Class 8

Materials used in daily Life

Introduction to Materials Used in Daily Life

Definition: Materials are the substances or mixtures that form the foundation of everyday objects, tools, and products. They range from natural resources like wood and minerals to synthetic ones like plastics and chemicals. In this chapter, we focus on acids, bases, salts, and related concepts, which are crucial for understanding chemical reactions in daily life.

Importance: These materials influence health, environment, and technology. For instance, acids and bases are used in cleaning and cooking, while salts provide essential minerals. In Nepal, materials like traditional soaps (bases) and iodized salt (salts) support hygiene and nutrition. Understanding them promotes safe usage and innovation, such as eco-friendly cleaners.

Classification: Materials are grouped by chemical nature: Acids (proton donors), Bases (proton acceptors), Salts (ionic compounds from neutralization), Indicators (pH detectors), and Alloys (metal mixtures). They interact in reactions like neutralization, affecting pH and properties.

Deep Insight: Materials' properties stem from atomic structure; e.g., acids release H^+ ions due to electron loss. Historically, ancient civilizations used acids (vinegar) for preservation and bases (ashes) for soap-making. In modern times, sustainable sourcing (e.g., organic acids from fruits) reduces environmental impact. Nepal's biodiversity provides natural materials like citric acid from lemons, highlighting the link between nature and chemistry.

Real-Life Examples: Acids in fruit juices for digestion; bases in baking soda for rising dough; salts in seawater for desalination; alloys in bicycle frames for strength. Misuse, like strong acid spills, can cause harm, emphasizing safety education.

Environmental and Economic Aspects: Materials contribute to GDP (e.g., chemical industries in Nepal) but pose risks like pollution from acid rain. Recycling alloys conserves resources, aligning with global sustainability goals.

Acids

Definition: Acids are chemical compounds that ionize in water to produce hydrogen ions (H^+), resulting in a sour taste, corrosive nature, and ability to turn blue litmus paper red. They are essential in digestion, cleaning, and industry but can be hazardous if concentrated.

Physical Properties:
Sour taste: Due to H^+ ions stimulating taste buds (e.g., lemon juice).
Corrosive: Dissolve metals and tissues; strong acids like HCl cause burns.
Solubility: Most dissolve in water, forming aqueous solutions.
Conductivity: Conduct electricity in solution due to ions.
Odor: Generally odorless, but organic acids like acetic acid have a vinegar smell.
State: Can be liquid (HCl), solid (citric acid crystals), or gas (HCl fumes).
Chemical Properties:
Reaction with Metals: Produce hydrogen gas and salt (e.g., $2HCl + Zn \rightarrow ZnCl_2 + H_2\uparrow$); reactivity increases down the metal activity series.
Neutralization: React with bases to form salt and water (e.g., $HCl + NaOH \rightarrow NaCl + H_2O$); exothermic reaction.
Reaction with Carbonates: Produce CO_2 gas (e.g., $2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2\uparrow$).
pH Effect: Always <7; strong acids fully ionize, weak ones partially.
Types:
Mineral Acids: Inorganic, derived from minerals; strong and corrosive. Examples: Hydrochloric acid (HCl: used in steel cleaning), Sulfuric acid (H_2SO_4: in car batteries, fertilizers), Nitric acid (HNO_3: in explosives, dyes). They are monoprotic (HCl) or polyprotic (H_2SO_4).
Organic Acids: Carbon-based, from living organisms; generally weak and edible. Examples: Acetic acid (CH_3COOH: vinegar, 5% concentration), Citric acid ($C_6H_8O_7$: lemons, oranges), Lactic acid ($C_3H_6O_3$: yogurt, milk fermentation), Formic acid (HCOOH: ant stings). They have carboxyl groups (-COOH).
Uses:
Household: Vinegar for pickling, lemon juice for cleaning stains.
Industrial: HCl for metal etching, H_2SO_4 in detergents and paints.
Biological: Stomach acid (HCl) for digestion; citric acid in beverages.
Medical: Ascorbic acid (vitamin C) for immunity.
Environmental: Phosphoric acid in fertilizers, but overuse causes eutrophication.
Deep Insight: Acids' strength is measured by dissociation constant (Ka); pKa <0 for strong acids. In Nepal, organic acids from fruits like oranges prevent scurvy, while mineral acids in industries contribute to pollution. Acids play a role in acid-base equilibrium, crucial for blood pH (7.4). Historical uses include alchemists' aqua regia (HNO_3 + HCl) for dissolving gold. Safety: Dilute acids are safe, but concentrated ones require gloves; neutralization with bases treats spills.
Real-Life Examples: Battery acid corroding terminals; citric acid in soft drinks; formic acid causing ant bites. In Nepal, acetic acid in traditional pickles preserves food without refrigeration.
Bases

Definition: Bases are compounds that accept protons (H^+) or release hydroxide ions (OH^-) in water, giving a bitter taste, slippery feel, and ability to turn red litmus blue. They counteract acids and are vital for cleaning and health.
Physical Properties:
Bitter taste: Due to OH^- ions (e.g., soap solution).
Slippery feel: Soapy texture from saponification.
Corrosive: Strong bases like NaOH dissolve tissues.
Solubility: Alkalis (soluble bases) dissolve in water; insoluble ones like $Ca(OH)_2$ are used in paints.
Conductivity: Conduct electricity in solution.
Odor: Some like ammonia have a pungent smell.
State: Solids (NaOH pellets), liquids (ammonia solution), or gases (NH_3).
Chemical Properties:
Neutralization: React with acids to form salt and water (e.g., NaOH + HCl → NaCl + H_2O); endothermic or exothermic.
Reaction with Acids: Always produce water and salt.
Saponification: React with fats/oils to form soaps (e.g., NaOH + fat → soap + glycerol).
pH Effect: Always >7; strong bases fully dissociate.
Uses:
Household: Baking soda ($NaHCO_3$) for baking and cleaning; soap for hygiene.
Industrial: Caustic soda (NaOH) in paper, textiles; ammonia in fertilizers.
Medical: Antacids like milk of magnesia for indigestion.
Environmental: Lime (CaO) to neutralize acidic soils.
Deep Insight: Bases' strength via Kb; pKb >0 for weak bases. In Nepal, bases in traditional lye soaps from wood ash. Alkalis are soluble hydroxides; historical uses include Egyptian mummification with natron (Na_2CO_3). Safety: Strong bases cause burns; weak ones like baking soda are edible. Bases maintain alkaline pH in blood, preventing acidosis.
Real-Life Examples: Soap dissolving grease; ammonia in window cleaners; lime in cement. In Nepal, baking soda in momos for fluffiness.
Salts
Definition: Salts are ionic compounds produced from the reaction between acids and bases, consisting of cations (positive ions) from bases and anions (negative ions) from acids. They are crystalline solids with high melting points.
Types:
Neutral Salts: Formed from strong acid + strong base; pH 7, no hydrolysis. E.g., Sodium chloride (NaCl: table salt), Potassium nitrate (KNO_3: fertilizer).
Acidic Salts: From strong acid + weak base; hydrolyze to acidic solution (pH <7). E.g., Sodium hydrogen sulfate ($NaHSO_4$), used in detergents.

Basic Salts: From weak acid + strong base; hydrolyze to basic solution (pH >7). E.g., Sodium bicarbonate ($NaHCO_3$: baking soda), Calcium carbonate ($CaCO_3$: limestone).
Properties: Soluble in water (most), conduct electricity in molten/solution form, have definite crystal structures, high melting/boiling points.
Uses: Food seasoning (NaCl), water softening (Na_2CO_3), fertilizers (KCl), preservatives ($NaNO_3$), construction ($CaSO_4$ in plaster).
Deep Insight: Salts' pH from hydrolysis; e.g., acidic salts release H^+. In Nepal, iodized NaCl prevents thyroid issues. Historical: Romans used salt for trade. Electrolytes in salts conduct; e.g., NaCl in batteries.
Real-Life Examples: Epsom salt ($MgSO_4$) for baths; road salt (NaCl) for de-icing. In Nepal, rock salt from mines.

Indicators

Definition: Indicators are substances that change color based on pH, indicating acidity or basicity. They are weak acids or bases that ionize differently in acidic/basic environments.
Examples:
Litmus: Red in acid, blue in base; natural from lichens.
Turmeric: Yellow in acid, red in base; from rhizomes.
Phenolphthalein: Colorless in acid, pink in base; synthetic.
Methyl Orange: Red in acid, yellow in base.
Uses: Lab testing, soil pH for farming, water quality.
Deep Insight: Color change at equivalence point; e.g., litmus at pH 7. In Nepal, turmeric used in festivals for color tests. Indicators are dyes; pH range specific.
Real-Life Examples: Litmus in urine tests; turmeric in food coloring.

pH Scale

Definition: The pH scale measures hydrogen ion concentration in solutions, ranging from 0 (most acidic) to 14 (most basic); 7 is neutral. $pH = -\log[H^+]$; logarithmic, so pH 4 is 10 times more acidic than pH 5.
Examples: Gastric juice (pH 1-2), Lemon (pH 2), Milk (pH 6.5), Blood (pH 7.4), Soap (pH 9-10), Drain cleaner (pH 13).
Importance: Affects enzyme activity, plant growth, corrosion.
Deep Insight: Calculated from $[H^+]$; buffers maintain pH. In Nepal, pH testing for rivers prevents pollution. Historical: Invented by Sørensen in 1909.
Real-Life Examples: pH strips in pools; meters in labs.

Acid Rain

Definition: Acid rain is precipitation (rain, snow) with pH <5.6, caused by dissolved sulfuric and nitric acids from pollutants.
Causes: Industrial emissions (SO_2 from coal burning), vehicle exhaust (NO_2), forming H_2SO_4 and HNO_3. In Nepal, brick kilns and traffic in Kathmandu contribute; global sources like Indian industries affect transboundary.

Effects: Erodes buildings/statues, acidifies soils (kills plants, leaches nutrients), harms aquatic life (fish die), corrodes metals, causes respiratory diseases. In Nepal, Chitwan's wildlife and Pokhara's lakes suffer.
Deep Insight: Wet deposition (rain) and dry (particles); monitored via pH meters. Mitigation: Scrubbers in chimneys, electric vehicles. Nepal's vulnerability due to mountains trapping pollutants.
Real-Life Examples: Taj Mahal discoloration; forest dieback in Europe.

Hardness of Water

Definition: Hardness is the presence of calcium and magnesium ions (Ca^{2+}, Mg^{2+}) that prevent soap from lathering easily.
Soft Water: Low mineral content; forms lather quickly. Sources: Rainwater, distilled water.
Hard Water: High Ca^{2+}/Mg^{2+}; poor lather, scale formation. Sources: Groundwater in Nepal's limestone areas.
Types:
Temporary Hardness: Caused by bicarbonates ($Ca(HCO_3)_2$); removed by boiling (forms $CaCO_3$ precipitate) or Clark's method (lime addition).
Permanent Hardness: Caused by sulfates/chlorides ($CaSO_4$); not removed by boiling; softened by ion exchange (washing soda) or distillation.
Advantages: Provides calcium/magnesium for bones/teeth; prevents pipe corrosion.
Disadvantages: Wastes soap (curd formation), deposits scale in pipes/kettles, reduces appliance efficiency, causes skin dryness.
Deep Insight: Measured in ppm (parts per million); >120 ppm hard. In Nepal, Terai water is hard; softened for tea/coffee. Historical: Romans used soft water for baths.
Real-Life Examples: Scale in geysers; soft water in bottled drinks.

Alloys

Definition: Alloys are homogeneous mixtures of two or more metals (or metal + non-metal) designed for enhanced properties like strength and corrosion resistance.
Characteristics: Harder than pure metals, higher melting points, malleable/ductile, resistant to corrosion, specific colors/shines.
Examples:
Brass: 60-70% copper + 30-40% zinc; golden, malleable, used in locks, musical instruments, utensils. Prevents dezincification.
Bronze: 88% copper + 12% tin; hard, corrosion-resistant, used in statues, coins, bearings. Historical: Bronze Age tools.
Steel: 98-99% iron + 0.5-1.5% carbon (+ Mn, Cr for stainless); strong, ductile, used in construction, vehicles, cutlery. Types: Mild (low C), stainless (Cr for rust resistance).

Deep Insight: Alloys form solid solutions; e.g., interstitial (C in Fe). In Nepal, brass in jewelry, steel in Everest expeditions. Recycling alloys saves energy.
Real-Life Examples: Coins (brass), bells (bronze), bridges (steel).
Key Concepts and Applications
Neutralization Reactions: Acid + Base → Salt + Water; stoichiometry (equal moles). Used in antacids.
pH Calculations: $[H^+] = 10^{(-pH)}$; e.g., pH 3 has $[H^+] = 0.001$ M.
Deep Insight: Materials' chemistry explains phenomena like rust (acidic corrosion) or soap scum (hard water reaction).
Key Formulas and Units
pH: $-\log[H^+]$
Neutralization: $n_1V_1 = n_2V_2$ (normality × volume)
Hardness: ppm = (mass of $CaCO_3$ / mass of water) × 10^6
Deep Insight: Alloy composition in percentages.
Important Diagrams and Concepts
pH scale with examples.
Neutralization titration curve.
Acid rain formation cycle.
Water softening process.
Deep Insight: Alloy phase diagrams.
Exam Tips
Memorize properties, reactions, examples; practice pH calculations.
Relate to Nepal: Acid rain in cities, hard water in regions.
Understand types deeply; e.g., why temporary hardness boils off.
Common mistakes: Confusing acidic/basic salts; pH vs. concentration.
Important Questions for Exams (Class 7 Level) – Including BLE and Nepal Board Style
Very Short Answer Questions (1-2 words or simple phrases)
What is an acid? (BLE: Basic definition)
Name a mineral acid. (Nepal Board: Types)
What is the pH of a base? (BLE: pH concept)
Define neutralization. (Nepal Board: Reactions)
What causes acid rain? (BLE: Environmental)
Short Answer Questions (1-2 sentences)
Explain the physical properties of acids with examples. (BLE: Properties)
How do indicators work? Give an example. (Nepal Board: pH testing)
Describe the types of hardness of water. (BLE: Water quality)
What are the advantages of alloys? (Nepal Board: Materials)
How is acid rain formed? (BLE: Causes)
Long Answer Questions (Detailed explanations, 4-6 sentences)

Describe the physical and chemical properties of acids and bases. Explain their types and uses in daily life, with examples from Nepal. (BLE: Comprehensive properties; Nepal Board: Applications)
Explain the pH scale, indicators, and their importance. Discuss how pH affects health and environment. (Nepal Board: pH concepts; BLE: Indicators)
Discuss acid rain: its causes, effects on Nepal's environment, and prevention measures. (BLE: Environmental issues; Nepal Board: Local impact)
Explain hardness of water: types, causes, advantages, disadvantages, and methods to soften it. Relate to daily life in Nepal. (Nepal Board: Water chemistry; BLE: Types)
Describe alloys with characteristics and examples like brass, bronze, and steel. Explain their uses and why they are preferred over pure metals. (BLE: Alloys; Nepal Board: Examples)
Note: These expanded notes are designed to cover at least 5 PDF pages when formatted, with in-depth explanations, examples, deep insights, and Nepal-specific references. They align with Nepal's Class 7 Science curriculum and BLE/Nepal Board exam patterns, emphasizing conceptual depth for exam preparation. Practice diagrams and numerical problems for better understanding.