

General Science Questions for the RRB NTPC Graduate and UG Exam 2026

Q.1 Why did Mendeleev leave gaps in his periodic table?

- A. For undiscovered elements
- B. To include isotopes
- C. To avoid repetition of elements
- D. To make the table look symmetrical

Answer: A

Sol: The correct answer is **(A) For undiscovered elements**

Explanation:

- Dmitri Mendeleev, while arranging elements in increasing atomic mass, observed that certain elements did not fit the pattern and left **intentional gaps** in his periodic table.
- He predicted that these gaps would be filled by **elements that were not discovered at that time** but would be found in the future.
- Later discoveries like **gallium (eka-aluminium)** and **germanium (eka-silicon)** confirmed his predictions and proved the effectiveness of his periodic law.

Information Booster:

- Mendeleev published his periodic table in **1869**.
- He arranged elements on the basis of **atomic mass** and chemical properties.
- His table contained 63 known elements.
- He even predicted the properties of future elements.
- Modern periodic law later shifted to **atomic number** (Moseley).

Q.2 What is the relation between the frequency (f) and time period (T) of a sound wave?

- A. $f = T$
- B. $f = 1/T$
- C. $f = T/2$
- D. $f = 2T$

Answer: B

Sol: Correct Answer: (B) $f = 1/T$

Explanation:

- The relationship between frequency (f) and time period (T) is **inversely proportional**.
- **Time Period (T):** This is the time taken by the wave to complete one full oscillation or cycle. Its SI unit is the second (s).
- **Frequency (f):** This is the number of complete oscillations or cycles occurring per unit of time (usually one second). Its SI unit is the Hertz (Hz).
- Since frequency counts how many cycles happen in a second and time period is the duration of one single cycle, they are mathematically the reciprocals of each other.

Information Booster:

- A wave with a high frequency will have a very short time period because the cycles are happening very rapidly.
- Conversely, a wave with a low frequency will have a long time period because each cycle takes more time to complete.
- This relationship ($f = 1/T$) is fundamental to all types of periodic motion, including sound waves, light waves, and the motion of a simple pendulum.

Additional Knowledge:

- **Option (A):** $f = T$ would mean frequency and time period are identical, which is physically impossible as they have different dimensions and units (s^{-1} vs s).
- **Option (C):** $f = T/2$ suggests frequency is half the time period, which does not represent the reciprocal physical nature of these properties.
- **Option (D):** $f = 2T$ suggests frequency increases as the time taken for one cycle increases, which contradicts the definition of frequency.

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Q.3 The mention of DNA as a long polymer of deoxyribonucleotides implies which structural characteristic?

- A. It is composed of a sugar-phosphate backbone and nitrogenous bases.
- B. Each nucleotide is linked by hydrogen bonds in a parallel fashion.
- C. The sequence is circular and self-replicating.
- D. The molecule consists of multiple independent short chains.

Answer: A

Sol: The correct answer is (A) It is composed of a sugar-phosphate backbone and nitrogenous bases.

Explanation:

- DNA is a **long polymer made of repeating units called deoxyribonucleotides**.
- Each nucleotide consists of **deoxyribose sugar, phosphate group, and nitrogenous base**.
- These form a **sugar-phosphate backbone**, with bases projecting inside to form base pairs.

Information Booster:

- DNA is a **double helix**, discovered by **Watson & Crick (1953)**.
- Nitrogenous bases: **A, T, G, C**.
- Base pairing rule: **A-T and G-C** (Chargaff's Rule).
- Bonds: **Phosphodiester bonds** join nucleotides; **hydrogen bonds** join base pairs.
- DNA is stored in chromosomes within the **nucleus** (in eukaryotes).

Q.4 What is the name of the principle which states that each point on a wavefront acts as a source of secondary wavelets that spread in all directions and form a new wavefront?

- A. Doppler's Principle
- B. Superposition Principle
- C. Huygens' Principle
- D. Fermat's Principle

Answer: C

Sol: Correct Answer: (c) Huygens' Principle

Explanation:

- **Huygens' Principle** states that **every point on a wavefront acts as a source of secondary spherical wavelets**, which spread out in all directions.
- The **new wavefront** at any later time is the **tangent surface** to all these secondary wavelets.

Information Booster:

- Proposed by **Christiaan Huygens** in 1678.
- Used to explain:
 - **Reflection**
 - **Refraction** (with Huygens-Fresnel extension)
 - **Diffraction**
 - **Interference**
- Essential in understanding the **wave nature of light**.

Additional Knowledge:

- **Doppler's Principle (a):** Explains the **change in frequency or wavelength** due to relative motion between source and observer (e.g., ambulance siren).
- **Superposition Principle (b):** States that when two or more waves overlap, the resultant displacement is the **algebraic sum** of individual displacements.
- **Fermat's Principle (d):** States that light travels between two points by the path that **requires the least time**.

Q.5 What is the relation between the speed of sound $\{v\}$, its wavelength $\{\lambda\}$ and time period $\{T\}$?

- A. $\{v = \lambda \times T\}$
- B. $\{v = \lambda / T\}$
- C. $\{v = T / \lambda\}$
- D. $\{v = \lambda + T\}$

Answer: B

Sol:

The correct answer is (b) $\{v = \lambda / T\}$

Explanation:

- Speed is defined as distance divided by time. In wave mechanics, the distance covered in one cycle is the wavelength $\{\lambda\}$.
- The time taken for one complete cycle is the time period $\{T\}$.
- Therefore, the formula for speed is $\{v = \lambda / T\}$.

Information Booster:

- Since frequency (f) is the reciprocal of the time period ($f = 1/T$), the formula can also be written as $v = f \times \lambda$.
- In a given medium under constant physical conditions, the speed of sound remains constant for all frequencies.

Additional Knowledge:

- The speed of sound is highest in solids and lowest in gases.
- Sound waves are longitudinal waves, meaning particles of the medium vibrate parallel to the direction of wave travel.

Q.6 Rutherford's planetary model of atom is also called the _____.

- Discrete energy orbit model of atom
- Nuclear model of atom
- Wave model of atom
- Plum pudding model of atom

Answer: B

Sol: Correct Answer: (b) Nuclear model of atom

Explanation:

- Rutherford's model is called the **Nuclear Model of Atom** because he proposed that the atom has a **small, dense, positively charged nucleus** at the center with electrons revolving around it like planets around the sun.

Information Booster:

- The model was based on the **gold foil experiment**, where most alpha particles passed through but some were deflected, indicating a concentrated mass (nucleus).
- This model disproved Thomson's plum pudding concept.

Additional Knowledge:

- **(a) Discrete energy orbit model:** Refers to Bohr's model, not Rutherford's.
- **(c) Wave model of atom:** Related to quantum mechanical model (Schrödinger).
- **(d) Plum pudding model:** J.J. Thomson's model where electrons were embedded in a positively charged sphere.

Q.7 In renal physiology, which segment of the nephron is most critical for generating the osmotic gradient that concentrates urine?

- Collecting duct
- Loop of Henle
- Distal convoluted tubule
- Proximal convoluted tubule

Answer: B

Sol: Correct Answer: (B) Loop of Henle

Explanation:

- The **Loop of Henle**, especially its **thick ascending limb**, is the most critical nephron segment for creating the **osmotic gradient** in the renal medulla.
- This gradient is essential for the **concentration of urine**, enabling water reabsorption in the collecting duct under the influence of **ADH**.

Information Booster:

- The Loop of Henle uses the **countercurrent multiplier mechanism** to maintain a high medullary osmolarity.
- **Descending limb:** permeable to water, not solutes → filtrate becomes concentrated.
- **Ascending limb:** impermeable to water, actively pumps out Na^+ , K^+ , Cl^- → medullary interstitium becomes hyperosmotic.

Additional Knowledge:

- **Collecting duct:**
 - Performs **final urine concentration** via ADH action but depends on the gradient created by the Loop of Henle.
- **Distal convoluted tubule:**
 - Primarily involved in fine-tuning Na^+ , K^+ , Ca^{2+} reabsorption; not in generating the osmotic gradient.

- **Proximal convoluted tubule:**
 - Reabsorbs ~65% of filtrate but plays little role in medullary osmotic gradient formation.

Q.8 Which of the following statements is correct with reference to the industrial use of freon?

- A. It is used in refrigeration and aerosol production.
- B. It is used for textile dyeing.
- C. It is primarily used in food processing and as a food preservative.
- D. It is used as a pesticide and insecticide.

Answer: A

Sol: Correct Answer: (A) It is used in refrigeration and aerosol production.

Explanation:

- **Freon** is a **chlorofluorocarbon (CFC)** commonly used as a **refrigerant** in cooling systems.
- It is also used as a **propellant** in aerosol sprays.
- Freon is chemically stable, non-flammable, and effective in heat transfer, making it suitable for refrigeration.

Information Booster:

- Freon was widely used in **refrigerators, air conditioners, and industrial cooling units.**
- Due to ozone-depleting effects, many freons were phased out under the **Montreal Protocol (1987).**
- Modern substitutes include **HCFCs, HFCs, and natural refrigerants.**
- Freons are non-toxic but harmful to the **stratospheric ozone layer.**
- CFC-12 was one of the most commonly used freons in earlier refrigeration systems.

Additional Knowledge:

- **Textile dyeing (Option B):** Uses chemicals like dyes, mordants, and surfactants, not freon.
- **Food processing/preservation (Option C):** Uses preservatives like sodium benzoate or refrigeration without freon-based direct additives.
- **Pesticide/insecticide (Option D):** Freons are not used as pesticides; insecticides include DDT, malathion, etc.

Q.9 Which of the following foods is a source of animal protein?

- A. Pulses
- B. Beans
- C. Eggs
- D. Nuts

Answer: C

Sol: The correct answer is (c) Eggs

Explanation:

- . Eggs are obtained from animals.
- . Rich in high-quality protein.
- . Contain all essential amino acids.
- . Easily digestible.
- . Important for growth and repair.

Information Booster:

- . Eggs are called complete protein.
- . Also rich in vitamins and minerals.

Q.10 Which of the following statements is NOT correct with reference to the main group elements?

- A. Their reactivity does not follow any periodic trend.
- B. They include both s-block and p-block elements.
- C. Their valence shell configurations help predict chemical behaviour.
- D. They are also called representative elements.

Answer: A

Sol: The correct answer is (A) Their reactivity does not follow any periodic trend.

Explanation:

- Main group elements *do* follow periodic trends such as increasing metallic character down a group and increasing non-metallic character across a period.

- Therefore, saying their reactivity “does not follow any trend” is **incorrect**.

Information Booster:

- Main group elements include **Groups 1, 2, and 13–18**.

- Their chemical behaviour is predictable because of **valence shell configurations**.

- They exhibit trends in ionisation energy, atomic radius, electronegativity, and reactivity.

Additional Knowledge:

- **Option B – Correct:** Main group elements include **s-block and p-block**.

- **Option C – Correct:** Their **valence shell configuration** determines their chemical properties.

- **Option D – Correct:** They are indeed called **representative elements**.

Q.11 Which of the following pairs is an acid-base conjugate pair?

- A. H^+ and O^{2-}
- B. HCl and Cl_2
- C. NH_4^+ and NH_3
- D. H_2O and H_2O_2

Answer: C

Sol: The correct answer is (c) NH_4^+ and NH_3

Explanation:

- A conjugate acid–base pair differs by **one proton (H^+)**.

- NH_4^+ (**acid**) donates one H^+ to form NH_3 (**base**).

- Hence, NH_4^+/NH_3 satisfies the acid–base conjugate pair definition.

Information Booster:

- Conjugate acid = base + H^+ .

- Conjugate base = acid – H^+ .

- Water forms conjugate pair: H_2O/OH^- .

- Strong acids have weak conjugate bases.

- Conjugate pairs are central to Bronsted–Lowry theory.

Q.12 What pigment do petunias have that gives them a reddish-purple colour in an acidic environment (low pH)?

- A. Lycopene
- B. Anthocyanins
- C. Betalains
- D. Carotenes

Answer: B

Sol: The correct answer is (b) Anthocyanins

Explanation:

- . Anthocyanins are water-soluble plant pigments.

- . They are sensitive to pH changes.

- . In acidic conditions, they appear red or purple.

- . In alkaline conditions, they turn blue.

- . Petunia flower colour depends on vacuolar pH.

Information Booster:

- . Anthocyanins are found in grapes and berries.

- . They belong to the flavonoid group.

Additional Knowledge:

Lycopene (Option a)

- . Red pigment in tomatoes.

Betalains (Option c)

- . Found in beetroot and cactus.

Carotenes (Option d)

- . Orange pigments in carrots.

Q.13 Optical fibres work on the principle of _____.

- A. Reflection only
- B. Refraction only
- C. Total internal reflection
- D. Total internal refraction

Answer: C

Sol:

The correct answer is (c) Total internal reflection

Explanation:

- Optical fibres transmit light through **total internal reflection**.
- Light repeatedly reflects within the fibre core without escaping.
- This allows transmission of signals over **long distances with minimal loss**.

Information Booster:

- Optical fibres are widely used in **telecommunications and internet networks**.
- They offer **high bandwidth and low signal attenuation**.

Additional Knowledge:

- Fibre optics are immune to **electromagnetic interference**.

Q.14 What is the specific heat of copper, which is often used for pots and pans because it heats up quickly?

- A. 604.2 J kg⁻¹ K⁻¹
- B. 239.3 J kg⁻¹ K⁻¹
- C. 712.1 J kg⁻¹ K⁻¹
- D. 386.4 J kg⁻¹ K⁻¹

Answer: D

Sol:

The correct answer is (d) 386.4 J kg⁻¹ K⁻¹

Explanation:

- Copper has a specific heat capacity of 386.4 J kg⁻¹ K⁻¹, meaning it requires relatively little heat energy to rise in temperature.
- This property allows copper utensils to heat up rapidly, making them ideal for cooking.
- Low specific heat ensures faster thermal response compared to metals like iron or aluminium.

Information Booster:

- Copper is also an excellent thermal conductor, further increasing its efficiency for cookware.
- Materials with low specific heat and high conductivity are preferred in professional kitchens.

Additional Knowledge:

- Option (a) and (c) are too high for copper's specific heat capacity.
- Option (b) 239.3 J kg⁻¹ K⁻¹ is close to aluminium's value, not copper's.
- Metals with lower specific heat get hot faster, which is why copper is widely used.

Q.15 A buffer solution has [CH₃COOH] = 0.1 M and [CH₃COO⁻] = 0.1 M. If pK_a of CH₃COOH is 4.76, then what is its pH?

- A. 4.76
- B. 3.76
- C. 7.00
- D. 5.76

Answer: A

Sol: Correct Answer: A

Explanation:

- For a buffer solution, pH is calculated using the **Henderson-Hasselbalch equation**:

$$\text{pH} = \text{p}K_a + \log \left(\frac{[\text{A}^-]}{[\text{HA}]}\right)$$

- Given:

$$[\text{CH}_3\text{COOH}] = 0.1 \text{ M}, [\text{CH}_3\text{COO}^-] = 0.1 \text{ M}$$

- Ratio = $0.1 / 0.1 = 1 \rightarrow \log(1) = 0$
- Therefore:

$$\text{pH} = 4.76 + 0 = 4.76$$

Information Booster:

- When the concentration of weak acid and its conjugate base in a buffer are equal, **pH = pKa**.

Q.16 The Michaelis-Menten constant (K_m) of an enzyme is defined as:

- The substrate concentration at which the reaction rate is half of V_{\max}
- The maximum reaction rate (V_{\max})
- The enzyme concentration required for half-maximal catalysis
- The inhibitor concentration that reduces enzyme activity by 50%

Answer: A

Sol: The correct answer is: **(A) The substrate concentration at which the reaction rate is half of V_{\max}**

Explanation:

- The **Michaelis-Menten constant (K_m)** is a key parameter in enzyme kinetics.
- It is defined as the **substrate concentration** at which the **reaction velocity is half of the maximum velocity (V_{\max})**.
- K_m gives an idea of the **affinity of the enzyme for its substrate**:
 - **Lower K_m → higher affinity** (enzyme reaches half-max rate at low substrate concentration)
 - **Higher K_m → lower affinity**

Information Booster:

- The **Michaelis-Menten equation** is: $V = \frac{V_{\max}[S]}{K_m + [S]}$

where:

The concept is valid under the **steady-state assumption** in enzyme kinetics.

K_m has units of **molar concentration (e.g., mM or μM)**.

It is specific to each **enzyme-substrate pair** and is affected by **pH, temperature, and ionic strength**.

- ◦ **V** = reaction velocity
- ◦ **V_{\max}** = maximum velocity
- ◦ **[S]** = substrate concentration
- ◦ **K_m** = Michaelis constant

Additional Knowledge:

- **Option B (V_{\max}):** Represents the **maximum rate** of the enzyme-catalyzed reaction when the enzyme is fully saturated with substrate.
- **Option C:** Refers to enzyme concentration, not K_m . K_m is independent of enzyme concentration.
- **Option D:** Describes **IC50**, which is the concentration of an **inhibitor** that reduces enzyme activity by 50%—unrelated to K_m .

- Enzyme kinetics is crucial in **drug design, metabolic engineering,** and **diagnostics,** as K_m helps predict how enzymes will behave under different substrate levels.

Q.17 The inability to isolate intact DNA for structural studies prior to the 1950s was primarily due to which molecular feature?

- A. DNA's high melting point
- B. DNA's susceptibility to UV degradation
- C. DNA's interaction with histone proteins
- D. DNA's large polymeric nature and fragility

Answer: D

Sol: Correct Answer: (D) DNA's large polymeric nature and fragility

Explanation:

- Before the 1950s, scientists struggled to isolate **intact, high-molecular-weight DNA** because it is a **long, fragile polymer** that easily breaks during extraction.
- Mechanical shearing, harsh chemicals, and rudimentary purification methods caused **DNA degradation,** preventing structural studies like X-ray diffraction.

Information Booster:

- Early extraction methods often produced **short, degraded DNA fragments,** unsuitable for determining helical structure.
- Intact DNA requires **gentle handling,** controlled pH, and protection from nucleases—techniques not yet refined at the time.
- Improved methods developed in the 1950s enabled Rosalind Franklin and others to obtain **fibrous, high-quality DNA** needed for structural analysis.

Q.18 What is the theoretical value of the Stefan–Boltzmann constant (σ) which defines the power emitted per unit area by a black body as a function of temperature?

- A. $5.17 \times 10^{-9} \text{ W m}^{-2} \text{ K}^{-4}$
- B. $5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
- C. $5.91 \times 10^{-7} \text{ W m}^{-2} \text{ K}^{-4}$
- D. $5.35 \times 10^{-10} \text{ W m}^{-2} \text{ K}^{-4}$

Answer: B

Sol:

The correct answer is (b) $5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$

Explanation:

- The **Stefan–Boltzmann constant** is a fundamental physical constant.
- It relates the **total energy radiated** by a black body to the **fourth power of temperature.**
- The law is expressed as $E = \sigma T^4$.

Information Booster:

- The law applies to **ideal black bodies.**
- It is used in **astrophysics and thermodynamics.**

Additional Knowledge:

- Named after **Josef Stefan** and **Ludwig Boltzmann.**

Q.19 Which law explains colours of stars based on temperature?

- A. Wien's Displacement Law
- B. Kepler's Laws
- C. Snell's Law
- D. Hooke's Law

Answer: A

Sol: The correct answer is (a) Wien's Displacement Law

Explanation:

- Relates wavelength to temperature.

- Hotter bodies emit shorter wavelengths.
- Explains star colour variation.
- Used in astronomy.
- Fundamental radiation law.

Information Booster:

- Blue stars are hotter than red stars.
- $\lambda_{\max} \times T = \text{constant}$.

Q.20 Which of the following best explains the functional diversity of RNA molecules in cells?

- Their ability to form double-stranded helical structures
- Their linear sequence of deoxyribonucleotides
- Their capability to act as adapter, structural and catalytic molecules
- Their permanent role as genetic material

Answer: C

Sol: The correct answer is (C) Their capability to act as adapter, structural and catalytic molecules

Explanation:

- RNA molecules perform multiple roles in cells such as **mRNA (messenger), tRNA (adapter), and rRNA (structural)**.
- Some RNA molecules also show **catalytic activity** (ribozymes).
- Due to these varied roles, RNA exhibits **functional diversity** in cellular processes.
- These functions are crucial for **protein synthesis and gene expression regulation**.

Information Booster:

- RNA contains **ribose sugar**, not deoxyribose.
- Can be **single-stranded** and fold into complex shapes.
- **Ribozymes** were discovered by Thomas Cech & Sidney Altman.
- mRNA carries genetic code from DNA to ribosomes.
- tRNA brings amino acids during protein synthesis.

Q.21 Who obtained the first accurate value of the speed of light using a rotating mirror apparatus in 1862?

- Albert A. Michelson
- Marie Alfred Cornu
- Charles Wheatstone
- Jean Bernard Léon Foucault

Answer: D

Sol:

The correct answer is (d) Jean Bernard Léon Foucault

Explanation:

- Jean Bernard Léon Foucault measured the speed of light using a **rotating mirror method** in 1862.
- His experiment significantly improved the accuracy of earlier measurements.
- It also helped establish that the **speed of light is slower in water than in air**, supporting the wave theory of light.

Information Booster:

- Foucault's experiment refined earlier work by **Fizeau**.
- The rotating mirror technique allowed laboratory-based measurement.

Additional Knowledge:

- Albert Michelson later achieved even greater precision using improved methods.

Q.22 Which of the following physical quantities has zero dimension in mass and time?

- Force
- Work
- Volume
- Momentum

Answer: C

Sol: Correct Answer: (c)

Explanation

- **Volume** represents the space occupied by an object in three dimensions (Length × Breadth × Height).
- Its dimensional formula is $[L^3]$.
- When expressed in terms of Mass (M), Length (L), and Time (T), it is written as $[M^0L^3T^0]$. Thus, it has **zero dimension** in mass and time.

Information Booster

- **Dimensional Analysis** helps in checking the correctness of physical equations.
- Quantities like **Angle** and **Strain** are completely dimensionless ($[M^0L^0T^0]$).

Additional Knowledge

- **Force** : Product of mass and acceleration ($F=ma$); Dimensions: $[M^1L^1T^{-2}]$.
- **Work** : Force × Displacement; Dimensions: $[M^1L^2T^{-2}]$.
- **Momentum** : Mass × Velocity; Dimensions: $[M^1L^1T^{-1}]$.

Q.23 Which of the following options best represents the predictions of a Punnett square?

- A. Genetic linkage relationships in siblings
- B. DNA sequence in parents
- C. Genetic mutations over several generations
- D. Genotype and phenotype probabilities

Answer: D

Sol: The correct answer is (d) Genotype and phenotype probabilities

Explanation:

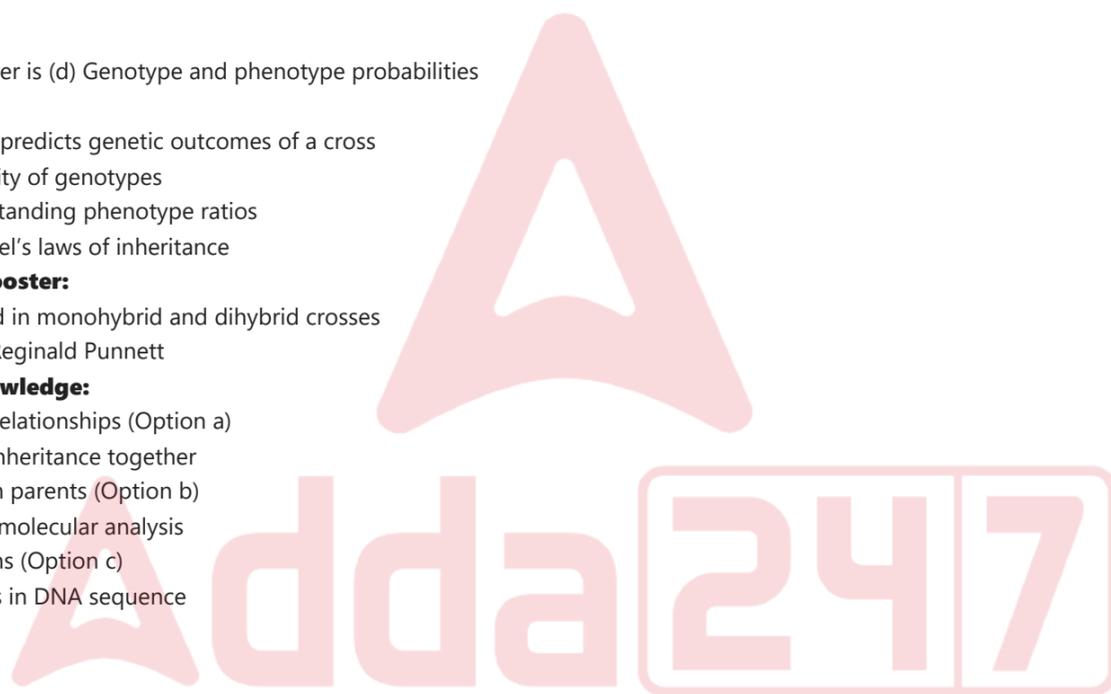
- Punnett square predicts genetic outcomes of a cross
- Shows probability of genotypes
- Helps in understanding phenotype ratios
- Based on Mendel's laws of inheritance

Information Booster:

- Commonly used in monohybrid and dihybrid crosses
- Introduced by Reginald Punnett

Additional Knowledge:

- Genetic linkage relationships (Option a)
- Concern gene inheritance together
- DNA sequence in parents (Option b)
- Determined by molecular analysis
- Genetic mutations (Option c)
- Involve changes in DNA sequence



Q.24 Which of the following best defines impulse in mechanics?

- A. The rate of change of momentum multiplied by the distance
- B. The product of mass and velocity
- C. The change in displacement over time
- D. The product of force and the time for which it acts

Answer: D

Sol:

The correct answer is (d) The product of force and the time for which it acts

Explanation:

- In mechanics, impulse is defined as the product of force and the time interval during which the force acts on a body.
- Mathematically, Impulse (J) = Force (F) × Time (Δt).
- Impulse is equal to the change in momentum of the body, as given by Newton's Second Law of Motion.
- It is particularly useful in analyzing situations where a large force acts for a very short duration, such as in collisions, kicks, or hammering a nail.

Information Booster:

- SI unit of impulse is newton-second (N-s).
- Since momentum has units of kg-m/s, impulse and momentum have the same dimensions.
- Increasing the time of impact reduces the force experienced, which is why safety devices like seat belts and airbags are effective.

Additional Knowledge (Information about incorrect options):

Rate of change of momentum multiplied by distance (Option a)

- Rate of change of momentum is force, not impulse.

Product of mass and velocity (Option b)

- This defines momentum, not impulse.
- Change in displacement over time (Option c)
- This defines velocity, not impulse.

Q.25 The complete sequencing of the human genome has marked the beginning of:

- A. cytogenetics
- B. immunology
- C. genomics
- D. structural biology

Answer: C

Sol: The correct answer is (C) genomics

Explanation:

- The complete sequencing of the human genome marked the **beginning of the era of genomics**.
- Genomics is the branch of biology that studies **structure, function, evolution, and mapping of genomes**.
- The **Human Genome Project (2003)** played a key role in starting this field, providing the full DNA sequence of humans.

Information Booster:

- Human genome contains **3 billion base pairs**.
- Human Genome Project started in **1990** and completed in **2003**.
- Genomics helps in **personalized medicine & disease prediction**.
- It led to advances in **gene therapy and biotechnology**.
- The study involves **DNA sequencing and bioinformatics tools**.

Additional Knowledge:

- Cytogenetics – Study of **chromosomes** under a microscope.
- Immunology – Study of **immune system**.
- Structural biology – Study of **protein & molecular structures**.

Q.26 What is the condition for total internal reflection to occur?

- A. Light must travel from a rarer medium to a denser medium at an angle of 90° .
- B. Light must travel from a denser to a rarer medium at an angle greater than the critical angle.
- C. Light must strike the boundary at 90° to the normal separating any two mediums of different refractive indices.
- D. The refractive indices of both media must be equal.

Answer: B

Sol:

The correct answer is (b) Light must travel from a denser to a rarer medium at an angle greater than the critical angle.

Explanation:

- TIR occurs only when light travels from an optically denser medium to an optically rarer medium, such as from glass to air or water to air.
- When the angle of incidence exceeds the critical angle, the refracted ray disappears and the entire light ray is reflected back into the denser medium.
- The critical angle is defined as the angle of incidence in the denser medium for which the angle of refraction in the rarer medium becomes 90° .
- If the angle of incidence is less than the critical angle, partial refraction and partial reflection occur, not total internal reflection.
- This principle is fundamental to the working of optical fibres, prisms, binoculars, and periscopes, all of which rely on repeated total internal reflections.

Information Booster:

- The value of the critical angle depends on the refractive indices of the two media.
- Materials with higher refractive index (like diamond) have smaller critical angles, making TIR easier to achieve.
- Optical fibres use TIR to transmit light signals over long distances with minimal energy loss, forming the backbone of modern telecommunications.
- Additional Knowledge (Information about incorrect options):
- Light must travel from a rarer medium to a denser medium at an angle of 90° (Option a)
- TIR never occurs when light travels from a rarer to a denser medium.
- In this case, light always refracts into the denser medium.

Light must strike the boundary at 90° to the normal separating any two mediums (Option c)

- An incidence angle of 90° means the ray travels along the surface, not into the second medium.
- This condition does not lead to total internal reflection.
- The refractive indices of both media must be equal (Option d)
- If refractive indices are equal, no refraction or reflection occurs at the boundary.
- TIR requires different refractive indices, specifically denser to rarer transition.

Q.27 The luminous efficacy of monochromatic radiation of frequency 540×10^{12} Hz, Kcd, is to be ___ when expressed in lumen per watt.

- A. 641

- B. 683
- C. 679
- D. 655

Answer: B

Sol:

The correct answer is (B) 683

Explanation:

- The frequency 540×10^{12} Hz corresponds to 555 nm (green light), where the human eye's sensitivity is maximum.
- SI defines luminous efficacy at this wavelength as exactly 683 lumen/watt.
- This is used as a reference for all photometric measurements.
- The candela (cd) is defined using this luminous efficacy standard.

Information Booster:

- Luminous flux unit: lumen (lm).
- Luminous intensity unit: candela (cd).
- Human eye responds most strongly to green light.

Q.28 In the balanced reaction $2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$, what is the mole ratio of aluminium to aluminium chloride?

- A. 2 : 3
- B. 2 : 2
- C. 3 : 2
- D. 1 : 2

Answer: B

Sol: Correct Answer: B

Explanation:

- From the balanced equation $2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$, the coefficients show the ratio of reacting and produced substances.
- Aluminium (Al) has a coefficient of **2**, and aluminium chloride (AlCl_3) also has a coefficient of **2**.
- Therefore, the **mole ratio of Al : AlCl_3 = 2 : 2**.

Information Booster:

- Balanced chemical equations follow the **law of conservation of mass**.
- Coefficients indicate **relative moles**, not masses or volumes.
- Mole ratios from balanced equations are used in **stoichiometric calculations**.
- 1 mole of any substance contains **6.022×10^{23} particles (Avogadro's number)**.
- Aluminium chloride (AlCl_3) is an **ionic compound** formed by aluminium and chlorine.

Q.29 Which law is most frequently applied when calculating the electric field, particularly when high symmetry is present?

- A. Lenz's Law
- B. Gauss's Law
- C. Faraday's Law
- D. Coulomb's Law

Answer: B

Sol:

Solution:

Correct Answer: (b) Gauss's Law

Explanation:

- Gauss's Law is especially useful for calculating electric fields when there is high symmetry (spherical, cylindrical, or planar).
- It relates the electric flux through a closed surface to the charge enclosed.
- It simplifies calculations compared to direct application of Coulomb's law in symmetric cases.

Information Booster:

- Mathematical form: $\oint \mathbf{E} \cdot d\mathbf{A} = Q_{\text{enc}} / \epsilon_0$
- Common applications: charged sphere, infinite line charge, infinite plane sheet.
- It is one of Maxwell's equations.

Additional Knowledge:

- Coulomb's law is better for point charges without symmetry.
- Faraday's law deals with electromagnetic induction.
- Lenz's law gives the direction of induced current.

Q.30 In which year did French physicist Sadi Carnot create the Carnot engine, which uses thermodynamic principles to function as an ideal heat engine?

- A. 1830
- B. 1820
- C. 1824
- D. 1813

Answer: C

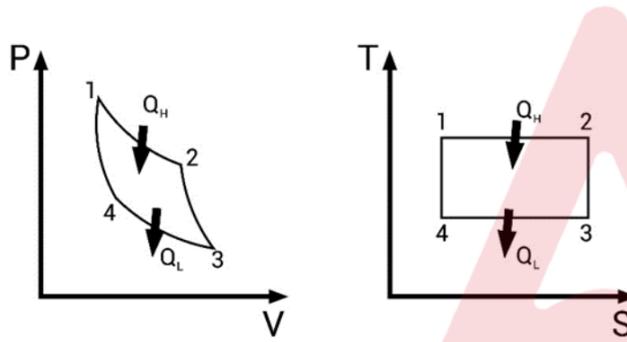
Sol: Correct Answer: (c)

Explanation

- **Sadi Carnot** proposed the theoretical model of the Carnot engine in **1824**.
- He published his work in a book titled "*Reflections on the Motive Power of Fire*".

Information Booster

- The **Carnot Engine** is a theoretical thermodynamic cycle that provides the maximum possible efficiency that any heat engine can achieve.
- It laid the foundation for the **Second Law of Thermodynamics**.



Q.31 Let's denote Z as the number of atoms per unit cell, M as the molar mass of the substance, and N_A as Avogadro's number. Which for

- A. $d = \frac{Z \times M}{a^3 \times N_A}$
- B. $d = \frac{M \times a^3}{Z \times N_A}$
- C. $d = \frac{Z \times M}{M \times a^3}$
- D. $d = \frac{M \times a^3}{Z \times N_A}$

Answer: A

Sol: The correct answer is **(a) $d = (Z * M) / (a^3 * N_a)$**

Explanation:

- The **density (d) of a unit cell** is defined as the mass of the unit cell divided by its volume.
- **Mass of unit cell** = (Number of atoms in unit cell, Z) * (Mass of each atom, m).
- **Mass of an individual atom (m)** = (Molar mass, M) / (Avogadro's number, N_a).
- **Volume of a cubic unit cell** = (a^3) , where 'a' is the edge length of the unit cell.
- Combining these, the density formula is derived as **$d = (Z * M) / (a^3 * N_a)$** .

Information Booster:

- The value of **Z** depends on the crystal structure: **Z = 1** for Simple Cubic (SCC), **Z = 2** for Body-Centred Cubic (BCC), and **Z = 4** for Face-Centred Cubic (FCC).
- **Density** is an **intensive property**, meaning the density of the unit cell is the same as the density of the entire substance.
- This formula helps in calculating the **atomic mass** of a substance or the **Avogadro number** if other parameters are experimentally determined.
- If the unit cell is not cubic, the volume (a^3) is replaced by the specific volume formula for that crystal system (e.g., hexagonal or monoclinic).

Additional Knowledge: Simple Cubic Lattice:

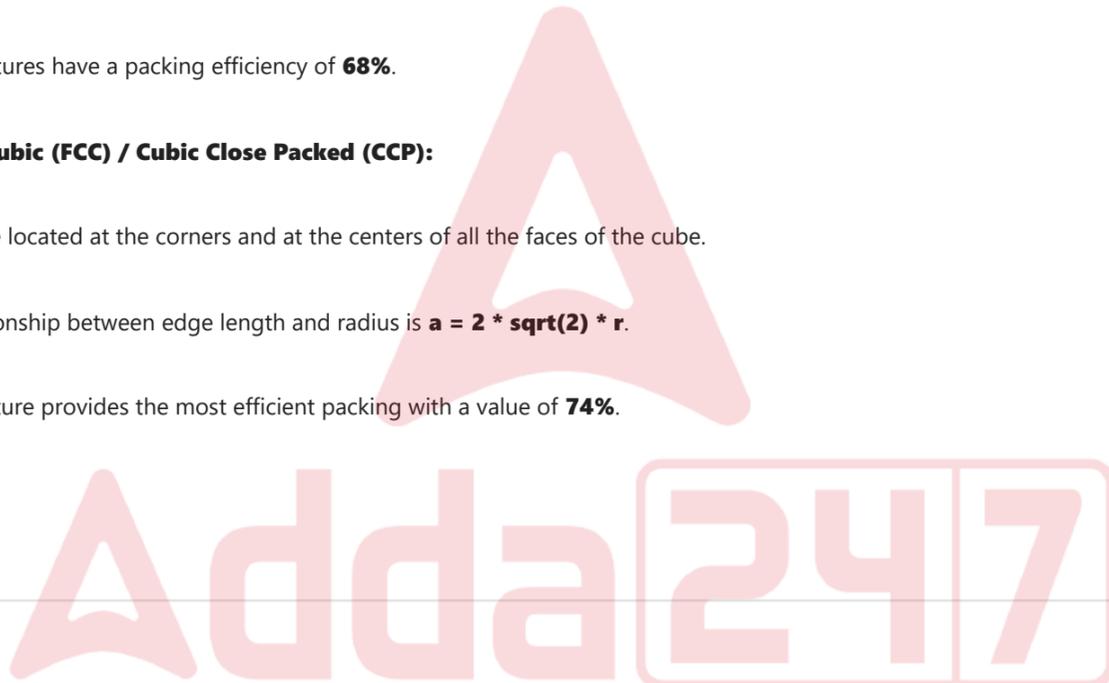
- In a simple cubic lattice, atoms are only at the corners, and they touch each other along the edge.
- The relationship between edge length 'a' and atomic radius 'r' is **$a = 2r$** .
- It has the lowest **packing efficiency** among common cubic structures, at approximately **52.4%**.

Body-Centred Cubic (BCC):

- Atoms are at the corners and one atom is at the center of the cube.
- The relationship between edge length and radius is **$a = 4r / \sqrt{3}$** .
- BCC structures have a packing efficiency of **68%**.

Face-Centred Cubic (FCC) / Cubic Close Packed (CCP):

- Atoms are located at the corners and at the centers of all the faces of the cube.
- The relationship between edge length and radius is **$a = 2 * \sqrt{2} * r$** .
- This structure provides the most efficient packing with a value of **74%**.



Q.32 What is the value of one roentgen (R) when expressed in SI units?

- A. 1.0×10^{-3} grays
- B. 3.7×10^{10} disintegrations per second
- C. 2.58×10^{-4} coulombs per kilogram
- D. 1.6×10^{-19} coulombs

Answer: C

Sol:

The correct answer is (c) 2.58×10^{-4} coulombs per kilogram

Explanation:

- The roentgen (R) is a non-SI unit used to measure exposure to ionising radiation, particularly X-rays and gamma rays.
- In the SI system, radiation exposure is measured in coulombs per kilogram (C/kg).
- One roentgen is defined as the amount of radiation that produces 2.58×10^{-4} coulombs of charge per kilogram of air.
- This definition is based on the ionisation produced in air, not on the energy absorbed by body tissues.

Information Booster:

- Exposure \neq Absorbed dose: Exposure (roentgen) measures ionisation in air, while absorbed dose is measured in gray (Gy).
- 1 gray (Gy) = 1 joule per kilogram.
- Other related units include sievert (Sv) for biological effect and becquerel (Bq) for radioactivity.

Additional Knowledge (Information about incorrect options):

1.0×10^{-3} grays (Option a)

- Gray measures absorbed dose, not exposure.
- It is not the SI equivalent of roentgen.

3.7×10^{10} disintegrations per second (Option b)

- This equals 1 curie (Ci), a unit of radioactivity, not radiation exposure.
- 1.6×10^{-19} coulombs (Option d)
- This is the charge of an electron, unrelated to radiation exposure units.

Q.33 Which industries commonly used Tetrachloromethane as a degreasing agent?

- A. Textile industries
- B. Food processing industries
- C. Manufacturing and mechanical industries
- D. Bottling industries

Answer: C

Sol: The correct answer is (C) Manufacturing and mechanical industries

Explanation:

- **Tetrachloromethane (Carbon Tetrachloride)** was commonly used as a **degreasing agent** in **manufacturing and mechanical industries**.
- It was used for **cleaning metal machines, removing oil and grease**.
- However, its use has declined due to **toxicity and ozone-depleting effects**.
- It is now regulated under **environmental protection guidelines**.

Information Booster:

- Chemical formula – **CCl_4** .
- Used earlier in **fire extinguishers and dry-cleaning** too.
- Classified as a **hazardous air pollutant**.
- Causes liver and nervous system damage.
- Banned under **Montreal Protocol (1987)** for its ozone harm.

Q.34 What is the primary reason that roughage is included in a balanced human diet?

- A. It builds muscles.
- B. It aids digestion and prevents constipation.
- C. It helps in fat storage.
- D. It increases sugar absorption.

Answer: B

Sol: Correct Answer: B

Explanation:

- Roughage (dietary fibre) adds bulk to food.
- It helps in smooth movement of food through the digestive tract.
- Prevents constipation by retaining water and easing bowel movement.

Information Booster:

- Roughage is found in fruits, vegetables, whole grains and legumes.
- It is **not digested** by the human body but is essential for healthy gut functioning.
- Also helps maintain a healthy weight and supports overall digestive health.

Additional Knowledge:

- **Option A:** Does not build muscles — proteins are responsible for muscle growth.
- **Option C:** Roughage does not help in fat storage; it actually helps regulate weight.
- **Option D:** Roughage does not increase sugar absorption; it **slows** sugar absorption, helping maintain stable blood sugar levels.

Q.35 Which enzyme, secreted by the chief cells of the stomach, is crucial for initiating the digestion of proteins?

- A. Amylase
- B. Gastric lipase
- C. Pepsinogen (converted to pepsin)
- D. Trypsinogen (converted to trypsin)

Answer: C

Sol: The correct answer is (C) Pepsinogen (converted to pepsin)

Explanation:

- Chief cells of the stomach secrete **pepsinogen**, an inactive enzyme.
- In presence of **hydrochloric acid (HCl)**, pepsinogen is converted into **active pepsin**, which starts **protein digestion**.
- Pepsin breaks proteins into **peptides** (simpler chains).

Information Booster:

- HCl is secreted by **parietal cells**.
- Pepsin works best at **pH 1.5–2.0 (acidic)**.
- Amylase → digests carbohydrates (not proteins).
- Gastric lipase → digests **fats** in stomach.
- Trypsinogen → secreted by pancreas, not stomach.

Additional Knowledge:

- Chief cells are also called **zymogenic cells**.
- Protein digestion begins in **stomach**, ends in **small intestine**.
- Trypsin & chymotrypsin work in **duodenum**.

Q.36 If HF is a weak acid, what can be inferred about the strength of its conjugate base F⁻?

- It is neutral.
- It is a strong base.
- It is a weak base.
- It is a strong acid.

Answer: C

Sol: The correct answer is: (C) It is a weak base

Explanation:

- Hydrofluoric acid (HF) is a **weak acid**, meaning it does not completely dissociate in aqueous solution.
- The **strength of an acid and its conjugate base are inversely related**.
- Since HF ionizes only partially, its conjugate base **fluoride ion (F⁻)** has a **limited tendency to accept protons (H⁺)**.
- Therefore, **F⁻ behaves as a weak base**, not a strong one.

Information Booster:

- Weak acids form **weak conjugate bases**.
- HF is weak due to the **strong H–F bond** and high electronegativity of fluorine.
- Conjugate acid–base pairs follow the relation **K_a × K_b = K_w**.
- Strong acids like HCl have **extremely weak conjugate bases** (Cl⁻).
- Among hydrogen halides, **HF is the weakest acid**.
- F⁻ shows basic nature but **cannot act as a strong base**.

Additional Knowledge:

- (A) It is neutral** – F⁻ carries a negative charge and shows basic behavior.
(B) It is a strong base – Conjugate bases of weak acids are not strong bases.
(D) It is a strong acid – F⁻ cannot donate a proton, so it is not an acid.

Q.37 Which of the following statements is NOT correct with reference to the periodic trend of metallic character?

- Metallic character decreases across a period from left to right.
- Metallic character increases across a period from left to right.
- Metallic character increases down a group.
- The change from metallic to non-metallic is gradual.

Answer: B

Sol: **Correct Answer: B**

The statement "**Metallic character increases across a period from left to right**" is **NOT correct**.

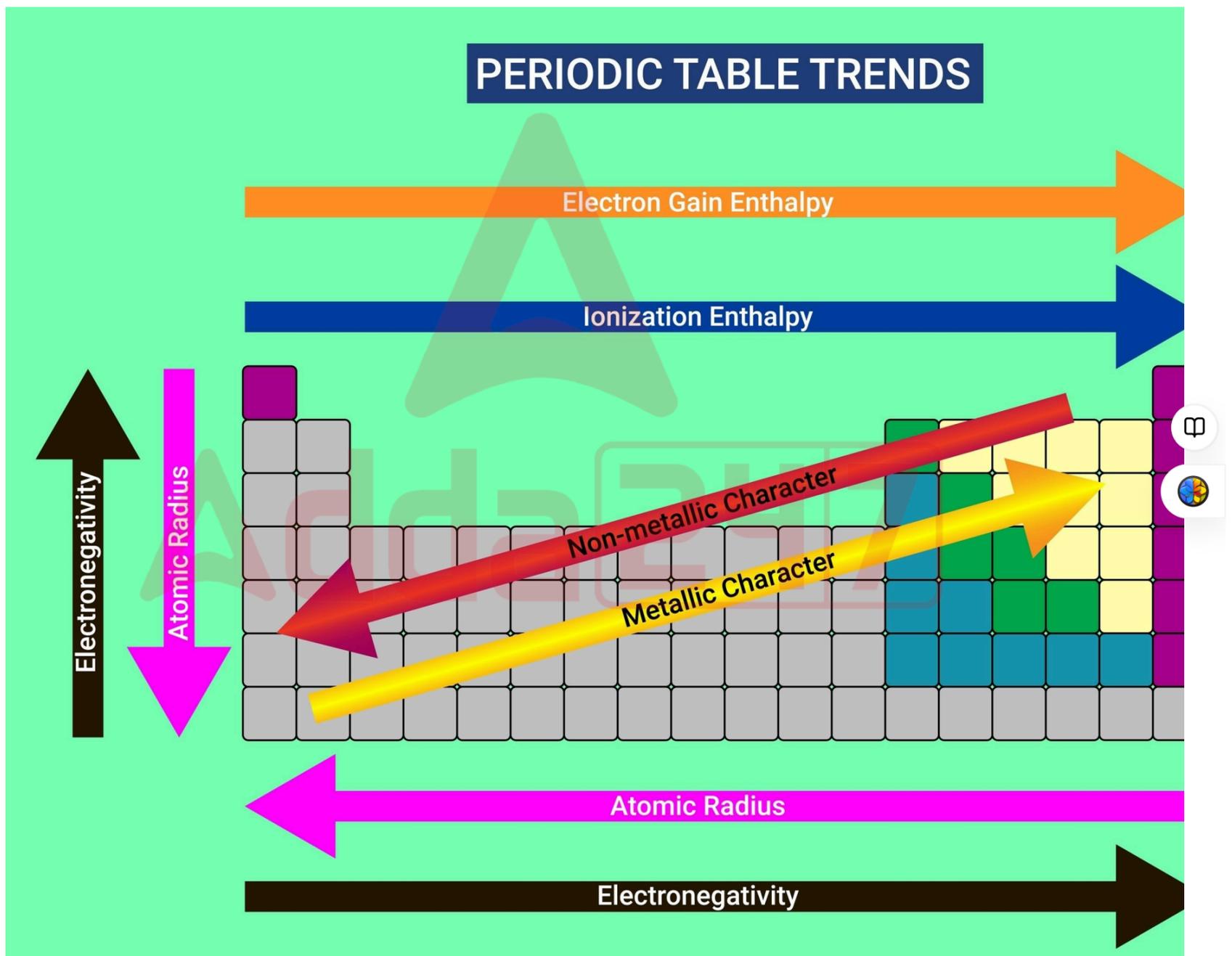
Explanation:

- **A. Metallic character decreases across a period (Correct):** As you move right, the effective nuclear charge increases, pulling electrons closer and n
- **B. Metallic character increases across a period (Incorrect):** This contradicts the observed trend where elements transition from reactive metals (le
- **C. Metallic character increases down a group (Correct):** Increasing atomic size and the "shielding effect" make it easier for the nucleus to let go o
- **D. The change is gradual (Correct):** The existence of **metalloids** (like Boron, Silicon, and Germanium) acts as a bridge between the distinct properti

Information Booster:

Periodic Trends

To master these questions for exams, remember that **Metallic Character** is synonymous with **Electropositivity** (the tendency to lose electrons).

**Key Drivers of the Trend:**

1. **Nuclear Charge:** As protons are added across a period, the "pull" on electrons strengthens.
2. **Atomic Radius:** Larger atoms (found at the bottom of groups) have valence electrons very far from the nucleus, making them easy to "stolen" or lost.
3. **Shielding Effect:** Inner electron shells act as a screen, reducing the nucleus's grip on the outermost electrons.

Additional Knowledge: Metals vs. Non-Metals

Property	Metals	Non-Metals
Electron Action	Lose electrons (Form Cations)	Gain electrons (Form Anions)
Nature of Oxides	Basic (e.g., Na_2O)	Acidic (e.g., SO_2)
Bonding	Ionic bonding with non-metals	Covalent bonding with each other
Position	Left side of the Periodic Table	Right side of the Periodic Table

Exam Pro-Tip

If you ever get confused, look at **Group 1 (Alkali Metals)** vs. **Group 17 (Halogens)**. Group 1 atoms (like Sodium) are classic metals because they have one electron to lose. Group 17 atoms (like Chlorine) are classic non-metals because they are desperate to gain one.

Q.38 What is another name for representative elements?

- A. Transition elements
- B. Transuranium elements
- C. Main group elements
- D. Inner-Transition elements

Answer: C

Sol: Correct Answer: C

Explanation:

- Representative elements are also known as **main group elements** because they belong to the s-block and p-block of the periodic table (except He).
- They show a wide range of physical and chemical properties and represent typical element behavior.

Information Booster:

- Main group elements include Groups 1, 2 and 13–18.
- They commonly form ionic or covalent bonds and are important in organic, biological, and environmental chemistry.

Additional Knowledge:

- **A. Transition elements:** d-block elements (Groups 3–12); not representative elements.
- **B. Transuranium elements:** Elements with atomic number >92; mostly synthetic and radioactive.
- **D. Inner-transition elements:** f-block elements (lanthanides and actinides); not classified as representative elements.

Q.39 Which of the following is a disproportionation reaction?

- A. $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$
- B. $\text{Zn} + \text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$
- C. $\text{Cu} + \text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + \text{NO}_2 + \text{H}_2\text{O}$
- D. $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HCl} + \text{HOCl}$

Answer: D

Sol: The correct answer is (D) $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HCl} + \text{HOCl}$

Explanation:

- A **disproportionation reaction** is a redox reaction in which **the same element is simultaneously oxidised and reduced** in a single reaction.
- In the reaction $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HCl} + \text{HOCl}$, chlorine (Cl_2) is both reduced (to HCl) and oxidised (to hypochlorous acid, HOCl).
- Thus, chlorine undergoes two different oxidation number changes at the same time – a key feature of disproportionation.
- Such reactions are common for **halogens** like Cl, Br, and I because they exist in multiple oxidation states.

Information Booster:

- Oxidation number of Cl in $\text{Cl}_2 = 0$.
- In HCl, Cl has oxidation state -1 (reduction).
- In HOCl, Cl has oxidation state $+1$ (oxidation).
- Disproportionation mostly happens in compounds/elements that lie in the **middle of an oxidation series**.
- Other examples: $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$ and $3\text{ClO}^- \rightarrow 2\text{Cl}^- + \text{ClO}_3^-$.

Additional Knowledge:

- **(A) $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$** – Normal redox reaction; Cl is reduced, Na oxidised (no disproportionation).
- **(B) $\text{Zn} + \text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$** – Metal–acid reaction; Zn oxidised and H^+ reduced.
- **(C) $\text{Cu} + \text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + \text{NO}_2 + \text{H}_2\text{O}$** – Copper is oxidised, nitrogen reduced (not disproportionation).

Q.40 Which of the following is NOT a state function or state variable in a thermodynamic system?

- Enthalpy
- Work
- Pressure
- Internal energy

Answer: B

Sol:

The correct answer is: (b) Work

Explanation

In thermodynamics, properties are classified based on whether they depend on the history of the system or just its current condition.

• **State Functions (or State Variables):** These depend only on the initial and final states of the system, not on how the change was accomplished. If you know the current state (e.g., Temperature, Pressure), the value is fixed regardless of how the system got there.

• **Path Functions:** These depend on the specific path or process taken to go from the initial state to the final state.

Work (w) is a path function because the amount of work done depends on the specific process (e.g., an adiabatic process vs. an isothermal process) used to change the system, even if the starting and ending points are identical.

Information Booster:

The distinction is often expressed mathematically:

• **State Functions** have exact differentials. The net change of a state function in a closed cycle is always zero.

• **Path Functions** have inexact differentials. The net work done in a cycle is not zero; it is equal to the area enclosed by the path on a pressure-volume graph.

Additional Knowledge (Why other options are State Functions)

• **Enthalpy (H):** Defined as $H = U + PV$. Since Internal Energy (U), Pressure (P), and Volume (V) are all state functions, their combination (Enthalpy) is also a state function.

• **Pressure (P):** This is a fundamental thermodynamic coordinate. The pressure of a gas in a container is a fixed value at a specific moment, regardless of whether the gas was previously compressed or heated to reach that state.

• **Internal Energy (U):** The First Law of Thermodynamics states that the change in Internal Energy (ΔU) equals heat (q) plus work (w). While heat and work are path functions, their sum (ΔU) is constant between two specific states.

Q.41 Why is the common cold rarely considered a lower respiratory tract infection?

- It requires a vector for lower tract transmission.
- Rhinoviruses only infect the upper respiratory tract.
- Antibodies prevent it from entering the lungs.
- The virus is destroyed in the alveoli.

Answer: B

Sol: The correct answer is: (B) Rhinoviruses only infect the upper respiratory tract

Explanation:

• **Rhinoviruses**, which cause the common cold, **thrive at lower temperatures (33–35°C)** found in the **nose and upper respiratory tract**.

• The lower respiratory tract (lungs) is warmer (37°C), making it **unfavorable for viral replication**.

• Hence, common cold infections rarely spread to or affect the lungs.

Information Booster:

- Rhinoviruses mainly infect nasal mucosa.
- Optimal viral growth occurs in cooler airways.

- Upper tract includes nose, pharynx, larynx.
- Lower tract includes trachea, bronchi, lungs.
- Severe cold symptoms are due to immune response, not lung infection.

Q.42 What type of combustion occurs when we bring a burning matchstick near a gas stove in the kitchen and turn on the knob of the gas stove?

- A. Delayed combustion
- B. Rapid combustion
- C. Slow combustion
- D. Spontaneous combustion

Answer: B

Sol: Correct answer is: (B) Rapid combustion

Explanation:

- When LPG comes in contact with a burning matchstick, it burns quickly with a flame, releasing heat instantly. This fast-burning reaction is called **rapid combustion**.

Information Booster:

- Rapid combustion needs an external flame and produces heat and light immediately, common in LPG, petrol, and kerosene.

Additional Knowledge :

- **Delayed combustion:**
 - Fuel burns after some **delay**, like in diesel engines.
- **Slow combustion:**
 - Occurs at a **slow rate** without flame, e.g., rusting, respiration.
- **Spontaneous combustion:**
 - Substance **catches fire on its own** without external flame, e.g., white phosphorus, coal heaps.

Q.43 The coordination number of atoms in a body-centered cubic (BCC) lattice is:

- A. 8
- B. 6
- C. 4
- D. 12

Answer: A

Sol: The correct answer is (A) 8

Explanation:

- In a **Body-Centered Cubic (BCC) lattice**, each atom is surrounded by **8 nearest neighboring atoms**, so the **coordination number is 8**.
- One atom is located at the center of the cube and it is surrounded by the 8 corner atoms of the cube.

Information Booster:

- BCC → Coordination number = **8**.
- FCC (Face-Centered Cubic) → Coordination number = **12**.
- Simple Cubic → Coordination number = **6**.
- BCC structures are generally **more rigid & less dense** than FCC.
- Example of BCC metals – **Iron (at room temperature), Chromium, Tungsten**.

Additional Knowledge:

- BCC has **2 atoms per unit cell**.
- FCC has **4 atoms per unit cell**.
- Packing efficiency of BCC ≈ **68%**.
- Packing efficiency of FCC ≈ **74%**.

Q.44 What is the function of a diathermic wall in a thermodynamic system?

- A. It allows the flow of heat between systems
- B. It allows the exchange of matter only

- C. It prevents the exchange of both matter and energy
- D. It allows the flow of only work

Answer: A

Sol: The correct answer is (a) It allows the flow of heat between systems

Explanation

- A diathermic wall permits the transfer of heat energy.
- It helps systems reach thermal equilibrium.
- Matter does not pass through such walls.

Information Booster

- A diathermic wall contrasts with an adiabatic wall.
- Used in thermodynamic experiments and models.

Additional Knowledge:

- Heat flow depends on temperature difference, not the wall itself.

Q.45 Which of the following can have higher optical density but lower mass density?

- A. Water
- B. Turpentine
- C. Germanium
- D. Glass

Answer: B

Sol: Correct Answer: (b) Turpentine

Explanation:

- **Optical density** depends on the **refractive index**, not the mass of the substance.
- **Turpentine** has a **higher refractive index (~1.47–1.48)** than water (1.33), meaning it has **higher optical density**.
- But its **mass density (~0.87 g/cm³)** is **lower than water (1 g/cm³)**.
- Hence, turpentine is a classic example of **higher optical density but lower mass density**.

Information Booster:

- Optical density ↑ → Light slows down more in that medium.
- Mass density ↑/↓ has **no direct relation** with optical density.
- Refractive index is the key determinant of optical density.

Additional Knowledge:

- **Water (a):** Has lower optical density ($n = 1.33$) compared to turpentine; mass density is higher.
- **Germanium (c):** Very high optical density ($n \approx 4$) **and** very high mass density — does not satisfy the condition.
- **Glass (d):** High optical density ($n \approx 1.5$) and **higher** mass density than water — not the correct example.



Q.46 For a spontaneous process at constant temperature and pressure, the Gibbs free energy change is _____.

- A. $\Delta G = 0$
- B. $\Delta G > 0$
- C. $\Delta G < 0$
- D. $\Delta G = \Delta H + T\Delta S$

Answer: C

Sol: The correct answer is **(C) $\Delta G < 0$**

Explanation:

- Gibbs free energy (G) determines the spontaneity of a chemical reaction at constant T and P.
- For a process to be spontaneous, ΔG must be negative ($\Delta G < 0$).

Information Booster:

- If $\Delta G = 0$, the system is in equilibrium.
- If $\Delta G > 0$, the process is non-spontaneous and requires external energy.

Additional Knowledge:

- The formula is $\Delta G = \Delta H - T\Delta S$, where ΔH is change in enthalpy and ΔS is change in entropy.

Q.47 What is the value of one carat when expressed in SI units?

- A. 500 milligrams

- B. 1 gram
- C. 100 milligrams
- D. 200 milligrams

Answer: D

Sol:

The correct answer is (d) 200 milligrams

Explanation:

- One carat is equal to 200 milligrams, which is the standard SI measurement used for weighing gemstones.
- The metric carat was internationally adopted in 1907 to standardise gem measurements.
- This unit is commonly used for diamonds and other precious stones.

Information Booster:

- Gem quality is assessed using the four Cs: carat, cut, clarity and colour.
- Carat refers to weight, not size; two stones of equal carat may differ in dimensions.

Additional Knowledge:

- 500 mg (a) and 100 mg (c) do not correspond to any recognised gem measurement unit.
- 1 gram (b) equals 5 carats, not 1 carat.

Q.48 Which group did iodine belong to in Mendeleev's table?

- A. Group VI
- B. Group VII
- C. Group VIII
- D. Group V

Answer: B

Sol: The correct answer is **(b) Group VII**

Explanation:

- Mendeleev organized elements in his original periodic table primarily based on **increasing atomic weight** and similar **chemical properties**.
- **Iodine** belonged to **Group VII** because it shared chemical properties with the other elements in that vertical column: Fluorine (F), Chlorine (Cl), and Bromine (Br).
- These elements, known as the **halogens**, all exhibit similar reactivity, typically forming strong acids with hydrogen (e.g., HI) and salts with metals (e.g., KI).

Information Booster:

- Group VII was also known for containing elements that are generally **monovalent** (having a valency of 1) in their most common reactions.
- Mendeleev left deliberate **gaps** in his table for undiscovered elements, showing his confidence in the periodic law.

Additional Knowledge:

- In the modern periodic table, the group that contains the halogens (F, Cl, Br, I) is designated as **Group 17**.
- Mendeleev's arrangement correctly placed Iodine after Tellurium, despite the slightly higher atomic weight of Tellurium, to maintain the consistency of chemical properties within the groups—a key success of his table.

Q.49 In which year did Mendeleev publish the periodic table?

- A. 1869
- B. 1894
- C. 1903
- D. 1948

Answer: A

Sol: Correct Answer is: A) 1869

Explanation:

- **Dmitri Mendeleev** published the **first periodic table in 1869**, arranging elements on the basis of **atomic mass** and predicting properties of undiscovered elements.

Information Booster:

- Mendeleev left **gaps** for elements yet to be discovered (like **gallium, scandium, germanium**).
- His table gained acceptance because his **predictions were accurate**.
- Known as the **“Father of the Periodic Table.”**
- Later modern periodic law was developed by **Henry Moseley (1913)**.

Periodic Table – Key Facts**1. Modern Periodic Table**

- Based on **atomic number (Z)**, not atomic mass.
- **Periodic Law:** Properties of elements are periodic functions of their **atomic number**.

2. Structure

- **7 Periods** (horizontal rows).
- **18 Groups** (vertical columns).
- **118 confirmed elements** (till present).

3. Blocks of the Periodic Table

- **s-block:** Group 1 & 2 (Alkali + Alkaline earth).
- **p-block:** Group 13–18 (Mixed properties).
- **d-block:** Transition metals.
- **f-block:** Lanthanides & Actinides (inner transition metals).

Q.50 The addition of H^+ ions to the equilibrium $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$ will:

- A. Lead to no change
- B. Stop the reaction
- C. Shift the equilibrium right
- D. Shift the equilibrium left

Answer: D

Sol: The correct answer is (D) Shift the equilibrium left

Explanation:

- The equilibrium reaction is:
 $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$
- Adding more **H^+ ions** increases the concentration of the product side.
- According to **Le Chatelier's Principle**, the reaction will shift **towards the left** to reduce the excess H^+ .
- This results in **more CH_3COOH formation**.
- Therefore, the equilibrium moves to the **left side**.

Information Booster:

- Le Chatelier's Principle – A system opposes any imposed change.
- CH_3COOH is a **weak acid** \rightarrow partially dissociates.
- Increasing products pushes equilibrium backward.
- pH decreases when H^+ is added.
- Equilibrium shift helps maintain acid-base balance.