PAPER 1 EQUATIONS

Common ions

+	-
H⁺	Cl-
Ag⁺	Br⁻
Li+	OH ⁻
Na⁺	NO ₃ -
Mg ²⁺	SO4 ²⁻
Ca ²⁺	CO3 ²⁻
Zn ²⁺	PO4 ³⁻
Cu ²⁺	
Fe ²⁺ (iron II)	
Fe ³⁺ (iron III)	
Al ³⁺	

Formulae of ionic compounds

Select the correct formulae, by looking at the charges and getting the total + charge to equal the total - charge, from the four choices for each question

Q1] Lithium nitrate

LiNO ₃	Li ₂ NO ₃	Li(NO ₃) ₂	Li ₂ (NO ₃) ₂
Q2] Silver bromide			
AgBr	Ag_2Br_2	AgBr ₂	Ag ₂ Br
Q3] Sodium sulphate			
NaSO ₄	Na_2SO_4	Na(SO ₄) ₂	Na_3SO_4
Q4] Calcium hydroxide			
CaOH	Ca₂OH	Ca(OH) ₂	Ca(OH)₃
Q5] Aluminium sulphate			
AISO ₄	AI(SO ₄) ₂	AI_2SO_4	Al ₂ (SO ₄) ₃

Group 1 metals:

Elements have 1 electron in outer shell Always form 1+ ions Elements always oxidised (OIL) $X \rightarrow X^+ + e$ Reactions vigorous and more violent as you go down group

6] Group 1 + Oxygen

a) balance this



b) write a **half-equation** to show what happened to lithium during this reaction.

c) write a symbol equation for the reaction of rubidium with oxygen .

7] Group 1 + water

a) Explain why group 1 are known as the "alkali metals" ?

b) Why do group 1 metals react with water ?

c) Balance this :

 $\underline{Cs}_{(s)} + \underline{H_2O}_{(l)} \rightarrow \underline{CsOH}_{(aq)} + \underline{H_2}_{(g)}$

d) write a **half-equation** to show what happened to Caesium in the above equation.

e) write a balanced symbol equation for the reaction of rubidium with water.

f) In Q2c, which ion in the solution causes it to be alkaline ?

8] Group 1 + Group 7

a) In terms of electrons, how do group 1 and group 7 elements change when they react together ?

b) What is the formula of Sodium iodide ?

c) Complete this symbol equation for the reaction of potassium with chlorine (incl. state symbols) & balance it.

 K (s) +	Cl _{2 (l)}	→	 ()

d) Use your work on 3c to write a balanced symbol equation for the reaction of rubidium with astatine.

Group 7 – halogens

9] Group 7 displacement reactions

This is a halogen displacement reaction :

 $Cl_{2 (aq)} + 2LiBr_{(aq)} \rightarrow Br_{2 (aq)} + 2LiCl_{(aq)}$

a) Why is lithium bromide used "in solution" for this reaction, as it would normally be a solid at room temperature and pressure.

b) What would you SEE happening at this reaction takes place ?

c) Suggest why chlorine is used in solution for this reaction, as chlorine is a gas ?

d) What is the role ("job") of lithium ions in this reaction ?

e) Write an ionic equation for this reaction by removing the "spectator ions".

f) Which is the more powerful reducing agent in this reaction CI atoms or Br⁻ ions? How do you know? (a reducing agent reduces the thing that it is reacting with by giving it electrons !)

g) (paper 2 stuff) Describe what you would observe if you added silver nitrate solution to the products of this reaction ?

DRILLING

- 10] Write balanced symbol equations for the following halogen displacement reactions :
- a) Bromine and potassium iodide solution ?

Br _{2 (aq)} +	KI (aq) →	(aq) -	+ (aq)
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b) Fluorine and sodium chloride solution ?

c) Bromine and potassium astatide solution ?

- 11] Write *ionic equations* for the 3 reactions in Q10.
- a) Bromine and potassium iodide solution ?

b) Fluorine and sodium chloride solution ?

c) Bromine and potassium astatide solution ?

METAL REACTIONS

Metal + Oxygen reactions

12] Balance these metal element + oxygen reactions :

a)		K _(s) + _	O _{2 (9}	_{g)} →	K ₂ O _(s)		
b)		Ca _(s) +	O ₂	(g) →	CaO (s	i)	
c)		AI _(s) + _	O ₂ ((g) →	Al ₂ O _{3 (s})	
d)	All three read	ctions above sh	now metal elem	nents being oxi	dised in 2 ways.	What are they ?	
e)	Which of the	e 3 reactions wo	ould not need a	bunsen flame	to make it happe	n ?	
f) .	All 3 reaction	is are fast. As s	such the metal	tarnishes rath	er completely oxic	lising. What doe	s this mean ?
g) ' sta	Write both ox rted for you :	kidation and red	luction half-equ	uations for the	3 reactions above	. The first one h	as been
i)	(OX)	_K ➔ K⁺ +	е	(RED)	O ₂ +	e →	02-
j)							

Metal + water

(not as many to do here, as not all metals react with water)
•K, Na, Li + Ca all form <u>hydroxide</u> compounds when they react with cold water.
•Mg reacts VERY slowly with cold water (several days) or rapidly with steam to form oxide.
•Zn, Fe and Cu only form <u>oxide</u> compounds and they only react with steam slowly

13] Complete these symbol equations for metals reacting with water/steam.



d) Once again, the same thing is happening to the metal. Write a half-equation to show what happens to zinc in Q13c and state whether this is oxidation or reduction ?

Metal + Acid

[General equation] Metal + acid → metal salt + hydrogen

The salt depends on the acid used. HCl forms **chloride** salts H₂SO₄ forms **sulphate** salts HNO₃ forms **nitrate** salts

14] Select the correct formulae of the following metal salts formed in reactions with acids, by looking at the charges and getting the total + charge to equal the total - charge, from the four choices for each question

a] Potassium sulphate	e		
KSO ₄	K_2SO_4	K(SO ₄) ₂	K_3SO_4
b] Zinc Nitrate			
ZnNO ₃	Zn_2NO_3	Zn(NO ₃) ₂	Zn(NO ₃) ₃
c] Iron III chloride			
FeCl	Fe ₃ Cl	FeCl ₂	FeCl ₃
15] Complete these met Li forms 1+ ions Mg forms 2+ ions Al forms 3+ ions	tal – acid equations :		
a) Li _(s) +	HCI _(aq)	LiCl (aq) +H2(g	3)
b) Li (s) +	HNO _{3 (aq)}	(aq) + _	H _{2(g)}
c) Li _(s) +	H₂SO₄ (aq) ➔	(aq) +	(g)
d) Mg _(s) +	HCI _(aq) →	_ MgCl _{2 (aq)} +	.H _{2(g)}



16] You can also represent these reactions as **ionic equations** – which show more detail on what actually happened.

eg/ [full equation] $2Rb_{(s)} + 2HCl_{(aq)} \rightarrow 2RbCl_{(aq)} + H_{2(g)}$

decisions:

- the acid part of the HCI (the thing that makes HCI an acid) are the H⁺ ions.

- here CI is CI ions on the left and CI ions on the right. In other words, no change ! Spectator ionsremove them.

- have to leave the H_2 in at the end to show what happened to the H+ ions.

Answer:

[ionic equation] $2Rb + 2H^+ \rightarrow 2Rb^+ + H_2$

write ionic equations for the following metal - acid reactions:

a) [Full] $2Cs + 2HNO_3 \rightarrow 2CsNO_3 + H_2$

b) [Full] $Cu + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2$

c) [Full] 2Fe + $6HNO_3 \rightarrow 2Fe(NO_3)_3 + 3H_2$

d) [Full] 2Cs + $H_2SO_4 \rightarrow Cs_2SO_4 + H_2$

e) [Full] 2Cs + 2HCl \rightarrow 2CsCl + H₂

ACID REACTIONS

- anything that reacts with an acid (and neutralises it) is known as a "base".
- bases include : metal elements (eg/ Cu), metal oxide compounds (eg/ CuO), metal hydroxide compounds (eg/ Cu(OH)₂) and metal carbonate compounds (eg/ CuCO₃).
- some metal hydroxides are soluble in water. These are known as "**alkalis**". (eg/ LiOH, NaOH, KOH)
- they're all neutralisation reactions.
- in each reaction, the acid does the same thing ! It gives away H⁺ ions that turn into either H₂ gas *(reaction with metal only)* or H₂O.

 once again, the type of acid determines the type of salt formed : HCl forms chloride salts H₂SO₄ forms sulphate salts HNO₃ forms nitrate salts

Here are the general equations for these reactions:

Metal oxide + acid → metal salt + water

(eg/ Na₂O + 2HCl \rightarrow 2NaCl + H₂O..... H₂O because 2xH from acid and O from base)

Metal hydroxide + acid → metal salt + water

(eg/ NaOH + HCl \rightarrow NaCl + H₂O H₂O because H from acid and OH from base)

Metal carbonate + acid → metal salt + water + carbon dioxide

 $(eg/Na_2CO_3 + 2HCI \rightarrow 2NaCI + H_2O + CO_2)$

Metal oxide + acid

17] Complete these equations (some just require balancing):





^{18]} Write ionic equations for 17a, 17d and 17g below.

Metal hydroxide + acid reactions



20] Write ionic equations for 19a and 19d below

Metal carbonate + acid reactions





^{22]} Write **ionic equations** for 21a and 21d below Remember, the acid donates its H⁺, the negative ion part (the non-metal bit) of the base accepts the acids H⁺.

OTHER BITS AND PIECES

Thermal decomposition of metal carbonates and metal hydrogen carbonates.

- metal carbonates are weird ! They are the only ionic compounds that breakdown when heated and form new substances. Most ionic compounds just get hotter and hotter as solids, and if you heat them to a high enough temperature they melt. But as soon as they cool down again, they reform the same solid ionic compound.

- they breakdown to metal oxide (solid) and give off carbon dioxide gas (hello - limewater test)

- Sodium hydrogen carbonate (NaHCO₃) also does this. Important because this is baking powder, used to make cakes rise and in self-raising flour.

- they all break down at different rates (watch out for a rate Q here or an experimental Q). Some metal carbonates are more thermally stable than others.

a)	Li2CO3 → Li2C) +CO ₂	
b)	Na₂CO₃ →	+CO ₂	
c)	CaCO₃ →	+CO ₂	
d)	MgCO₃ →	+CO ₂	
e) [slightl	y diff for hydrogen carbonates. They als	o give off water]	
	NaHCO₃ →	+ CO ₂ +	H ₂ O

23] Complete these equations (remember, the carbonate ion is a 2- ion CO_3^{2-})

Extracting metals from their ores:

by using carbon and heat to steal their oxygen.

- only works for metals lower down in the reactivity series (below C).
- C reduces the metal, by taking the oxygen attached to it. The metal becomes an element (by gain of electrons.
- lots of heat required.

Metal oxide + carbon → metal + carbon dioxide

24] Complete these equations.

a)



b) $\underline{\qquad} Fe_2O_3 + \underline{\qquad} C \rightarrow \underline{\qquad} + CO_2$