Affiliated to CBSE, New Delhi (Affiliation No. 1030642)

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CLASS X · SCIENCE (086) · CHEMISTRY · CBSE BOARD EXAMINATION 2027

CHAPTER 3

Metals and Non-metals

Answer Booklet · CBSE marking-scheme answers with marks for every point

Every question of the chapter booklet | Marks shown point by point | MCQ keys with reasons

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HOW TO USE THE ANSWERS

1. Answer the question in your notebook **first**. Open this booklet only to check.
2. Each answer is written the way the CBSE marking scheme sets it out: **value points**, with the **mark for each point** in orange beside it.
3. Give yourself marks point by point. Use the same **key words** in your own answers.
4. Equations must be balanced; diagrams must be labelled; numericals need formula, substitution and unit.
5. Copy every wrong answer to the My Mistakes page of your booklet.

READ THIS FIRST

Marking Guide

Model answers to every question in the chapter booklet, set out the way a CBSE examiner marks them.

HOW MARKS ARE GIVEN IN SCIENCE ANSWERS

1. **MCQ and assertion–reason (1 mark):** only the correct option scores. The reason given here is for your understanding.
2. **2 and 3 marks:** one mark (or ½) for each correct **value point**. The examiner looks for the key word – a long answer without it scores less than a short answer with it.
3. **Equations:** a correct balanced equation earns its full mark; an unbalanced one, or one with wrong formulae, usually earns ½ or nothing.
4. **Numericals:** formula, substitution and the final answer **with unit** are marked separately.
5. **Diagrams:** marks for a correct drawing and for the labels asked for. An unlabelled diagram earns little.
6. **Case study (4 marks):** 1 + 1 + 2. **Long answer (5 marks):** the split is shown beside each point.

PART A · ANSWERS

A NCERT Practice – Answers

Marking-scheme answers for every question in Part A of the chapter booklet.

Physical properties

A1. Name a metal that: **(i)** is a liquid at room temperature **(ii)** is soft enough to cut with a knife **(iii)** is the best conductor of heat **(iv)** is a comparatively poor conductor of heat [2]

(i) Mercury. ½

(ii) Sodium (or potassium, lithium). ½

(iii) Silver (copper is next). ½

(iv) Lead (or mercury). ½

A2. What do the terms malleable and ductile mean? Name the metal that is the most ductile. [2]

Malleable: can be beaten into thin sheets. Ductile: can be drawn into thin wires. 1

Gold. 1

A3. Why are copper and aluminium used to make cooking vessels, and why are electric wires covered with PVC or rubber? [2]

Copper and aluminium are good conductors of heat (and have high melting points). 1

Metal wires conduct electricity; PVC/rubber are insulators that prevent shocks and short circuits. 1

A4. Name a non-metal that: **(i)** is a liquid at room temperature **(ii)** is lustrous **(iii)** is the hardest natural substance **(iv)** conducts electricity [2]

(i) Bromine. ½

(ii) Iodine. ½

(iii) Diamond (carbon). ½

(iv) Graphite (carbon). ½

A5. You have a hammer, a battery, a bulb, a switch and connecting wires. How will you use them to tell samples of metals from non-metals? [3]

Hammer each sample: metals flatten into sheets (malleable); non-metals break into pieces (brittle). 1

Connect each sample in a circuit with the battery, bulb and switch. 1

The bulb glows with a metal (good conductor) but not with a non-metal (poor conductor; graphite is an exception). 1

Chemical properties of metals

A6. Why are sodium and potassium stored under kerosene? [2]

They react so vigorously with oxygen (and moisture) of the air that they catch fire. 1

Kerosene keeps air and moisture away from them. 1

A7. Write balanced equations for the reactions of: **(i)** iron with steam **(ii)** calcium with water **(iii)** potassium with water [3]

(i) $3\,Fe + 4\,H_2O \longrightarrow Fe_3O_4 + 4\,H_2$ 1

(ii) $Ca + 2\,H_2O \longrightarrow Ca(OH)_2 + H_2$ 1

(iii) $2\,K + 2\,H_2O \longrightarrow 2\,KOH + H_2 + \text{heat}$ 1

A8. What are amphoteric oxides? Give two examples and write one equation to show this nature. [3]

Metal oxides that react with both acids and bases to give salt and water. 1

Aluminium oxide and zinc oxide. 1

$Al_2O_3 + 2\,NaOH \longrightarrow 2\,NaAlO_2 + H_2O$ (or with HCl: $Al_2O_3 + 6\,HCl \longrightarrow 2\,AlCl_3 + 3\,H_2O$). 1

A9. Name two metals that give hydrogen with dilute acids and two that do not. [2]

Give hydrogen: magnesium, zinc (also iron, aluminium). 1

Do not: copper, silver (also gold, mercury). 1

A10. Why is hydrogen not usually given off when a metal reacts with nitric acid? Name the metals that are exceptions. [2]

Nitric acid is a strong oxidising agent: it oxidises the hydrogen formed to water and is itself reduced to oxides of nitrogen. 1

Magnesium and manganese give hydrogen with very dilute nitric acid. 1

A11. What is aqua regia? Why is it special? [2]

A freshly prepared mixture of concentrated HCl and concentrated HNO_3 in the ratio 3 : 1. 1

It can dissolve gold and platinum, which neither acid can dissolve alone. 1

Reactivity series

A12. Four metals J, K, L and M were put in salt solutions with these results: J displaced iron from iron(II) sulphate but not zinc from zinc sulphate; K did not react with copper sulphate but displaced silver from silver nitrate; L displaced zinc from zinc sulphate; M did not react even with silver nitrate. **(i)** Which is the most reactive? **(ii)** What will happen if K is put in copper sulphate solution? **(iii)** Arrange the four metals in decreasing order of reactivity. [3]

(i) L is the most reactive (it displaces zinc). 1

(ii) Nothing happens: K is less reactive than copper. 1

(iii) L > J > K > M. 1

A13. What will you see when zinc granules are added to iron(II) sulphate solution? Write the equation. [2]

The pale green solution becomes colourless and a grey deposit of iron forms. 1

$Zn + FeSO_4 \longrightarrow ZnSO_4 + Fe$ 1

A14. An iron knife is dipped in blue copper sulphate solution. What change is seen and why? [2]

The blue solution turns pale green and a brown coat of copper forms on the knife. 1

Iron is more reactive than copper and displaces it: $Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$ 1

A15. Oxides of zinc, magnesium and copper are each heated with the metals zinc, magnesium and copper. In which cases does displacement take place? [2]

Magnesium displaces zinc from zinc oxide and copper from copper oxide. 1

Zinc displaces copper from copper oxide; copper displaces nothing. 1

Ionic compounds

A16. (a) Write the electron-dot structures of sodium, oxygen and magnesium. (b) Show the formation of Na_2O and MgO by transfer of electrons. (c) Name the ions present in these compounds. [5]

(a) Na (2,8,1): one dot; O (2,6): six dots; Mg (2,8,2): two dots around the symbol. 1½

(b) Na_2O: two Na atoms each give one electron to an O atom: $2\,Na \longrightarrow 2\,Na^+ + 2\,e^-$; $O + 2\,e^- \longrightarrow O^{2-}$ 1½

MgO: one Mg atom gives two electrons to an O atom: $Mg \longrightarrow Mg^{2+} + 2\,e^-$; $O + 2\,e^- \longrightarrow O^{2-}$ 1½

(c) Na^+ and O^{2-}; Mg^{2+} and O^{2-}. ½

A17. Why do ionic compounds have high melting points? [1]

The ions are held by strong electrostatic attraction, so a lot of energy is needed to separate them. 1

A18. When do ionic compounds conduct electricity, and why not in the solid state? [2]

They conduct when molten or dissolved in water, because the ions can then move. 1

In the solid, the ions are fixed in a rigid structure and cannot move. 1

Occurrence and extraction

A19. Define (i) mineral (ii) ore (iii) gangue. [3]

(i) An element or compound that occurs naturally in the earth's crust. 1

(ii) A mineral from which a metal can be extracted profitably. 1

(iii) The impurities such as soil and sand present in the ore. 1

A20. Name two metals that are found in the free state in nature, and explain why they occur free. [2]

Gold and silver (also platinum, copper). 1

They are very low in the reactivity series, so they are not attacked by oxygen and other chemicals. 1

A21. Explain roasting and calcination with one equation each. [4]

Roasting: a sulphide ore is heated strongly in excess air to change it into the oxide. 1

$2\,ZnS + 3\,O_2 \longrightarrow 2\,ZnO + 2\,SO_2$ 1

Calcination: a carbonate ore is heated strongly in limited air to change it into the oxide. 1

$ZnCO_3 \longrightarrow ZnO + CO_2$ 1

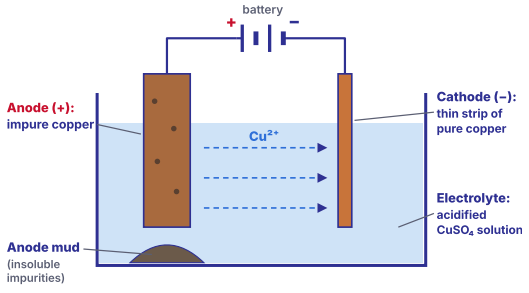
A22. Which process is used to get a metal from its oxide? Give an example with an equation. [2]

Reduction (with carbon, or a more reactive metal). 1

$ZnO + C \longrightarrow Zn + CO$ 1

A23. Describe the electrolytic refining of copper with a labelled diagram. [5]

Labelled diagram: anode, cathode, electrolyte, anode mud, battery. 2



Anode: impure copper; cathode: thin strip of pure copper; electrolyte: acidified copper sulphate solution. 1

On passing current, copper from the anode dissolves and an equal amount of pure copper deposits on the cathode. 1

Soluble impurities go into the solution; insoluble impurities settle below the anode as anode mud. 1

Corrosion and alloys

A24. What are the conditions needed for iron to rust? Give two ways of preventing it. [2]

Both air (oxygen) and water (moisture) must be present. 1

Painting, oiling or greasing, galvanising, chrome plating, making alloys (any two). 1

A25. Explain why silver articles become black and copper vessels become green on long exposure to air. [2]

Silver reacts with sulphur compounds in air to form black silver sulphide. 1

Copper reacts with moist carbon dioxide in air to form green basic copper carbonate. 1

A26. What is an alloy? Name the constituents of brass, bronze and solder. [2]

A homogeneous mixture of two or more metals, or a metal and a non-metal. ½

Brass: copper and zinc. Bronze: copper and tin. Solder: lead and tin. 1½

A27. Why is pure gold not used for making jewellery? What is meant by 22-carat gold? [2]

Pure (24-carat) gold is very soft, so ornaments would bend and wear. 1

22 parts of gold alloyed with 2 parts of copper or silver. 1

B

PART B · ANSWERS

Exemplar Practice – Answers

Marking-scheme answers for every question in Part B of the chapter booklet.

Multiple choice

Q	Answer	Working / reason
B1	**(b)** Gold	1 g of gold can be drawn into a wire about 2 km long.
B2	**(a)** sodium	Sodium is soft and very reactive.
B3	**(c)** ZnO	ZnO reacts with both acids and bases.
B4	**(c)** Copper	Copper is below hydrogen in the series.
B5	**(b)** X^{2+}	It loses its two outer electrons.
B6	**(b)** 3 : 1	Three parts HCl to one part HNO_3.
B7	**(d)** $AgNO_3$ solution + copper	Copper is more reactive than silver.
B8	**(b)** (i), (iii) and (iv)	They do not dissolve in kerosene.
B9	**(b)** join railway tracks	It gives molten iron.
B10	**(c)** Solder	Its low melting point suits electrical joints.

Short answer

B11. Element A burns in air with a dazzling white flame. The white ash dissolves in water and the solution turns red litmus blue. Identify A and write the equations for both steps. [3]

A is magnesium. 1

$2\,Mg + O_2 \longrightarrow 2\,MgO$ 1

$MgO + H_2O \longrightarrow Mg(OH)_2$ – a basic solution. 1

B12. Why does calcium start floating when it reacts with water? Why does the hydrogen not catch fire, as it does with sodium? [2]

Bubbles of hydrogen stick to the surface of the calcium and make it float. 1

The reaction is less violent; the heat given out is not enough to set the hydrogen on fire. 1

B13. Metal X occurs as the sulphide XS. Heating XS in air gives XO, which is heated with coke to give X. X is used to coat iron to prevent rusting. Identify X and write the two equations. [3]

X is zinc. 1

$2\,ZnS + 3\,O_2 \longrightarrow 2\,ZnO + 2\,SO_2$ 1

$ZnO + C \longrightarrow Zn + CO$ 1

B14. Why cannot sodium be obtained by heating its oxide with carbon? How is it obtained? Write the reactions at the two electrodes. [3]

Sodium has a greater affinity for oxygen than carbon has. 1

By electrolysis of molten sodium chloride. 1

Cathode: $Na^+ + e^- \longrightarrow Na$; anode: $2\,Cl^- \longrightarrow Cl_2 + 2\,e^-$ 1

B15. Element P has the configuration 2, 8, 1 and Q has 2, 8, 7. (a) What type of bond forms between them? (b) Write the formula of the compound. (c) Will it conduct electricity in the solid state? [3]

(a) Ionic bond, by transfer of one electron from P to Q. 1

(b) PQ (P is sodium, Q is chlorine: NaCl). 1

(c) No; the ions cannot move in the solid. It conducts when molten or in solution. 1

B16. Iron sheets are given a thin coat of zinc. Name this process. Why is the iron protected even when the coat gets scratched? [2]

Galvanisation. 1

Zinc is more reactive than iron, so zinc reacts (corrodes) in place of the iron. 1

C

PART C · ANSWERS

Board Pattern Practice – Answers

Marking-scheme answers for every question in Part C of the chapter booklet.

Physical properties

Q	Answer	Working / reason
C1	**(c)** Lead	Lead and mercury are poor conductors of heat.
C2	**(b)** ductility	Ductility.
C3	**(a)**	Both true; R explains A.

C4. Describe an activity to show that metals are good conductors of heat. [3]

Clamp an aluminium or copper wire (rod) on a stand and fix a pin with wax at its free end (or several pins along it). 1

Heat the other end of the wire with a spirit lamp. 1

After some time the wax melts and the pin falls: heat has travelled through the metal, so metals conduct heat. 1

C5. Give reasons: (a) gold and silver are used for jewellery (b) aluminium foil is used to wrap food. [2]

(a) They are lustrous, very malleable and ductile, and do not corrode. 1

(b) Aluminium is malleable, so it can be beaten into thin foils; the foil is light and its oxide layer keeps it from reacting. 1

Reactions with oxygen, water and acids

Q	Answer	Working / reason
C6	**(b)** calcium	Hydrogen bubbles stick to calcium.
C7	**(c)** Al_2O_3	Al_2O_3 is amphoteric.
C8	**(a)**	Both true; R explains A.

C9. What are amphoteric oxides? Classify Al_2O_3, K_2O and SO_2 as acidic, basic or amphoteric. [2]

Metal oxides that react with both acids and bases to give salt and water. 1

Al_2O_3 – amphoteric; K_2O – basic; SO_2 – acidic. 1

C10. Write balanced equations for: (a) aluminium oxide with hydrochloric acid (b) aluminium oxide with sodium hydroxide (c) sodium with water. [3]

(a) $Al_2O_3 + 6\,HCl \longrightarrow 2\,AlCl_3 + 3\,H_2O$ 1

(b) $Al_2O_3 + 2\,NaOH \longrightarrow 2\,NaAlO_2 + H_2O$ 1

(c) $2\,Na + 2\,H_2O \longrightarrow 2\,NaOH + H_2$ 1

C11. Equal strips of Mg, Al, Zn, Fe and Cu are put in five test tubes of dilute HCl. (a) Arrange them by the rate of fizzing. (b) Why is there no change with copper? (c) Write the equation for magnesium. **[3]**

(a) Mg > Al > Zn > Fe (fastest to slowest). 1

(b) Copper is less reactive than hydrogen, so it cannot displace hydrogen from the acid. 1

(c) $Mg + 2\,HCl \longrightarrow MgCl_2 + H_2$ 1

Reactivity series and displacement

Q	Answer	Working / reason
C12	**(a)** colourless to blue	Copper nitrate is blue.
C13	**(c)** $Cu + FeSO_4$	Copper is less reactive than iron.

C14. Metal P displaces metal Q from the solution of Q's sulphate, but Q cannot displace P. (a) Which is more reactive? (b) If P is zinc and the solution of Q's sulphate is blue, name Q and write the equation. **[2]**

(a) P. ½

(b) Q is copper. ½

$Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$ 1

C15. What do you observe, and why, when (a) a copper strip is kept in iron(II) sulphate solution (b) a zinc strip is kept in copper sulphate solution? **[2]**

(a) No change: copper is less reactive than iron and cannot displace it. 1

(b) The blue colour fades and a reddish-brown copper deposit forms on zinc: zinc is more reactive and displaces copper. 1

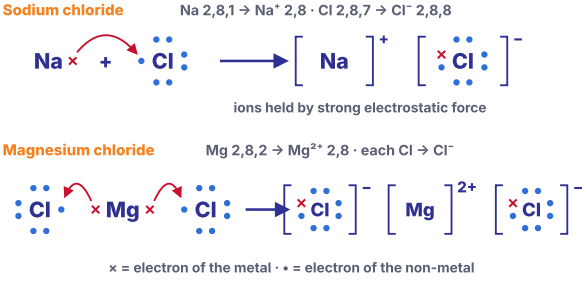
Ionic compounds

Q	Answer	Working / reason
C16	**(a)** 2,8,1 and 2,8,7	A metal (Na) and a non-metal (Cl).
C17	**(b)** when molten	Ions move only in the molten state or in solution.

C18. Show the formation of magnesium chloride by the transfer of electrons. Name the ions present. **[3]**

Mg (2,8,2) loses two electrons: $Mg \longrightarrow Mg^{2+} + 2\,e^-$ 1

Each of two Cl atoms (2,8,7) gains one electron: $Cl + e^- \longrightarrow Cl^-$; dot-cross diagram: 1



Ions: Mg^{2+} and Cl^-; formula $MgCl_2$. 1

C19. Why are ionic compounds soluble in water but not in kerosene? Why do they have high boiling points? **[2]**

Water is able to separate the ions from each other; kerosene and petrol cannot. 1

Strong electrostatic forces between ions need a lot of energy to overcome. 1

C20. Element X has configuration 2, 8, 2 and Y has 2, 6. (a) Which is a metal? (b) What ion does each form? (c) Write the formula of the compound and name the type of bond. **[3]**

(a) X (it has 2 valence electrons to lose). 1

(b) X^{2+} and Y^{2-}. 1

(c) XY (MgO); ionic (electrovalent) bond. 1

Extraction and refining of metals

Q	Answer	Working / reason
C21	**(b)** heating a carbonate ore in limited air	Calcination is for carbonate ores.
C22	**(b)** a thin strip of pure copper	Pure copper deposits on it.
C23	**(a)**	Both true; R explains A.

C24. How is mercury obtained from cinnabar? Write the equations. Why can such metals be obtained by heating alone? **[3]**

$2\,HgS + 3\,O_2 \longrightarrow 2\,HgO + 2\,SO_2$ (heating in air) 1

$2\,HgO \longrightarrow 2\,Hg + O_2$ (further heating) 1

Mercury is low in the reactivity series; its oxide breaks down on heating alone. 1

C25. Copper is obtained from Cu_2S by heating in air. Write the two equations and say why no reducing agent like carbon is needed. **[3]**

$2\,Cu_2S + 3\,O_2 \longrightarrow 2\,Cu_2O + 2\,SO_2$ 1

$2\,Cu_2O + Cu_2S \longrightarrow 6\,Cu + SO_2$ 1

Copper is low in the series: its oxide is reduced by the sulphide itself on heating. 1

C26. Write the equation for the thermit reaction. Name the reducing agent and give one use of the reaction. **[3]**

$Fe_2O_3 + 2\,Al \longrightarrow 2\,Fe + Al_2O_3 + \text{heat}$ 1

Aluminium is the reducing agent. 1

It gives molten iron, used to join railway tracks or cracked machine parts. 1

Corrosion and alloys

Q	Answer	Working / reason
C27	**(b)** nickel and chromium	It is hard and does not rust.

C28	**(b)** a thin oxide layer protects them	The oxide layer stops further reaction.

C29. Iron nails are kept in three test tubes: A – tap water, open to air; B – boiled distilled water with a layer of oil; C – dry air over anhydrous calcium chloride. In which tube do the nails rust? Explain each result. **[3]**

A: the nails rust – both air and water are present. 1

B: no rust – boiling removes dissolved air and the oil keeps air out. 1

C: no rust – calcium chloride absorbs the moisture, so the air is dry. 1

C30. Pure iron is soft. How is it made hard and strong? Why is solder used to join electrical wires? **[2]**

By alloying it with a small amount of carbon (about 0.05%) to make steel. 1

Solder (lead + tin) has a low melting point, so it melts easily to join the wires. 1

Long answer

C31. (a) Write equations for: (i) sodium with water (ii) iron with steam (iii) zinc with dilute hydrochloric acid. (b) Why does copper not react with dilute acids? (c) What is aqua regia? **[5]**

(i) $2\,Na + 2\,H_2O \longrightarrow 2\,NaOH + H_2$ 1

(ii) $3\,Fe + 4\,H_2O \longrightarrow Fe_3O_4 + 4\,H_2$ 1

(iii) $Zn + 2\,HCl \longrightarrow ZnCl_2 + H_2$ 1

(b) Copper is below hydrogen in the reactivity series and cannot displace it. 1

(c) Conc. HCl and conc. HNO_3 in the ratio 3 : 1; it dissolves gold and platinum. 1

C32. (a) Give the steps, with equations, to obtain zinc from zinc sulphide ore. (b) Explain how the zinc obtained is refined. **[5]**

(a) Enrichment: the gangue is removed. ½

Roasting: $2\,ZnS + 3\,O_2 \longrightarrow 2\,ZnO + 2\,SO_2$ 1

Reduction with carbon: $ZnO + C \longrightarrow Zn + CO$ 1

(b) Electrolytic refining: impure zinc is the anode, a thin strip of pure zinc the cathode, and a zinc salt solution the electrolyte. 1½

Pure zinc deposits on the cathode; impurities stay in solution or settle as anode mud. 1

C33. (a) Show the formation of calcium oxide (Ca: 2,8,8,2; O: 2,6) by transfer of electrons. (b) State three properties of ionic compounds with a reason for each. **[5]**

(a) $Ca \longrightarrow Ca^{2+} + 2\,e^-$; $O + 2\,e^- \longrightarrow O^{2-}$; ions held as $Ca^{2+}\,O^{2-}$ (CaO). 2

(b) Hard solids – strong attraction between ions. 1

High melting and boiling points – much energy needed to separate the ions. 1

Conduct when molten or in solution – the ions are free to move (not in the solid). 1

PART D · ANSWERS

D Case-Based Questions – Answers

Marking-scheme answers for every question in Part D of the chapter booklet.

D1. Case Study · The Hot Rods [4]

(i) Which material conducts heat best? **[1]**

Copper (its pin fell first). 1

(ii) Why did the pin on the glass rod not fall? **[1]**

Glass is a poor conductor of heat, so not enough heat reached the far end to melt the wax. 1

(iii) Name the metal that is the best conductor of heat and two metals that are comparatively poor conductors of heat. **[2]**

Best conductor: silver. 1

Poor conductors: lead and mercury. 1

OR

(iii) Why are cooking pans made of copper or aluminium, while their handles are made of plastic or wood? **[2]**

Copper and aluminium are good conductors of heat, so food cooks quickly. 1

Plastic and wood are poor conductors, so the handles stay cool to hold. 1

D2. Case Study · From Ore to Metal [4]

(i) Name the process used to change ore X into the oxide. **[1]**

Calcination (X is zinc carbonate). 1

(ii) Name the gas given off when ore Y is heated in air. **[1]**

Sulphur dioxide (SO_2). 1

(iii) Write the equations for the roasting of the sulphide ore and the reduction of the oxide. **[2]**

$2\,ZnS + 3\,O_2 \longrightarrow 2\,ZnO + 2\,SO_2$ 1

$ZnO + C \longrightarrow Zn + CO$ 1

OR

(iii) Why can aluminium not be obtained in this way? How is it obtained? **[2]**

Aluminium has a greater affinity for oxygen than carbon, so carbon cannot reduce its oxide. 1

By electrolytic reduction of molten aluminium oxide. 1

D3. Case Study · The Old House [4]

(i) What two conditions caused the iron gate to rust? **[1]**

The presence of both air (oxygen) and water (moisture). 1

(ii) What is the green coat on the copper pot? **[1]**

Basic copper carbonate, formed with moist carbon dioxide of the air. 1

(iii) Name the metals in brass and in solder. Why is solder used for joining wires? **[2]**

Brass: copper and zinc. Solder: lead and tin. 1

Solder has a low melting point. 1

OR

(iii) What is galvanisation? Why did the scratched bucket not rust? **[2]**

Coating iron or steel with a thin layer of zinc. 1

Zinc is more reactive than iron, so it reacts in place of the iron even when scratched. 1