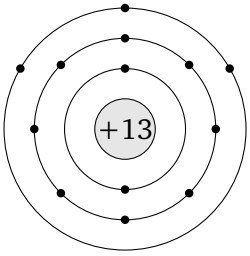
JEECUP Group A Chemistry Sample Paper -15

Duration: 45 Minutes **Maximum Marks: 100**

Instructions

- This paper contains **25** Multiple Choice Questions (Single Correct).
- Each correct answer carries **+4 marks**. No marks will be deducted for incorrect answers. Unattempted questions carry **0** marks.
- Only **one** option is correct for each question.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. An element has 13 protons and 14 neutrons in its nucleus. Which of the following Bohr-bury diagrams correctly represents the electronic distribution in its stable univalent/trivalent elemental shell structure?



Identify the total number of valence electrons present in this neutral atom.

(A) 1

(B) 2

(C) 3

(D) 4

Q2. A sample of methane (CH_4) gas is maintained in a closed container. When a specific energy threshold is applied, the gas undergoes thermal splitting. Which of the following options correctly describes the total number of covalent bonds present in exactly 3.2 grams of pure methane gas? (Atomic mass: $C = 12$, $H = 1$)

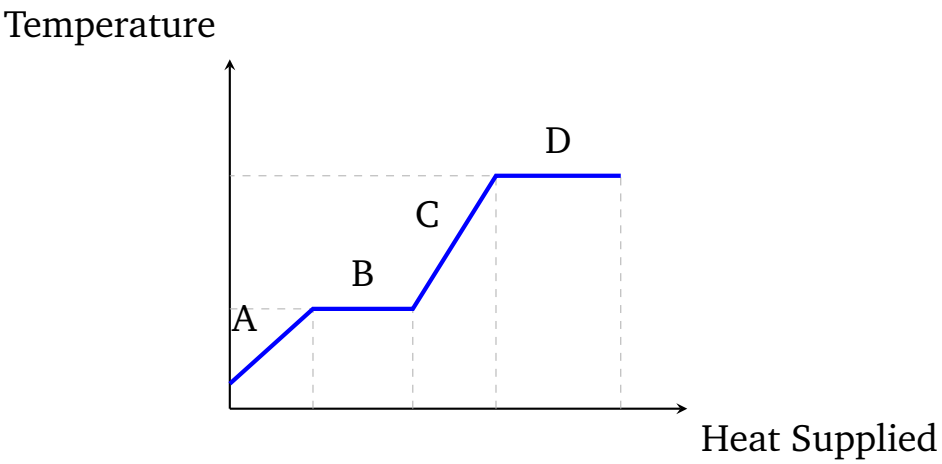
(A) $0.2 \times N_A$

(B) $0.8 \times N_A$

(C) $1.2 \times N_A$

(D) $4.0 \times N_A$

Q3. Consider the following phase transition diagram for a pure substance under variable thermal conditions:



Which region in the above graph represents the latent heat of vaporization, where the liquid phase completely transforms into the gaseous state at a constant boiling temperature?

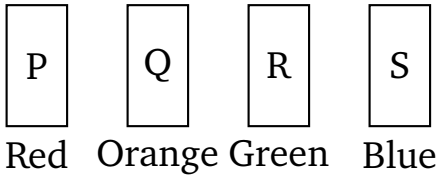
(A) Region A

(B) Region B

(C) Region C

(D) Region D

Q4. Four test tubes containing aqueous solutions of different substances are examined using universal indicator paper. The observed color changes and approximate scale responses are illustrated below:



Which test tube contains a solution that is most likely to be an aqueous sample of a strong acid like dilute hydrochloric acid (HCl)?

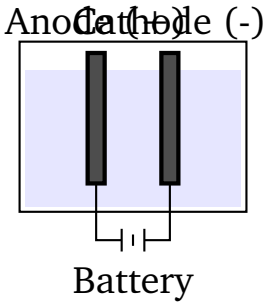
(A) P

(B) Q

(C) R

(D) S

Q5. During a laboratory demonstration, an experimental setup is prepared to perform the electrolysis of acidulated water. An electrical current is passed through the apparatus as shown:



What is the correct volumetric ratio of gases collected over the anode (+) to the gas collected over the cathode (-) during this electrochemical splitting?

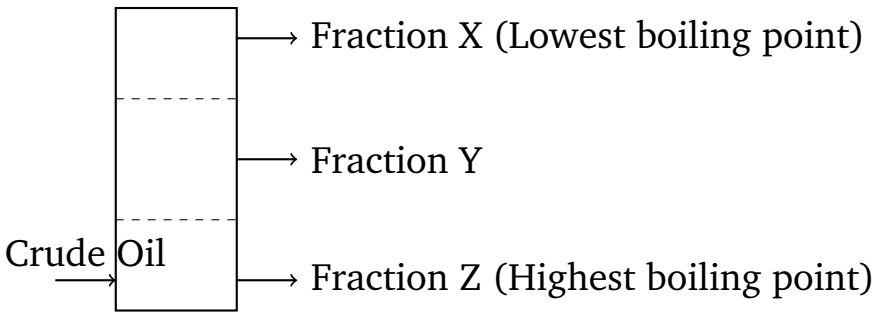
(A) $1:2$

(B) $2:1$

(C) $8:1$

(D) $1:1$

Q6. A fractional distillation column is set up to separate different fractions of crude oil based on their respective boiling point gradients:



Which of the following compounds is most likely to be recovered at the position marked as Fraction X at the top of the distillation column?

(A) Liquefied Petroleum Gas ($C_3 - C_4$ alkanes)

(B) Heavy Diesel Fuel ($C_{15} - C_{18}$ hydrocarbons)

(C) Lubricating Engine Oil ($C_{20}+$ hydrocarbons)

(D) Kerosene Fraction ($C_{11} - C_{14}$ alkanes)

Q7. An atom of an element X has an electronic configuration of $2, 8, 7$. In which group and period of the modern periodic table should this element be correctly placed?

(A) Group 7, Period 3

(B) Group 17, Period 3

(C) Group 17, Period 2

(D) Group 7, Period 2

Q8. Which of the following elements has the highest non-metallic character and highest electronegativity among the given set of elements: Carbon (C), Nitrogen (N), Oxygen (O), and Fluorine (F)?

(A) Carbon

(B) Nitrogen

(C) Oxygen

(D) Fluorine

Q9. When carbon dioxide gas is passed through freshly prepared clear lime water for a prolonged and extended period, the initially formed white turbidity dissolves completely. The structural formula of the soluble compound responsible for clearing the turbidity is:

(A) $CaCO_3$

(B) $Ca(OH)_2$

(C) $Ca(HCO_3)_2$

(D) CaO

Q10. An oxide of an unknown element E dissolves completely in water to turn a blue litmus solution red. Element E is most likely to be categorized as a:

(A) Highly reactive reactive metal

(B) Typical non-metal

(C) Noble gas substance

(D) Amphoteric transition element

Q11. An element M reacts violently with cold water to evolve a highly flammable gas G along with an alkaline product. The flame test of the resulting metal compound gives a distinct lilac color. Identify the metal M.

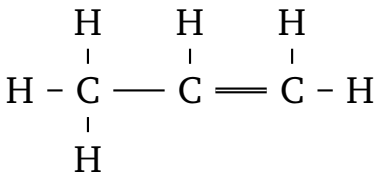
(A) Sodium (Na)

(B) Potassium (K)

(C) Calcium (Ca)

(D) Magnesium (Mg)

Q12. Consider the following organic structural layout representing an acyclic hydrocarbon series:



What is the correct IUPAC name for this unsaturated organic compound?

(A) Propane

(B) Propene

(C) Propyne

(D) Cyclopropene

Q13. A compound contains two elements: A (Atomic weight $= 12$) and B (Atomic weight $= 1$). If the mass ratio of $A : B$ in the given sample is found to be $4 : 1$, what is its empirical formula?

(A) AB_3

(B) A_2B

(C) AB_4

(D) CH_2

Q14. The fundamental nature of an alpha (α) particle emitted during structural isotopic disintegration was studied by Ernest Rutherford. An α-particle is identical to a:

(A) Singly ionized Hydrogen atom

(B) Fast-moving electron stream

(C) Doubly ionized Helium nucleus

(D) Neutral particle with zero net charge

Q15. Which type of chemical bond is formed when there is a complete transfer of one or more electrons from the outermost shell of one atom to the outermost shell of another atom, resulting in strong electrostatic forces of attraction?

(A) Non-polar covalent bond

(B) Coordinate covalent bond

(C) Electrovalent (ionic) bond

(D) Hydrogen metallic bond

Q16. The process of heating an ore strongly below its melting point in the absolute absence or highly limited supply of air, generally carried out for carbonate and hydrated ores to remove volatile impurities, is technically known as:

(A) Roasting

(B) Calcination

(C) Smelting

(D) Froth floatation

Q17. When iron filings are added to an aqueous solution of copper sulfate ($CuSO_4$), the blue color of the solution slowly changes to light green, and a reddish-brown deposit is observed. What category of chemical reaction does this represent?

(A) Combination reaction

(B) Decomposition reaction

(C) Single displacement reaction

(D) Double displacement reaction

Q18. The pH value of an aqueous solution prepared by dissolving sodium acetate (CH_3COONa) salt in pure distilled water will be:

(A) Exactly equal to 7

(B) Greater than 7

(C) Less than 7

(D) Zero

Q19. Which of the following organic compounds is the principal constituent of biogas and compressed natural gas (CNG)?

(A) Ethane

(B) Methane

(C) Butane

(D) Acetylene

Q20. Two chemical elements possess the same mass number but have different atomic numbers due to varying nuclear charge configurations. Such architectural atomic pairs are known as:

(A) Isotopes

(B) Isobars

(C) Isotones

(D) Isomers

Q21. The principal structural components of an alloy called Brass are:

(A) Copper and Tin ($Cu + Sn$)

(B) Lead and Tin ($Pb + Sn$)

(C) Iron and Chromium ($Fe + Cr$)

(D) Copper and Zinc ($Cu + Zn$)

Q22. Which of the following compounds reacts with sodium bicarbonate ($NaHCO_3$) solution to release carbon dioxide gas with rapid and brisk effervescence?

(A) Ethanol (C_2H_5OH)

(B) Ethanoic acid (CH_3COOH)

(C) Dimethyl ether (CH_3OCH_3)

(D) Acetone (CH_3COCH_3)

Q23. Moving from left to right along a short period of the Modern Periodic Table, the atomic radius of the elements generally trends towards:

(A) Linearly increasing due to additional shell addition

(B) Decreasing due to an increase in effective nuclear charge

(C) Remaining perfectly constant across all groups

(D) Irregularly fluctuating without any periodic correlation

Q24. Which of the following chemical formulas represents the composition of Plaster of Paris?

(A) $CaSO_4 \cdot \frac{1}{2}H_2O$

(B) $CaSO_4 \cdot 2H_2O$

(C) $CuSO_4 \cdot 5H_2O$

(D) $CaCl_2 \cdot 2H_2O$

Q25. What mass of solid calcium carbonate ($CaCO_3$) must be thermally decomposed to produce exactly 22.4 liters of carbon dioxide (CO_2) gas at standard temperature and pressure (STP)? (Atomic masses: $Ca = 40$, $C = 12$, $O = 16$)

(A) 50 grams

(B) 100 grams

(C) 22.4 grams

(D) 44 grams

Detailed Solutions

Q1.

Solution

Concept:

An atom contains a dense nucleus surrounded by orbiting electrons distributed across distinct energy shells following the Bohr-Bury scheme ($2n^2$ rule). The total number of protons dictates the atomic number and electronic layout of a neutral atom, where the outermost shell electrons represent the valence shell count.

Solution:

(a) The given element possesses 13 protons. In a neutral atomic state, the number of electrons equals the number of protons, giving exactly 13 electrons.

(b) Distributing these 13 electrons using the Bohr-Bury guidelines fill the K shell ($n = 1$) with 2 electrons and the L shell ($n = 2$) with 8 electrons.

(c) The remaining electrons occupy the M shell ($n = 3$), which calculates to $13 - (2 + 8) = 3$ electrons.

(d) Looking at the provided TikZ graphic, the innermost circle represents the nucleus ($+13$). The three concentric rings outerward contain 2, 8, and 3 electrons respectively.

(e) Because the outermost occupied energy boundary is the third shell, the 3 electrons residing in this shell constitute the valence electrons. This corresponds to Aluminum, which forms a stable trivalent cation.

Final Answer: The total number of valence electrons is 3.

Answer: (C)

Go Back to Question 1

Q2.

Solution

Concept:

Stoichiometric conversions link the measurable mass of a molecular substance to its microscopic chemical composition. By computing the molar quantity using atomic weights, the total number of individual molecules can be determined via Avogadro's constant, which subsequently reveals the constituent chemical bonds.

Solution:

(a) Methane has the chemical formula CH_4. Its molecular mass is calculated by adding the individual atomic weights of its constituent elements: $12 + (4 \times 1) = 16$ g/mol.

(b) The number of moles contained within the sample is determined by dividing the given mass by its calculated molar mass: 3.2 g$/16$ g/mol $= 0.2$ moles.

(c) One single molecule of methane (CH_4) consists of one central carbon atom bound to four surrounding hydrogen atoms through four distinct, single covalent shared electron pairs.

(d) Therefore, one mole of methane molecules contains exactly 4 moles of covalent shared single bonds.

(e) To find the total structural bonds in the given sample, multiply the calculated moles of gas by the bonds per molecule: 0.2 moles $\times$ 4 bonds/molecule $= 0.8 \times N_A$.

Final Answer: The total number of covalent bonds is $0.8 \times N_A$.

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept:

Heating curves track phase modifications as heat energy is supplied over time. Plateaus indicate phase changes where temperature remains static because the added kinetic thermal energy is consumed entirely as latent heat to break intermolecular attractive forces rather than increasing particle velocity.

Solution:

(a) The diagram depicts two distinct flat plateaus representing isothermal phase equilibrium stages during a continuous heating process.

(b) The first lower temperature plateau, labeled as region B, corresponds to the melting point phase change where a solid shifts into a liquid.

(c) Following region B, the temperature rises through region C as the liquid absorbs sensible heat up to its boiling threshold.

(d) The second higher temperature plateau, labeled as region D, indicates the boiling point where liquid transforms into vapor.

(e) During this transition, the temperature remains perfectly constant while latent heat of vaporization is absorbed to break liquid cohesion, rendering region D the vaporization zone.

Final Answer: Region D represents the latent heat of vaporization.

Answer: (D)

Go Back to Question 3

Q4.

Solution

Concept:

Universal indicators display a continuous spectrum of color indicators corresponding to the precise hydrogen ion concentration within an aqueous system. The standard color shifts vary sequentially from red for strongly acidic regions to violet for highly alkaline chemical environments.

Solution:

(a) Dilute hydrochloric acid (HCl) is a strong mineral acid that completely dissociates in an aqueous medium to yield a high concentration of hydronium ions.

(b) Highly acidic solutions with low pH values falling between 1 and 3 react with universal indicator mixtures to express a deep red coloration.

(c) As acidity diminishes into weak organic acid levels, the indicator color transitions through orange and yellow hues.

(d) Neutral environments like water measure near pH 7 and manifest a green tone, while basic profiles turn blue or violet.

(e) Test tube P displays a red reaction, proving it contains the lowest pH value and matches a strong acid sample.

Final Answer: Test tube P contains the strong acid solution.

Answer: (A)

Go Back to Question 4

Q5.

Solution

Concept:

Faraday's principles and stoichiometric water composition govern the electrolytic decomposition of water. Passing a direct electrical current through acidulated water induces simultaneous redox transformations at the separated electrode boundaries, liberating gaseous elements.

Solution:

(a) The balanced chemical equation describing the decomposition of liquid water molecules reads: $2H_2O \rightarrow 2H_2 + O_2$.

(b) During water electrolysis, hydrogen ions undergo reduction at the negative electrode (cathode) to form hydrogen gas: $4H^+ + 4e^- \rightarrow 2H_2$.

(c) Simultaneously, oxidation occurs at the positive electrode (anode) to generate oxygen gas: $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$.

(d) The stoichiometry shows that for every two volumes of hydrogen gas produced, exactly one volume of oxygen gas is evolved.

(e) The question asks for the specific volume ratio of anode gas (oxygen) to cathode gas (hydrogen), which equates to a volumetric profile of $1 : 2$.

Final Answer: The volumetric ratio of the collected gases is $1 : 2$.

Answer: (A)

Go Back to Question 5

Q6.

Solution

Concept:

Industrial fractional distillation separates complex petroleum mixtures by exploiting differences in boiling points. As vaporized crude oil ascends a fractionating tower, compounds cool and condense at designated levels depending on the length of their carbon chains.

Solution:

(a) The internal temperature profile of an industrial distillation column is highest at the bottom and lowest at the top exit.

(b) Hydrocarbons possessing short carbon chains exhibit weak intermolecular van der Waals forces, giving them low boiling points.

(c) These volatile compounds remain gaseous and travel to the topmost section, labeled Fraction X, before condensing.

(d) Heavy oils with long carbon links possess high boiling points and settle immediately near the hot base as Fraction Z.

(e) Comparing options, Liquefied Petroleum Gas contains light $C_3 - C_4$ alkanes, which vaporize easily and collect at the top column exit.

Final Answer: Fraction X is Liquefied Petroleum Gas.

Answer: (A)

Go Back to Question 6

Q7.

Solution

Concept:

The structural architecture of the modern periodic table directly mirrors atomic electronic arrangements. The total number of occupied electron shells defines the period placement, whereas the valence shell configuration determines the periodic group alignment.

Solution:

(a) The unknown element X features an explicit configuration written as $2, 8, 7$.

(b) Counting the values reveals three distinct energy levels (K, L, and M) containing electrons, meaning it belongs in Period 3.

(c) The outer valence shell contains exactly 7 electrons.

(d) According to IUPAC formatting for main-group p-block elements, groups are assigned by adding 10 to the valence electron count when it exceeds 2.

(e) Adding 10 to the 7 valence electrons places element X inside Group 17, identifying it as the halogen element Chlorine.

Final Answer: Element X belongs in Group 17, Period 3.

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept:

Electronegativity represents the relative atomic pull exerted on shared bonding pairs. Non-metallic character and electronegativity values track together, increasing across periods due to rising nuclear charge pulling outer electrons closer.

Solution:

(a) The elements Carbon, Nitrogen, Oxygen, and Fluorine occupy sequential positions across Period 2 of the periodic table.

(b) Moving left to right, the atomic number rises alongside proton addition while electrons fill the same principal shell.

(c) This increases effective nuclear pull, shrinking atomic radii and strengthening attraction for external electrons.

(d) Fluorine sits furthest right among the choices, maximizing this periodic electrostatic structural trend.

(e) Consequently, Fluorine holds the highest electronegativity rating (4.0 on Pauling's scale) and the strongest non-metallic character.

Final Answer: Fluorine exhibits the highest non-metallic character.

Answer: (D)

Go Back to Question 8

Q9.

Solution

Concept:

Carbonate equilibrium pathways dictate solubility shifts during lime water testing. Introducing carbon dioxide gas to calcium hydroxide initiates a two-stage chemical transition, converting insoluble salts into a clear, coordinated bicarbonate phase.

Solution:

(a) Passing carbon dioxide gas through clear lime water ($Ca(OH)_2$) initially precipitates insoluble calcium carbonate: $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 \downarrow + H_2O$.

(b) This suspended white solid creates the characteristic milky turbidity observed in short-duration reactions.

(c) When extra carbon dioxide gas is bubbled into the system over an extended period, it reacts further with the water and precipitate.

(d) This secondary acidic environment transforms the carbonate into calcium bicarbonate: $CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2$.

(e) Because calcium bicarbonate dissolves completely in aqueous solutions, the initial white milkiness clears up entirely.

Final Answer: The soluble compound formed is $Ca(HCO_3)_2$.

Answer: (C)

Go Back to Question 9

Q10.

Solution

Concept:

Elemental categories exhibit distinct acid-base behavior through their corresponding oxides. Dissolving oxides in water allows classification, as non-metal compounds form acidic solutions while metallic structures generate basic environments.

Solution:

(a) The experimental observations state that dissolving the oxide of element E in water creates a solution that turns blue litmus red.

(b) Turning blue litmus paper red is a defining property of an acidic solution with a high hydronium ion concentration.

(c) Chemical principles establish that covalent non-metal oxides react with water molecules to produce acids.

(d) For example, non-metal oxides like sulfur dioxide or carbon dioxide generate sulfurous or carbonic acids when dissolved.

(e) Conversely, metallic elements yield basic hydroxides, meaning element E must be classified as a typical non-metal.

Final Answer: Element E is categorized as a typical non-metal.

Answer: (B)

Go Back to Question 10

Q11.

Solution

Concept:

Alkali metals exhibit distinct reactivity pathways with water, releasing thermal energy and hydrogen gas. Emitted metal ions can also be identified by flame tests, where valence electrons emit element-specific wavelengths of light upon returning to ground state.

Solution:

(a) The problem describes a highly reactive metal element that interacts vigorously with cold water to generate an alkaline solution and a flammable gas.

(b) This general reactivity profile points to alkali or alkaline earth metals, where gas G represents hydrogen (H_2).

(c) To narrow down the specific identity of metal M, look at the atomic flame emission data.

(d) When volatilized in a flame, sodium ions yield a brilliant yellow color, while calcium outputs brick-red.

(e) Potassium ions release a distinct light purple or lilac hue, which uniquely identifies metal M as Potassium (K).

Final Answer: The identity of metal M is Potassium (K).

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept:

IUPAC nomenclature provides systematic naming rules for open-chain hydrocarbons. Standard structural identification requires locating the longest continuous carbon chain containing any multiple bonds, followed by assigning numbering priorities to maintain low position addresses.

Solution:

(a) Examining the provided structural diagram reveals a linear arrangement of three linked carbon atoms.

(b) A three-carbon continuous parent alkane chain is designated by the prefix "prop-".

(c) The bond linking the second and third carbon positions contains a double covalent shared electron sharing profile.

(d) The presence of this double bond classifies the hydrocarbon as an alkene, changing the functional suffix to "-ene".

(e) Numbering the chain from right to left gives the double bond the lowest locant position (carbon-1), yielding the final systematic IUPAC name propene.

Final Answer: The systematic IUPAC name for the compound is Propene.

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept:

An empirical formula represents the simplest whole-number ratio of the atoms of each element present in a chemical compound. It is determined by converting the given mass ratios of the constituent elements into atomic mole ratios using their respective atomic weights.

Solution:

(a) The given mass ratio of the two elements present in the compound sample is $A : B = 4 : 1$.

(b) To find the relative number of moles of each element, divide the mass proportion of each element by its respective atomic weight.

(c) For element A, the relative moles are calculated as $4/12 = 1/3$. For element B, the relative moles are calculated as $1/1 = 1$.

(d) To convert these fractional molar values into simple integers, multiply both molar values by the common denominator, which is 3.

(e) This multiplication yields a simplified ratio of 1 atom of A to 3 atoms of B, giving the final empirical formula AB_3.

Final Answer: The empirical formula of the compound is AB_3.

Answer: (A)

Go Back to Question 13

Q14.

Solution

Concept:

Alpha radiation consists of heavy, high-energy particles emitted during specific nuclear decay sequences. Identifying the subatomic composition and charge of these particles establishes their identity relative to standard elemental nuclei.

Solution:

(a) An alpha particle is ejected from unstable heavy nuclei during radioactive disintegration to decrease atomic volume.

(b) Each alpha particle contains exactly two protons and two neutrons bound closely together inside its structure.

(c) Because it contains two protons and zero electrons, it carries a net positive charge of $+2$.

(d) The chemical element that contains two protons in its standard neutral nucleus is Helium.

(e) Removing both electrons from a Helium atom leaves behind a bare nucleus containing two protons and two neutrons, making an alpha particle completely identical to a doubly ionized Helium nucleus.

Final Answer: An alpha particle is a doubly ionized Helium nucleus.

Answer: (C)

Go Back to Question 14

Q15.

Solution

Concept:

Chemical bonds develop to lower atomic potential energy by completing outer valence electron shells. The mechanism of shell completion differentiates ionic bonds from covalent structures based on whether electrons are shared or fully relocated.

Solution:

(a) Electrovalent bonding occurs when atoms with low ionization energy interact with atoms possessing high electron affinity.

(b) In this process, a metallic atom completely loses one or more valence electrons to transform into a positively charged cation.

(c) Simultaneously, a non-metallic atom gains those lost electrons to transform into a negatively charged anion.

(d) This complete particle relocation satisfies the octet rule for both interacting species, creating stable electronic structures.

(e) The resulting oppositely charged ions are held together firmly by powerful, multi-directional electrostatic forces of attraction, forming an ionic lattice.

Final Answer: The chemical bond formed is an electrovalent (ionic) bond.

Answer: (C)

Go Back to Question 15

Q16.

Solution

Concept:

Pyrometallurgical processing transforms crude concentrated mineral ores into reactive metal oxides. Choosing between roasting and calcination depends on the chemical composition of the ore and the presence of oxygen during heating.

Solution:

(a) Roasting involves heating sulfide mineral ores intensely in a regular, plentiful supply of oxygen gas to cause chemical oxidation.

(b) Calcination involves heating carbonate, hydrated, or hydroxide ores to high temperatures in the absolute absence or limited supply of air.

(c) Thermal energy breaks down carbonate components during calcination, releasing carbon dioxide gas: $CaCO_3 \rightarrow CaO + CO_2$.

(d) For hydrated minerals, the applied heat drives away chemically bound moisture as water vapor, leaving a porous oxide behind.

(e) Because the description specifies the absence of air and targets carbonate structures, the process is technically identified as calcination.

Final Answer: The process described is known as Calcination.

Answer: (B)

Go Back to Question 16

Q17.

Solution

Concept:

Reactivity series arrangements dictate the feasibility of single replacement interactions. A more chemically active element can displace a less active metal ion from its dissolved salt solution by forcing an electron transfer.

Solution:

(a) According to the electrochemical reactivity series, elemental iron possesses a higher oxidation potential than metallic copper.

(b) When solid iron filings are introduced to a blue copper sulfate solution, iron atoms readily lose electrons to form ferrous ions.

(c) The dissolved copper ions accept these electrons, precipitating out of solution as solid copper metal: $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$.

(d) As iron dissolves to form ferrous sulfate ($FeSO_4$), the intense blue color of the solution transitions into a light green hue.

(e) The displaced copper metal deposits onto the remaining iron filings as a visible, reddish-brown metallic layer.

Final Answer: This chemical process represents a single displacement reaction.

Answer: (C)

Go Back to Question 17

Q18.

Solution

Concept:

Salt hydrolysis alters the neutral balance of water by generating unequal concentrations of hydronium or hydroxyl ions. The chemical nature of the parent acid and base determines whether a salt solution tests acidic or basic.

Solution:

(a) Sodium acetate (CH_3COONa) is an ionic salt formed by neutralizing a weak organic acid with a strong alkali base.

(b) Dissolving sodium acetate in water causes complete dissociation into sodium cations and acetate anions.

(c) The sodium ion does not react with water, but the conjugate acetate anion undergoes hydrolysis by capturing hydrogen ions from water molecules.

(d) This reaction releases free hydroxyl ions (OH^-) into the system: $CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$.

(e) The accumulation of hydroxyl ions makes the solution basic, shifting the logarithmic pH scale reading above 7.

Final Answer: The pH value of the aqueous solution will be greater than 7.

Answer: (B)

Go Back to Question 18

Q19.

Solution

Concept:

Biomass conversion and geological compression generate simple hydrocarbon gases through anaerobic decomposition. These fuels consist primarily of light alkanes that burn cleanly in oxygen to release thermal energy.

Solution:

(a) Biogas is generated through the anaerobic breakdown of organic waste material by specialized methanogenic bacteria.

(b) Compressed natural gas is extracted from subterranean geological reservoirs formed by long-term thermal compression of organic matter.

(c) Chemical analysis shows that both fuel mixtures consist mostly of methane (CH_4), which typically makes up over 75 percent of the volume.

(d) Other heavier hydrocarbons like ethane, propane, and butane are present only in minor, trace percentages.

(e) Because methane releases a large amount of heat per unit mass during combustion, it is the primary active component in these gases.

Final Answer: The principal constituent of biogas and CNG is Methane.

Answer: (B)

Go Back to Question 19

Q20.

Solution

Concept:

Nuclear composition defines the structural classifications of differing atomic varieties. Nuclides are categorized based on similarities or differences in their absolute counts of protons, neutrons, or total combined nucleons.

Solution:

(a) The mass number of an atom represents the total combined sum of protons and neutrons residing inside its central nucleus.

(b) The atomic number represents the total number of protons, which defines the positive charge and chemical identity of the element.

(c) Isotopes are atoms of the same element that have identical atomic numbers but different mass numbers due to varying neutron counts.

(d) Isobars are atoms of different chemical elements that share the exact same mass number but possess distinct, unique atomic numbers.

(e) For example, Argon-40 and Calcium-40 are classic isobars because they share a mass number of 40 while holding different nuclear proton counts.

Final Answer: Atomic pairs with matching mass numbers are called Isobars.

Answer: (B)

Go Back to Question 20

Q21.

Solution

Concept:

Alloys are solid mixtures of multiple metals or non-metals combined to improve strength, hardness, and corrosion resistance. Copper serves as the primary base metal for several common historical and industrial alloys.

Solution:

(a) Mixing different metal atoms distorts the regular metallic crystal lattice, making the resulting alloy mechanically stronger than its pure components.

(b) Brass is a highly malleable, golden-colored alloy composed primarily of copper combined with varying percentages of zinc.

(c) Bronze is a different copper-based alloy composed mainly of copper combined with tin.

(d) Solder is a low-melting-point alloy used to join electrical components, made by blending lead and tin.

(e) Because the question asks specifically for the composition of brass, the correct metallic combination is copper and zinc ($Cu + Zn$).

Final Answer: The principal structural components of Brass are Copper and Zinc.

Answer: (D)

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Q22.

Solution

Concept:

Carboxylic acids exhibit higher acidity than alcohols or phenols due to resonance stabilization of the carboxylate anion. This acidity allows them to decompose weak carbonate salts, releasing gas.

Solution:

(a) Sodium bicarbonate ($NaHCO_3$) is a weak basic salt that reacts with acids to produce a metal salt, water, and carbon dioxide.

(b) Alcohols like ethanol are too weakly acidic to react with bicarbonate salts, so they show no visual reaction.

(c) Ethanoic acid (CH_3COOH) is a carboxylic acid that readily releases protons to decompose the bicarbonate ion.

(d) The chemical equation is: $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2 \uparrow$.

(e) The rapid liberation of insoluble carbon dioxide gas creates strong, visible effervescence in the reaction vessel.

Final Answer: Ethanoic acid reacts with sodium bicarbonate to release carbon dioxide.

Answer: (B)

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Q23.

Solution

Concept:

Periodic trends track how changing nuclear properties affect atomic structure. Atomic size depends on the electrostatic balance between the positive nucleus and the negative electron cloud.

Solution:

(a) Moving left to right across a specific period, electrons are added to the same principal energy shell.

(b) At the same time, protons are added to the nucleus, increasing the positive charge of the center.

(c) Because the inner electron shells provide a similar amount of shielding, the effective nuclear charge pulling on the outer shell increases.

(d) This stronger electrostatic attraction pulls the outer electron cloud closer to the nucleus.

(e) This tightening effect shrinks the boundaries of the electron shells, causing the atomic radius to decrease across the period.

Final Answer: The atomic radius decreases due to increasing effective nuclear charge.

Answer: (B)

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Q24.

Solution

Concept:

Controlled thermal dehydration changes the crystal structure of calcium sulfate minerals. Adjusting the temperature during heating controls how many molecules of crystallization remain in the salt.

Solution:

(a) Gypsum is a naturally occurring mineral composed of calcium sulfate dihydrate, written as $CaSO_4 \cdot 2H_2O$.

(b) Heating gypsum carefully to about 373 Kelvin drives off three-quarters of its bound water of crystallization.

(c) This partial dehydration yields calcium sulfate hemihydrate, which has the chemical formula $CaSO_4 \cdot \frac{1}{2}H_2O$.

(d) This hemihydrate form is commonly known as Plaster of Paris, which sets into a hard solid when mixed with water.

(e) If heated above 393 Kelvin, all water is lost, forming anhydrous calcium sulfate, also called dead burnt plaster.

Final Answer: The chemical formula for Plaster of Paris is $CaSO_4 \cdot \frac{1}{2}H_2O$.

Answer: (A)

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Q25.

Solution

Concept:

Molar gas volume values connect macroscopic gas volumes directly to stoichiometry. Avogadro's law states that one mole of any ideal gas occupies a specific fixed volume under standard temperature and pressure conditions.

Solution:

(a) The balanced chemical equation for the thermal decomposition of calcium carbonate is: $CaCO_3 \rightarrow CaO + CO_2$.

(b) The stoichiometry shows that decomposing 1 mole of solid $CaCO_3$ produces exactly 1 mole of carbon dioxide gas.

(c) According to standard gas values, 1 mole of any gas occupies a volume of 22.4 liters at STP.

(d) To generate 22.4 liters of CO_2 gas, exactly 1 mole of calcium carbonate must decompose.

(e) The molar mass of $CaCO_3$ is calculated from its atomic weights: $40+12+(3\times16) = 100$ g/mol, meaning 1 mole weighs 100 grams.

Final Answer: The required mass of calcium carbonate is 100 grams.

Answer: (B)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	B	3	D	4	A	5	A
6	A	7	B	8	D	9	C	10	B
11	B	12	B	13	A	14	C	15	C
16	B	17	C	18	B	19	B	20	B
21	D	22	B	23	B	24	A	25	B