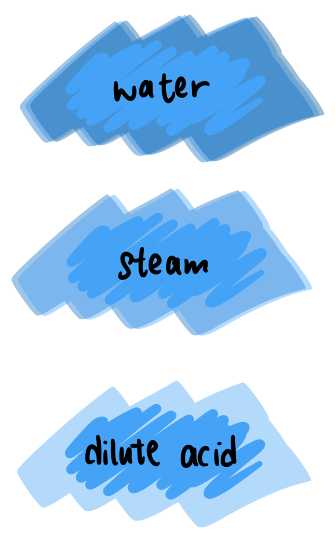
Metal reactions

1 Metal reactivity series

	Oxide		Metal		Ion	
	K_2O	←	K (钾)	→	K^+	paraffin oil
	Na_2O	←	Na (钠)	→	Na^+	
白	CaO	←	Ca (钙)	→	Ca^{2+}	airtight bottle
	MgO	←	Mg (镁)	→	Mg^{2+}	
	Al_2O_3	←	Al (铝)	→	Al^{3+}	
白冻黄热	ZnO	←	Zn (锌)	→	Zn^{2+}	
黑 (iron (II, III) oxide = mixture of FeO & Fe_2O_3)	Fe_3O_4	←	Fe (铁)	→	Fe^{2+}	very pale green
	SnO_2	←	Sn (锡)	→	Sn^{2+}/Sn^{4+}	
黄冻橙热	PbO	←	Pb (铅)	→	Pb^{2+}/Pb^{4+}	
						H_2
黑	CuO	←	Cu (铜)	→	Cu^{2+}	rare but possible, 看题目找线索
红 (稀有)	HgO	←	Hg (汞)	→	Hg^{2+}	
黑	Ag_2O	←	Ag (银)	→	Ag^+	

(Cu: reddish brown)



2 Reactions

WITH OXYGEN

metal + O_2 $\xrightarrow{\Delta}$ metal oxide

(Δ: mostly require heat, 但比 Mg reactive 的 (ie 钾钠钙) 不用加热)

- eg. $4Na + O_2 \rightarrow 2Na_2O$
- eg2. $3Fe + 2O_2 \rightarrow Fe_3O_4$ ← mixture of ① iron (II) oxide FeO ② iron (III) oxide Fe_2O_3, ①:② = 1:1
- observable changes
  > change in colour (metal colour → oxide colour)
  > change in shininess (metal: shiny → oxide: dull)
  > flame colour (for Cu, Ca, Na, K, Fe, Mg)
  Cu: bluish green, Ca: brick red, Na: golden yellow, K: lilac (变成 oxide 后的 flame colour); Fe: yellow sparks, Mg: bright white (加热金属的 flame colour)

WITH NON-METAL ELEMENTS

metal + X → ionic compound

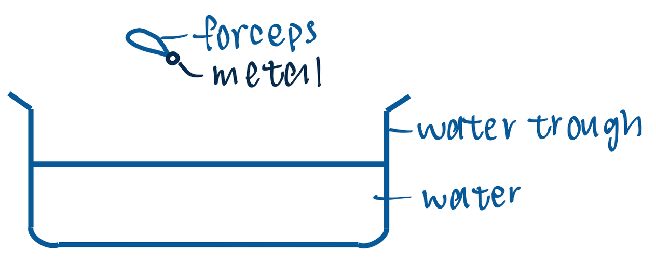
- 不 reactive 的 (eg. N_2) 要加热
- 注意 non-metal 通常是两颗 atom 组成一个 molecule
- $6Na + N_2 \xrightarrow{\Delta} 2Na_3N$ (N_2 有 triple bond → unreactive)
- $2Na + Cl_2 \rightarrow 2NaCl$

WITH WATER & ACIDS

a. liquid water

$M_{(s)} + H_2O_{(l)} \rightarrow MOH_{(s/aq)} + H_{2(g)}$ ← 假设 metal 的 ion 是 1+

- K Na Ca Mg Al Zn Fe ...
  (K Na Ca: ✓ react at room temp.; Mg: ✓ react (hot water); Al Zn Fe: x react)



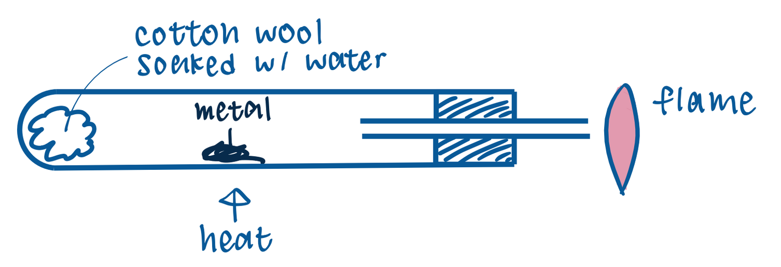
- add excess water (水要够多, 金属要够小)
- place metal w/ forceps

- observable changes
  > <metal> dissolves
  > insoluble salt: <colour> solid deposits (metal 和 hydroxide 的颜色必须不同)
    soluble salt + coloured ion: solution changes from colourless to <colour>
  > colourless gas bubbles evolve

b. water vapour

$2M + H_2O_{(g)} \rightarrow M_2O + H_{2(g)}$

- K Na Ca Mg Al Zn Fe, Sn Pb Cu ...
  (K – Fe: ✓ react; Sn Pb Cu: x react) (☆ $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$)



- burn outlet w/ flame to burn excess H_2 (flammable)

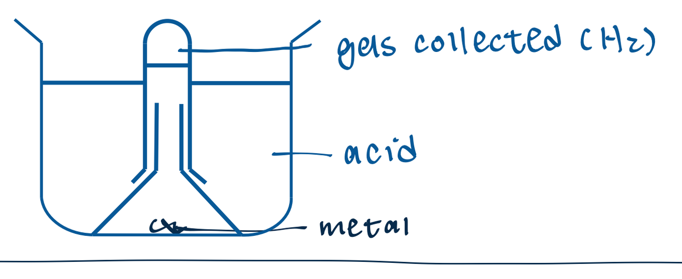
- observable changes
  > change in colour (metal colour → oxide colour)
  > change in shininess (metal: shiny → oxide: dull)

c. acids

$2M + 2H^+A^- \rightarrow 2M^+A^- + H_2$

acid: dilute/conc. HCl; dilute H_2SO_4; very dilute HNO_3; CH_3COOH
(for rx of metal & other acids see Acid and Bases topic)

- K Na Ca Mg Al Zn Fe Sn Pb, Cu Hg Ag Au
  (K – Pb: ✓ react; Cu Hg Ag Au: x react)



- ∵ H_2 does not dissolve in water
  ∴ ✓ collect under water

- observable changes
  > <metal> dissolves
  > insoluble salt: <colour> solid deposits
    soluble salt + coloured metal ion: solution changes from colourless to <colour>
  > colourless gas bubbles evolve