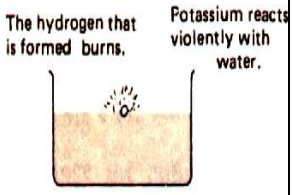
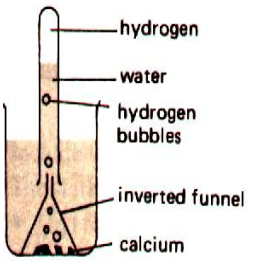
Suggested Answers on Note (Chapter 9) P.4

Metal + Air / Oxygen ⟶ Metal oxide

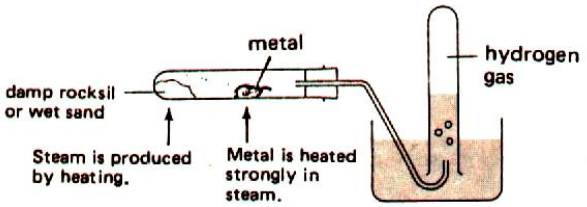
Metals	Reaction with oxygen	Other observations	Equations
Potassium (K)	Only a **little heat** is required to start the reaction. React vigorously (強烈的) with a large amount of heat energy released. White powder of oxide formed.	**Lilac** (pure purple) flame (淡紫色火焰)	$4K(s) + O_2(g) \longrightarrow 2K_2O(s)$
Sodium (Na)		**Golden yellow** flame	**$4Na + O_2 \longrightarrow 2Na_2O$ (white)**
Calcium (Ca)	**Strong heating** required. A lot of heat is given out. White powder formed. Reaction less vigorous.	**Brick-red** flame (磚紅色)	**$2Ca + O_2 \longrightarrow 2CaO$ (white)**
Magnesium (Mg)		**Dazzling (眩目的) white** flame	**$2Mg + O_2 \longrightarrow 2MgO$ (white)**
Aluminium (Al)		React with **no flame**	**$4Al + 3O_2 \longrightarrow 2Al_2O_3$ (white)**
Zinc (Zn)	**Strong heating** required. Some heat evolved.	The powder left is **yellow when hot** and **white when cold**	**$2Zn + O_2 \longrightarrow 2ZnO$** **ZnO: hot – yellow, cold – white**
Iron (Fe)		Iron powder burns with sparks (火花)	**$2Fe + O_2 \longrightarrow 2FeO$ (green)** **$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$ (brown)** **$3Fe + 2O_2 \longrightarrow Fe_3O_4$ (black)** **[$Fe_3O_4 = FeO \bullet Fe_2O_3$]**
Lead (Pb)	**Strong heating** required. Oxide forms only on the surface of metal.	Melts on strong heating to silvery ball; a powder which is **orange when hot** and **yellow when cold** on the surface	**$2Pb + O_2 \longrightarrow 2PbO$** **PbO: hot – orange, cold – yellow**
Copper (Cu)		Surface turns **black**	**$2Cu + O_2 \longrightarrow 2CuO$ (black)**
Mercury (Hg)		**Red** powder on the surface	**$2Hg + O_2 \longrightarrow 2HgO$ (red)**
Silver (Ag)	Silver and gold show **no change** even when heated strongly.		
Gold (Au)			

Suggested Answers on Note (Chapter 9) P.5

Metals react with cold water **Metal + Water ⟶ Metal hydroxide + Hydrogen**

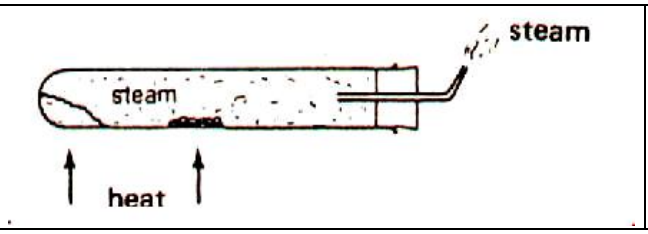
Potassium **Sodium**	With forceps, drop a small piece of metal into a trough of water.  	1. Reacts violently with cold water 2. Floats on water and produces H_2 gas 3. Moves quickly around the surface of the water 4. Burns with coloured flames 5. Solution becomes alkaline	**Equation:** **$2K + 2H_2O \longrightarrow 2KOH + H_2$** **$2Na + 2H_2O \longrightarrow 2NaOH + H_2$**
Calcium	 	1. Metals sink to the bottom 2. Hydrogen gas formed at a moderate rate 3. Calcium gradually disappears 4. Solution becomes cloudy as $Ca(OH)_2$ is slightly soluble in water	**Equation:** **$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$**

Heated metals react with steam **Metal + Steam ⟶ Metal Oxide + Hydrogen**

Magnesium **Zinc** **Iron** **(No reaction for Al)***	 	**Equation:** **$Mg + H_2O \longrightarrow MgO + H_2$** **$2Al + 3H_2O \longrightarrow Al_2O_3 + 3H_2$**

* The **oxide layer** on the surface of aluminium prevents the metal from reaction. If we remove the oxide layer, aluminium reacts with steam.

Heated metals do not react with water or steam

Lead **Copper** **Mercury** **Silver** **Gold**	 	**No reaction**

Suggested Answers on Note (Chapter 9) P.7

Metal +
- **Hydrochloric acid ⟶ Metal chloride + Hydrogen**
- **Sulphuric acid ⟶ Metal sulphate + Hydrogen**
- **Nitric acid ⟶ Metal nitrate + Hydrogen**

Suggested Answers on Note (Chapter 9) P.8 – 9

1. (a) Magnesium + dilute hydrochloric acid

$Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$

(b) Calcium + very dilute nitric acid

$Ca(s) + 2HNO_3(aq) \longrightarrow Ca(NO_3)_2(aq) + H_2(g)$

(c) Copper + dilute sulphuric acid

No reaction

(d) Iron + very dilute nitric acid

$Fe(s) + 2HNO_3(aq) \longrightarrow Fe(NO_3)_2(aq) + H_2(g)$

2. (a) Iron / Nickel / Chromium

(b) $Fe(s) + H_2SO_4(aq) \longrightarrow FeSO_4(aq) + H_2(g)$
$2Cr(s) + 3H_2SO_4(aq) \longrightarrow Cr_2(SO_4)_3(aq) + 3H_2(g)$
$Ni(s) + H_2SO_4(aq) \longrightarrow NiSO_4(aq) + H_2(g)$

3. (a) First, lead reacts slowly and colourless gas bubble evolved.
Then, reaction stop and the surface of lead is covered by a white layer.

(b) $Pb(s) + 2HCl(aq) \longrightarrow PbCl_2(s) + H_2(g)$

4. (a) B > A > D > C

(b) A: Zinc
B: Calcium
C: Copper
D: Iron

Suggested Answers on Note (Chapter 9) P.10 – 11

a. $H^+(aq) + OH^-(aq) \longrightarrow H_2O(l)$

b. $2I^-(aq) + Cl_2(g) \longrightarrow 2Cl^-(aq) + I_2(aq)$

c. $SnO(s) + 2H^+(aq) \longrightarrow Sn^{2+}(aq) + H_2O(l)$

d. $2Na(s) + 2H^+(aq) \longrightarrow 2Na^+(aq) + H_2(g)$

e. $Fe^{3+}(aq) + 3OH^-(aq) \longrightarrow Fe(OH)_3(s)$

f. $2Ag^+(aq) + 2OH^-(aq) \longrightarrow Ag_2O(s) + H_2O(l)$

g. $Cu(s) + 4H^+(aq) + 2NO_3^-(aq) \longrightarrow Cu^{2+}(aq) + 2NO_2(g) + 2H_2O(l)$

h. $CaCO_3(s) + 2H^+(aq) \longrightarrow Ca^{2+}(aq) + CO_2(g) + H_2O(l)$

i. $2MnO_4^-(aq) + 16H^+(aq) + 10Cl^-(aq) \longrightarrow 2Mn^{2+}(aq) + 5Cl_2(g) + 8H_2O(l)$

j. $Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6Fe^{2+}(aq) \longrightarrow 6Fe^{3+}(aq) + 2Cr^{3+}(aq) + 7H_2O(l)$

Suggested Answers on Note (Chapter 9) P.14

Metal	Cu^{2+} (aq)	Mg^{2+} (aq)	Zn^{2+} (aq)	Fe^{2+} (aq)	Ag^{+} (aq)
Copper		No change	No change	No change	$Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$ $Cu + 2Ag^{+} \rightarrow Cu^{2+} + 2Ag$
Magnesium	$Mg + Cu(NO_3)_2 \rightarrow Mg(NO_3)_2 + Cu$ $Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$		$Mg + Zn(NO_3)_2 \rightarrow Mg(NO_3)_2 + Zn$ $Mg + Zn^{2+} \rightarrow Mg^{2+} + Zn$	$Mg + Fe(NO_3)_2 \rightarrow Mg(NO_3)_2 + Fe$ $Mg + Fe^{2+} \rightarrow Mg^{2+} + Fe$	$Mg + 2AgNO_3 \rightarrow Mg(NO_3)_2 + 2Ag$ $Mg + 2Ag^{+} \rightarrow Mg^{2+} + 2Ag$
Zinc	$Zn + Cu(NO_3)_2 \rightarrow Zn(NO_3)_2 + Cu$ $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$	No change		$Zn + Fe(NO_3)_2 \rightarrow Zn(NO_3)_2 + Fe$ $Zn + Fe^{2+} \rightarrow Zn^{2+} + Fe$	$Zn + 2AgNO_3 \rightarrow Zn(NO_3)_2 + 2Ag$ $Zn + 2Ag^{+} \rightarrow Zn^{2+} + 2Ag$
Iron	$Fe + Cu(NO_3)_2 \rightarrow Fe(NO_3)_2 + Cu$ $Fe + Cu^{2+} \rightarrow Fe^{2+} + Cu$	No change	No change		$Fe + 2AgNO_3 \rightarrow Fe(NO_3)_2 + 2Ag$ $Fe + 2Ag^{+} \rightarrow Fe^{2+} + 2Ag$
Silver	No change	No change	No change	No change	

Suggested Answers on Note (Chapter 9) P.15

1. (a) No reaction

   (b) $Mg(s) + FeBr_2(aq) \longrightarrow MgBr_2(aq) + Fe(s)$

   (c) No reaction

   (d) $2Al(s) + 3ZnSO_4(aq) \longrightarrow Al_2(SO_4)_3(aq) + 3Zn(s)$

2. (a) $Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$ [No ionic equation]

   (b) No.

   (c) $Fe(s) + 2H^+(aq) \longrightarrow Fe^{2+}(aq) + H_2(g)$

   (d) No. (As $CaSO_4(s)$)

   (e) $Mg(s) + Pb^{2+}(aq) \longrightarrow Mg^{2+}(aq) + Pb(s)$

Suggested Answers on Note (Chapter 9) P.18 – 28

1. (a) sodium

   (b) copper, iron

   (c) copper, zinc (and iron)

   (d) aluminium, sodium

   (e) sodium

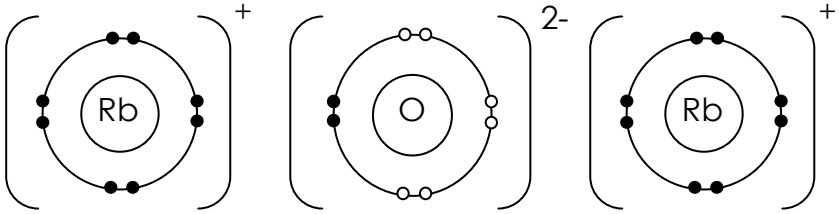
   (f) copper

2. (a) P : zinc
   Q : silver (or copper)

   (b) magnesium, zinc, silver (or copper)

   (c) $Zn(s) + 2H^+(aq) \longrightarrow Zn^{2+}(aq) + H_2(g)$

3. (a) Rb_2O
   The melting point of Rb_2O is higher than that of SO_3 because Rb_2O is an ionic compound, the ions are held together by strong electrostatic force while SO_3 is a covalent compound, the molecules are held together by weak van der Waal's force.



   (b) Rb is more reactive than K because the size of Rb atom is larger, its outermost electron is held less strongly and is thus easier to be lost.

   (c) Electrolysis of molten RbCl, Rb is liberated at the cathode.

   (d) Rb melts to a silvery ball and darts about on the water surface with a hissing sound, becoming smaller and smaller in size. Hydrogen gas is given off, and it burns spontaneously.
   $2Rb(s) + 2H_2O(l) \longrightarrow 2RbOH(aq) + H_2(g)$

   (e) Rb has two isotopes ^{85}Rb and ^{87}Rb.
   85.5 is the weighted average.

   (f) (i) flammable and explosive.
   (ii) keep out of water.

4. (a) A layer of inert oxide of aluminium (Al_2O_3) prevents the metal from further oxidation.

   (b) Aluminium is lighter than steel.

   (c) Since soft-drink may contain acids that may dissolve the Al_2O_3 layer, the plastic film is used to protect the oxide from contact with the soft-drink.

   (d) hydrochloric acid

   (e) $3HCl(aq) + Al(OH)_3(s) \longrightarrow AlCl_3(aq) + 3H_2O(l)$

5. (a) (i) $2H^+(aq) + Z(s) \longrightarrow Z^+(aq) + H_2(g)$
   (ii) $Y(s) + Fe^{2+}(aq) \longrightarrow Fe(s) + Y^{2+}(aq)$

   (b) Z > Y > Fe > X
   From experiment I and II, Z is the most reactive metal because it displaces hydrogen from water.
   From experiment II, Y must be more reactive than Fe because it displaces iron from $FeSO_4$ solution.
   From experiment III, X must be the least reactive metal (e.g. Ag) because its oxide X_2O decomposes to give the metal on heating.

6. (a) hydrogen

   (b) Copper does not react with dilute HCl.
   Copper forms a black powder.
   Copper does not give a flame when heated.

   (c) (i) magnesium / calcium / zinc.
   (ii) e.g. magnesium oxide.
   (iii) e.g. $Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$

7. (a) Lithium and sodium (density < 1.00 g/cm^3).

   (b) copper

   (c) (i) Lithium. It floats on water but is less active than sodium.
   (ii) $2Li(s) + 2H_2O(l) \longrightarrow 2LiOH(aq) + H_2(g)$

8. (a) $2Al(s) + 3CuSO_4(aq) \longrightarrow Al_2(SO_4)_3(aq) + 3Cu(s)$

   (b) Becomes covered with a brown deposit.

   (c) Aluminium takes the place of copper in copper(II) sulphate.

   (d) e.g. calcium ions. Al is lower than Ca in the reactivity series.

   (e) Do it again after finished Section 3.
   6 g of Al $\longrightarrow$ 0.22 moles of Al;
   from equation, 0.22 moles Al $\longrightarrow$ 0.33 moles Cu $\longrightarrow$ 21.12 g Cu.

9. (a) B, C, D, A

   (b) B: silver is displaced. D: no reaction.

   (c) Iron or lead.
   The metal must be above copper (as it reacts with $CuSO_4$ solution) and below zinc (no reaction with $ZnSO_4$ solution).

10. (a) $Mg(s) + CuSO_4(aq) \longrightarrow MgSO_4(aq) + Cu(s)$
    Mg dissolves, solution turns colourless / pale blue from blue, brown solid gives out.

    (b) No reaction.

    (c) $Zn(s) + 2AgNO_3(aq) \longrightarrow Zn(NO_3)_2(aq) + 2Ag(s)$
    Zn dissolves, solution remains colourless, black / grey solid gives out.

    (d) $Ca(s) + 2H_2O\ (l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$
    Ca dissolves, solution remains colourless, colourless gas bubbles gives out.

    (e) No reaction.

    (f) $2PbO(s) + C(s) \longrightarrow 2Pb(s) + CO_2(g)$
    PbO turn orange from yellow when hot, silvery solid gives out.

11. (a) D but not A can react with cold water. Therefore D is more reactive.

(b) C more reactive. As oxide of B is reduced by heat alone, B is low in the reactivity series and will not react with dilute acid.

(c) B, A, C, D.

(d) (i) The order of reactivity is the order in which the metals were discovered.
(ii) More reactive metals discovered recently. It was more difficult to separate the metals from their compounds.

(e) B is silver or gold (oxide reduced by heat alone).
D is a very reactive metal, e.g. sodium.
A and C are between Ca and Pb in the reactivity series, with C above A.

12. (a) (i)
- Iron dissolved.
- Gas bubbles were given off.

$Fe(s) + 2HCl(aq) \longrightarrow FeCl_2(aq) + H_2(g)$

(ii)
- A golden yellow flame was observed.
- A white smoke was formed.

$4Na(s) + O_2(g) \longrightarrow 2Na_2O(s)$

(iii)
- The yellow solid turned orange.
- A solid with metallic lustre was formed.

$2PbO(s) + C(s) \longrightarrow 2Pb(s) + CO_2(g)$

(iv)
- Zinc dissolved.
- A brown solid deposited.
- The blue colour of the solution faded gradually.

$Zn(s) + CuSO_4(aq) \longrightarrow Cu(s) + ZnSO_4(aq)$

(v) A brown solid with metallic lustre was formed.
$CuO(s) + Mg(s) \longrightarrow Cu(s) + MgO(s)$

(b) (i) Calcium oxide is very stable.
It cannot be reduced by carbon.

(ii) Copper is less reactive than magnesium.
It cannot displace magnesium from magnesium nitrate solution.

13. (a) Group II

(b) (i) X burned with a very bright light.
(ii) $2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$

(c) (i) X dissolved. / Gas bubbles were given off.
(ii) $Mg(s) + H_2SO_4(aq) \longrightarrow MgSO_4(aq) + H_2(g)$

(d) (i) Y burned with a lilac flame.
(ii) $4K(s) + O_2(g) \longrightarrow 2K_2O(s)$

(e) (i) Z might be iron.
(ii) $Fe(s) + H_2SO_4(aq) \longrightarrow FeSO_4(aq) + H_2(g)$

14. (a) (i) Caesium hydroxide
(ii) $2Cs(s) + 2H_2O(l) \longrightarrow 2CsOH(aq) + H_2(g)$
(iii) Difference – Caesium reacts more vigorously.
Similiarity – Similar products (hydroxide + hydrogen) are formed.

(b) • Caesium is a soft metal.
• Caesium has a low melting point.