Chapter 4: The World of Metals and Non-metals

Exercises — Let Us Enhance Our Learning

Q1 Which metal is commonly used to make food packaging materials as it is cheaper, and its thin sheets can be folded easily into any shape?
(i) Aluminium
(ii) Copper
(iii) Iron
(iv) Gold

SOLUTION

The question asks which metal is used for food packaging because it is cheap and can be beaten into thin, flexible sheets.

Evaluating each option:
(i) Aluminium — Correct. Aluminium is inexpensive, highly malleable (it can be beaten into very thin foil), lightweight, and does not react with food. Aluminium foil is widely used to wrap food items such as sandwiches, chocolates, and takeaway containers.
(ii) Copper — Incorrect. Copper is more expensive than aluminium and is not commonly used for food packaging.
(iii) Iron — Incorrect. Iron reacts with moisture to form rust, making it unsuitable for direct food packaging; it is also heavier.
(iv) Gold — Incorrect. Gold is far too expensive to use for everyday food packaging, even though it is highly malleable.

The chapter states that aluminium foil is used for wrapping food items as a practical example of malleability.

Answer: (i) Aluminium — it is cheap, highly malleable, and its thin sheets can be folded easily into any shape for food packaging.

Q2 Which of the following metal catches fire when it comes in contact with water?
(i) Copper
(ii) Aluminium
(iii) Zinc
(iv) Sodium

SOLUTION

The question asks which metal reacts so vigorously with water that it catches fire.

Evaluating each option:
(i) Copper — Incorrect. Copper does not react with water under ordinary conditions.
(ii) Aluminium — Incorrect. Aluminium has a protective oxide layer that prevents it from reacting with water under normal conditions.
(iii) Zinc — Incorrect. Zinc reacts with steam at high temperatures but does not catch fire on contact with water.
(iv) Sodium — Correct. The chapter states that sodium is stored in kerosene because it reacts vigorously with oxygen and water, generating a lot of heat. When sodium contacts water, it reacts so rapidly that the heat produced is enough to ignite the hydrogen gas released, causing fire.

The chapter explicitly mentions: 'sodium is a metal which is stored in kerosene because it reacts vigorously with oxygen and water.'

Answer: (iv) Sodium — it reacts vigorously with water, releasing large amounts of heat that can cause it to catch fire; it is therefore stored in kerosene.

Q3 State with reason(s) whether the following statements are True [T] or False [F].
(i) Aluminium and copper are examples of non-metals used for making utensils and statues.
(ii) Metals form oxides when combined with oxygen, the solution of which turns blue litmus paper to red.
(iii) Oxygen is a non-metal essential for respiration.
(iv) Copper vessels are used for boiling water because they are good conductors of electricity.

SOLUTION

(i) Aluminium and copper are examples of non-metals used for making utensils and statues. — FALSE
Reason: Aluminium and copper are metals, not non-metals. The chapter describes metals as lustrous, hard, malleable, ductile, and good conductors of heat and electricity. Aluminium and copper display all these properties. Non-metals such as sulfur and coal are non-lustrous, brittle, and poor conductors.

(ii) Metals form oxides when combined with oxygen, the solution of which turns blue litmus paper to red. — FALSE

Reason: Metals react with oxygen to form metal oxides that are basic in nature. Basic solutions turn red litmus paper to blue (not blue litmus to red). The chapter demonstrates this clearly with magnesium oxide: 'it changes the colour of red litmus paper to blue; hence, it is basic in nature.' It is non-metal oxides (e.g., sulfur dioxide dissolving to form sulfurous acid) that are acidic and turn blue litmus red.

(iii) Oxygen is a non-metal essential for respiration. — TRUE
Reason: The chapter lists oxygen among non-metals ('Some other non-metals are oxygen, hydrogen, nitrogen, carbon, etc.') and explicitly states 'We breathe in oxygen, which is a non-metal, and without it, we would not be able to survive.'

(iv) Copper vessels are used for boiling water because they are good conductors of electricity. — FALSE
Reason: Copper vessels are used for heating or boiling water because copper is a good conductor of heat, not electricity. The chapter states 'metals are good conductors of heat' and explains that this is why metal vessels are used for cooking. Conduction of electricity is a separate property that is relevant to electrical wiring, not to cooking vessels.

Answer: (i) F — aluminium and copper are metals, not non-metals. (ii) F — metal oxides are basic; their solutions turn red litmus blue, not blue litmus red. (iii) T — oxygen is a non-metal essential for respiration. (iv) F — copper vessels are used because copper conducts heat well, not because it conducts electricity.

Q4 Why are only a few metals suitable for making jewellery?

SOLUTION

Jewellery requires metals that possess a specific combination of properties. The chapter describes the key properties of metals, from which we can identify the requirements for jewellery-making:

1. Lustre: Jewellery must be visually attractive. Only metals with high metallic lustre (brightness and shine) are suitable. Most metals lose their lustre over time due to corrosion. The chapter describes corrosion as 'gradual deterioration of metal surfaces caused by air, water, or other substances.' For example, iron rusts and silver develops a black coating.

2. Resistance to corrosion: Jewellery must maintain its appearance over long periods of time. Metals like iron rust when exposed to moist air, making them

unsuitable. Metals used for jewellery must resist tarnishing and corrosion.

3. Malleability and ductility: Jewellery is crafted into complex, intricate shapes. The metal must be highly malleable (beaten into thin sheets) and ductile (drawn into thin wires). The chapter notes that 'Gold and silver are the most malleable metals' and gold is so ductile that one gram can be drawn into a 2-kilometre-long wire.

4. Non-reactive nature: The metal should not react with skin, sweat, or air under normal conditions.

Only a few metals — primarily gold, silver, and platinum — satisfy all these requirements simultaneously. Most other metals may be too reactive (iron, sodium), too dull, or too brittle for fine jewellery work.

Answer: Only a few metals are suitable for jewellery because jewellery requires: (1) high lustre for visual appeal, (2) resistance to corrosion so the metal does not tarnish or rust over time, (3) high malleability and ductility to be shaped into intricate designs and fine wires, and (4) non-reactive nature with skin and air. Metals like gold and silver meet all these requirements, while most others corrode, lose lustre, or lack the necessary workability.

Q5 Match the uses of metals and non-metals given in Column I with the jumbled names of metals and non-metals given in Column II.

Column I:

(i) Used in electrical wiring

(ii) Most malleable and ductile

(iii) Living organisms cannot survive without it.

(iv) Plants grow healthy when fertilisers containing it are added to the soil.

(v) Used in water purification

Column II:

(a) E N X Y G O

(b) N E C O H I R L

(c) P E P O R C

(d) T E N G O I N R

(e) O G D L

SOLUTION

First, decode the anagrams in Column II:

(a) E N X Y G O → OXYGEN
(b) N E C O H I R L → CHLORINE
(c) P E P O R C → COPPER
(d) T E N G O I N R → NITROGEN
(e) O G D L → GOLD

Now match each use:

(i) Used in electrical wiring → (c) COPPER
The chapter states that metals are good conductors of electricity and mentions 'wires of metals like copper or aluminium in electrical fittings.' Copper is the primary metal used in electrical wiring due to its high electrical conductivity.

(ii) Most malleable and ductile → (e) GOLD
The chapter explicitly states: 'Gold and silver are the most malleable metals.' For ductility, the chapter notes: 'Gold is so ductile that one gram of it can be drawn into a 2 kilometre-long wire!'

(iii) Living organisms cannot survive without it → (a) OXYGEN
The chapter states: 'We breathe in oxygen, which is a non-metal, and without it, we would not be able to survive.'

(iv) Plants grow healthy when fertilisers containing it are added to the soil → (d) NITROGEN
The chapter states: 'Nitrogen is used in the manufacturing of fertilisers and other chemicals. It is an essential nutrient for the growth of plants.'

(v) Used in water purification → (b) CHLORINE
The chapter states: 'Chlorine is a non-metal commonly used in water purification.'

Answer: (i) → (c) COPPER; (ii) → (e) GOLD; (iii) → (a) OXYGEN; (iv) → (d) NITROGEN; (v) → (b) CHLORINE.

Q6 What happens when oxygen reacts with magnesium and sulfur. What are the main differences in the nature of products formed?

SOLUTION

Reaction of oxygen with Magnesium:
When magnesium burns in the presence of oxygen (air), it forms magnesium oxide.
Magnesium + Oxygen → Magnesium oxide

The chapter describes this: 'magnesium ribbon burns with a dazzling white flame and changes into a white powder. This powder is magnesium oxide. It is formed due to the reaction between magnesium and oxygen present in the air.'
Nature of the product: Magnesium oxide is basic in nature. When dissolved in water, the solution turns red litmus paper blue. The chapter confirms: 'it changes the colour of red litmus paper to blue; hence, it is basic in nature. Generally, oxides of metals are basic in nature.'

Reaction of oxygen with Sulfur:
When sulfur burns in the presence of oxygen (air), it forms sulfur dioxide gas.
Sulfur + Oxygen → Sulfur dioxide
The chapter states: 'On burning sulfur in air (oxygen), sulfur dioxide gas is formed. On dissolving sulfur dioxide gas in water, sulfurous acid is formed.'
Nature of the product: Sulfur dioxide dissolved in water forms sulfurous acid, which is acidic in nature. The solution turns blue litmus paper red. The chapter confirms the solution is 'acidic in nature.' Generally, oxides of non-metals are acidic in nature.

Main differences in the nature of products:
Magnesium oxide (metal oxide) — basic in nature; turns red litmus blue; dissolves in water to form a basic solution.
Sulfur dioxide (non-metal oxide) — acidic in nature; turns blue litmus red; dissolves in water to form sulfurous acid (an acidic solution).

Answer: Magnesium reacts with oxygen to form magnesium oxide (white powder), which is basic in nature (turns red litmus blue). Sulfur reacts with oxygen to form sulfur dioxide gas, which dissolves in water to form sulfurous acid, which is acidic in nature (turns blue litmus red). The key difference: metal oxides (like magnesium oxide) are basic; non-metal oxides (like sulfur dioxide) are acidic.

Q7 Complete the following flow chart:
[A substance] + Air → Heat → Ash → Water → Add blue and red litmus solutions separately → Change in blue litmus solution: [?] → Change in red litmus solution: Blue → [Nature: ?]

SOLUTION

The flow chart describes burning a substance in air to form ash (an oxide), then dissolving it in water and testing with litmus.

Key clue from the flow chart: the red litmus solution changes to BLUE. A solution that turns red litmus blue is basic in nature.

From the chapter: 'Generally, oxides of metals are basic in nature.' When magnesium (a metal) burns in air, it forms magnesium oxide (ash/white powder). When dissolved in water, the solution is basic — it turns red litmus blue and does NOT turn blue litmus red (blue litmus remains blue in a basic solution).

Filling in the blanks:
The substance being burned: a METAL (e.g., magnesium) — because its oxide is basic.
Change in blue litmus solution: NO CHANGE (blue litmus remains blue in a basic solution; it does not turn red).
Change in red litmus solution: turns BLUE (as stated in the chart).
Nature of the solution: BASIC.

This matches the chapter's demonstration of burning magnesium: the white oxide dissolves in water to give a basic solution that turns red litmus blue and leaves blue litmus unchanged.

Answer: The substance is a metal (e.g., magnesium). Its oxide dissolves in water to give a basic solution. Change in blue litmus: no change (remains blue). Change in red litmus: turns blue. Nature of solution: Basic.

Q8 You are provided with the following materials. Discuss which material would be your choice to make a pan that is most suitable for boiling water and why?
iron, copper, sulfur, coal, plastic, wood, cardboard

SOLUTION

A pan for boiling water must satisfy several requirements:
1. It must withstand high temperatures without melting, burning, or decomposing.
2. It must be a good conductor of heat so that the heat from the flame transfers efficiently to the water.
3. It must be able to be shaped into a pan (malleable or formable).
4. It must be safe and non-reactive with water.

Evaluating each material:
Iron — A suitable metal. Iron is a metal, a good conductor of heat, has a very high melting point, and is malleable, so it can be shaped into a pan. Iron (as cast iron or steel) is in fact widely used to make cooking vessels. Its only drawback is that it

can rust in moist conditions, but it is still a valid choice for a pan.

Copper — Best choice. The chapter states that metals are good conductors of heat and that metal vessels are used for cooking precisely because of this property. Copper has a high melting point (1085°C), is malleable (can be shaped into a pan), is an excellent conductor of heat (better than iron), and does not react with water under normal boiling conditions.

Sulfur — Not suitable. Sulfur is a non-metal, brittle (not malleable, so cannot be shaped into a pan), has a low melting point (~115°C) which is close to boiling water temperature, and burns in air. It would melt and catch fire.

Coal — Not suitable. Coal is a non-metal, brittle (it breaks into pieces when hammered), does not conduct heat well, and would simply burn/combust when placed over a flame.

Plastic — Not suitable. Plastic has a low melting point; it would melt or deform at the temperatures needed to boil water (100°C or above). Plastic is also a poor conductor of heat.

Wood — Not suitable. Wood is a poor conductor of heat (the chapter demonstrates this using the wooden spoon in hot water) and would catch fire when placed on a flame.

Cardboard — Not suitable. Cardboard would absorb water and disintegrate; it would also burn or char immediately on a flame.

Choice: A metal is required, and copper is the most suitable — it is the best conductor of heat among the choices. Iron is also a valid metal choice (metals like iron are commonly used for pans); copper is preferred because it conducts heat even better.

Answer: A metal should be chosen, and copper is the best choice. It is an excellent conductor of heat (transfers heat efficiently from flame to water), has a high melting point, is malleable (can be shaped into a pan), and does not react with water. Iron is also a suitable metal (good heat conductor, high melting point), but copper conducts heat even better. The non-metals and other materials — sulfur, coal, plastic, wood, and cardboard — are unsuitable because they are poor conductors of heat, have low melting/burning points, are brittle, or would catch fire or disintegrate.

Q9 You are provided with three iron nails, each dipped in oil, water and vinegar. Which iron nail will not rust, and why?

SOLUTION

The chapter explains rusting based on Activity 4.5:
'The presence of both water and air is essential for [brown deposits/rust] to develop. Thus, moist air is responsible for the development of brown deposits on objects made of iron.'
'The rusting of iron can be prevented by several methods such as painting, oiling, greasing...'

Analysing each iron nail:

Iron nail dipped in oil:
Oil forms a protective coating over the surface of the iron nail. This coating prevents contact between the iron nail and both water (moisture) and air (oxygen). Since the chapter states that both water and air are required for rusting, the oil barrier blocks both, preventing rust.
This nail will NOT rust.

Iron nail dipped in water:
Water alone, without dissolved air/oxygen, does not cause rusting (as shown in bottle B of Activity 4.5, where the nail in boiled and cooled water — with the air excluded by an oil layer — did not rust). However, ordinary water (not freshly boiled) contains dissolved oxygen from the air. A nail simply dipped in open water is exposed to both water and dissolved air/oxygen.
This nail will rust (it is in contact with both water and dissolved air).

Iron nail dipped in vinegar:
Vinegar is an acidic solution. Acids accelerate the rusting/corrosion of iron by reacting with the metal surface and enhancing the electrochemical process. This nail will rust faster than the one in plain water.
This nail will rust (most rapidly).

The iron nail dipped in oil will NOT rust because the oil coating creates a barrier that prevents contact with both moisture and air, which are the two essential requirements for rusting.

Answer: The iron nail dipped in oil will not rust. Oil forms a protective coating that prevents the nail from coming into contact with both water (moisture) and air (oxygen) — the two substances the chapter identifies as essential for rusting. The nail in water and the nail in vinegar are exposed to moisture and dissolved oxygen, so both will rust (the one in vinegar will rust faster because the acid accelerates corrosion).

Q10 How do the different properties of metals and non-metals determine their uses in everyday life?

SOLUTION

The chapter describes several key properties of metals and non-metals and explains how these properties lead to specific practical uses.

Metals:

1. Malleability — Metals can be beaten into thin sheets. This property is used to make aluminium foil for wrapping food items, thin silver foil on sweets, flat pans (tawas), and sheets for construction and packaging.

2. Ductility — Metals can be drawn into wires. This is used to make copper and aluminium electrical wiring, metal strings for musical instruments (veena, sitar, guitar), metal wires for ornaments (bangles, necklaces), and steel wire ropes for suspension bridges and cranes.

3. Sonority — Metals produce a ringing sound when struck. This is why bells, ghungroos (ankle bells), and musical percussion instruments are made of metals.

4. Good conductors of heat — Metals transfer heat efficiently. This is why cooking vessels (pots, pans) are made of metals such as copper, aluminium, and iron. The handles are made of wood or plastic (poor conductors) to prevent burns.

5. Good conductors of electricity — Metals allow electric current to flow through them easily. This is why electrical wiring, switches, and circuit components are made of metals (copper, aluminium). In contrast, plastic and rubber (poor conductors) are used for insulation, for screwdriver handles, and for electricians' gloves and shoes.

6. Strength and hardness — Iron and steel (iron + carbon) are used to make farming tools (ploughs, spades, axes), construction materials, and machinery.

7. Lustre — Lustrous metals like gold and silver are used for jewellery, decorative

items, and medals.

Non-metals:

1. Oxygen — Essential for respiration (breathing) of all living organisms. Also used in medical oxygen cylinders.

2. Carbon — The building block of all life forms; essential component of proteins, fats, and carbohydrates required for growth and energy.

3. Nitrogen — Used in the manufacturing of fertilisers, providing essential nutrients for the growth of plants.

4. Chlorine — Used in water purification to kill harmful microorganisms.

5. Iodine — Applied on wounds as an antiseptic solution.

Answer: Metals: malleability → aluminium foil, cooking vessels, tools; ductility → electrical wiring, musical strings, ornaments; sonority → bells, ghungroos; heat conductivity → cooking pots and pans; electrical conductivity → wiring, circuits; strength → farming/construction tools; lustre → jewellery. Non-metals: oxygen → respiration; carbon → building block of life; nitrogen → fertilisers for plant growth; chlorine → water purification; iodine → antiseptic.

Q11 One of the methods of protecting iron from getting rusted is to put a thin coating of zinc metal over it. Since sulfur does not react with water, can it be used for this purpose? Justify your answer.

SOLUTION

The method of coating iron with a thin layer of zinc to prevent rusting is called galvanisation. The chapter mentions this: 'applying a protective layer of zinc metal on iron (galvanisation)' as a method to prevent rusting.

The question asks: can sulfur be used instead of zinc to protect iron from rusting?

The answer is NO. Sulfur cannot be used for this purpose. Here is the justification:

1. Sulfur is not a metal and is not malleable: Sulfur is a non-metal. The chapter states that non-metals 'are neither malleable nor ductile.' Sulfur is brittle — it breaks into pieces when hammered. A coating material must be able to adhere uniformly to the iron surface and form a continuous, flexible layer. Sulfur cannot do this; it would crack and break off, leaving the iron exposed.

2. A protective coating requires more than just water-inertness: The chapter states rusting requires BOTH air and water. Even if sulfur does not react with water (as the chapter confirms in Activity 4.8: 'there is no reaction when sulfur is placed in water'), it does not mean sulfur can form a durable, adherent protective layer on iron that seals out both water and oxygen. Zinc works as a galvanising agent not just because it is unreactive with water, but because it can coat iron uniformly, is malleable, bonds well with the iron surface, and is itself resistant to corrosion under normal atmospheric conditions.

3. Sulfur's physical properties make it unsuitable as a protective coating: Sulfur is a powder or crystalline brittle solid at room temperature. It cannot be applied as a smooth, adherent metallic coating in the way zinc can.

Therefore, sulfur cannot substitute for zinc in protecting iron from rusting, despite not reacting with water.

Answer: No, sulfur cannot be used to protect iron from rusting. Even though sulfur does not react with water, it is a non-metal that is brittle and neither malleable nor ductile — it cannot form a smooth, adherent, flexible coating on iron. Zinc works because it is a metal that can be uniformly deposited on iron, is malleable, bonds well to the surface, and seals out both moisture and air. Sulfur would crack and fall off, leaving the iron exposed.

Q12 An ironsmith heats iron before making tools. Why is heating necessary in this process?

SOLUTION

The chapter opens with the story of Yashwant and Anandi visiting an ironsmith named Sudarshan, who heats iron in a furnace before shaping it.

The key property involved is malleability — the ability of a material to be beaten into thin sheets or shapes.

At room temperature, iron is hard and requires a great deal of force to deform. However, when iron is heated to a high temperature, it becomes red hot and its internal structure becomes more flexible, allowing it to be shaped more easily with a hammer.

The chapter describes this directly: 'Sudarshan is heating an iron block in the furnace. It has become red hot. He starts beating it hard with a hammer.' When Anandi asks why, Sudarshan explains: 'I am beating it to shape it into an axe.'

Reasons why heating is necessary:

1. Heating makes iron more malleable — the metal becomes soft enough to be beaten and shaped by a hammer without breaking. At room temperature, even though iron is malleable, it requires extreme force. Heating significantly reduces the force needed.
2. Heating allows the ironsmith to bend, stretch, and mould the iron into complex shapes — such as tools like spades, axes, trowels, and tongs — that would be very difficult or impossible to achieve with cold iron.
3. The heat allows the iron atoms to move more freely, making the metal more pliable and workable.

In summary, heating exploits the malleability of iron at high temperatures, making it possible to shape iron into useful tools.

Answer: Heating is necessary because it makes iron more malleable — at high temperatures (red hot), iron becomes pliable and can be easily beaten with a hammer into the desired shape (axes, spades, tongs, etc.). At room temperature, iron is hard and requires far greater force to deform. The ironsmith heats the iron to exploit its malleability at high temperatures, enabling him to shape it efficiently into tools.