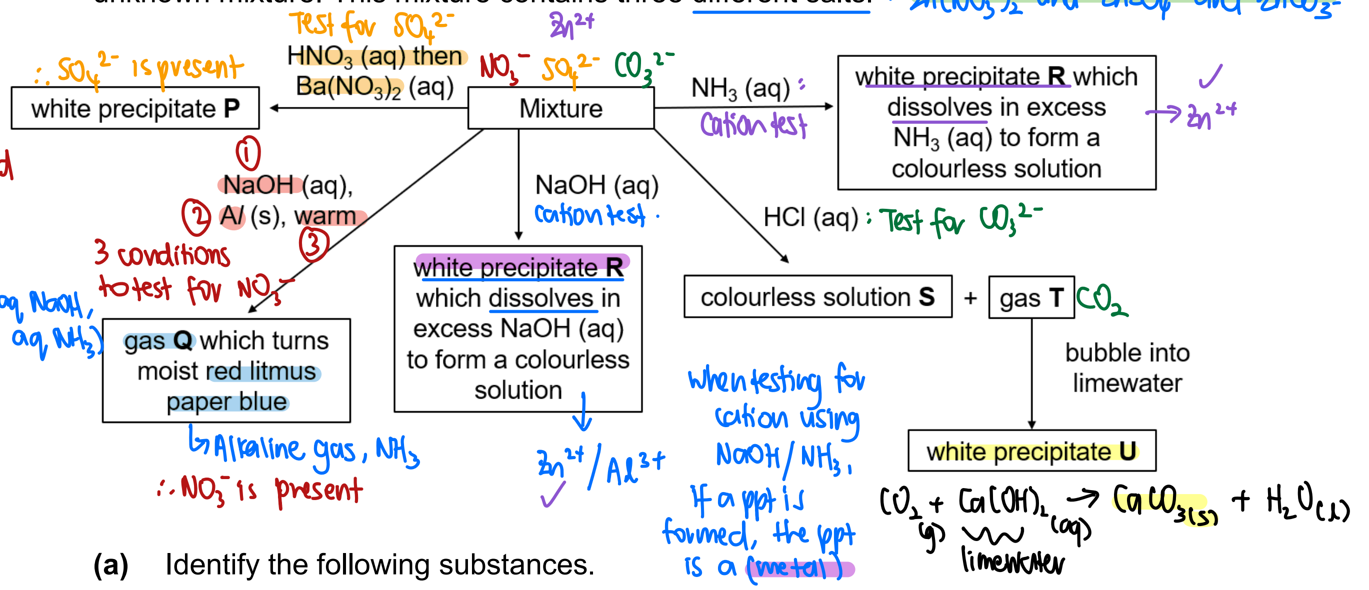
Qualitative Analysis.

paid 6.

A7 The following reaction scheme describes some of the reaction carried out on an unknown mixture. This mixture contains three different salts. : $Zn(NO_3)_2$ and $ZnSO_4$ and $ZnCO_3$.

Recommended Sequence
① Gases
② cation test (aq NaOH, aq NH_3)
③ anion test



(a) Identify the following substances.

P: $BaSO_4$ / Barium sulfate

Q: NH_3 / Ammonia

R: $Zn(OH)_2$ / Zinc hydroxide

S: $ZnCl_2$ / zinc chloride.

T: CO_2 / carbon dioxide

U: $CaCO_3$ / calcium carbonate [6]

(b) Suggest two of the salts that the mixture contains.

salt 1: Zinc nitrate

salt 2: Zinc carbonate OR zinc sulfate [2]

[Total: 8]

A9 Wollastonite, $CaSiO_3$, can be produced from the reaction between calcium phosphate and silicon dioxide.

$$2Ca_3(PO_4)_2 + 6SiO_2 \rightarrow P_4O_{10} + 6CaSiO_3$$

100 g of calcium phosphate, $Ca_3(PO_4)_2$, was used in this reaction. The actual mass of wollastonite produced was 87 g.

Calculate the percentage yield of wollastonite.

↳ $\% \text{ yield} = \dfrac{\text{actual yield (87g)}}{\text{theoretical yield (???)}} \times 100\%$

↳ predicted amt of product via stoichiometry.

① no. of mol of $Ca_3(PO_4)_2 = \dfrac{100}{3(40) + 2(31) + 8(16)}$

$= 0.32258$ mol

no. of mol $= \dfrac{\text{mass (g)}}{\text{molar mass (g/mol)}}$

1 tonne $= 1 \times 10^6$ g

② compare mol ratio $Ca_3(PO_4)_2 : CaSiO_3$

2 : 6

1 : 3

0.32258 mol : 0.32258×3

$= 0.96774$ mol

③ Theoretical mass of $CaSiO_3 = 0.96744 \times [40 + 28 + 3(16)]$

$= 112.26$g

$\% \text{ yield} = \dfrac{87g}{112.26g} \times 100\%$

$= 77.5\%$

[4]

[Total: 4]

$Mg^{2+} : NO_3^-$
1 : 2

B12 30.0 cm³ of 0.80 mol/dm³ nitric acid was reacted with 10 g of magnesium.

since info on both reactants given. Determine limiting reactant.

(a) Calculate the mass of magnesium nitrate produced.

① construct balanced chem eqn: $Mg + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2$

10g   30.0 cm³
0.80 mol/dm³

no. of mol of Mg = $\frac{10}{24}$
= 0.41667 mol

no. of mol of HNO_3 = $0.80 \times \frac{30}{1000}$
= 0.024000 mol (available)

② compare mol ratio of reactant $Mg : HNO_3$
1 : 2
0.41667 mol : 0.41667 × 2
= 0.83334 mol (required)
0.02400 mol (avail)
∴ As there is insufficient nitric acid to react w/ Mg, HNO_3 is the LR

③ compare mol ratio of LR to product of interest
$HNO_3 : Mg(NO_3)_2$
2 : 1
0.02400 mol : 0.0120 mol

∴ Mass of $Mg(NO_3)_2$ = 0.0120 × [24 + 2(14) + 6(16)]
= 1.776g
= 1.78g (3 s.f.).

[3]

(b) A gas was produced in this reaction. Describe the test and observation to confirm the identity of the gas.

Insert a lighted splint at the mouth of test tube. Lighted splint will

extinguish w/ a 'pop' sound as hydrogen gas is produced. [1]

(c) Suggest a change in observation if nitric acid was replaced with ethanoic acid, CH_3COOH, for this reaction. Explain why.

strong acid: completely ionises in water to produce a higher conc of H^+ ions.

weak acid partially dissociates in water to produce a lower conc of H^+ ions

one out of two possible observations

① Reaction takes a longer time to complete

② Effervescence is produced at a slower rate when ethanoic acid is used.

[2]

AI: Ammonium,
Group I salts
↳ Titration

① solubility: soluble, non-AI
② method: excess / ICA (Typical acid rxns)
↳ insoluble compound + acid

(d) Describe the steps to prepare pure and dry magnesium nitrate crystals from nitric acid and magnesium.

$MgO / Mg(OH)_2 / MgCO_3$ HNO_3

① With constant stirring, add excess magnesium into a beaker of (dilute) nitric acid until no more effervescence is observed / until no more solid can dissolve.

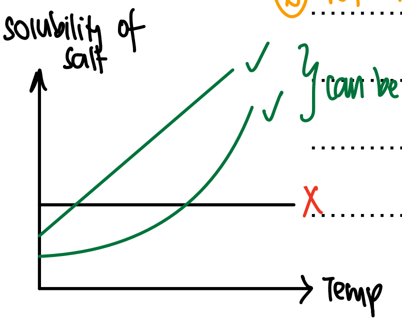
② Filter to obtain magnesium nitrate sol^{n} as filtrate.

③ Heat filtrate until it is saturated and leave the solution to cool and crystallise.

④ Filter the mixture to obtain magnesium nitrate crystals as residue.

⑤ Rinse crystals with little amount of cold distilled water.

⑥ Pat dry using sheets of filter paper.



} can be crystallised.

[4]

[Total: 10]

1) $Ag + HCl \longrightarrow AgCl$ Feasible?
NO as Ag is unreactive.

2) $Ag_2CO_3 + HCl \longrightarrow AgCl_{(s)}$ Feasible? NO, as there is an insoluble layer of AgCl coating the Ag_2CO_3 reactant.
(s) (aq)
insoluble
↓
Method: precipitation
$(aq) + (aq) \rightarrow (s)$

If qn specified to start w/ Ag_2CO_3, react w/ HNO_3 first
$AgNO_{3(aq)}$

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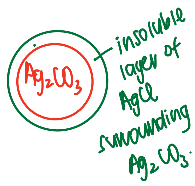
$\underline{?} + HCl_{(aq)} \rightarrow AgCl_{(s)}$
Ag^+-containing solution
∴ $AgNO_3$.



Extraction method

most reactive
Potassium
Sodium
Calcium
Magnesium
Aluminium
Carbon
Zinc
Iron
Lead
Hydrogen
Copper
Silver
Gold
least reactive

electrolysis of its molten compound (Potassium – Aluminium)

chemical reduction from ore using C (Zinc – Gold)
↓
e.g: $2ZnO + C \longrightarrow 2Zn + CO_2$

Copper, Silver, Gold } unreactive metals.

Reactive metals: above H

Structure	simple molecular structure	giant molecular structure
Attractive forces	weak IMFOA b/w molecules	extensive network of strong covalent bonds
Energy	little amt of energy to overcome	v. large amt of energy is required to overcome
Conclusion		

Qualitative Analysis

34 When sulfur is burned, sulfur dioxide is produced.

↳ can be oxidised to SO_3. ∴ Tested using an OA (acidified $KMnO_4$)

How can the identity of sulfur dioxide be confirmed?

	test	observation
A	insert a glowing splint into the gas	the glowing splint rekindles
B	use a piece of damp blue litmus paper	blue litmus paper turns red and is then bleached
C	use a piece of damp red litmus paper	red litmus paper turns blue and is then bleached
D	use a piece of filter paper soaked with acidified potassium manganate(VII)	purple potassium manganate(VII) turns colourless

35 Separate tests were performed on an unknown solution. The results are shown in the table below.

↳ of $Fe(OH)_2$ ∴ Fe^{2+} ions is present.

test	observation
add aqueous sodium hydroxide Test for Cation	green precipitate forms and is insoluble in excess sodium hydroxide
add nitric acid Test for CO_3^{2-}	no observable change ∴ no CO_3^{2-} present
add aqueous sodium hydroxide, aluminium foil and warm Test for NO_3^-	pungent gas evolved which turned moist red litmus paper blue

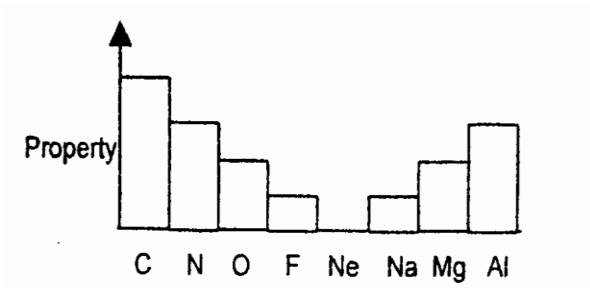
↳ $NH_{3(g)}$ evolved : positive test for NO_3^-

What is the unknown solution?

A ammonium nitrate
B iron(II) carbonate
C iron(II) nitrate
D iron(III) sulfate

(C)

36 A property of the elements from carbon to aluminium is shown on the chart.



What are the elements arranged according to?

A group number
B number of electron shells
C number of protons
D valency

37 Which statement is true for all noble gases?

↳ Monatomic, inert.

A They are coloured elements. ✗
B They are stable and inert.
C They have high densities.
D They have the octet configuration.

↳ He has duplet config!

(B)

38 Halogens can take part in displacement reactions. → more reactive element displaces less reactive element from salt solutions

$$X_2 + 2NaBr \rightarrow 2NaX + Br_2$$

Some halogens are listed below.

Group 17

I fluorine
II chlorine
III iodine
IV astatine

F_2 and Cl_2 are more reactive than bromine ∴ can displace bromine from NaBr

F, Cl, Br, I, At

Reactivity decreases down Group 17

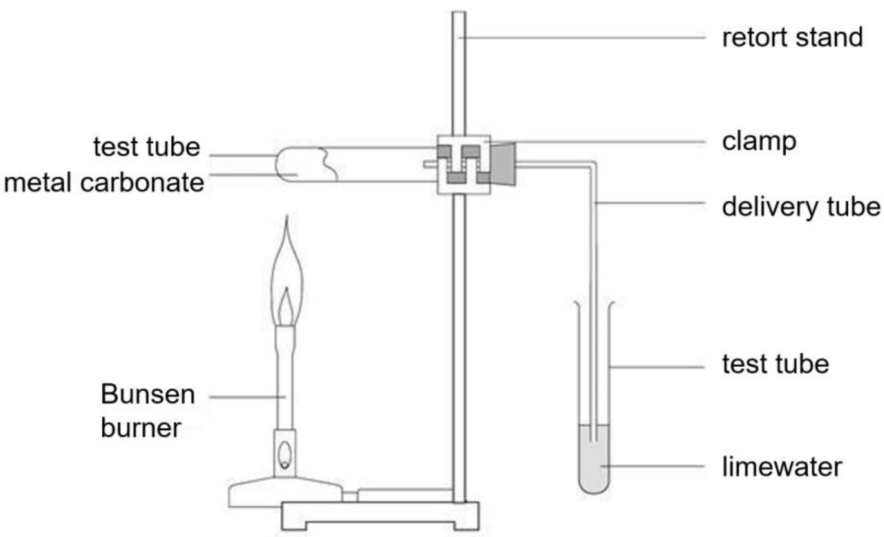
less reactive than bromine ∴ cannot displace bromine.

Which halogens could **X** be?

A **I** and **II**
B **I** and **IV**
C **II** and **III**
D **III** and **IV**

(A)

39 A metal carbonate was heated as shown in the diagram below.



The metal carbonate was heated strongly for an hour, but the limewater showed no observable change. → CO_2 is not produced. ∴ Metal carbonate is highly thermally stable and does not decompose.

Which of the following could the metal carbonate most likely be?

Only Group 1 CO_3^{2-} do not thermally decompose

A calcium carbonate
B magnesium carbonate
C sodium carbonate
D zinc carbonate

(C)

If metal oxides can be reduced by H_2, metal oxide contain less reactive metals.

40 The table below shows some information on four metals and their compounds.

Metal	adding hydrochloric acid	heating of ores with hydrogen	adding the metal to a solution of the sulfate of **J**
G	hydrogen evolved	steam produced	no visible change
H	no visible change	steam produced	no visible change
I	hydrogen evolved	no visible change	J formed → I is more reactive than J.
J	hydrogen evolved	no visible change	no visible change

least reactive

Since oxides of I and J cannot be reduced, I and J are more reactive than G and H

What is the order of reactivity of these metals?

	least reactive	→		most reactive
A	H	I	G	J
~~**B**~~	I	G	J	H
C	H	G	J	I
~~**D**~~	J	G	H	I

(C)

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