

JEECUP Group A Chemistry Sample Paper - 14

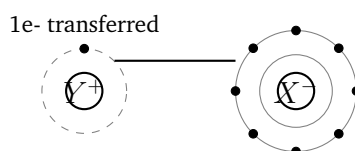
Duration: 45 Minutes

Maximum Marks: 100

Instructions

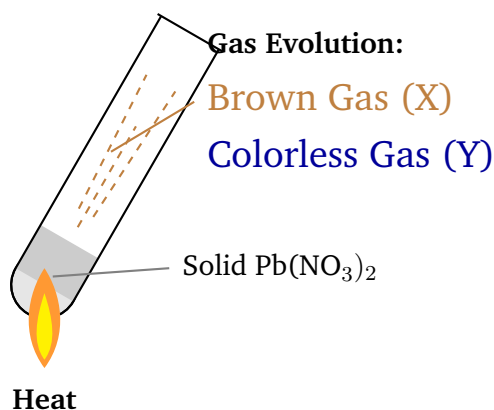
- This paper contains **25** Multiple Choice Questions (Single Correct).
- Each correct answer carries **+4 marks**. No marks will be deducted for incorrect answers. Unattempted questions carry **0** marks.
- Only **one** option is correct for each question.
- Use of mobile phones, smartwatches, or any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

Q1. An atom of an element X has an electronic configuration of 2, 8, 7. It combines with an atom of element Y which has an electronic configuration of 2, 1. Which of the following TikZ representations accurately portrays the electron transfer and the resulting bond formation between Y and X ?



- (A) Covalent bond formed by sharing a pair of electrons where both share equal electronegativity.
- (B) Ionic bond formed by the complete transfer of one electron from Y to X , resulting in Y^+ and X^- .
- (C) Coordinate covalent bond where X donates its lone pair completely to the vacant orbital of Y .
- (D) Metallic bond where both X and Y release electrons into a common pool of mobile valence electrons.
- Q2.** A student performs a thermal decomposition experiment by heating solid lead nitrate, $Pb(NO_3)_2$, in a boiling tube as represented in the schema below.





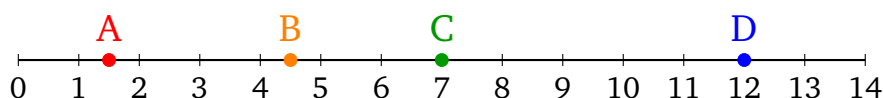
Identify the brown gas (X), the colorless gas (Y), and the color of the solid residue left inside the tube after cooling.

- (A) X = NO_2 , Y = O_2 , Residue = Yellow (PbO)
 (B) X = N_2O , Y = O_2 , Residue = White ($\text{Pb}(\text{NO}_2)_2$)
 (C) X = NO , Y = O_3 , Residue = Red (Pb_3O_4)
 (D) X = NO_2 , Y = N_2 , Residue = Black (PbO_2)

Q3. Consider the basic conversion pathways of ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) shown in the reaction network below. What are the chemical identities of Reagent P and Reagent Q respectively:

- (A) P = Dilute HCl , Q = H_2/Ni
 (B) P = Alkaline KMnO_4 , Q = Concentrated H_2SO_4
 (C) P = Concentrated H_2SO_4 , Q = Alkaline KMnO_4 or acidified $\text{K}_2\text{Cr}_2\text{O}_7$
 (D) P = Acidified $\text{K}_2\text{Cr}_2\text{O}_7$, Q = Anhydrous AlCl_3

Q4. The pH variations of four sample solutions (A, B, C, D) are tested with a universal indicator and charted along a horizontal pH axis:



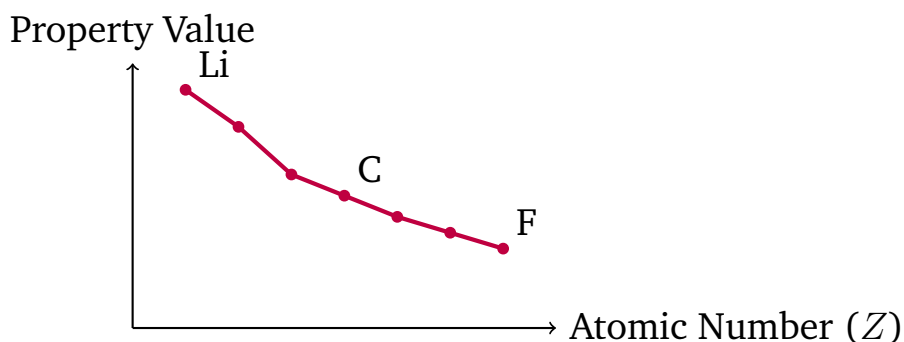
Which option lists these samples in the exact order of their increasing hydrogen ion concentration $[\text{H}^+]$?

- (A) $\text{A} < \text{B} < \text{C} < \text{D}$



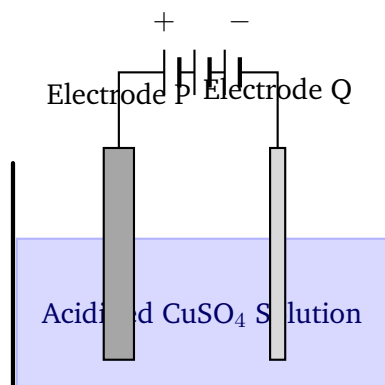
- (B) $D < C < B < A$
 (C) $C < D < B < A$
 (D) $A < C < B < D$

Q5. The variation of a specific periodic property across the second period elements (Li to F) is plotted conceptually in the diagram below:



Which key periodic property does this graph represent?

- (A) Ionization Potential
 (B) Electronegativity
 (C) Atomic Radius
 (D) Electron Gain Enthalpy
- Q6.** An electrolytic tank is set up for the refining of an impure copper strip. The configuration is diagrammed below:



During successful electrolytic refining, which materials should Electrode P and Electrode Q consist of?



- (A) P = Pure copper, Q = Impure copper
(B) P = Impure copper, Q = Pure copper
(C) P = Carbon rod, Q = Pure copper
(D) P = Impure copper, Q = Platinum strip
- Q7.** The maximum number of electrons that can be accommodated in the shell with principal quantum number $n = 3$ is calculated directly from basic quantum mechanical formulas. What is this value?
- (A) 8
(B) 18
(C) 32
(D) 2
- Q8.** When hydrogen sulfide gas (H_2S) is bubbled through an aqueous solution of copper sulfate (CuSO_4), a black precipitate of copper sulfide (CuS) forms along with sulfuric acid in solution. This reaction is classified fundamentally as which type of chemical change?
- (A) Combination reaction
(B) Thermal decomposition reaction
(C) Displacement reaction
(D) Double displacement reaction
- Q9.** Which of the following compounds is chemically known as calcium sulfate hemihydrate and is prepared by heating gypsum to a highly regulated temperature of 373 K?
- (A) Bleaching Powder
(B) Baking Soda
(C) Plaster of Paris
(D) Washing Soda



- Q10.** Sulfide ores are generally converted into their respective metal oxides by heating them strongly in the presence of excess air. What is this pyrometallurgical process called?
- (A) Calcination
(B) Roasting
(C) Smelting
(D) Reduction
- Q11.** An organic compound with the molecular formula C_3H_6O gives a positive test with 2,4-dinitrophenylhydrazine but does not reduce Tollens' reagent. Identify its structural formula and IUPAC name.
- (A) CH_3CH_2CHO (Propanal)
(B) CH_3COCH_3 (Propanone)
(C) $CH_2 = CH - CH_2OH$ (Prop-2-en-1-ol)
(D) $CH_3CH_2O - CH_3$ (Methoxyethane)
- Q12.** According to Mendeleev's Periodic Law, the properties of elements are a periodic function of their corresponding:
- (A) Atomic numbers
(B) Atomic masses
(C) Number of neutrons
(D) Atomic volumes
- Q13.** Which statement correctly describes the nature of properties observed in covalent compounds compared to ionic compounds?
- (A) Covalent compounds generally possess high melting points and are excellent electrical conductors in solid states.
(B) Covalent compounds are formed by complete electron transfer and are highly soluble in polar solvents like water.



- (C) Covalent compounds generally have low melting and boiling points due to weak intermolecular forces and do not conduct electricity readily.
- (D) Covalent compounds form giant rigid crystal lattices that remain highly non-volatile at all extreme temperatures.

Q14. In the balanced chemical equation: $a\text{MnO}_2 + b\text{HCl} \rightarrow c\text{MnCl}_2 + d\text{H}_2\text{O} + e\text{Cl}_2$, find the stoichiometric coefficients a, b, c, d , and e respectively.

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

Q15. Which of the following acids is present in ant stings and causes a sharp, burning pain upon injection into the skin?

- (A) Methanoic acid
- (B) Oxalic acid
- (C) Tartaric acid
- (D) Citric acid

Q16. An element M reacts violently with cold water to form a basic solution along with the evolution of a gas that catches fire spontaneously. Identify element M from the reactivity series.

- (A) Iron (Fe)
- (B) Copper (Cu)
- (C) Sodium (Na)
- (D) Magnesium (Mg)

Q17. The fundamental component of compressed natural gas (CNG) and bio-gas, which acts as an efficient and clean-burning fuel, is:



- (A) Butane
- (B) Ethane
- (C) Methane
- (D) Propane

Q18. As we move from top to bottom within a given group of the Modern Periodic Table, what is the observed trend for metallic character and valency?

- (A) Metallic character increases while the valency remains exactly constant.
- (B) Metallic character decreases while the valency linearly increases.
- (C) Both metallic character and valency increase simultaneously.
- (D) Metallic character remains constant while the valency decreases.

Q19. Which of the following pairs of molecules contains a triple covalent bond within their elementary diatomic or polyatomic structure?

- (A) O_2 and CO_2
- (B) N_2 and C_2H_2
- (C) H_2 and NH_3
- (D) Cl_2 and CH_4

Q20. Fatty or oily foods develop an unpleasant smell and taste when kept exposed to atmospheric air for extended periods. This phenomenon is termed as:

- (A) Corrosion
- (B) Calcination
- (C) Rancidity
- (D) Reduction



- Q21.** When an aqueous solution of sodium chloride undergoes electrolysis via the chlor-alkali process, what are the primary chemical products formed at the anode, cathode, and within the electrolyte container?
- (A) Anode: O_2 , Cathode: H_2 , Solution: HCl
(B) Anode: Cl_2 , Cathode: H_2 , Solution: $NaOH$
(C) Anode: H_2 , Cathode: Cl_2 , Solution: $NaCl$
(D) Anode: Cl_2 , Cathode: Na , Solution: $NaOCl$
- Q22.** Which of the following statements explains why non-metals generally do not displace hydrogen gas from dilute mineral acids?
- (A) Non-metals are electron donors and reduce hydrogen ions easily.
(B) Non-metals are electronegative elements that act as electron acceptors and cannot readily donate electrons to reduce H^+ ions into H_2 gas.
(C) Non-metals form basic oxides when reacting with hydronium ions.
(D) Non-metals possess highly unstable crystalline orientations that prevent hydrogen gas formation.
- Q23.** Saponification is the alkaline hydrolysis of an ester. The treatment of ethyl ethanoate ($CH_3COOCH_2CH_3$) with aqueous sodium hydroxide ($NaOH$) generates which pair of chemical products?
- (A) CH_3CH_2COONa and CH_3OH
(B) CH_3COONa and CH_3CH_2OH
(C) $HCOONa$ and $CH_3CH_2CH_2OH$
(D) CH_3COOH and CH_3CH_2ONa
- Q24.** Which of the following options represents a purely physical change rather than a permanent chemical transformation?
- (A) Burning of liquefied petroleum gas (LPG)
(B) Souring of milk at room temperature during summer



- (C) Sublimation of solid ammonium chloride or camphor upon gentle heating
- (D) Fermentation of grape juice into wine

Q25. The structural phenomenon responsible for the unique properties of diamond and graphite, where a single element exists in multiple physical crystalline states with drastically different mechanical behaviors, is known as:

- (A) Isomerism
- (B) Homology
- (C) Allotropy
- (D) Catenation



Detailed Solutions

Q1.

Solution

Concept:

Chemical bonding depends on valence configurations. Atoms with one to three valence electrons tend to lose them to form stable cations, while those with seven valence electrons accept them to form stable anions. This mutual exchange completes their respective octets.

Solution:

- (a) Element Y has a configuration of 2, 1. It readily loses its single valence electron to achieve a stable helium configuration, forming the univalent cation Y^+ .
- (b) Element X has a configuration of 2, 8, 7. It requires exactly one electron to complete its outermost octet shell, forming the univalent halide-like anion X^- .
- (c) The absolute transfer of this electron from the electropositive atom Y to the electronegative atom X sets up strong electrostatic forces of attraction between the oppositely charged species.
- (d) This electrostatic attraction binds the ions together into a rigid lattice, creating a classic ionic bond.
- (e) Options involving covalent, coordinate, or metallic pool sharing are incorrect because the diagram explicitly shows complete electron migration and distinct charge separation without any orbital overlapping.

Final Answer: The bond formed is ionic.

Answer: (B)

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Q2.

Solution**Concept:**

Thermal decomposition involves breaking down a single chemical reactant into multiple products using thermal energy. Heavy metal nitrates typically yield metal oxides, nitrogen dioxide, and oxygen gas upon strong heating.

Solution:

- (a) Lead nitrate decomposes according to the balanced chemical equation:
$$2\text{Pb}(\text{NO}_3)_2 \rightarrow 2\text{PbO} + 4\text{NO}_2 + \text{O}_2.$$
- (b) The evolution of the dense brown gas X is due to nitrogen dioxide (NO_2), which is a characteristic pollutant product of this reaction.
- (c) The colorless gas Y that supports combustion is molecular oxygen (O_2).
- (d) The solid residue remaining in the boiling tube is lead(II) oxide (PbO), which looks reddish-brown when hot but settles into a clear yellow shade after cooling down.
- (e) Other combinations like nitrous oxide or ozone are chemically impossible under these standard thermal decomposition pathways.

Final Answer: X is NO_2 , Y is O_2 , and the residue is yellow PbO .

Answer: (A)

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Q3.

Solution**Concept:**

Functional group transformations of alcohols depend on specific reaction conditions. Controlled oxidation yields carboxylic acids, while high-temperature acid-catalyzed transformations yield unsaturated hydrocarbons.

Solution:

- (a) Heating ethanol at 443 K with concentrated sulfuric acid (H_2SO_4) causes intramolecular dehydration. The acid acts as a powerful dehydrating agent, removing a water molecule to create ethene ($\text{CH}_2 = \text{CH}_2$). Thus, Reagent P is concentrated H_2SO_4 .
- (b) Converting an alcohol directly into a carboxylic acid requires a powerful oxidizing agent capable of introducing oxygen atoms.
- (c) Alkaline potassium permanganate (KMnO_4) or acidified potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) provides the necessary nascent oxygen to convert ethanol into ethanoic acid (CH_3COOH). Thus, Reagent Q is an oxidizing agent.
- (d) Dilute mineral acids or reducing setups like nickel catalysts cannot accomplish these specific chemical modifications.

Final Answer: Reagent P is conc. H_2SO_4 and Reagent Q is alkaline KMnO_4 .

Answer: (C)

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Q4.

Solution**Concept:**

The pH scale measures hydronium activity in aqueous environments. It ranges from 0 to 14, where low values represent acidic conditions and high values represent basic conditions.

Solution:

- (a) The mathematical relationship is defined by the negative logarithm equation: $\text{pH} = -\log[\text{H}^+]$. This inverse relationship means lower pH values correspond to higher concentrations of hydrogen ions.
- (b) Sample A has a pH of 1.5, indicating it is strongly acidic with the highest amount of free hydrogen ions.
- (c) Sample B has a pH of 4.5, making it weakly acidic, while Sample C has a pH of 7.0, indicating a neutral solution.
- (d) Sample D has a pH of 12.0, meaning it is strongly basic and contains the lowest concentration of hydrogen ions.
- (e) Arranging the samples in order of increasing hydrogen ion concentration means sorting them from the highest pH value to the lowest pH value: $D < C < B < A$.

Final Answer: The correct sequence is $D < C < B < A$.

Answer: (B)

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Q5.

Solution**Concept:**

Periodic properties change systematically across rows and columns due to variations in nuclear charge and electron shielding. Recognizing these trends helps identify elements and predict their chemical behavior.

Solution:

- (a) Moving left to right across the second period from lithium to fluorine increases the atomic number and adds protons to the nucleus.
- (b) This increase in nuclear charge pulls the electron shells closer to the nucleus because the shielding effect remains relatively constant within the same period.
- (c) This strong inward pull causes the atomic radius to decrease steadily across the period.
- (d) Properties like ionization potential, electronegativity, and electron gain enthalpy generally increase along this path, which contradicts the downward trend shown in the graph.
- (e) The graph shows a steady decline from lithium down to fluorine, which matches the behavior of atomic radii.

Final Answer: The periodic property shown is Atomic Radius.

Answer: (C)

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Q6.

Solution**Concept:**

Electrolytic refining purifies crude metals using targeted redox reactions. An electric current drives metal ions from an impure electrode into an electrolyte solution, where they deposit onto a pure electrode.

Solution:

- (a) The electrolytic cell contains an acidic copper sulfate solution acting as the electrolyte.
- (b) Electrode P is connected to the positive terminal of the power supply, making it the anode. Oxidation occurs at the anode, causing impure copper to dissolve into the solution as copper ions (Cu^{2+}).
- (c) Electrode Q is connected to the negative terminal, making it the cathode. Reduction occurs at the cathode, where copper ions from the solution gain electrons and deposit as pure copper metal.
- (d) Impurities either dissolve or collect beneath the anode as anode mud.
- (e) Therefore, to purify the metal, Electrode P must be made of impure copper and Electrode Q must be made of pure copper.

Final Answer: Electrode P is impure copper and Electrode Q is pure copper.

Answer: (B)

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Q7.

Solution**Concept:**

Electron distribution within atomic shells follows quantum mechanical principles. Each primary energy level contains subshells defined by the principal quantum number.

Solution:

- (a) The maximum number of electrons that any primary shell can hold is calculated using the formula $2n^2$, where n represents the principal quantum number.
- (b) For the M-shell, the principal quantum number is $n = 3$.
- (c) Substituting this value into the equation gives: $2 \times (3)^2 = 2 \times 9 = 18$.
- (d) These 18 electrons are distributed across three subshells: two electrons in the 3s orbital, six electrons in the 3p orbitals, and ten electrons in the 3d orbitals.
- (e) Other options like 8 or 32 apply to the $n = 2$ or $n = 4$ energy levels, respectively.

Final Answer: The maximum number of electrons accommodated is 18.

Answer: (B)

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Q8.

Solution**Concept:**

Chemical reactions are classified by how atoms rearrange. Double displacement reactions involve two ionic compounds exchanging ion partners in an aqueous solution.

Solution:

- (a) The chemical equation for the reaction is: $\text{CuSO}_4(\text{aq}) + \text{H}_2\text{S}(\text{g}) \rightarrow \text{CuS}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq})$.
- (b) In this reaction, copper ions (Cu^{2+}) combine with sulfide ions (S^{2-}) to form a black precipitate of copper sulfide.
- (c) At the same time, hydrogen ions (H^+) combine with sulfate ions (SO_4^{2-}) to form sulfuric acid in the solution.
- (d) This mutual exchange of cations and anions between the reactants classifies the process as a double displacement reaction.
- (e) It cannot be a single displacement reaction because neither element displaces the other from its elemental form.

Final Answer: The chemical change is a double displacement reaction.

Answer: (D)

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Q9.

Solution**Concept:**

Industrial salts are manufactured by thermal processing under carefully controlled temperatures. Heating calcium sulfate dihydrate alters its water of crystallization, changing its physical properties.

Solution:

- (a) Gypsum is represented by the chemical formula $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.
- (b) Heating gypsum to 373 K causes it to lose three-quarters of its water of crystallization, yielding calcium sulfate hemihydrate: $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$.
- (c) This hemihydrate compound is commonly known as Plaster of Paris, which forms a hard mass when remixed with water.
- (d) The temperature must be kept at 373 K. Heating it past this point drives off all water molecules, leaving behind anhydrous calcium sulfate, also known as dead burnt plaster.
- (e) Other commercial options, like baking soda or bleaching powder, have completely different chemical structures.

Final Answer: The compound is Plaster of Paris.

Answer: (C)

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Q10.

Solution**Concept:**

Metallurgical extraction uses thermal processing to convert concentrated ores into metal oxides, which are easier to reduce into pure metals.

Solution:

- (a) Sulfide ores are converted into metal oxides by heating them strongly below their melting points in the presence of excess air. This industrial process is called roasting.
- (b) A typical example is roasting zinc blende: $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$.
- (c) Calcination is a different process used for carbonate ores, where the material is heated in limited air or a vacuum to drive off carbon dioxide.
- (d) Smelting involves reducing the oxide ore with carbon at high temperatures, which occurs later in the extraction process.

Final Answer: This pyrometallurgical process is called roasting.

Answer: (B)

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Q11.

Solution**Concept:**

Functional group analysis uses specific chemical tests to differentiate between organic isomers. Compounds with a carbonyl group react with hydrazine derivatives, but only aldehydes reduce mild oxidizing agents.

Solution:

- (a) The molecular formula C_3H_6O indicates the presence of either an aldehyde, a ketone, or an unsaturated alcohol.
- (b) A positive 2,4-DNP test confirms the presence of a carbonyl group, which narrows the options down to propanal or propanone.
- (c) Because the compound does not reduce Tollens' reagent to form a silver mirror, it cannot be an aldehyde. This rules out propanal.
- (d) Therefore, the compound must be a ketone. Propanone (CH_3COCH_3) fits these test results and shares this molecular formula.
- (e) Isomers containing alcohol or ether groups do not react with 2,4-DNP reagents.

Final Answer: The compound is CH_3COCH_3 (Propanone).

Answer: (B)

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Q12.

Solution**Concept:**

Early periodic tables organized elements by their physical and chemical properties based on macroscopic measurements available in the nineteenth century.

Solution:

- (a) Mendeleev stated that the physical and chemical properties of elements are periodic functions of their atomic masses.
- (b) He arranged the known elements in order of increasing atomic mass, which allowed him to group elements with similar properties into vertical columns.
- (c) This organization highlighted periodic trends, helping him predict the existence and properties of undiscovered elements like gallium and germanium.
- (d) Henry Moseley later updated this approach by showing that atomic number, rather than atomic mass, is the fundamental property used in the Modern Periodic Table.

Final Answer: The properties are a periodic function of atomic masses.

Answer: (B)

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Q13.

Solution

Concept: Chemical behavior and physical states depend directly on bonding nature. Covalent molecules rely on electron sharing, producing localized structures held together by discrete intermolecular links rather than continuous network grids.

Solution:

- (a) Covalent compounds are formed by the mutual sharing of valence electrons between electronegative non-metal atoms to achieve stable configurations.
- (b) Unlike ionic compounds which form massive crystalline structures held by strong electrostatic forces, covalent substances exist as individual molecular units.
- (c) The weak intermolecular forces, such as van der Waals interactions, require minimal thermal energy to overcome during state transitions.
- (d) Consequently, these compounds exhibit characteristically low melting points and low boiling points compared to ionic salts.
- (e) Because all valence electrons are tightly localized within bonds or lone pairs, they lack mobile ions or free electrons to conduct electricity.

Final Answer: Covalent compounds generally possess low melting points and do not conduct electricity.

Answer: (C)

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Q14.

Solution

Concept: The law of conservation of mass states that atoms cannot be created or destroyed in a closed system. Balancing equations requires adjusting coefficients to equalize atoms on both sides.

Solution:

- (a) The unbalanced chemical expression is given as: $a\text{MnO}_2 + b\text{HCl} \rightarrow c\text{MnCl}_2 + d\text{H}_2\text{O} + e\text{Cl}_2$.
- (b) Inspecting manganese shows one atom on each side, meaning coefficient a equals coefficient c . Let $a = 1$ and $c = 1$.
- (c) Looking at the oxygen atoms, the left reactant has two units from dioxide, requiring the right side coefficient d to equal 2.
- (d) To balance the four hydrogen atoms now present in two molecules of water, the reactant coefficient b for hydrochloric acid must become 4.
- (e) Checking chlorine atoms, four units on the left yield two units in manganese chloride, leaving two units for gas, making coefficient e equal 1.

Final Answer: The balanced coefficients are 1, 4, 1, 2, 1.

Answer: (B)

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Q15.

Solution

Concept: Natural biological defense mechanisms rely on chemical irritants. Many insects and plants synthesize simple organic acids to protect themselves against predators or perceived threats.

Solution:

- (a) When an ant stings, it injects an acidic liquid into the dermal layers of the skin, causing swelling, inflammation, and sharp pain.
- (b) The active chemical component responsible for this painful response is methanoic acid, commonly referred to by its traditional name, formic acid.
- (c) The structural formula of this simple single-carbon carboxylic acid is represented as HCOOH.
- (d) The painful symptoms can be neutralized by applying a mild basic solution, such as a paste of sodium bicarbonate, directly to the affected area.
- (e) Other acids like citric, tartaric, or oxalic acids are found in fruits and leaves but are not present in insect venom.

Final Answer: The acid present in ant stings is methanoic acid.

Answer: (A)

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Q16.

Solution

Concept: The reactivity series organizes metals by their relative ease of oxidation. Highly electropositive elements react vigorously with water, extracting enough energy to cause visible ignition.

Solution:

- (a) Alkali metals like sodium are positioned at the top of the reactivity series due to their extremely low first ionization energies.
- (b) Sodium reacts violently with cold water according to the reaction: $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$.
- (c) This exothermic reaction generates substantial heat, which raises the temperature of the surrounding solution and causes it to become strongly basic.
- (d) The thermal energy released is high enough to ignite the escaping hydrogen gas, creating a characteristic popping sound and yellow flame.
- (e) Less active metals like magnesium require hot water or steam, while iron and copper do not react with cold water.

Final Answer: Element M is sodium metal.

Answer: (C)

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Q17.

Solution

Concept: Hydrocarbon fuels serve as primary energy sources. Clean-burning fuels consist mainly of short-chain alkanes that undergo complete combustion with minimal particulate byproduct formation.

Solution:

- (a) Compressed natural gas and biogas are widely used as environmentally friendly alternatives to heavy petroleum distillates.
- (b) The primary component of these gaseous fuels is methane, an alkane with the molecular formula CH_4 , which makes up over eighty percent of their composition.
- (c) Methane undergoes clean combustion according to the equation: $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$.
- (d) This process produces high thermal energy output per unit mass while releasing fewer carbon pollutants than complex long-chain hydrocarbons.
- (e) Longer alkanes like propane and butane are stored under pressure as liquid petroleum gas, making them distinct from compressed natural gas mixtures.

Final Answer: The fundamental component of CNG is methane.

Answer: (C)

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Q18.

Solution

Concept: Electronic structures determine periodic patterns. Moving down a group adds electron shells, which increases atomic size and alters how effectively the nucleus holds valence electrons.

Solution:

- (a) Moving from top to bottom within a vertical group adds a new principal energy level or electron shell at each successive period.
- (b) This expansion increases the distance between the valence electrons and the positive nucleus, amplifying the internal electronic shielding effect.
- (c) The weakened nuclear attraction makes it easier for atoms to lose valence electrons, causing a steady increase in metallic character.
- (d) Valency is determined by the number of valence electrons, which remains identical for all elements within a specific group.
- (e) Consequently, elements down a column maintain a constant valency while showing increasingly metallic behaviors.

Final Answer: Metallic character increases while valency remains constant.

Answer: (A)

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Q19.

Solution

Concept: Covalent bond multiplicity depends on how many electrons are needed to satisfy orbital stability. When atoms share three electron pairs, they form a strong triple bond containing one sigma and two pi components.

Solution:

- (a) Diatomic nitrogen has a valence configuration of 2, 5. Each nitrogen atom requires three additional electrons to achieve a stable neon configuration.
- (b) To satisfy this requirement, two nitrogen atoms share three pairs of electrons, forming a strong triple covalent bond ($\text{N} \equiv \text{N}$).
- (c) Ethyne (C_2H_2) features two carbon atoms that share three electron pairs with each other while binding to hydrogen atoms, creating a central triple bond ($\text{H} - \text{C} \equiv \text{C} - \text{H}$).
- (d) Molecules like oxygen and carbon dioxide utilize double bonds, whereas hydrogen and methane rely on single sigma bonds.
- (e) Therefore, nitrogen and ethyne are the only pair containing triple covalent bonds in their structures.

Final Answer: Triple covalent bonds exist within N_2 and C_2H_2 .

Answer: (B)

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Solution

Concept: Atmospheric oxygen degrades perishable food items over time. Chemical changes in unsaturated lipids alter molecular compositions, generating volatile compounds with distinct odors.

Solution:

- (a) Foods containing fats and oils undergo spontaneous chemical transformations when exposed to atmospheric oxygen, moisture, and light.
- (b) This process involves the auto-oxidation of unsaturated fatty acid chains, which breaks down lipid structures into short-chain aldehydes and ketones.
- (c) These degradation products give the spoiled food an unpleasant taste and a sour, stale odor.
- (d) This chemical degradation of lipid-containing food matrices is termed rancidity.
- (e) Rancidity can be slowed by adding antioxidants, storing food in airtight containers, or flushing packaging with inert gases like nitrogen.

Final Answer: The lipid decomposition process is termed rancidity.

Answer: (C)

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Q20.

Solution

Concept: Industrial chlor-alkali systems use electrolytic current to decompose saltwater brine. The process separates ionic species to yield valuable chemical commodities at each electrode terminal.

Solution:

- (a) The electrolysis of concentrated aqueous sodium chloride involves competing ionic migrations at the positive and negative interfaces.
- (b) Chloride anions surrender electrons at the positive anode, undergoing oxidation to generate elemental chlorine gas (Cl_2).
- (c) At the negative cathode, hydronium ions accept electrons more easily than sodium ions, undergoing reduction to release flammable hydrogen gas (H_2).
- (d) The consumption of hydronium ions leaves excess hydroxide anions behind, which pair with sodium ions to form sodium hydroxide (NaOH).
- (e) This combined pathway yields chlorine gas at the anode, hydrogen gas at the cathode, and caustic soda within the electrolyte solution.

Final Answer: Products are Cl_2 at anode, H_2 at cathode, and NaOH solution.

Answer: (B)

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Q21.

Solution

Concept: Acid displacement reactions rely on electron transfer. For a substance to liberate hydrogen gas from an acid, it must reduce hydronium ions by acting as an effective electron donor.

Solution:

- (a) Metals displace hydrogen from mineral acids because they are electropositive and readily donate valence electrons to reduce acidic protons.
- (b) Non-metals are highly electronegative elements with high ionization potentials, meaning they attract valence electrons rather than losing them.
- (c) When mixed with dilute mineral acids, non-metals cannot donate the electrons needed to reduce hydronium ions (H^+) into diatomic hydrogen gas (H_2).
- (d) Because non-metals cannot act as reducing agents in these conditions, they do not undergo displacement reactions with acids.
- (e) Physical factors like crystalline orientation or melting thresholds do not influence this fundamental chemical behavior.

Final Answer: Non-metals are electron acceptors and cannot reduce hydrogen ions.

Answer: (B)

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Q22.

Solution

Concept: Ester cleavage under alkaline conditions breaks down organic linkages. Base-catalyzed hydrolysis splits ester molecules into a corresponding alcohol and a stable carboxylic acid salt.

Solution:

- (a) Ethyl ethanoate is an ester represented by the structural formula $\text{CH}_3\text{COOCH}_2\text{CH}_3$.
- (b) Treating this ester with hot sodium hydroxide breaks the central ester linkage through nucleophilic attack by hydroxide ions.
- (c) The carbonyl fragment gains an oxygen atom, forming an ethanoate salt, while the alkyl group binds to a hydroxyl group to form ethanol.
- (d) The reaction is balanced as: $\text{CH}_3\text{COOCH}_2\text{CH}_3 + \text{NaOH} \rightarrow \text{CH}_3\text{COONa} + \text{CH}_3\text{CH}_2\text{OH}$.
- (e) This pathway yields sodium ethanoate alongside ethyl alcohol, matching the standard products of saponification reactions.

Final Answer: The products are sodium ethanoate and ethanol.

Answer: (B)

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Q23.

Solution

Concept: Physical transformations alter the state or appearance of a substance without modifying its underlying molecular structure. Chemical changes rearrange atomic bonds to form entirely new chemical compounds.

Solution:

- (a) Sublimation involves a direct phase transition from a solid state to a gaseous state, bypassing the liquid phase completely when thermal energy is applied.
- (b) Solid ammonium chloride absorbs heat to transition into vapor without changing its chemical identity or forming permanent new substances.
- (c) The composition of the chemical matrix remains identical throughout the phase change, allowing the solid to be recovered through cooling.
- (d) In contrast, burning petroleum gas, fermenting fruit juices, and souring milk break down old atomic bonds to form permanent new chemical products.

Final Answer: The sublimation of ammonium chloride represents a physical change.

Answer: (C)

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Q24.

Solution

Concept: Structural variations in elemental forms lead to diverse physical properties. Elemental substances can arrange their constituent atoms into distinct crystalline layouts while retaining identical chemical compositions.

Solution:

- (a) Carbon can form a variety of structural networks, ranging from rigid three-dimensional diamond lattices to layered hexagonal sheets of graphite.
- (b) This capability arises because carbon atoms can form different hybridization states, which leads to varying spatial configurations.
- (c) This phenomenon, where an element exists in multiple physical forms with distinct physical attributes but identical chemical profiles, is called allotropy.
- (d) Diamond and graphite represent two prominent crystalline allotropes of carbon, each exhibiting vastly different electrical conductivity and hardness profile values.
- (e) Isomerism involves compounds with identical molecular formulas but different configurations, while catenation refers to the ability of atoms to form long elemental chains.

Final Answer: The structural phenomenon described is allotropy.

Answer: (C)

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Answer Key

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

