Qualitative Analysis

- 1. <u>Describe the use of aqueous sodium hydroxide and aqueous ammonia to identify the following cations:</u>
 - a. <u>Aluminum</u>
 - b. <u>Ammonium</u>
 - c. <u>Calcium</u>
 - d. <u>Copper (II)</u>
 - e. <u>lron (II)</u>
 - f. <u>Iron (III)</u>
 - g. <u>Lead (II)</u>
 - h. <u>Zinc</u>

Cation	Effect of aq. NaOH	Effect of aq. ammonia
Aluminium (Al3+)	White ppt, soluble in excess giving colourless	White ppt, insoluble in excess
	solution	
Ammonium (NH4+)	Ammonia produced on warming	
Calcium (Ca2+)	White ppt., insoluble in excess	No ppt
Copper (II) (Cu2+)	Light blue ppt, insoluble in excess (weak alkali:	Light blue ppt, soluble in excess
	blue ppt dissolves to give dark blue solution)	giving a dark blue solution
Iron (II) (Fe2+)	Green ppt, insoluble in excess	Green ppt, insoluble in excess
Iron (III) (Fe3+)	Red-brown ppt, insoluble in excess	Red-brown ppt, insoluble in excess
Lead (II) (Pb2+)	White ppt, soluble in excess giving colourless	White ppt, insoluble in excess
	solution	
Zinc (Zn2+)	White ppt, soluble in excess giving colourless	White ppt, soluble in excess giving
	solution	colourless solution

- Between aluminium and lead, add potassium iodide solution (lead (II) iodide will form a pale yellow ppt while aluminium iodide is soluble and no ppt is formed)
- Note: zinc, aluminium and lead which are all amphoteric oxides, which explains why the precipitate is soluble in excess alkali (whereas calcium is a basic oxide and does not react with NaOH)
- 2. Describe the tests to identify the following anions
 - a. Carbonate: by the addition of dilute acid and subsequent use of limewater
 - i. Effervescence is observed and carbon dioxide is produced
 - b. Chloride: by reaction of an aqueous solution with nitric acid and aqueous silver nitrate
 i. White ppt (insoluble silver chloride)
 - c. Iodide: by reaction of an aqueous solution with nitric acid and aqueous silver nitrate
 - i. Pale yellow ppt (insoluble silver iodide)
 - d. Nitrate: by reduction with aluminium and aqeous sodium hydroxide to ammonia and subsequent use of litmus paper
 - i. Ammonia produced, which turns red litmus paper blue
 - e. Sulfate: by reaction of an aqueous solution with nitric acid and aqueous barium nitrate
 i. White ppt (insoluble barium sulfate)
 - f. Additional Information:
 - i. Dilute nitric acid is always added to the confirmatory test since it reacts which any carbonate ions which may be present, thus when acid is added and the ppt still remains it means no carbonate is present, and the ppt is due to the suspected anion
- 3. <u>Perform simple collection and laboratory tests to identify gases: oxygen, hydrogen, carbon dioxide, sulfur dioxide, chlorine and ammonia</u>
 - a. Ammonia: turns damp red litmus paper blue
 - b. Carbon dioxide: forms a white ppt when bubbled into limewater

- c. Chorine: turns blue litmus paper red and then bleaches it
- d. Hydrogen: "pops" with a lighted splint
- e. Oxygen: relights a glowing splint
- f. Sulfur dioxide: turns aqueous potassium manganate (VII) colourless
 - i. Sulfur dioxide is a strong reducing agent (itself oxidized to SO3) while potassium manganate is a strong oxidizing agent

Other Notes:

• Use of scientific language such as 'effervescence', 'precipitate' and 'colourless solution'

Colour of Precipitate	Possible Identity
Black	CuO, C, MnO2, I2, metal powder
Blue	Copper (II) compounds
Reddish-Brown	Fe(OH)3, Cu (can be pink or brown)
Green	CuCO3 and CuCl2 + FeSO4 (pale green) + Fe(OH)2 (dirty green) + nickel/chromium
Orange	K2Cr2O7, Pb3O4
Yellow	PbI2, AgI (pale yellow)
Purple	KMnO4
White	Most compounds of Na+, K+, Ca2+, Zn2+, Al3+, Pb2+, NH4+, BaSO4, PbSO4, CaSO4,
	PbCl2, AgCl, ZnO (yellow when hot and white when cooled)

Solubility Table:

Most carbonates are insoluble (except sodium, potassium and ammonium carbonate)		
Most hydroxides are insoluble (except sodium, potassium and ammonium hydroxide)		
Ca(OH)2 is sparingly soluble		
Barium, lead (II) and calcium sulfate are insoluble		
Lead (II) and silver chloride are insoluble		
Lead (I) and silver iodide are insoluble		

Reaction Results:

Formation of Solid	Precipitation reaction: insoluble product is formed	
Formation of Liquid	Acid-base reaction	
Formation of Gas	Dilute acid reacts with carbonate to produce carbon dioxide	
	Dilute acid reacts with metal to produce hydrogen	
	Dilute acid reacts with sulfite to produce sulfur dioxide	
	Ammonium salt reacts with base to produce ammonia gas	
Decomposition	CuCO3 -> CuO + CO2	
	2H2O2 -> 2H2O + O2	
Complex Formation	Zn(OH)2 + 2NaOH -> Na2Zn(OH)4 (sodium zincate)	