared to rich and lean fuel.

(D) Hydrocarbon emission remains low.

(E) Carbon monoxide emission decreases compared to rich fuel.

Choose the **correct** answer from the options given below :

(1) (A), (B) and (E) Only

(2) (A), (B) and (D) Only

(3) (A), (B), (C), (D) and (E)

(4) (A), (B), (D) and (E) Only

(3)

A B C D E are correct statement

a. **fuel consumption decreases**: **True.** The stoichiometric ratio does not necessarily reduce fuel consumption, but it ensures that the fuel is burned efficiently in the ideal air/fuel proportion.

b. power of engine remains optimum: **True.** The stoichiometric air/fuel ratio is considered ideal for achieving maximum power and efficiency from the engine, as it ensures complete combustion.

c. NOx emission remains high compared to rich and lean fuel: **True.** In a stoichiometric mixture, combustion is more complete, which can lead to higher peak combustion temperatures. This tends to increase the formation of NOx (nitrogen oxides), which is a byproduct of high temperatures.

d. hydrocarbon emission remains low: **True.** The stoichiometric ratio typically results in complete combustion, which minimizes the production of unburned hydrocarbons (HC), reducing HC emissions compared to rich mixtures.

e. carbon monoxide emission decreases compared to rich fuel: **True.** A rich air/fuel mixture (too much fuel) results in incomplete combustion, which produces higher levels of carbon monoxide (CO). The stoichiometric mixture ensures more complete combustion, reducing CO emissions compared to a rich mixture.

65. Which of the following is emitted in least amount when coal is burnt ?

(1) Sulphur dioxide
(2) Ammonia
(3) Carbon dioxide
(4) Nitrogen oxides

(2) ammonia.

When coal is burned, it primarily produces the following gases:

- Sulfur dioxide (SO_2): Coal contains sulfur, and when it is burned, sulfur combines with oxygen to form sulfur dioxide.
- Carbon dioxide (CO_2): Coal is a carbon-based fuel, so combustion releases a significant amount of CO_2, a greenhouse gas.
- NOx (nitrogen oxides): The combustion of coal also leads to the formation of nitrogen oxides, particularly at high temperatures.

66. Arrange the following in the **decreasing order** of species richness.

(A) Fungi

(B) Vascular plants

(C) Insects, centipedes and millipedes

(D) Vertebrates

(E) Crustaceans

Choose the **correct** answer from the options given below :

(1) (A), (B), (C), (D), (E)

(2) (A), (B), (E), (D), (C)

(3) (C), (A), (B), (E), (D)

(4) (E), (D), (C), (B), (A)

(3)

NA

67. Arrange the following materials in **decreasing order** of their albedo.

(A) Pure, Fresh Snow

(B) Pure, Old Snow

(C) Ice

(D) Desert

(E) Savana

Choose the **correct** answer from the options given below :

(1) (B), (A), (C), (D), (E)

(2) (C), (A), (B), (D), (E)

(3) (A), (B), (C), (E), (D)

(4) (A), (B), (C), (D), (E)

(4)

Table showing albedos of different materials from "Fundamentals of Remote Sensing and Airphoto Interpretation" by Avery and Berlin 1992

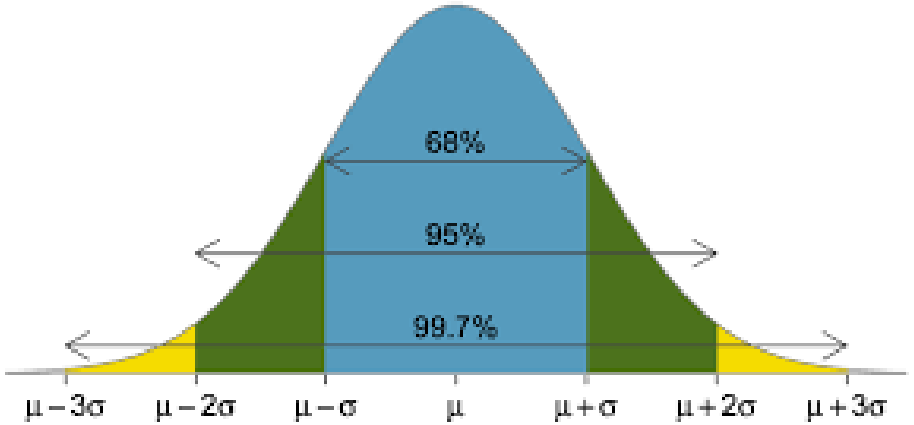
Material	Percent Reflected
Fresh Snow	80-95
Thick Cloud	70-80
Water (sun near horizon)	50-80
Old Snow	50-60
Light soil	25-45
Thin Cloud	20-30
Dry soil	20-25
Wet soil	15-25
Deciduous forest	15-20
Dark soil	5-15
Asphalt	5-10
Crops	10-25
Coniferous forest	10-15
Water (sun near zenith)	3-5

68. If data on a variable is distributed normally with a mean 20 and standard deviation 4, the probability that the variable lies between 16 and 24, is :

(1) ~ 0.5
(2) ~ 0.68
(3) ~ 0.80
(4) ~ 0.95

(2)

•Approximately **68%** of the data falls within **1 standard deviation** (SD) of the mean.
•Approximately **95%** falls within **2 standard deviations** of the mean.
•Approximately **99.7%** falls within **3 standard deviations** of the mean.
So, based on your example:
•**Mean = 20**
•**Standard deviation = 4**
If you add **1 standard deviation** to the mean, you get:
20 + 4 = 24
If you subtract **1 standard deviation** from the mean, you get:
20 - 4 = 16



Therefore, **68% of the data** will fall between **16 and 24** in this case.
This means there's a **0.68 probability** that a randomly selected value from this normal distribution will fall within this range.

69. A cone of depression forms when :

(A) A stream flows into a sinkhole

(B) Water in the zone of aeration is replaced by water from the zone of saturation

(C) A spring forms where a perched water table intersects the surface

(D) Water is withdrawn from a well faster than it can be replaced

Choose the **correct** answer from the options given below :

(1) (A) and (B) Only

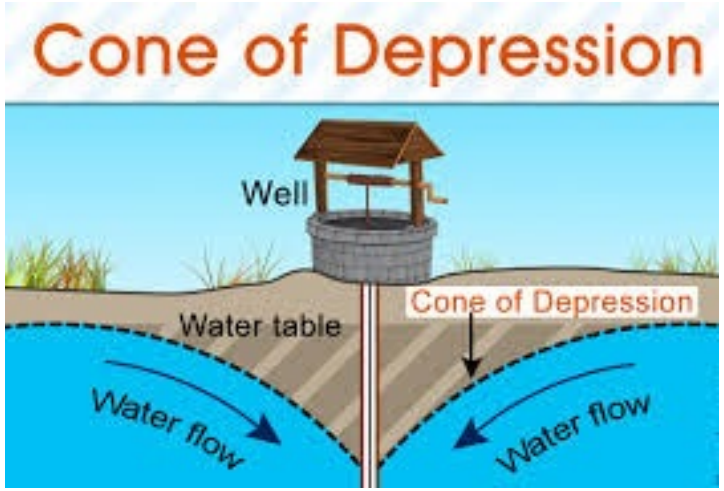
(2) (D) Only

(3) (C) and (D) Only

(4) (A), (B) and (D) Only

(2) D only

A **cone of depression** forms in a well when water is withdrawn **faster than it is replaced**. This occurs because the rate of water extraction exceeds the rate at which groundwater is naturally replenished, creating a drop in the water level around the well.



70. Which of the following is **NOT** an *ex-situ* bioremediation tool ?

(1) Bioreactors
(2) Biofilters
(3) Bioventing
(4) Land farming

(3)

Technology	Examples	Technique details	Benefits	Limitations
In situ Bioremediation	Biosparging	Involves injection of air under pressure to enhance biological activity of microbes (Sharma 2012).	NonInvasive	Environmental constraints
	Bioventing	It involves supplying air and nutrients through well (Atlas & Phillip 2005)	Relatively passive	Extended treatment time
	Bioaugmentation	It involves supplying specialised microbes or genetically engineered microbes to target specific Pollutants (Thapa et al. 2012)	Natural attenuation processes	Monitoring difficulties
	Biostimulation	It involves the management of the natural environment to optimise the growth and activity of the natural microbial population (Crivelaro et al. 2010)	Natural attenuation process	Extended treatment time
Ex situ Bioremediation	Land Farming	Involve tilling of top soil and adding water and nutrients (Soccol et al. 2003)	Cost efficient, and low ground water contamination (Besalatpour et al. 2011)	Space requirements
	Composting	Anaerobic,convert's solidorganic wastes intohumus-likematerial (Nataraj et al. 2007)	Rapid reaction rate, Low cost	Requires nitro-gen supplemen-tationExtended treatment time
	Biopiles	It is a hybrid of land farming and composting (Wu & Crapper 2009)	Provides favourable environment for indigenous microbes	Need to control abiotic loss
	Bioreactors	These are basically tanks in which living organisms carry outbiological reactions (Chikere et al. 2011)	Better rate and extent of degradation (Sonawdekar 2012)	Highly expensive

71. Match **List - I** with **List - II**.

	List - I (Definition)		**List - II (Term)**
(A)	The ratio of mass of water vapour to the mass of dry air	(I)	Bowen Ratio
(B)	The ratio of mass of water vapour to the mass of air (dry + water vapour)	(II)	Absolute humidity
(C)	The ratio of mass of water vapour to the volume of air	(III)	Specific humidity
(D)	The ratio of sensible heat to latent heat fluxes at Earth's surface	(IV)	Mixing Ratio

Choose the **correct** answer from the options given below :

(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(2) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

(3) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

(4) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(4)

Bowen Ratio is a concept used in meteorology and environmental science to describe the relationship between the **sensible heat flux** and the **latent heat flux** at the Earth's surface. It is a dimensionless ratio and is used to understand how energy is transferred between the surface and the atmosphere.

Bowen Ratio(B)= Sensible Heat Flux (H) / Latent Heat Flux (LE)

Mixing Ratio (r)=Mass of dry air (mda) / Mass of water vapor (mwv)

Ratio of mass of water vapor to volume of air → A. Absolute humidity

- Absolute Humidity refers to the mass of water vapor per unit volume of air, typically expressed in grams per cubic meter (g/m^3).

Ratio of mass of water vapor to mass of air (dry + water vapor) → B. Specific humidity

- Specific Humidity refers to the mass of water vapor per unit mass of air (including both dry air and water vapor), typically expressed in grams of water vapor per kilogram of air (g/kg).

72. Identify the correct sequence of regional metamorphosis of shale.

(A) Slate

(B) Schist

(C) Phyllite

(D) Gneiss

Choose the **correct** answer from the options given below :

(1) (A), (B), (C), (D)

(2) (B), (A), (D), (C)

(3) (D), (C), (B), (A)

(4) (A), (C), (B), (D)

(4)

The correct sequence of regional metamorphism for **shale**

1. **Slate**: The lowest grade of metamorphism. Shale, when subjected to low pressure and temperature, transforms into slate. It has a fine-grained texture and excellent cleavage.
2. **Phyllite**: As the temperature and pressure increase, slate can metamorphose into phyllite. Phyllite has a slightly coarser texture than slate and exhibits a shiny appearance due to the growth of mica minerals.
3. **Schist**: With further metamorphism (higher pressure and temperature), phyllite can change into schist. Schist has a much coarser texture and distinct foliated layers, and it often contains visible mica crystals.
4. **Gneiss**: Under even higher temperatures and pressures, schist can metamorphose into gneiss. Gneiss has a banded texture due to the segregation of minerals into light and dark bands.

Correct sequence:
1. Slate → 3. Phyllite → 2. Schist → 4. Gneiss

73. Concentration of dissolved oxygen in water is determined by :

(A) Turbulence

(B) Temperature

(C) Concentration of oxygen in atmosphere

(D) Activity of organism

(E) Genetic diversity

Choose the **correct** answer from the options given below :

(1) (A), (B), (C) and (D) Only

(2) (B), (C) and (D) Only

(3) (B), (C), (D) and (E) Only

(4) (A), (B), (D) and (E) Only

(1)

1, 2, 3, and 4 affect the concentration of dissolved oxygen in water:

1.Turbulence: Increases the mixing of water, promoting oxygen exchange between water and air, which raises dissolved oxygen levels, especially in fast-moving water.

2.Temperature: Colder water holds more dissolved oxygen than warmer water, so as water temperature increases, oxygen solubility decreases.

3.Concentration of oxygen in the atmosphere: The oxygen level in the air affects how much can dissolve in water; more oxygen in the atmosphere allows more to dissolve in the water.

4.Activity of organisms: Organisms like fish and bacteria consume oxygen for respiration. The more active or numerous the organisms, the more oxygen is consumed, reducing the dissolved oxygen concentration.

Genetic diversity doesn't directly affect dissolved oxygen but influences the overall health and functioning of an ecosystem.

74. Loss of biodiversity causes loss of :

(A) Provisioning services

(B) Regulating services

(C) Cultural services

(D) Supporting services

Choose the **correct** answer from the options given below :

(1) (A) and (B) Only

(2) (A), (B) and (C) Only

(3) (B), (C) and (D) Only

(4) (A), (B), (C) and (D)

(4)

These four are all essential services provided by biodiversity. Therefore, if biodiversity is lost, these services—such as provisioning, regulating, cultural, and others—will be impacted.

75. C : N ratio of plant tissues is :
(1) higher than C : N ratio of bacteria
(2) lower than C : N ratio of fungi
(3) lower than C : N ratio of terrestrial animals
(4) lower than C : N ratio of aquatic animals

(1) Higher than C:N ratio of bacteria

Explanation: Plant tissue typically has a higher C:N ratio compared to bacteria because plants tend to store more carbon relative to nitrogen.

76. In the analysis of coal, when the ratio of all the inorganic base compounds in the ash to the sum of all acid compounds in the ash, is multiplied by the percentage of sodium oxide in the ash, it is called :

(1) Fouling Factor
(2) Alkali Index
(3) Base to acid Ratio
(4) Slagging Factor

(2) Alkali Index

- The **Alkali Index (AI)** is calculated by multiplying the **Base-to-Acid Ratio** (ratio of inorganic base compounds to acid compounds in ash) with the **percentage of sodium oxide (Na_2O) in the ash**.
- It is an indicator of **slagging and fouling tendencies** in coal combustion.
- A **higher Alkali Index** suggests a greater tendency for **slagging and fouling** in boilers due to the formation of sticky deposits.

<u>As per UGC Answer key: 1. Fouling Factor, which is wrong</u>

Q.77

Match **List - I** with **List - II**.

List - I (Mineral)		**List - II (Silicate structure)**
(A) Augite	(I)	Double Chains
(B) Hornblende	(II)	Single Chains
(C) Biotite	(III)	Three dimensional network
(D) Quartz	(IV)	Sheet

Choose the **correct** answer from the options given below :

(1) (A)-(I), (B)-(II), (C)-(IV), (D)-(III)

(2) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(3) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(4) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

(3)

List - I (Mineral)	List - II (Silicate Structure)
(a) **Augite**	(2) Single Chains
(b) **Hornblende**	(1) Double Chains
(c) **Biotite**	(4) Sheet
(d) **Quartz**	(3) Three-dimensional network

- Augite is a pyroxene mineral, and pyroxenes have a single-chain silicate structure.
- Hornblende belongs to the amphibole group, which has a double-chain silicate structure.
- Biotite is a mica mineral, and micas have a sheet silicate (phyllosilicate) structure.
- Quartz is a tectosilicate, meaning it has a three-dimensional network of SiO_4 tetrahedra.

78. Match **List - I** with **List - II**.

List - I (Elements in humic substances)		**List - II** (Concentration range)	
(A)	C	(I)	45% - 55%
(B)	O	(II)	30% - 45%
(C)	H	(III)	3% - 6%
(D)	N	(IV)	1% - 5%

Choose the **correct** answer from the options given below :

(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(2) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

(3) (A)-(I), (B)-(II), (C)-(IV), (D)-(III)

(4) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(1)

Humic substances (including humic acid, fulvic acid, and humin) are complex organic compounds derived from the decomposition of plant and microbial matter. Their **elemental composition** generally follows this order:

- **Carbon (C):** ~50–60%
- **Oxygen (O):** ~30–40%
- **Hydrogen (H):** ~4–6%
- **Nitrogen (N):** ~1–5%
- **Sulfur (S):** ~0.5–2%

(79) According to Hazardous Waste Management Rules 2016, a substance shall be classified hazardous if it :

(A) exhibits inflammability and corrositivity

(B) has acute inhalation LD_{50} less than 50000 ppm as a gas or vapour

(C) forms potentially explosive mixtures with water

(D) has acute aquatic toxicity with 50% mortality with in 24 hrs. for Zebra fish

(E) exhibits reactivity

Choose the **correct** answer from the options given below :

(1) (A), (B), (D) and (E) Only

(2) (A), (C) and (E) Only

(3) (A), (D) and (E) Only

(4) (A), (C), (D) and (E) Only

(2) According to the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, a waste is classified as hazardous if it exhibits certain properties, including:

1.(A) Inflammability and Corrosivity ✅

A substance is hazardous if it is flammable (easily catches fire) or corrosive (can destroy materials or tissues).

2.(C) Forms Potentially Explosive Mixtures with Water ✅

Some substances react violently with water, releasing toxic gases or forming explosive mixtures (e.g., sodium, potassium, calcium carbide).

3.(D) Acute Aquatic Toxicity ❌

If a substance causes 50% mortality in Zebra fish (Brachydanio rerio) within 96 hours, not 24 hrs so it is considered hazardous.

4.(E) Reactivity ✅

Substances that react violently, release toxic gases, or undergo explosive decomposition are classified as hazardous.

The LD_{50} (Lethal Dose 50%) for inhalation toxicity is **not a standard criterion** under the Hazardous Waste Management Rules, 2016.

(80) Identify the correct sequence of coal grade formation from sedimentary to metamorphic rock.

(A) Peat

(B) Anthracite

(C) Bituminous

(D) Lignite

Choose the **correct** answer from the options given below :

(1) (D), (A), (C), (B)

(2) (D), (C), (B), (A)

(3) (A), (D), (C), (B)

(4) (A), (B), (C), (D)

(3) (A), (D), (C), (B)

The sequence of coal grade formation from sedimentary to metamorphic rock generally follows the stages of coalification, where coal increases in carbon content and hardness with increasing burial depth, temperature, and pressure over time.

(A) Peat - This is the initial stage of coal formation from plant remains in a sedimentary environment.

(D) Lignite - Next, peat transforms into lignite, which is a soft brown coal with relatively low carbon content.

(C) Bituminous - With further burial and temperature increase, lignite turns into bituminous coal, which is harder and has a higher carbon content.

(B) Anthracite - Finally, with the highest degree of coalification, bituminous coal can transform into anthracite, the hardest and most carbon-rich form of coal, which is considered metamorphic.

81. Arrange the following in terms of increasing range of values they can take.

(A) Coefficient of determination
(B) Sum of the deviations about mean
(C) Standard normal variate
(D) Coefficient of correlation

Choose the correct answer from the options given below :

(1) (A), (B), (C), (D)
(2) {B), (C), (D), (A)
(3) (A), (C), (D), (B)
(4) (B), (A), (D), (C)

(4) (B), (A), (D), (C).

1.(B) Sum of the deviations about the mean: This is *always* zero. The sum of deviations of any set of data points from their mean will always equal zero. So, its range is a single point: {0}.

2.(A) Coefficient of determination (R-squared): This value ranges from 0 to 1 (inclusive). So, its range is [0, 1].

3.(D) Coefficient of correlation (r): This value ranges from -1 to +1 (inclusive). So, its range is [-1, 1].

4.(C) Standard normal variate (Z-score): A standard normal variate can theoretically take any value from negative infinity to positive infinity. Its range is (-∞, +∞).

82. Arrange the energy conversion processes in the following in order from the least to the most efficient.

(A) Electric hot water heater

(B) Photosynthesis

(C) Solar cell

(D) Electric generator

(E) Aircraft jet engine

Choose the **correct** answer from the options given below :

(1) (A), (B), (C), (D), (E)

(2) (B), (D), (E), (C), (A)

(3) (C), (B), (A), (E), (D)

(4) (B), (C), (E), (D), (A)

(4)

(B) Photosynthesis - Efficiency can vary, but it's generally around 1% to 3% for natural photosynthesis in plants, with some crops achieving slightly higher under optimal conditions.

(C) Solar cell - Efficiency for commercial photovoltaic solar cells ranges from about 14% to 24%, with some cutting-edge lab models going higher but not yet commercially available.

(E) Aircraft jet engine - Modern jet engines have efficiencies around 40% to 50% in terms of converting fuel into mechanical work.

(D) Electric generator - Efficiency can vary based on type and size, but large industrial generators can achieve efficiencies over 90%, with smaller ones still commonly above 80%.

(A) Electric hot water heater - Efficiency is essentially 100% for converting electrical energy to heat, although there are losses in the system like through insulation or standby losses, but in terms of direct energy conversion, it's about as close as you can get to 100% efficiency.

83. The best method for separation and identification of trace levels of high molecular weight biomolecules is :

(1) GC - MS
(2) HPLC with UV detection
(3) LC - MS
(4) GPC with RI detection

(3) LC-MS (Liquid Chromatography-Mass Spectrometry)

- LC-MS combines Liquid Chromatography (LC) and Mass Spectrometry (MS), making it highly effective for the separation, identification, and quantification of trace levels of high molecular weight biomolecules (e.g., proteins, peptides, nucleic acids).

- Liquid Chromatography separates the biomolecules based on their interaction with the stationary phase, while Mass Spectrometry provides detailed information on molecular weight and structure, enabling precise identification.

84. The process, which is NOT part of the Sedimentary rock formation, is :

(1) Deposition
(2) Intrusion
(3) Lithification
(4) Erosion

(2) Intrusion

Erosion (✓) → Part of Sedimentary Rock Formation
Breaks down existing rocks into sediments through wind, water, ice, or biological activity.
Deposition (✓) → Part of Sedimentary Rock Formation
Sediments **settle in layers** in water bodies, deserts, or other environments.
Lithification (✓) → Part of Sedimentary Rock Formation
Compaction and cementation **turn loose sediments into solid rock** over time.

Intrusion refers to the process where magma pushes into existing rock formations and solidifies beneath the Earth's surface.
This process is associated with igneous rocks, not sedimentary rocks.

85. Identify the models that are appropriate for univariate data.

(A) Logit Regression

(B) Exponential Smoothing

(C) Moving Average

(D) Auto-regressive

Choose the **correct** answer from the options given below :

(1) (A), (B) and (C) Only

(2) (B), (C) and (D) Only

(3) (A), (B) and (D) Only

(4) (A), (C) and (D) Only

(2) (B), (C), and (D) Only

(A) Logit Regression - This is typically used for binary classification problems where the outcome is categorical (yes/no, 0/1). It's not generally used for univariate data analysis where the focus is on a single variable over time

(B) **Exponential Smoothing** - This method is specifically designed for forecasting univariate time series data. It's appropriate for univariate data as it involves smoothing the data over time to forecast future values.

(C) Moving Average - Like exponential smoothing, this is a forecasting method for univariate time series data where each point is replaced by the average of neighboring points to smooth out short-term fluctuations.

(D) **Auto-regressive (AR)** - This model is used for time series data where future values are regressed on past values of the same series, making it suitable for univariate data.

Exponential Smoothing (B) and Moving Average (C) are explicitly for univariate time series data. Auto-regressive (D) is also suitable for univariate time series data.

86. For quantitative analysis in the visible region of the spectrum, cuvets (sample holders) can be made of :

(A) Quartz

(B) Transparent plastic

(C) Glass

(D) Fused Silica

Choose the **correct** answer from the options given below :

(1) (A) Only

(2) (A) and (C) Only

(3) (A), (B) and (C) Only

(4) (A), (B), (C) and (D)

(4) (A), (B), (C), and (D)

(A) Quartz - Quartz cuvets are excellent for UV and visible spectroscopy because they transmit light across a wide range of wavelengths, including the entire visible spectrum. However, they are more commonly associated with UV spectroscopy due to their transparency in the UV range as well.

(B) Transparent Plastic - Many types of transparent plastics can be used for visible spectroscopy since they are transparent in the visible range. They are often used for disposable cuvets because they are less expensive than quartz or glass for routine analysis.

(C) Glass - Standard glass cuvets are suitable for measurements in the visible region. They transmit light well in this spectrum but cut off in the UV region, making them less ideal for UV spectroscopy but fine for the visible part. (

(D) Fused Silica - Similar to quartz, fused silica is transparent across a broad range of wavelengths, including the visible spectrum. It's often used interchangeably with quartz for spectroscopy applications where UV transparency is also desired.

87. The masses of both proton and neutron are approximately 1.67×10^{-27} kg. The mass of $^{4}_{2}He$ nucleus is about 6.64×10^{-27} kg. The energy released in the formation of a helium nucleus from two protons and two neutrons is :

(1) $\sim 6.68 \times 10^{-27}$ J

(2) $\sim 4 \times 10^{-29}$ J

(3) $\sim 6.64 \times 10^{-27}$ J

(4) $\sim 3.60 \times 10^{-12}$ J

Options

1. 1
2. 2
3. 3
4. 4

(4). ~3.60x10¯12J

The fusion of two protons and two neutrons to form a helium-4 (^4He) nucleus releases energy due to mass defect, as per Einstein's equation $E=\Delta m \cdot c^2$

The total mass before fusion is 6.68×10^{-27} kg, but the helium nucleus has a lower mass of 6.64×10^{-27} kg, resulting in a mass defect (Δm) of 4.0×10^{-29} kg.

Substituting into the equation with $c=3.0\times10^8$ m/s, the energy released is 3.6×10^{-12} J

88. The Solar constant is :

(A) average temperature at sun's surface

(B) a measure of solar energy impinging upon sun facing unit area of earth's top of atmosphere

(C) 1000 W/m^2

(D) variable

Choose the **correct** answer from the options given below :

(1) (A), (C) and (D) Only

(2) (B), (C) and (D) Only

(3) (B) and (D) Only

(4) (A) and (C) Only

(3). (B) and (D) Only

(2) (B), (C), and (D) Only. (As per Key)

- **(B)** "a measure of solar energy impinging upon sun-facing unit area of Earth's top of atmosphere": This is the correct definition of the Solar constant. It refers to the amount of solar energy that reaches the Earth's outer atmosphere per unit area.
- **(C)** "1000 W/m²": typically, it's about 1361 W/m². (Can't be round figure to 1000)
- **(D)** "variable": This is also true because the solar constant varies slightly due to changes in the Sun's output, as well as Earth's distance from the Sun during different times of the year.

89. Match **List - I** with **List - II**.

List - I (Solar Appliance)		**List - II (Uses)**
(A)	Solar Oven	(I) Provide fresh potable water
(B)	Solar Kiln	(II) Generate Electricity
(C)	Solar Still	(III) Drying products
(D)	Solar Thermal Collector	(IV) Cooking

Choose the **correct** answer from the options given below :

(1) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

(2) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(3) (A)-(I), (B)-(II), (C)-(IV), (D)-(III)

(4) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

(1). (A)-(IV),(B)-(III),(C)-(I) and (D)-(II)

- **(A) Solar Oven** – The primary use of a solar oven is for **cooking** food using solar energy,
- **(B) Solar Kiln** – A solar kiln is used to **dry products** like wood or other materials using solar heat.
- **(C) Solar Still** – A solar still is used to **provide fresh potable water** by distilling contaminated water using solar energy.
- **(D) Solar Thermal Collector** – A solar thermal collector is used to **generate electricity** by converting solar energy into thermal energy.

90. Match **List - I** with **List - II.**

	List - I (Surface Air Flow)		**List - II (Location)**
(A)	North East Trade Winds	(I)	30°N - 60°N
(B)	South East Trade Winds	(II)	0 - 30°N
(C)	Doldrums	(III)	0 - 30°S
(D)	Prevailing Westerlies	(IV)	Near Equator

Choose the **correct** answer from the options given below :

(1) (A)-(III), (B)-(II), (C)-(IV), (D)-(I)

(2) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(3) (A)-(I), (B)-(II), (C)-(IV), (D)-(III)

(4) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

(4).

- (A) North East Trade Winds – These winds are located between 0° to 30°N (near the equator, extending north),
- (B) South East Trade Winds – These winds are located between 0° to 30°S,
- (C) Doldrums – The doldrums are the area near the equator, characterized by calm winds,
- (D) Prevailing Westerlies – These winds are found in the regions between 30°N to 60°N and 30°S to 60°S.

91. A building can be awarded three star rating under GRIHA Rating Norms 2019 if its point score is :

(1) 72

(2) 68

(3) 52

(4) 81

(2). 68

Rating Threshold

GRIHA V 2019 Rating Thresholds	GRIHA Rating
25-40	★
41-55	★★
56-70	★★★
71-85	★★★★
86 or more	★★★★★

92. Coriolis acceleration of a particle over the earth's surface depends on :

(A) Angular Velocity of Earth

(B) Mass of the particle

(C) Latitude of the location

(D) Velocity of the particle

(E) Longitude of the location

Choose the **correct** answer from the options given below :

(1) (A), (B) and (C) Only

(2) (A), (C) and (D) Only

(3) (A), (D) and (E) Only

(4) (A), (B), (C) and (D) Only

(2). (A), (C) and (D) Only

The **Coriolis force** is an **inertial (fictitious) force** that acts on objects moving within a **rotating reference frame**, such as the Earth. It arises due to the rotation of the Earth and affects the trajectory of moving objects (e.g., air masses, ocean currents, projectiles).

Deflection Direction:

1. **Northern Hemisphere:** Deflected to the **right** of the direction of motion.
2. **Southern Hemisphere:** Deflected to the **left** of the direction of motion.
3. **Equator:** No Coriolis effect (since $\sin 0° = 0$).

The Coriolis force (**F***c*) acting on a particle of mass m*m* moving with velocity **v** in a rotating frame (Earth) is given by:

$\mathbf{F}_c = -2m(\boldsymbol{\Omega} \times \mathbf{v})$ Where:

- $\mathbf{F}_c$ = Coriolis force (vector)
- m = mass of the moving object
- $\boldsymbol{\Omega}$ = Earth's angular velocity vector (magnitude $\Omega = 7.29 \times 10-5$ rad/s, directed along the axis of rotation)
- **v** = velocity of the object relative to the rotating frame
- × = cross product (direction follows the right-hand rule)

Since $\mathbf{F}_c = m\mathbf{a}_c$, the Coriolis acceleration (a_c) is: $a_c = -2(\Omega \times v)$

- The acceleration is **perpendicular** to both **Ω** and **v**.
- It **does not depend on mass** (mass cancels out).

Factor	Effect on Coriolis Force
Angular velocity (Ω)	Higher rotation → Stronger Coriolis effect
Velocity (v)	Faster motion → Greater deflection
Latitude (ϕ)	Max at poles, zero at equator
Mass (m)	Affects force but not acceleration
Longitude	No effect

Coriolis acceleration depends on:

Velocity of the particle (v)

Latitude (via $\Omega \sin\phi$)

Does not depend on:

Mass of the particle

Longitude

Angular velocity (Ω) influences the effect but is not a direct variable in the acceleration formula

93. Under the Construction and Demolition Waste Management Rules 2016, segregation and approval of waste management plan from local authority is mandatory for waste generators who generate at least :

(1) 200 tons/project/month
(2) 300 tons/project/month
(3) 100 tons/project/month
(4) 10 tons/project/month

(2). 300 tons/project/month

Under the **Construction and Demolition Waste Management Rules 2016**, waste generators are required to segregate their waste and obtain approval for their waste management plan from the local authority if they generate at least **300 tons of waste per project per month**.

94. The source of Earth's interior heat is a combination of :

(1) Radioactivity, solar wind and earthquakes

(2) Decay of radioactive elements in the interior and the impacts of extraterrestrial objects

(3) Solar wind, compression and volcanism

(4) Nuclear fusion, volcanism and compression

(2). Decay of radioactive elements in the interior and the impacts of extraterrestrial objects

- **Decay of radioactive elements**: The Earth's interior heat is largely generated by the decay of radioactive isotopes (such as Uranium, Thorium, and Potassium) in the Earth's mantle and crust.

This process, known as **radioactive decay**, releases energy in the form of heat, which contributes significantly to the Earth's internal temperature.

- **Impacts of extraterrestrial objects**: The early Earth experienced significant impacts from extraterrestrial objects like asteroids and comets.

These impacts generated considerable heat, some of which has been retained in the Earth's interior. Although this source was more significant in Earth's early history, it still contributes to the Earth's internal heat.

95. Arrange the following Environmental Acts in chronological order.

(A) Environment (Protection) Act

(B) Air (Prevention and Control of Pollution) Act

(C) Water (Prevention and Control of Pollution) Act

(D) Wildlife (Protection) Act

(E) The Public Liability Insurance Act

Choose the **correct** answer from the options given below :

(1) (E), (B), (C), (D), (A)

(2) (C), (A), (D), (B), (E)

(3) (D), (C), (B), (A), (E)

(4) (E), (D), (A), (B), (C)

(3). (D),(C),(B),(A),(E)

- **Wildlife (Protection) Act (1972)**: This was enacted to protect India's wildlife and prevent poaching and habitat destruction.
- **Water (Prevention and Control of Pollution) Act (1974)**: This was one of the first major acts to address water pollution in India.
- **Air (Prevention and Control of Pollution) Act (1981)**: The Air Act was passed to control and prevent air pollution, coming a few years after the Water Act.
- **Environment (Protection) Act (1986)**: This comprehensive act was passed after the Bhopal Gas Tragedy to cover environmental protection in India, addressing various aspects of environmental pollution.
- **The Public Liability Insurance Act (1991)**: This act was introduced to provide compensation to individuals affected by hazardous accidents, mainly in industrial areas.

96. The difference between the amount of chlorine added to water and the amount of residual chlorine after a specified contact period, is defined as :

(1) Combined available chlorine
(2) Chlorine demand
(3) Free available chlorine
(4) Total chlorine

(2). Chlorine demand

The **chlorine demand** is defined as the difference between the amount of chlorine added to water and the amount of residual chlorine remaining after a specified contact period. It represents the amount of chlorine consumed by the water in processes such as oxidation, disinfection, and reactions with contaminants, leaving less residual chlorine.

97. Arrange the following in the **increasing order** of percentage of net primary productivity consumed by herbivores.

(A) Phytoplanktonic communities

(B) Tropical Rainforests

(C) Mangroves

(D) Grasslands

Choose the **correct** answer from the options given below :

(1) (A), (B), (C), (D)

(2) (C), (B), (D), (A)

(3) (C), (B), (A), (D)

(4) (B), (A), (C), (D)

(2). (C),(B),(D),(A)

(A), (C), (B), (D). ✅

Net Primary Productivity (NPP) refers to the amount of biomass or energy produced by plants (via photosynthesis) that remains after accounting for plant respiration. The percentage of NPP consumed by herbivores varies significantly across ecosystems due to differences in plant structure, decomposition rates, and herbivore activity.

Phytoplanktonic Communities (Marine Ecosystems)	**Lowest herbivore consumption (~10-20% of NPP).**
Mangroves	**Low-to-moderate herbivore consumption (~20-30% of NPP)**
Tropical Rainforests	**Moderate herbivore consumption (~30-40% of NPP).**
Grasslands	**Highest herbivore consumption (~40-60% of NPP).**

98. Resistance of a population to a pathogen as a result of immunity of a large portion of the population is known as :

(1) Innate immunity
(2) Adaptive immunity
(3) Morbidity
(4) Herd immunity

(4). Herd immunity

Herd immunity refers to the resistance of a population to a pathogen when a large portion of the population is immune to the disease, either through vaccination or previous infection. This significantly reduces the spread of the disease within the community because there are fewer susceptible individuals for the pathogen to infect.

(1) Innate immunity: This is the body's initial, non-specific defense against pathogens, present from birth. It involves barriers like skin and mucous membranes, as well as immune cells like phagocytes.

(2) Adaptive immunity: This is a specific immune response that develops after exposure to a pathogen. It involves the production of antibodies and memory cells to recognize and fight specific pathogens in the future.

(3) Morbidity: This refers to the incidence or prevalence of a disease or health condition in a population, not immunity.

99. Tidal Range :

(1) is the difference in water levels between a high tide and mean sea level

(2) is the difference in water levels between a low tide and mean sea level

(3) is the time span between two consecutive high and low tides

(4) is the difference in water levels between two consecutive high and low tides

(4). is the difference in water levels between two consecutive high and low tides

Tidal range refers to the vertical difference in water levels between the high tide and the low tide within one tidal cycle. It is a measure of how much the water level rises and falls due to the gravitational forces exerted by the moon and the sun.

Time span between two consecutive high and low tides describes the **tidal cycle**, not the tidal range. The tidal cycle is typically about 12 hours and 25 minutes.

100. Arrange the following wildlife conservation projects in chronological order.

(A) Project Tiger

(B) Project Elephant

(C) Crocodile Conservation

(D) GOI-UNDP Sea Turtle Project

Choose the **correct** answer from the options given below :

(1) (A), (B), (C), (D)

(2) (A), (C), (B), (D)

(3) (B), (A), (C), (D)

(4) (B), (C), (A), (D)

(2). (A), (C), (B), (D)

- **Project Tiger (1973)**: This was India's first major wildlife conservation initiative, launched in 1973 to protect tigers from poaching and habitat destruction. It remains one of the most successful conservation projects in India.

- **Crocodile Conservation (1975)**: The Crocodile Conservation project began in 1975 to protect the endangered species of crocodiles in India, such as the Saltwater and Gharial crocodiles. This was part of India's broader efforts in wildlife protection.

- **Project Elephant (1992)**: Launched in 1992 by the Government of India to address the declining elephant population and to conserve their habitat, Project Elephant aims to protect elephants through a range of conservation measures.

- **GOI-UNDP Sea Turtle Project (1999)**: This project, initiated in collaboration with the Government of India and the United Nations Development Programme (UNDP), focuses on conserving sea turtles and their nesting sites along India's coastline.

101. Match **List - I** with **List - II**.

	List - I (Soil order)		**List - II (Common range of CEC (c mol_c / kg))**
(A)	Histosols	(I)	110 - 170
(B)	Vertisols	(II)	33 - 67
(C)	Andisols	(III)	13 - 49
(D)	Spodosols	(IV)	2 - 57

Choose the **correct** answer from the options given below :

(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(2) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

(3) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

(4) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(1). (A)-(I),(B)-(II), (C)-(III),(D)-(IV)

The cation exchange capacity (CEC) is a measure of the soil's ability to hold onto cations (positively charged ions) and is an important indicator of soil fertility.

- Histosols: Histosols are organic soils, typically found in wetlands and peat bogs. They have a very high CEC due to the organic content, which usually ranges from 110-170 cmol/kg.
- Vertisols: Vertisols are clay-rich soils that expand and contract with moisture changes. Their CEC typically ranges from 33-67 cmol/kg.
- Andisols: Andisols are volcanic soils with high fertility. Their CEC typically ranges from 13-49 cmol/kg.
- Spodosols: Spodosols are acidic, leached soils often found in cool, moist climates. Their CEC typically ranges from 2-57 cmol/kg

102. Which of the following does NOT belong to primary wastewater treatment ?

(1) Bar Screen
(2) Grit Chamber
(3) Trickling Filter
(4) Primary Clarifier

(3). Trickling Filter

Primary wastewater treatment involves the physical removal of large particles and debris from wastewater. It primarily includes mechanical processes to filter out solid waste, leaving behind water that still contains dissolved and suspended organic matter.

Components components involved in **primary wastewater treatment** are:

1.Bar Screen: This is used to remove large debris (like sticks, plastic, and rags) from the wastewater. It is part of the initial physical screening process.

2.Grit Chamber: This is where heavier particles like sand, gravel, and other inorganic materials are removed due to their higher density.

3.Primary Clarifier: After the initial screening and grit removal, the primary clarifier is used to allow suspended solids to settle out of the water by gravity. This process separates solid matter from the wastewater.

103. F-Distribution is used in hypothesis testing in which of the following situations ?

(A) Influences about two population variances

(B) Comparing more than two population means

(C) Testing the significance of correlation coefficient

(D) Inference about a population mean

Choose the **correct** answer from the options given below :

(1) (A) and (B) Only

(2) (B) and (C) Only

(3) (C) and (D) Only

(4) (A) and (D) Only

(1). (A),and (B) Only

The **F-distribution** is commonly used in hypothesis testing in the following situations:

Inferences about two population variances: The F-distribution is used when comparing the variances of two populations. For example, an F-test can be used to test if two populations have different variances. This involves dividing the variances of the two samples, and the resulting statistic follows an F-distribution.

Comparing more than two population means: The F-distribution is used in **Analysis of Variance (ANOVA)**, which is a statistical method used to compare the means of three or more populations. ANOVA tests whether there are significant differences among the population means by comparing variances.

104. Identify the correct sequence of concentration in **increasing order** of following uranium isotopes in naturally occurring uranium ?

(A) U^{233}

(B) U^{234}

(C) U^{235}

(D) U^{238}

Choose the **correct** answer from the options given below :

(1) (A), (B), (C), (D)

(2) (A), (B), (D), (C)

(3) (D), (C), (B), (A)

(4) (D), (C), (A), (B)

(1). (A),(B),(C),(D)

- **U-233**: U-233 is not naturally abundant. It is a synthetic isotope, typically produced from thorium-232 in reactors. It is virtually absent in natural uranium.
- **U-234**: U-234 is a decay product of U-238 and exists in trace amounts in natural uranium, much less abundant than U-235 and U-238.
- **U-235**: U-235 is the isotope used for nuclear fuel and weapons. It is about 0.7% of naturally occurring uranium.
- **U-238**: U-238 is the most abundant isotope in natural uranium, making up about 99.3% of the natural uranium.

105. Arrange the following aquifer materials in increasing order of their porosity.

(A) Clay

(B) Limestone

(C) Gravel

(D) Fine Sand

Choose the **correct** answer from the options given below :

(1) (A), (B), (C), (D)

(2) (B), (C), (A), (D)

(3) (B), (C), (D), (A)

(4) (C), (B), (D), (A)

(3). (B),(C),(D),(A)

Porosity refers to the percentage of void space in a material that can hold water. For aquifer materials, porosity values typically range as follows:

- **Limestone (B):** Dense limestone has **low** primary porosity, usually between 1% and 20%, due to its consolidated nature and minimal pore space, unless fractured or dissolved (e.g., karst features).
- Gravel (C): Gravel has moderate porosity, typically between 20% and 35%, as coarse particles leave larger voids, but packing can reduce total void space.
- Fine Sand (D): Fine sand has higher porosity than gravel, typically between 30% and 40%, because smaller grains allow for more efficient packing with greater void space relative to solid volume.
- **Clay (A)**: Clay has the **highest** porosity, typically between 40% and 60%, due to its fine, plate-like particles that create extensive small pores, though permeability is low.

106. A typical basalt consists of approximately 50% :

(1) Al_2O_3

(2) FeO

(3) CaO

(4) SiO_2

(4). SiO_2

Basalt is an igneous rock that primarily consists of silicate minerals. Its typical composition is dominated by:

SiO_2 (Silicon Dioxide): This is the most abundant compound in basalt, typically making up around **50-55%** of the rock's composition. Silicon dioxide is a major component of the minerals in basalt, including plagioclase and pyroxene.

Basalt also contains other elements, but in smaller amounts:

1. **FeO (Iron Oxide)**: Basalt contains iron oxide, typically around 10-15%, depending on the specific type of basalt.
2. **CaO (Calcium Oxide)**: Calcium oxide is also present in basalt, contributing around 8-12%.
3. **Al_2O_3 (Aluminum Oxide)**: Aluminum oxide is present in basalt, but in a lesser amount compared to SiO_2, typically around 12-15%.

107. Which of the following is the most appropriate for visualising time sequence data of a variable ?

(1) Line chart
(2) Histogram
(3) Scatter plot
(4) Box plot

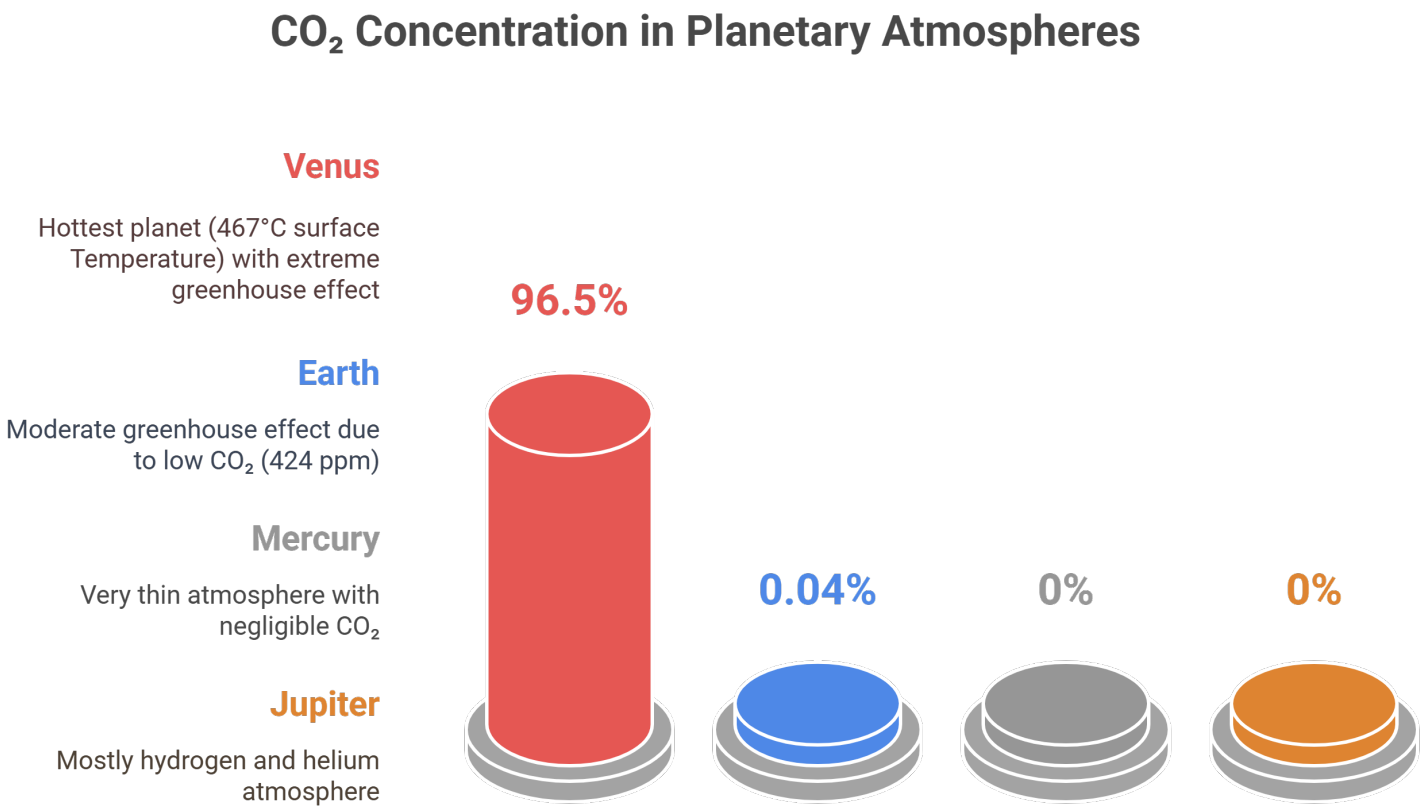
(1). Line chart

Line Chart: It is used to display data points in a time sequence and is ideal for visualizing trends, changes, and patterns over time. The x-axis typically represents time, while the y-axis represents the variable being measured. It helps in identifying trends or patterns over intervals (e.g., days, months, years).

108. Which of the following planets has maximum CO_2 concentration (by volume) in its atmospheric composition ?

(1) Earth
(2) Mercury
(3) Venus
(4) Jupiter

(3). Venus


CO_2 Concentration in Planetary Atmospheres
Venus
Hottest planet (467°C surface Temperature) with extreme greenhouse effect
Earth
Moderate greenhouse effect due to low CO_2 (424 ppm)
Mercury
Very thin atmosphere with negligible CO_2
Jupiter
Mostly hydrogen and helium atmosphere
96.5%
0.04%
0%
0%

109. Removal of a species leads to significant changes that spread throughout the food web. This species can be called as a :

(1) Climax species
(2) Invasive species
(3) Flagship species
(4) Keystone species

(4). Keystone species

A keystone species is one that has a disproportionately large effect on its ecosystem relative to its biomass or abundance. The removal of a keystone species can lead to significant changes throughout the food web, disrupting the balance and functioning of the ecosystem. Keystone species can affect the structure, diversity, and dynamics of the entire ecosystem, often through predator-prey relationships or their role in nutrient cycling.

110. The second order moment about mean is equal to :

(1) 0

(2) 1

(3) standard deviation

(4) variance

(4). variance

Moment Table:

Order (n)	Moment About Mean	Interpretation	Example (Normal Dist.)
1	0	Mean deviation (always zero).	0
2	Variance (σ^2)	Measures spread (dispersion).	$\sigma^2 = 4$ (if SD = 2)
3	Skewness	Measures asymmetry.	0 (symmetric dist.)
4	Kurtosis	Measures tail heaviness/peakedness.	3 (for normal dist.)

111. Match **List - I** with **List - II**.

	List - I (Sensors)		**List - II (Satellites)**
(A)	Multi Spectral Instrument (MSI)	(I)	INSAT-2
(B)	Very High Resolution Radiometer (VHRR)	(II)	TERRA
(C)	Linear Imaging Self Scanner-III (LISS-III)	(III)	SENTINEL-2
(D)	Multi-angle Imaging Spectroradiometer (MISR)	(IV)	IRS-1D

Choose the **correct** answer from the options given below :

(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(2) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

(3) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

(4) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

(3). (A)-(III),(B)-(I), (C)-(IV),(D)-(II)

Multi Spectral Instrument (MSI) – This sensor is associated with SENTINEL-2, part of the European Space Agency's Copernicus program, which uses this sensor for Earth observation. The MSI provides high-resolution multispectral imagery.

Very High Resolution Radiometer (VHRR) – This sensor was aboard the INSAT-2 series of Indian National Satellite System satellites. The VHRR provides imaging for meteorological and environmental monitoring.

Linear Imaging Self Scanner-III (LISS-III) – This sensor is onboard the IRS-1D (Indian Remote Sensing Satellite), which is part of India's satellite series used for Earth observation.

Multi-angle Imaging Spectroradiometer (MISR) – This sensor is on the TERRA satellite, which is part of NASA's Earth Observing System (EOS) used for climate and environmental monitoring, including atmospheric studies.

112. Which of the following have albedo greater than the global averag

(A) Ice

(B) Cumulus Clouds

(C) Stratus Clouds

(D) Dark wet Soil

(E) Forest

Choose the **correct** answer from the options given below :

(1) (A), (D) and (E) Only

(2) (A), (C) and (D) Only

(3) (A), (B), (C) and (D) Only

(4) (A), (B) and (C) Only

(4). (A),(B) and (C) Only

Albedo is the measure of reflectivity of a surface, expressed as a percentage (0–100%) or a decimal (0–1). The global average albedo is approximately 0.30 (30%). Surfaces with higher albedo reflect more sunlight,

Surface	Albedo Range (%)	Average Albedo (%)
Earth (Global Avg)	28–32	30
Fresh Ice (A)	50–90	70
Cumulus Clouds (B)	70–90	80
Stratus Clouds (C)	60–80	70
Dark Wet Soil (D)	5–15	10
Forest (E)	5–20	12

113. If two events 'A' and 'B' are independent, then which of the following expressions on probabilities are correct ?

(A) $P(A|B)=P(A)$

(B) $P(A|B)=\frac{P(A)}{P(B)}$

(C) $P(B|A)=P(B)$

(D) $P(B|A)=\frac{P(B)}{P(A)}$

Choose the **correct** answer from the options given below :

(1) (A) and (C) Only

(2) (B) and (D) Only

(3) (A) Only

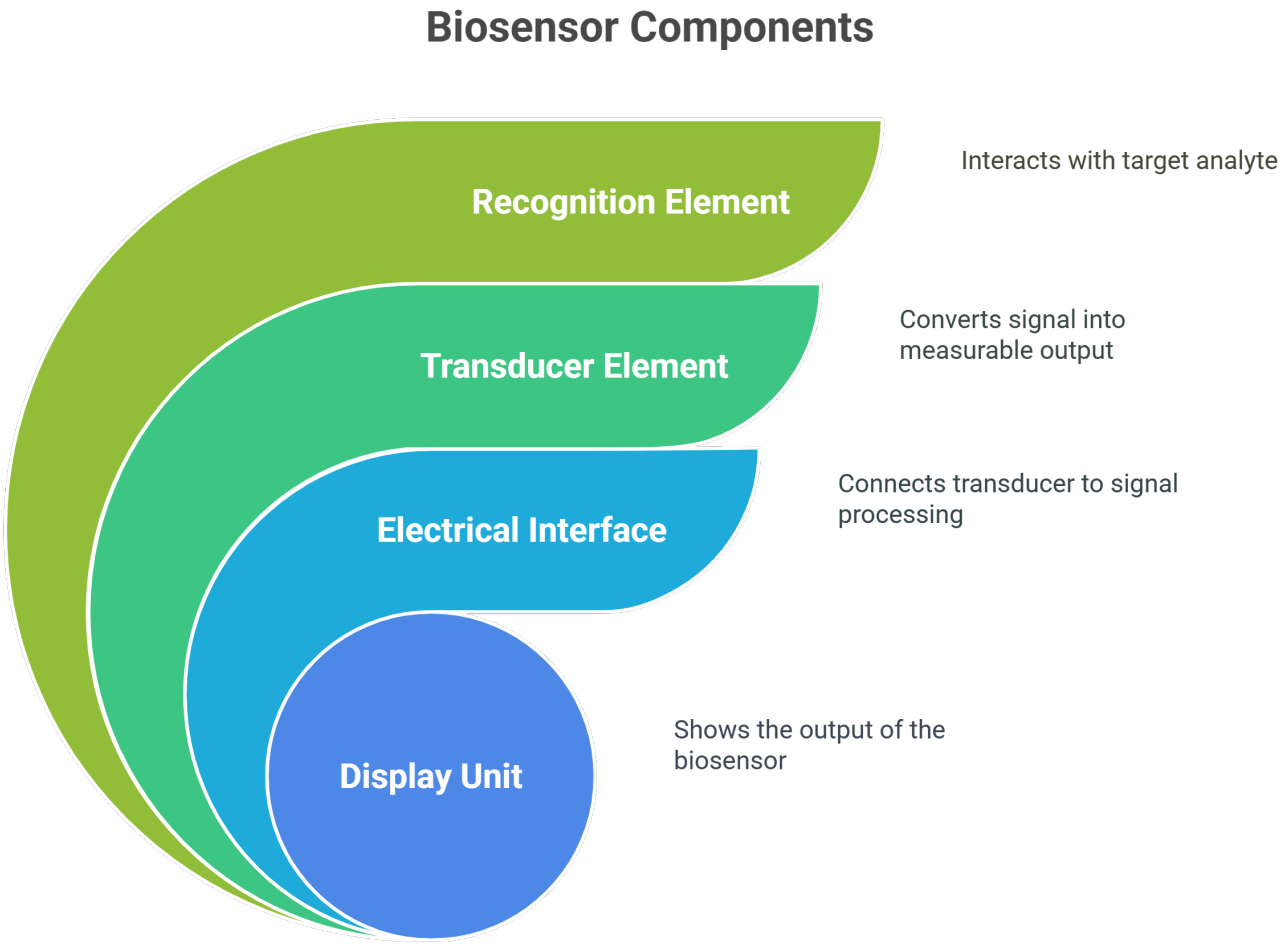
(4) (A) and (D) Only

(1). (A) and (C) Only

114. In which component of the biosensor does a whole bacterial cell work ?

(1) Electrical interface
(2) Transducer element
(3) Recognition element
(4) Display unit

(3). Recognition element



115. Arrange the following greenhouse gases in **decreasing order** of their concentration (by volume) in the Earth's atmosphere up to an altitude of 100 km.

(A) Ozone

(B) Carbon dioxide

(C) Methane

(D) Nitrous oxide

Choose the **correct** answer from the options given below :

(1) (C), (B), (D), (A)

(2) (B), (A), (C), (D)

(3) (B), (C), (D), (A)

(4) (A), (D), (C), (B)

(3). (B),(C),(D),(A)

Atmospheric Concentrations (up to 100 km altitude):

Greenhouse Gas	Typical Concentration (ppm)	Notes
Carbon dioxide (B)	~420 ppm (2023 levels)	Most abundant after H_2O vapor
Methane (C)	~1.9 ppm	Rapidly increasing
Nitrous oxide (D)	~0.3 ppm	Long-lived GHG
Ozone (A)	~0.02–0.1 ppm	Highly variable with altitude

116. A type of observational study that follows a group of participants over a period of time, examining how certain factors affect their health outcomes is referred to as :

(1) Experimental study
(2) Cohort study
(3) Case - control study
(4) Case - crossover study

(2). Cohort study

A cohort study is a type of observational study where a group of participants (called a "cohort") is followed over a period of time. The study aims to examine how certain exposures or factors affect the health outcomes of the participants.

Key characteristics of a cohort study:

- Prospective: It generally follows participants forward in time, from exposure to outcome.
- Observational: The researcher does not intervene; they only observe and record data.
- Used to study risk factors: It can be used to study the association between a risk factor (like smoking or diet) and health outcomes (like heart disease or cancer).

117. Polychloride biphenyls, PCBs :

(1) consist of more than 200 congeners with different numbers of chlorine atoms

(2) occur primarily as localized pollutants

(3) had no common uses, but were produced as manufacturing by-products

(4) are noted for their biological instability and, therefore toxicity

(1). Consist of more then 200 congeners with different numbers of chlorine atoms

Polychlorinated biphenyls (PCBs) are a group of chemical compounds that are composed of two linked biphenyl rings with chlorine atoms attached at various positions on the rings. These compounds are known to have a variety of congeners, meaning they exist in many different forms, each with a different number of chlorine atoms attached. There are more than 200 possible PCB congeners that can vary in terms of the number and position of chlorine atoms, which significantly affects their chemical properties and toxicity.

118. Match **List - I** with **List - II**.

	List - I (Chemicals)		**List - II (Purpose)**
(A)	$FeCl_3$	(I)	added to wastewater during activated sludge treatment to promote microbial growth
(B)	$Ca(OH)_2$	(II)	added to lower pH after chemical precipitation in soda-lime process
(C)	CO_2	(III)	used in the soda-lime process for removal of hardness
(D)	O_2	(IV)	added to aid in coagulation of particles before sedimentation

Choose the **correct** answer from the options given below :

(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(2) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

(3) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

(4) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(4). (A)-(IV),(B)-(III), (C)-(II),(D)-(I) as per key

The correct answer is **(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)**.

List - I (Chemicals)	List - II (Purpose)
(A) $FeCl_3$	(I) Coagulation
(B) $Ca(OH)_2$	(II) Softening
(C) CO_2	(III) Re-carbonation
(D) O_2	(IV) Aeration/Oxidation

- **$FeCl_3$ (Ferric chloride):** Used as a coagulant in water treatment to remove suspended particles.
- **$Ca(OH)_2$ (Calcium hydroxide):** Employed for softening water by precipitating hardness-causing ions.
- **CO_2 (Carbon dioxide):** Used in re-carbonation to stabilize water pH after softening.
- **O_2 (Oxygen):** Applied for aeration/oxidation to remove dissolved gases, oxidize contaminants, or support aerobic processes.

119. Choose the correct statement(s) about O_3 in atmosphere.

(A) O_3 steady state in troposphere depends on NO/NO_2 ratio.

(B) A one percent decrease in overhead O_3 is expected to result in increase of 2 percent UV-C at ground level.

(C) Ozone depleting potential is calculated with reference to CFC-111.

(D) Halons do not cause catalytic destruction of O_3 in stratosphere.

(E) HCl and $ClONO_2$ are catalytically active forms of chlorine in stratosphere.

Choose the **correct** answer from the options given below :

(1) (A), (B) and (C) Only

(2) (D) and (E) Only

(3) (A) Only

(4) (A), (B), (D) and (E) Only

(3). (A) Only

Statement	Correct?	Reasoning
(A)	✓	Tropospheric O_3 steady state depends on NO/NO_2 ratio.
(B)	X	Applies to UV-B, not UV-C (which never reaches the surface).
(C)	X	ODP is referenced to **CFC-11**, not "CFC-111".
(D)	X	Halons cause catalytic ozone destruction via bromine.
(E)	X	$HCl/ClONO_2$ are **reservoirs**; active forms are Cl/ClO.

120. The sensitivity of a remote sensing detector to differences in signal strength, is known as :

(1) Radiometric resolution
(2) Spectral resolution
(3) Spatial resolution
(4) Temporal resolution

(1). Radiometric resolution

- **Radiometric resolution** refers to the ability of a remote sensing detector to distinguish between different levels of signal intensity. It indicates the sensitivity of the sensor to differences in signal strength and how finely it can measure the intensity of the reflected or emitted electromagnetic radiation. A sensor with higher radiometric resolution can detect subtle variations in signal strength, leading to a more detailed image.
- **Spectral resolution** refers to the ability of a sensor to distinguish between different wavelengths or bands of electromagnetic radiation. It determines how finely a sensor can divide the electromagnetic spectrum.
- **Spatial resolution** refers to the smallest ground object that can be detected by the sensor. Higher spatial resolution means that the sensor can detect finer details on the Earth's surface.
- **Temporal resolution** refers to how frequently a sensor can collect data from the same location. It is related to the revisit time of the satellite or sensor.

121. Extended Producer Responsibility (EPR) mechanism has been incorporated for management of :

(A) Plastic Packaging Waste

(B) E-Waste

(C) Battery waste

(D) Used oil

(E) Waste tyre

Choose the **correct** answer from the options given below :

(1) (B) and (C) Only

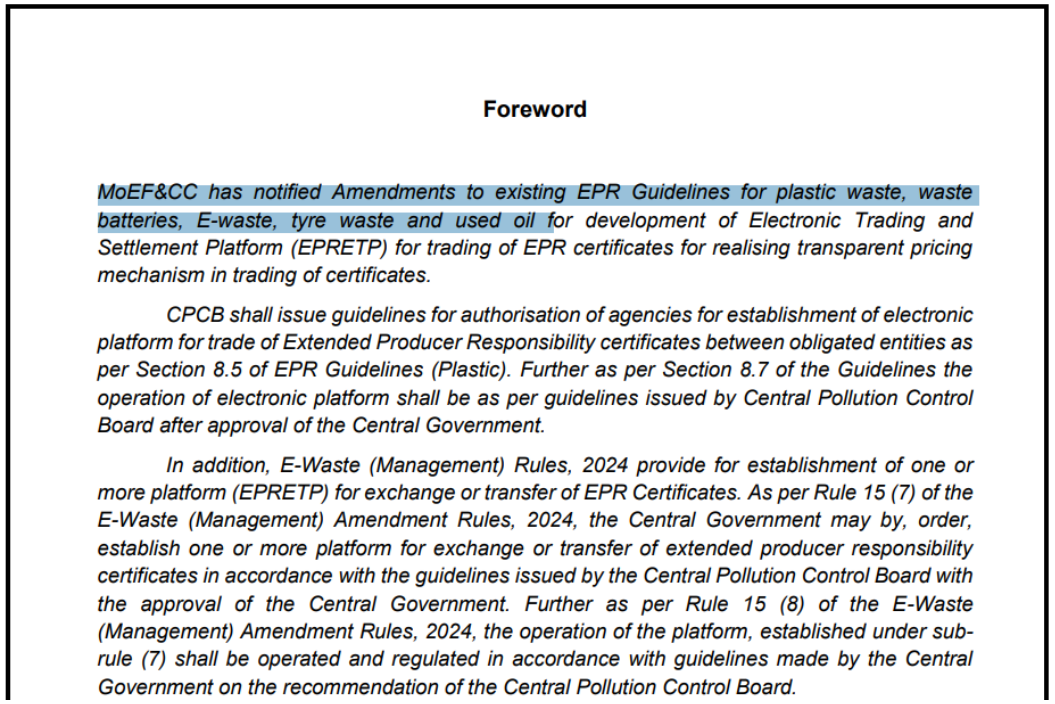
(2) (B), (C) and (D) Only

(3) (A), (B) and (C) Only

(4) (A), (B), (C), (D) and (E)

(4). (A),(B),(C),(D) and (E)

Extended Producer Responsibility (EPR) is a policy approach in which producers (manufacturers, importers, and brand owners) are given a significant responsibility—financial or physical—for the treatment or disposal of products once they are no longer useful to the consumer. This includes waste generated from the product's lifecycle, from packaging to electronic devices, batteries, used oil, etc.



Foreword

MoEF&CC has notified Amendments to existing EPR Guidelines for plastic waste, waste batteries, E-waste, tyre waste and used oil for development of Electronic Trading and Settlement Platform (EPRETP) for trading of EPR certificates for realising transparent pricing mechanism in trading of certificates.

CPCB shall issue guidelines for authorisation of agencies for establishment of electronic platform for trade of Extended Producer Responsibility certificates between obligated entities as per Section 8.5 of EPR Guidelines (Plastic). Further as per Section 8.7 of the Guidelines the operation of electronic platform shall be as per guidelines issued by Central Pollution Control Board after approval of the Central Government.

In addition, E-Waste (Management) Rules, 2024 provide for establishment of one or more platform (EPRETP) for exchange or transfer of EPR Certificates. As per Rule 15 (7) of the E-Waste (Management) Amendment Rules, 2024, the Central Government may by, order, establish one or more platform for exchange or transfer of extended producer responsibility certificates in accordance with the guidelines issued by the Central Pollution Control Board with the approval of the Central Government. Further as per Rule 15 (8) of the E-Waste (Management) Amendment Rules, 2024, the operation of the platform, established under sub-rule (7) shall be operated and regulated in accordance with guidelines made by the Central Government on the recommendation of the Central Pollution Control Board.

122. Under which conditions, atmosphere will be most stable ?
[Note : surface wind speed is measured at 10 m above the ground]

(1) wind speed of 2-3 m/s, cloudy night
(2) wind speed of 2-3 m/s, cloudy summer day
(3) wind speed of 2-3 m/s, clear night
(4) wind speed of < 2 m/s, cloudy night

(3). Wind speed of 2-3 m/s, clear night

Atmospheric stability is determined by how air behaves in response to temperature differences between the surface and the air above it. The atmosphere is most stable when the surface air is cooler than the air aloft, which tends to inhibit vertical mixing (convection).

- **Clear night:** During clear nights, the Earth's surface cools rapidly through radiation, causing the air near the surface to be cooler than the air above. This creates a stable atmospheric condition where vertical mixing is limited, and the atmosphere remains calm and stable. A moderate wind speed of 2-3 m/s doesn't disrupt this stability much.
- **Cloudy conditions:** On cloudy nights or days, clouds can trap heat, which reduces the cooling of the surface. Therefore, the air near the surface may not cool down as much, and the atmosphere may not be as stable as on a clear night.
- **Wind speed:** At wind speeds of less than 2 m/s, stability can be affected by local turbulence and the reduced mixing of air layers. When winds are stronger (greater than 2-3 m/s), they may mix the layers more, making the atmosphere less stable.

Thus, the most stable atmosphere occurs during clear nights with a moderate wind speed of 2-3 m/s.

123. Match **List - I** with **List - II**.

	List - I (Organisms)		**List - II (Associated process)**
(A)	C_3 species	(I)	Insignificant change in rate of photosynthesis with increase in CO_2 concentration
(B)	C_4 species	(II)	Increase in rate of photosynthesis with increase in CO_2 concentration
(C)	Birds and bats	(III)	Parallel evolution
(D)	Marsupial and placental mammals	(IV)	Convergent evolution

Choose the **correct** answer from the options given below :

(1) (A)-(I), (B)-(II), (C)-(IV), (D)-(III)

(2) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

(3) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(4) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(4). (A)-(II),(B)-(I), (C)-(IV),(D)-(III)

1. **C_3 species:** These plants show an increase in the rate of photosynthesis with an increase in CO_2 concentration because higher CO_2 levels reduce photorespiration, enhancing photosynthetic efficiency.

2. **C_4 species:** These plants have a CO_2-concentrating mechanism, making their photosynthesis rate less sensitive to changes in external CO_2. Hence, there is an insignificant change in the rate of photosynthesis with increased CO_2,

3. **Birds and bats:** Both can fly, but birds are avians and bats are mammals, with no recent common ancestor for flight. The evolution of flight in both is an independent adaptation to similar environmental pressures, representing convergent evolution.

4. **Marsupial and placental mammals:** Both are mammals sharing a common ancestor but diverged early. Similar traits (e.g., gliding or mole-like forms) evolved independently in each group due to similar ecological niches, illustrating parallel evolution.

124. Match **List - I** with **List - II**.

List - I (Components of time series)		**List - II (Definition)**	
(A)	Trend	(I)	Reflects the random variation of the time series value
(B)	Cyclical	(II)	Reflects a long-term movement in time series
(C)	Seasonal	(III)	An alternating sequence of points above and below a trend line lasting more than one year
(D)	Irregular	(IV)	A periodic pattern of change in time series within a year and repeated continuously

Choose the **correct** answer from the options given below :

(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(2) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

(3) (A)-(II), (B)-(IV), (C)-(III), (D)-(I)

(4) (A)-(I), (B)-(IV), (C)-(III), (D)-(II)

(2). (A)-(II),(B)-(III), (C)-(IV),(D)-(I)

- **Trend:** Reflects a long-term movement in the time series (e.g., gradual increase or decrease over years).
- **Cyclical:** Represents fluctuations lasting more than one year, often tied to economic cycles (e.g., boom and recession phases).
- **Seasonal:** Shows periodic patterns within a year that repeat continuously (e.g., higher sales in December).
- **Irregular:** Captures random, unpredictable variations (e.g., sudden spikes due to unforeseen events).

125. The shortwave radiation flux incident on the wall of a hypothetical isolated cubical building placed at a latitude of 50°N peaks in the morning period during summer season. The wall is facing which direction ?

(1) East
(2) West
(3) North
(4) South

(1). East

- During summer at a latitude of 50°N, the sun rises in the east and moves to the south as it gets higher in the sky, reaching its peak around noon in the southern sky.
- The peak of solar radiation in the morning happens when the sun is rising or just after sunrise.
- Hence, for a wall to receive the peak radiation in the morning, it must be facing east as the sun moves from the horizon in the east toward its higher positions in the sky.
- In the morning during the summer season at 50°N, the sun rises in the east and gradually moves higher in the sky towards the south at noon. Since the sun rises from the east, the wall facing east will receive the peak shortwave radiation flux in the morning, as the sun is directly incident on that surface.

126. Which feature of the chemical differentiation of Earth today reflects the influence of the iron catastrophe ?

(1) There is more iron in the core than in the crust.
(2) The lower lithosphere stores most of Earth's iron.
(3) Much of Earth's iron has escaped as a result of extraterrestrial impacts.
(4) Iron is rare in Earth.

(1). There is more iron in the core then in the crust.

- The iron catastrophe led to the separation of Earth's materials based on density. The heaviest materials, such as iron, sank toward the center of the Earth to form the core, while lighter materials formed the mantle and the crust.

- As a result, the core is composed primarily of iron and nickel, while the crust contains very little iron, especially in comparison to the core. This reflects the outcome of the iron catastrophe, where the denser iron sunk to the center during Earth's early differentiation.

127. Identify factor(s) that cause(s) the Beer's law relationship to be non linear :

(A) Polychromatic radiation

(B) Unknown chemical changes such as association or dissociation reactions

(C) Stray light

(D) Molecular or ionic interactions at high concentration

Choose the **correct** answer from the options given below :

(1) (A) Only

(2) (B) and (C) Only

(3) (A), (B) and (C) Only

(4) (A), (B), (C) and (D)

(4). (A),(B),(C) and (D)

- **Polychromatic radiation** (light containing multiple wavelengths) can cause non-linearity because Beer's Law assumes monochromatic light (single wavelength). If the light source is polychromatic, different wavelengths will interact with the sample differently, leading to variations in absorbance that don't follow a simple linear relationship.

- **Unknown chemical changes such as association or dissociation reactions:** Chemical reactions like association (molecules forming dimers or complexes) or dissociation (molecules breaking apart into smaller units) can cause deviations from Beer's Law. These reactions can change the effective concentration of the absorbing species, resulting in non-linear behavior in absorbance vs. concentration.

- **Stray light:** Stray light refers to light that is scattered or does not pass through the sample in the intended way. It can cause a deviation from Beer's Law because it artificially increases the measured light intensity, leading to an incorrect absorbance value. This results in a non-linear relationship, particularly at higher absorbance values.

- **Molecular or ionic interactions at high concentration:** At high concentrations, molecular or ionic interactions (such as aggregation or shielding effects) can occur. These interactions can alter the way the sample absorbs light, leading to a non-linear relationship between absorbance and concentration. At very high concentrations, molecules may influence each other's absorption properties, causing deviations from the expected linearity.

128. Match **List - I** with **List - II**.

	List - I (Substance)		**List - II (Chemical compounds)**
(A)	Lime stone	(I)	Calcium carbonate
(B)	Quick lime	(II)	Calcium hydroxide
(C)	Slaked lime	(III)	Aqueous solution of calcium hydroxide
(D)	Lime water	(IV)	Calcium oxide

Choose the **correct** answer from the options given below :

(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(2) (A)-(I), (B)-(IV), (C)-(II), (D)-(III)

(3) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(4) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

(2). (A)-(I),(B)-(IV), (C)-(II),(D)-(III)

- **Limestone:** Limestone is primarily composed of calcium carbonate ($CaCO_3$).
- **Quick lime:** Quick lime is produced by heating limestone to a high temperature, which causes it to decompose into calcium oxide (CaO).
- **Slaked lime**: Slaked lime is produced by adding water to quick lime (CaO), forming calcium hydroxide ($Ca(OH)_2$).
- **Lime water:** Lime water is an aqueous solution of calcium hydroxide ($Ca(OH)_2$).

129. In a solution, which of the following dissolved species would contribute positively to alkalinity ?

(A) CO_3^{2-}

(B) PO_4^{3-}

(C) HCO_3^-

(D) OH^-

(E) HS^-

Choose the **correct** answer from the options given below :

(1) (A) and (B) only

(2) (A) and (C) only

(3) (A), (C) and (D) only

(4) (A), (B), (C), (D) and (E)

(4). (A),(B),(C),(D) and (E)

- Phosphate ions (PO_4^{3-}) can act as a base and accept protons to form HPO_4^{2-}, contributing to alkalinity. So, this does contribute positively to alkalinity.
- Bicarbonate ions (HCO_3^-) are a buffer that can neutralize acids by reacting with H^+ to form H_2CO_3 (carbonic acid). Bicarbonate thus contributes positively to alkalinity.
- Hydroxide ions (OH^-) are a strong base that directly contributes to alkalinity because they can neutralize acids. They increase the alkalinity of a solution significantly.
- Hydrogen sulfide (H_2S) is an acidic compound that dissociates to produce H^+ ions, lowering the pH of the solution. Therefore, it does not contribute to alkalinity, as it is acidic.

130. A noise level meter placed at a distance of 5 m from a point source of noise, records a sound pressure level of 78 dB. If the noise level meter is placed at a distance of 20 m from the point source, the sound pressure level recorded will be approximately :

(1) 66 dB
(2) 69 dB
(3) 72 dB
(4) 75 dB

(1). 66 dB

To determine the sound pressure level (SPL) at a new distance from a point source, we use the inverse square law, which states that sound intensity decreases with the square of the distance from the source. The formula for the change in sound pressure level (in dB) is:

$$\Delta L = 20 \log_{10} \left(\frac{r_1}{r_2} \right)$$

$$\frac{r_1}{r_2} = \frac{5}{20} = \frac{1}{4}$$

$$\Delta L = 20 \log_{10} \left(\frac{1}{4} \right) = 20 \times (-0.602) \approx -12 \text{ dB}$$

$$L_2 = 78 \text{ dB} + (-12 \text{ dB}) = 66 \text{ dB}$$

131. A species originates :

(1) only from natural selection

(2) only from reproductive isolation

(3) from natural selection when it is coupled with reproductive isolation

(4) neither from natural selection nor from reproductive isolation

(3). from natural selection when it is coupled with reproductive isolation

Species formation, or speciation, is a complex process that typically occurs through a combination of natural selection and reproductive isolation.

Natural selection: This is the process where individuals with traits that are better suited to their environment tend to survive and reproduce more successfully. Over time, this can lead to the accumulation of favorable traits in a population, driving divergence between populations.

Reproductive isolation: For speciation to occur, two populations must become reproductively isolated, meaning they can no longer interbreed successfully. This isolation can occur due to geographical barriers (geographic isolation), behavioral differences, or other factors like temporal or mechanical isolation.

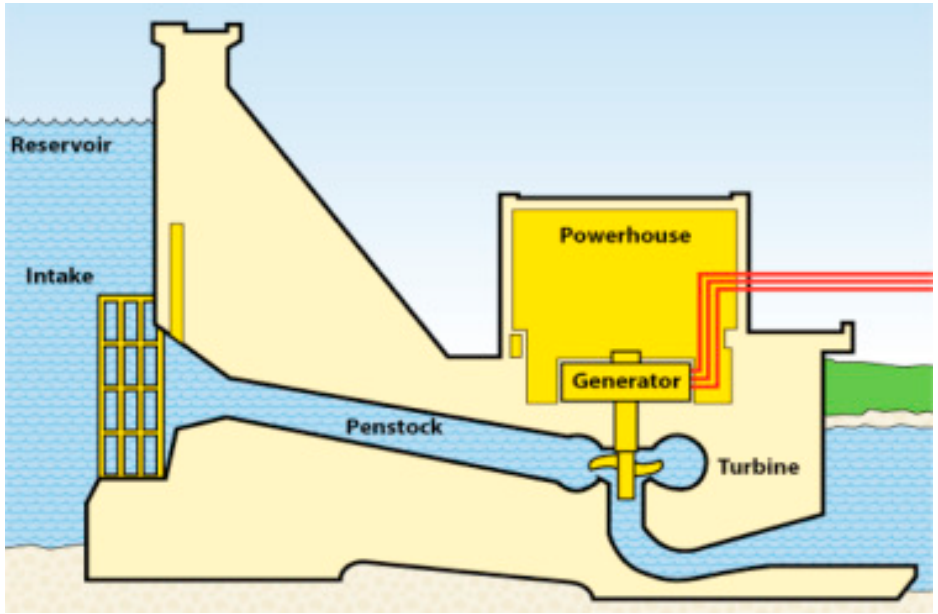
When natural selection causes populations to adapt to different environments or niches and reproductive isolation prevents gene flow between these populations, speciation is more likely to occur. Over time, this can result in the emergence of new species.

132. In a hydropower plant, huge pipes that deliver water to the turbines are known as :

(1) Head
(2) Reservoir
(3) Penstock
(4) Spillway

(3). Penstock

in a hydropower plant, the **penstock** is the large pipe or conduit that carries water from the reservoir to the turbines. The pressure from the water flowing through the penstock is used to turn the turbine blades, generating electricity.



Head: Refers to the height difference between the water source (reservoir) and the turbine, which determines the potential energy available for conversion into mechanical energy.

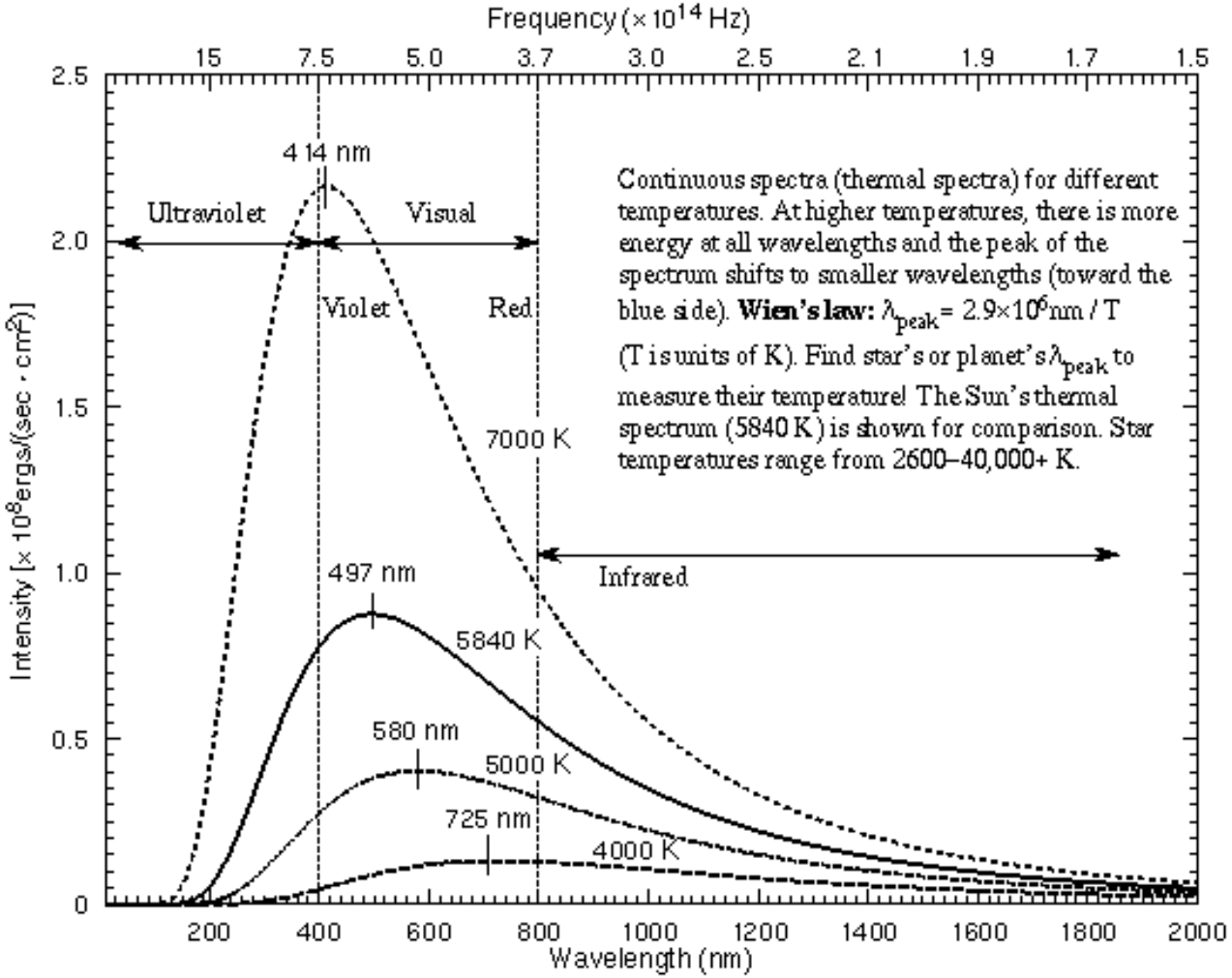
Reservoir: This is the large storage area where water is collected and stored before it is released through the penstock to the turbines.

Spillway: This is a structure used to release excess water from the reservoir, typically when the water level is too high, to prevent flooding or damage to the dam.

133. The intensity of solar radiation reaching at the top of the atmosphere of Earth, is maximum at ~500 nm. This can be explained by :

(1) Stefens-Boltzman Law
(2) Wein's displacement Law
(3) Kirchoff's Law
(4) Kepler's Law

(2). Wien's displacement Law



134. Match **List - I** with **List - II**.

	List - I (Process)		**List - II (Product)**
(A)	Dissolution of calcite	(I)	Chert
(B)	Oxidation of olivine	(II)	Kaolinite
(C)	Hydrolysis of orthoclase	(III)	Hematite
(D)	Hydrolysis of quartz	(IV)	Travertine

Choose the **correct** answer from the options given below :

(1) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(2) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

(3) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(4) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

(A)-(IV), (B)-(III), (C)-(II), (D)-(I).

Dissolution of calcite:

Calcite dissolves in water containing CO_2 to form calcium bicarbonate. When this solution evaporates or loses CO_2, **travertine** (a form of calcium carbonate) precipitates.

Oxidation of olivine:

Olivine (a ferromagnesian silicate) undergoes oxidation, forming iron oxides such as **hematite** (Fe_2O_3).

Hydrolysis of orthoclase:

Orthoclase (a feldspar mineral) reacts with water and CO_2 to form **kaolinite** (a clay mineral) along with dissolved silica and potassium ions.

Hydrolysis of quartz:

Quartz is highly resistant to chemical weathering, but under extreme conditions, it slowly dissolves to form **chert** (microcrystalline silica) as a secondary precipitate.

135. According to Beaufort wind scale, what is the correct **increasing order** of wind-speed of the following ?

(A) Storm

(B) Gale

(C) Hurricane

(D) Breeze

Choose the **correct** answer from the options given below :

(1) (A), (B), (D), (C)

(2) (A), (C), (B), (D)

(3) (D), (B), (C), (A)

(4) (D), (B), (A), (C)

(4). (D),(B),(A),(C)

- **Breeze:** A gentle wind, typically ranging from 1 to 7 knots (1-13 mph), which corresponds to Beaufort scale levels 1-3.
- **Gale:** A strong wind, typically between 34 to 40 knots (39-46 mph), corresponding to Beaufort scale levels 7-8.
- **Storm:** A very strong wind, typically between 48 to 55 knots (55-63 mph), corresponding to Beaufort scale levels 9-10.
- **Hurricane:** Extremely strong winds, generally 64 knots (74 mph) or more, corresponding to Beaufort scale level 12.

136. Which of the following is the correct criterion for site selection of sanitary landfills according to Solid Waste Management Rules 2016 ?

(1) at least 100 meters away from river
(2) at least 100 meters away from highways
(3) at least 100 meters away from schools
(4) at least 5 Kilometers away from Airports

(1). at least 100meters away from river

According to the Solid Waste Management Rules, 2016, for a sanitary landfill to be sited properly and avoid contamination of water resources, it must be located at least 100 meters away from rivers to prevent leachate from contaminating surface water bodies.

Other factors considered during the site selection may include avoiding proximity to residential areas, schools, and other sensitive zones, but the specified minimum distance from rivers is 100 meters in this case.

137. Match **List - I** with **List - II**.

List - I (Conference of the Parties (UNFCCC))		**List - II** (City)
(A)	COP26	(I) Baku
(B)	COP27	(II) Dubai
(C)	COP28	(III) Sharmel-Sheikh
(D)	COP29	(IV) Glasgow

Choose the **correct** answer from the options given below :

(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(2) (A)-(I), (B)-(III), (C)-(II), (D)-(IV)

(3) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

(4) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(4). (A)-(IV),(B)-(III), (C)-(II),(D)-(I)

- COP26 took place in Glasgow in 2021.
- COP27 took place in Sharm El-Sheikh, Egypt, in 2022.
- COP28 took place in Dubai, UAE, in 2023.
- COP29 took place in Baku, Azerbaijan (2024).

138. Arrange the following in the **increasing order** of relative concentration of dissolved oxygen in lake water.

(A) Oligotrophic lakes
(B) Eutrophic lakes
(C) Mesotrophic lakes
(D) Hypereutrophic lakes

Choose the **correct** answer from the options given below :

(1) (A), (B), (C), (D)
(2) (D), (B), (C), (A)
(3) (A), (C), (B), (D)
(4) (D), (C), (B), (A)

(2). (D),(B),(C),(A)

In terms of dissolved oxygen concentration in lake water, the general trend is as follows:

1. **Oligotrophic lakes** – These are nutrient-poor lakes with clear water. They typically have high levels of dissolved oxygen because there is less organic matter to decompose.
2. **Mesotrophic lakes** – These are moderately nutrient-rich lakes. They have moderate levels of dissolved oxygen, as the nutrient levels are higher than in oligotrophic lakes, but not as high as in eutrophic lakes.
3. **Eutrophic lakes** – These lakes are rich in nutrients, particularly nitrogen and phosphorus. They tend to have lower dissolved oxygen levels, especially in the deeper parts, due to increased microbial activity from decomposing organic matter.
4. **Hypereutrophic lakes** – These are highly nutrient-enriched lakes, typically resulting in excessive algal blooms. As a result, they have the lowest levels of dissolved oxygen, especially during the decomposition of algae and other organic material.

139. Radiation pertaining to wavelengths suitable for photosynthesis is about :

(1) 44 % of incident shortwave radiation

(2) 74 % of incident shortwave radiation

(3) 84 % of incident shortwave radiation

(4) 94 % of incident shortwave radiation

(1). 44% of incident shortwave radiation

- Shortwave radiation includes all wavelengths of light from the Sun, but only a small portion of this range (the visible light spectrum, which is around 400–700 nm) is absorbed by plants for photosynthesis.
- 44% represents the approximate proportion of incident shortwave radiation that is used in the process of photosynthesis. This is often referred to as photosynthetically active radiation (PAR).

140. Which of the following gases absorbs outgoing terrestrial radiation in longwave atmospheric window ?

(1) Oxygen
(2) Water vapour
(3) Ozone
(4) Nitrogen dioxide

(3). Ozone

Answer: Water vapour.

The longwave atmospheric window refers to the range of infrared wavelengths (8–14 μm) where Earth's thermal radiation escapes to space. However, certain greenhouse gases absorb some of this outgoing radiation, trapping heat in the atmosphere.

Oxygen (O_2) and Nitrogen dioxide (NO_2) do not significantly absorb longwave radiation in this window.

Ozone (O_3) primarily absorbs UV radiation and has minor absorption in the 9–10 μm range, but its effect is limited compared to water vapour.

Water vapour (H_2O) is the dominant absorber in the longwave atmospheric window, particularly around 6.3 μm and beyond 12 μm, effectively trapping outgoing terrestrial radiation.

141. Comprehension:

Read the following passage and answer the questions below :

The first phototrophs were anoxygenic and likely used H_2S as electron donor for CO_2 fixation, generating elemental sulfur (S^0) as a waste product. How could the first phototrophs have evolved at a time when life existed mostly near hydrothermal systems ? A clue came from the recent discovery of anoxygenic phototrophs living at hydrothermal vents in the complete darkeness of the deep ocean. These phototrophs actually carry out photosynthesis using infrared radiation generated by the heat of hydrothermal vents. Likewise, the first photosynthetic organisms likely lived in the dark, at hydrothermal vents where H_2S and infrared radiation were abundant. Diversification of anoxygenic phototrophs led to species that were able to use a range of electron donors including Fe^{2+}, which was abundant throughout Earth's early oceans. The ability to use Fe^{2+} as an electron donor likely allowed early phototrophs to escape from hydrothermal systems and colonize shallow regions of Earth's early oceans where light was abundant but where overlying water still provided protection from UV radiation. The ability to use solar radiation as an energy source allowed phototrophs to diversify extensively. By 2.5-3.3 bya, the cyanobacterial lineage evolved a photosystem capable of oxygenic photosynthesis in which H_2O supplanted H_2S as the reductant for CO_2, thereby generating O_2 as a waste product. About a billion years later, eukaryotic oxygen phototrophs appeared and can be seen in the microfossil record.

Which of the following chemical species played a crucial role in the early phototrophs' colonization in the shallow waters of Earth's early oceans ?

(1) H_2O
(2) O_2
(3) Fe^{2+}
(4) CO_2

(3). Fe^{2+}

The early phototrophs, particularly an oxygenic phototrophs, likely evolved in the absence of significant atmospheric oxygen and used different electron donors for photosynthesis. One crucial electron donor for early phototrophs was Fe^{2+} (ferrous iron), which was abundant in Earth's early oceans.

- Fe^{2+} (ferrous iron) could serve as an electron donor in the process of photosynthesis, allowing these organisms to perform an oxygenic photosynthesis (photosynthesis without the production of oxygen). This capability enabled early phototrophs to thrive in shallow waters where sunlight was abundant but where UV radiation was still filtered by the overlying water.

As a result, the use of Fe^{2+} allowed these early organisms to colonize new environments outside of the hydrothermal vents and diversify.

- H_2S (Hydrogen sulfide) was also an electron donor in some early phototrophs, but the widespread availability of Fe^{2+} in Earth's early oceans played a more significant role in enabling colonization of shallow regions.

This process marked a significant step in the evolution of photosynthetic organisms and their ability to use light as an energy source while avoiding the dangers of UV radiation.

142. Comprehension:

Read the following passage and answer the questions below :

The first phototrophs were anoxygenic and likely used H_2S as electron donor for CO_2 fixation, generating elemental sulfur (S^0) as a waste product. How could the first phototrophs have evolved at a time when life existed mostly near hydrothermal systems ? A clue came from the recent discovery of anoxygenic phototrophs living at hydrothermal vents in the complete darkeness of the deep ocean. These phototrophs actually carry out photosynthesis using infrared radiation generated by the heat of hydrothermal vents. Likewise, the first photosynthetic organisms likely lived in the dark, at hydrothermal vents where H_2S and infrared radiation were abundant. Diversification of anoxygenic phototrophs led to species that were able to use a range of electron donors including Fe^{2+}, which was abundant throughout Earth's early oceans. The ability to use Fe^{2+} as an electron donor likely allowed early phototrophs to escape from hydrothermal systems and colonize shallow regions of Earth's early oceans where light was abundant but where overlying water still provided protection from UV radiation. The ability to use solar radiation as an energy source allowed phototrophs to diversify extensively. By 2.5-3.3 bya, the cyanobacterial lineage evolved a photosystem capable of oxygenic photosynthesis in which H_2O supplanted H_2S as the reductant for CO_2, thereby generating O_2 as a waste product. About a billion years later, eukaryotic oxygen phototrophs appeared and can be seen in the microfossil record.

The early photosynthetic organisms likely existed in :

(1) Surface waters
(2) Shallow regions of oceans
(3) Layers of oceans where visible light was abundant but UV light was absent
(4) Deep in the oceans at specific places in ocean bottoms

(4). Deep in the oceans at specific places in ocean bottoms

The early photosynthetic organisms, particularly an oxygenic phototrophs, likely evolved in environments where light was scarce, such as hydrothermal vents deep in the oceans. The passage mentions that these organisms lived in the darkness of the deep ocean, utilizing infrared radiation generated by the heat of hydrothermal vents for photosynthesis. These organisms did not rely on sunlight directly, but on heat-generated radiation from the hydrothermal systems.
Additionally, the passage suggests that these phototrophs initially lived near hydrothermal systems in the deep ocean where visible light was not abundant, and their ability to use various electron donors, including Fe^{2+}, allowed them to thrive in such specific places.
This environment provided the necessary conditions for early phototrophs to perform an oxygenic photosynthesis without exposure to harmful UV radiation, which would have been detrimental in the absence of atmospheric protection. Therefore, the correct location of these early photosynthetic organisms would be the deep ocean at specific places near hydrothermal vents.

143. Comprehension:

Read the following passage and answer the questions below :

The first phototrophs were anoxygenic and likely used H_2S as electron donor for CO_2 fixation, generating elemental sulfur (S^0) as a waste product. How could the first phototrophs have evolved at a time when life existed mostly near hydrothermal systems ? A clue came from the recent discovery of anoxygenic phototrophs living at hydrothermal vents in the complete darkeness of the deep ocean. These phototrophs actually carry out photosynthesis using infrared radiation generated by the heat of hydrothermal vents. Likewise, the first photosynthetic organisms likely lived in the dark, at hydrothermal vents where H_2S and infrared radiation were abundant. Diversification of anoxygenic phototrophs led to species that were able to use a range of electron donors including Fe^{2+}, which was abundant throughout Earth's early oceans. The ability to use Fe^{2+} as an electron donor likely allowed early phototrophs to escape from hydrothermal systems and colonize shallow regions of Earth's early oceans where light was abundant but where overlying water still provided protection from UV radiation. The ability to use solar radiation as an energy source allowed phototrophs to diversify extensively. By 2.5-3.3 bya, the cyanobacterial lineage evolved a photosystem capable of oxygenic photosynthesis in which H_2O supplanted H_2S as the reductant for CO_2, thereby generating O_2 as a waste product. About a billion years later, eukaryotic oxygen phototrophs appeared and can be seen in the microfossil record.

The first photosynthetic organisms likely released :

(1) S^0
(2) H_2S
(3) CO_2
(4) O_2

(1). S^o

2nd line of paragraph

144. Comprehension:

Read the following passage and answer the questions below :

The first phototrophs were anoxygenic and likely used H_2S as electron donor for CO_2 fixation, generating elemental sulfur (S^0) as a waste product. How could the first phototrophs have evolved at a time when life existed mostly near hydrothermal systems ? A clue came from the recent discovery of anoxygenic phototrophs living at hydrothermal vents in the complete darkeness of the deep ocean. These phototrophs actually carry out photosynthesis using infrared radiation generated by the heat of hydrothermal vents. Likewise, the first photosynthetic organisms likely lived in the dark, at hydrothermal vents where H_2S and infrared radiation were abundant. Diversification of anoxygenic phototrophs led to species that were able to use a range of electron donors including Fe^{2+}, which was abundant throughout Earth's early oceans. The ability to use Fe^{2+} as an electron donor likely allowed early phototrophs to escape from hydrothermal systems and colonize shallow regions of Earth's early oceans where light was abundant but where overlying water still provided protection from UV radiation. The ability to use solar radiation as an energy source allowed phototrophs to diversify extensively. By 2.5-3.3 bya, the cyanobacterial lineage evolved a photosystem capable of oxygenic photosynthesis in which H_2O supplanted H_2S as the reductant for CO_2, thereby generating O_2 as a waste product. About a billion years later, eukaryotic oxygen phototrophs appeared and can be seen in the microfossil record.

Identify the most probable time when the ability to use water for photosynthesis developed in the organisms.

(1) 3.8 billion years ago
(2) 3 billion years ago
(3) 4 billion years ago
(4) 4.3 billion years ago

(2). 3 billion years ago

145. Comprehension:

Read the following passage and answer the questions below :

The first phototrophs were anoxygenic and likely used H_2S as electron donor for CO_2 fixation, generating elemental sulfur (S^0) as a waste product. How could the first phototrophs have evolved at a time when life existed mostly near hydrothermal systems ? A clue came from the recent discovery of anoxygenic phototrophs living at hydrothermal vents in the complete darkeness of the deep ocean. These phototrophs actually carry out photosynthesis using infrared radiation generated by the heat of hydrothermal vents. Likewise, the first photosynthetic organisms likely lived in the dark, at hydrothermal vents where H_2S and infrared radiation were abundant. Diversification of anoxygenic phototrophs led to species that were able to use a range of electron donors including Fe^{2+}, which was abundant throughout Earth's early oceans. The ability to use Fe^{2+} as an electron donor likely allowed early phototrophs to escape from hydrothermal systems and colonize shallow regions of Earth's early oceans where light was abundant but where overlying water still provided protection from UV radiation. The ability to use solar radiation as an energy source allowed phototrophs to diversify extensively. By 2.5-3.3 bya, the cyanobacterial lineage evolved a photosystem capable of oxygenic photosynthesis in which H_2O supplanted H_2S as the reductant for CO_2, thereby generating O_2 as a waste product. About a billion years later, eukaryotic oxygen phototrophs appeared and can be seen in the microfossil record.

The first phototrophs used which of the following types of radiations for photosynthesis ?

(1) Ultraviolet
(2) Violet
(3) Infrared
(4) Yellow

(3). Infrared

146. Comprehension:

Read the following passage and answer the questions below :

Waves expend their energy when they reach the coastline. But, the amount is surprisingly large. For example, the energy expended on a 400 km length of open coastline by waves with a height of about 1 m over a given period of time is approximately equivalent to the energy produced by one average-sized nuclear power plant over the same time period. Wave energy is approximately proportional to the square of the wave height. Thus, if wave height increases to 5 m, which is typical for large storms, then the energy expended, or wave power, increases 25 times over that of waves with a height of 1 m. When waves enter the coastal zone and shallow water, they impinge on the bottom and become steeper. Wave steepness is the ratio of wave height to wave length. Waves are unstable when the wave height is greater than about 10 percent (0.1) of the wave length. As waves move into shallow water, the wave period remains constant, but wave length and velocity decrease and wave height increases. The waves change shape from the rounded crests and troughs in deep water to peaked crests with relatively flat troughs in shallow water close to shore. Perhaps the most dramatic feature of waves entering shallow water is their rapid increase in height. The height of waves in shallow water, where they break, may be as much as twice their deep-water height.

Which of the following is a characteristic of the shallow water close to shore ?

(1) Rounded crests
(2) Rounded troughs
(3) Flat troughs
(4) Peaked troughs

(3). Flat troughs

147. Comprehension:

Read the following passage and answer the questions below :

Waves expend their energy when they reach the coastline. But, the amount is surprisingly large. For example, the energy expended on a 400 km length of open coastline by waves with a height of about 1 m over a given period of time is approximately equivalent to the energy produced by one average-sized nuclear power plant over the same time period. Wave energy is approximately proportional to the square of the wave height. Thus, if wave height increases to 5 m, which is typical for large storms, then the energy expended, or wave power, increases 25 times over that of waves with a height of 1 m. When waves enter the coastal zone and shallow water, they impinge on the bottom and become steeper. Wave steepness is the ratio of wave height to wave length. Waves are unstable when the wave height is greater than about 10 percent (0.1) of the wave length. As waves move into shallow water, the wave period remains constant, but wave length and velocity decrease and wave height increases. The waves change shape from the rounded crests and troughs in deep water to peaked crests with relatively flat troughs in shallow water close to shore. Perhaps the most dramatic feature of waves entering shallow water is their rapid increase in height. The height of waves in shallow water, where they break, may be as much as twice their deep-water height.

Which of the following corresponds to an unstable wave ?

(1) Wave height = 2m Wavelength = 30m
(2) Wave height = 2.5m Wavelength = 20m
(3) Wave height = 3m Wavelength = 40m
(4) Wave height = 1.5m Wavelength = 25m

(2). Wave height=2.5m Wavelength=20m

To determine which wave is unstable, we need to compare the wave height to the wavelength. According to the passage, waves become unstable when the wave height is greater than about 10% of the wavelength (i.e., the ratio of wave height to wavelength exceeds 0.1).

- Option 1: Wave height = 2m, Wavelength = 30m
  Ratio = 2 / 30 = 0.067 **(Stable)**
- **Option 2:** Wave height = 2.5m, Wavelength = 20m
  Ratio = 2.5 / 20 = 0.125 **(Unstable)**
- Option 3: Wave height = 3m, Wavelength = 40m
  Ratio = 3 / 40 = 0.075 **(Stable)**
- Option 4: Wave height = 15m, Wavelength = 25m
  Ratio = 1.5 / 25 = 0.06 **(Stable)**

148. Comprehension:

Read the following passage and answer the questions below :

Waves expend their energy when they reach the coastline. But, the amount is surprisingly large. For example, the energy expended on a 400 km length of open coastline by waves with a height of about 1 m over a given period of time is approximately equivalent to the energy produced by one average-sized nuclear power plant over the same time period. Wave energy is approximately proportional to the square of the wave height. Thus, if wave height increases to 5 m, which is typical for large storms, then the energy expended, or wave power, increases 25 times over that of waves with a height of 1 m. When waves enter the coastal zone and shallow water, they impinge on the bottom and become steeper. Wave steepness is the ratio of wave height to wave length. Waves are unstable when the wave height is greater than about 10 percent (0.1) of the wave length. As waves move into shallow water, the wave period remains constant, but wave length and velocity decrease and wave height increases. The waves change shape from the rounded crests and troughs in deep water to peaked crests with relatively flat troughs in shallow water close to shore. Perhaps the most dramatic feature of waves entering shallow water is their rapid increase in height. The height of waves in shallow water, where they break, may be as much as twice their deep-water height.

When waves move into shallow water, which of the following would NOT change ?

(1) Wave height
(2) Wave length
(3) Wave velocity
(4) Wave period

(4). Wave period

149. Comprehension:

Read the following passage and answer the questions below :

Waves expend their energy when they reach the coastline. But, the amount is surprisingly large. For example, the energy expended on a 400 km length of open coastline by waves with a height of about 1 m over a given period of time is approximately equivalent to the energy produced by one average-sized nuclear power plant over the same time period. Wave energy is approximately proportional to the square of the wave height. Thus, if wave height increases to 5 m, which is typical for large storms, then the energy expended, or wave power, increases 25 times over that of waves with a height of 1 m. When waves enter the coastal zone and shallow water, they impinge on the bottom and become steeper. Wave steepness is the ratio of wave height to wave length. Waves are unstable when the wave height is greater than about 10 percent (0.1) of the wave length. As waves move into shallow water, the wave period remains constant, but wave length and velocity decrease and wave height increases. The waves change shape from the rounded crests and troughs in deep water to peaked crests with relatively flat troughs in shallow water close to shore. Perhaps the most dramatic feature of waves entering shallow water is their rapid increase in height. The height of waves in shallow water, where they break, may be as much as twice their deep-water height.

Energy expended by waves of height 2 m on a 1000 km length of open coastline would be approximately equivalent to the energy produced by how many average sized nuclear power plants ?

(1) 10
(2) 4
(3) 2.5
(4) 5

(1). 10

150. Comprehension:

Read the following passage and answer the questions below :

Waves expend their energy when they reach the coastline. But, the amount is surprisingly large. For example, the energy expended on a 400 km length of open coastline by waves with a height of about 1 m over a given period of time is approximately equivalent to the energy produced by one average-sized nuclear power plant over the same time period. Wave energy is approximately proportional to the square of the wave height. Thus, if wave height increases to 5 m, which is typical for large storms, then the energy expended, or wave power, increases 25 times over that of waves with a height of 1 m. When waves enter the coastal zone and shallow water, they impinge on the bottom and become steeper. Wave steepness is the ratio of wave height to wave length. Waves are unstable when the wave height is greater than about 10 percent (0.1) of the wave length. As waves move into shallow water, the wave period remains constant, but wave length and velocity decrease and wave height increases. The waves change shape from the rounded crests and troughs in deep water to peaked crests with relatively flat troughs in shallow water close to shore. Perhaps the most dramatic feature of waves entering shallow water is their rapid increase in height. The height of waves in shallow water, where they break, may be as much as twice their deep-water height.

If wave height increases by 3 times, wave energy would increase by :

(1) 3 times
(2) 6 times
(3) 9 times
(4) 12 times

(3). 9 times

Wave energy is proportional to the square of the wave height. This means that if the wave height increases by a factor of 3, the energy expended by the wave would increase by a factor of square of 3, the energy would increase 9 times.