A-LEVEL INORGANIC CHEMISTRY PRACTICAL

PHYSICAL APPEARANCE.

Colour of substance	**Deduction**
Purple	MnO_4^- *i.e* Mn^{2+}
Violet	Cr^{3+}
Black	$CuO_{(s)} FeO. NiO_{(s)}$ *or* C_oO *hence* $Cu^{2+}, Fe^{2+}, Ni^{2+} Co^{2+}$
White	$Al^{3+}, Zn^{2+}, Pb^{2+}, Ca^{2+}, Mg^{2+}, Ba^{2+}, NH_4^+, Sn^{2+}, Sn^{4+}$
Blue	Cu^{2+}
Green	$Fe^{2+}, Cu^{2+}, Ni^{2+}, Cr^{3+}$
Yellow or orange	CrO_4^{2-} *or* $Cr_2O_7^{2-}$ *i.e* $Cr^{3+}/PbO_{(s)} i.e\ Pb^{2+}$
Deep pink or Red	Co^{2+}
Pale pink	Mn^{2+}

Colour and deduction of different solution.

Colour of solution	**Deduction**
Colourless	$Zn^{2+}, Pb^{2+}, Al^{3+}, Ca^{2+}, Mg^{2+}, Ba^{2+}, NH_4^+, Sn^{2+}$
Green	$Fe^{2+}, Cu^{2+}, Ni^{2+}, Cr^{3+}$
Brown	Fe^{3+}
Blue	Cu^{2+}
Yellow/ Orange	Cr^{6+} *either* CrO_4^{2-} *or* $Cr_2O_7^{2-}$
Deep pink/ Red	Co^{2+}
Purple	Mn^{2+} *from* MnO_4^-
Very pale pink	Mn^{2+}

Change of colour during heating.

Colour before heating	**Colour change after heating**	**Deduction**
Blue crystalline solid	Black residue	$CuO_{(s)}$ hence Cu^{2+}
Blue crystalline solid	White residue	Hydrated Cu^{2+}turns to anhydrous Cu^{2+}
White crystalline /powdered solid.	Yellow residue when hot turns white on cooling.	$ZnO_{(s)}$ formed hence Zn^{2+}
Green crystalline/powdered solid.	Black residue	$CuO_{(s)}$ formed hence Cu^{2+} $NiO_{(s)}$ formed hence Ni^{2+}
Pale green crystalline solid.	Brown residue	$Fe_2O_{3\,(s)}$ formed hence Fe^{3+}
Deep pink	Blue and then black on very strong heating.	Hydrated Co^{2+}turns to anhydrous Co^{2+}then to $CoO_{(s)}$
Very pale pink crystalline/ powdered solid	Black residue	$MnO_{2\,(s)}$ formed hence Mn^{2+}oxidized to Mn^{2+}
White crystalline/ powdered solid.	Brown residue when hot, turns yellow on cooling.	$PbO_{(s)}$ formed hence Pb^{2+}
White crystalline /powdered solid.	White residue	$Al_2O_3, MgO_{(s)}, CaO, BaO$ formed hence $Mg^{2+}, Ca^{2+}, Ba^{2+}$

Solubility.

Soluble salts	**Insoluble salts**
All nitrates	All carbonates other than those of sodium, potassium and ammonium ion.
All ethanoates/ Alcetates	All oxalates except of Na^+, K^+, NH_4^+
All hydrogen carbonates	All phosphates except of Na^+, K^+, NH_4^+

All potassium, sodium and ammonium salts. All nitrites, except silver nitrite which is sparingly soluble. All common halides All common sulphates **NB.** Calcium and silver sulphates are sparingly soluble. All sulphites All chromates **NB**. Calcium chromate is sparing soluble.	Halide of Pb^{2+}, Ag^{+}, Ca^{+} Sulphates of Pb^{2} and Ba^{2+} Sulphites of Pb^{2+}, Ba^{2+} and Ca^{2+} Hypochlorites of Pb^{2+} and Ag^{+} Chromates of Pb^{2+}, Ba^{2+}, Ag^{+} **NB**. Calcium chromate is sparingly soluble. Calcium sulphate and silver sulphate are sparingly soluble. Halides of Pb^{2+} are insoluble in cold water but sparingly soluble in warm water.

Sodium hydroxide solution.

Observation	**Deduction**
White precipitate soluble in excess to form a colourless solution.	$Zn^{2+}, Al^{3+}, Pb^{2+}, Sn^{2+}$
White precipitate insoluble in excess.	$Ca^{2+}, Mg^{2+}, Ba^{2+}$
Blue precipitate insoluble in excess	Cu^{2+}
Green precipitate insoluble in excess	Ni^{2+}
Dirty green precipitate insoluble in excess.	Fe^{2+}
Orange solution turns yellow	$Cr_2O_7^{2-}$ $turns$ to CrO_4^{2-}
Blue precipitate insoluble in excess, turns pink on standing, turns brown on further standing in air.	CO^{2+}
Green precipitate soluble in excess to form a green solution.	Cr^{3+}
Dirty white precipitate insoluble in excess turns brown on standing in air.	Mn^{2+}
Brown precipitate insoluble in excess	Fe^{3+}
No observable change in the cold, but on warming, a colourless, pungent, chocking gas that turns moist red litmus paper blue and forms dense white fumes with concentrated hydrochloric acid.	$NH_{(3)(s)}$ $evolved$ NH_4^+ confimed present

Ammonia hydroxide solution.

Observation	Deduction
White precipitate soluble in excess to form a colourless solution.	Zn^{2+}
White precipitate insoluble in excess.	$Pb^{2+}, Al^{3+}, Sn^{2+}, Mg^{2+}, Ba^{2+}$
Blue precipitate insoluble in excess.	Co^{2+}
Green precipitate insoluble in excess.	Cr^{3+}
Green precipitate soluble in excess to form a blue solution	Ni^{2+}
Dirty green precipitate insoluble in excess.	Fe^{2+}
Brown precipitate insoluble in excess.	Fe^{3+}
Blue precipitate soluble in excess to form a deep blue solution.	Cu^{2+}
Blue solution. No observable change	Ca^{+}, NH_4^{+}

Sodium hydrogen carbonate solution.

Test	Observation	Deduction
To the test solution, add excess sodium hydrogen carbonate solution.	White precipitate and effervescence of a colourless gas that turns moist litmus paper red and forms a white precipitate with calcium hydroxide solution.	Ca^{2+} present.
To the test solution, add excess sodium hydrogen carbonate solution and heat.	No observable change in the cold, but on heating, a white precipitate is formed and bubbles of a colourless gas that turns moist blue litmus paper red and forms a white precipitate with calcium hydroxide solution.	Mg^{2+} present.

Disodium hydrogen phosphate.

Test procedure	Observation	Deduction
To test solution, add solid ammonium chloride followed by 3-4	White precipitate soluble in excess dilute ammonia solution.	Zn^{2+} confirmed present

drops of disodium hydrogen phosphate solution and then dilute ammonia solution drop wise until in excess.	White precipitate insoluble in excess dilute ammonia solution.	Mg^{2+} present

Potassium iodide solution.

Test	Observation	Deduction
To the test solution, add 2-3 drops of potassium iodide solution.	Yellow precipitate is formed.	Pb^{2+} present
To the test solution, add potassium iodide solution drop-wise until in excess.	Yellow precipitate soluble in excess forming a colourless solution.	Pb^{2+} confirmed present.

Dilute hydrochloric acid.

Observation	Deduction
White precipitate dissolves on warming precipitate re-appears on cooling.	Pb^{2+} present

Dilute sulphuric acid

Test	Observation	Deduction
To test solution, add 2-3 drops of dilute sulphuric acid.	White precipitate	$Pb^{2+}, Ba^{2+}, Ca^{2+}$

Potassium hexacyanoferrate (III) solution.

Test	Observation	Deduction
To test solution, add 2-3 drops of potassium hexacyannoferate (III) solution.	Dark blue precipitate forms	Fe^{2+} confimed
	Brown precipitate forms	Ni^{2+} confirmed

Dimethyl glyoxime solution.

Test	Observation	Deduction
To test solution 2-3 drops of dilute ammonia solution followed by $1cm^3$of dimethyl glyoxime solution	Red precipitate/ pink precipitate forms	Ni^{2+}

Ammonium thiocyanate solution/ potassium thiocyanate solution.

Test	Observation	Deduction
To test solution, add 2-3 drops of ammonium thiocyanate solution.	Red solution forms	Fe^{3+}

Ammonium oxalate solution.

Test	Observation	Deduction
To the test solution, add ammonium oxalate solution followed by ethanoic acid.	White precipitate soluble in ethanoic acid on warming.	Ba^{2+} or Ca^{2+}
To the test solution, add ammonium oxalate solution, followed by ethanoic acid and warm.	White precipitate soluble in ethanoic acid on warming.	Ba^{2+} confirmed present.
To the test solution add ammonium oxalate solution followed by dilute hydrochloric acid.	White precipitate soluble in the acid.	Ba^{2+} or Ca^{2+}

Potassium chromate (VI) solution.

Test	Observation	Deduction
To the test solution, add 2-3 drops of potassium chromate (VI) solution followed by dilute sodium hydroxide solution until in excess.	Yellow precipitate soluble in excess dilute sodium hydroxide solution forming a yellow solution. Yellow precipitate insoluble in excess dilute	Pb^{2+} confirmed present Ba^{2+} confirmed present

	sodium hydroxide solution.	
To the test solution, add 2-3 drops of potassium chromate (VI) solution followed by dilute hydrochloric acid.	Yellow precipitate insoluble in dilute hydrochloric acid	Pb^{2+} confirmed present
To test solution, add 2-3 drops of potassium chromate (VI) solution followed by dilute hydrochloric acid.	Yellow precipitate soluble in dilute hydrochloric acid, precipitate re-appears on addition of dilute sulphuric acid.	Ba^{2+} confirmed present

Concentrated sulphuric acid.

Test	**Observation**	**Deduction**
To unknown solid, add 2-3 drops of concentrated sulphuric acid and warm gently.	Blue solid turns white	Hydrated Cu^{2+} salt turns anhydrous Cu^{2+}salt.
	Pink solid turns blue	Hydrated CO^{2+}salt turns to anhydrous salt

Concentrated hydrochloric acid.

Test	**Observation**	**Deduction**
To test solution, add concentrated hydrochloric acid drop wise until in excess	Yellow solution forms	Cu^{2+} confirmed
	Blue solution forms	Co^{2+} confirmed
	White precipitate forms that dissolves in excess to form a yellow solution.	Pb^{2+} confirmed
To test solution, add 1cm^3 of concentrated hydrochloric acid, followed by a spatula endful of solid ammonium thiocyanate then 1cm^3 of amylalcohol (pentanol) and then skake.	Blue solution forms in upper layer and purple solution in lower layer.	CO^{2+} confirmed

Concentrated nitric acid

Test	Observation	Deduction
To test solution, add 3-4 drops of concentrated nitric acid and warm	Pale green solution turns brown on standing	Fe^{2+} confirmed
To test solution, add 3-4 drops of concentrated nitric acid followed by a spatula endful of sodium bismathate/ lead (IV) oxide and then warm.	Pale pink solution turns to purple solution warming	Mn^{2+} confirmed

Sodium carbonate solution.

Test	Observation	Deduction
To test solution, add sodium carbonate solution drop wise until in excess. .	White precipitate insoluble in excess	$Zn^{2+}, Pb^{2+}, Sn^{2+}, Mg^{2+}, Ca^{2+}, Ba^{2+}$
	White precipitate insoluble in excess with effervescence of a colourless gas that turns moist blue litmus paper red and forms a white precipitate with calcium hydroxide solution	Al^{3+}
	Pink violet precipitate insoluble in excess	Co^{2+}
	No observable change	NH_4^+
	Green precipitate insoluble in excess	Ni^{2+}
	Dirty white precipitate insoluble in excess, turns brown on standing in air.	Mn^{2+}
	Green/ blue precipitate insoluble in excess.	Cu^{2+}
	Dirty green precipitate insoluble in excess	Fe^{2+}
	Brown precipitate insoluble in excess with effervescence of a colourless gas which turns moist blue litmus paper red and forms a white precipitate with calcium hydroxide solution.	Fe^{3+}

Action of lead(II) nitrate solution (or lead (II) acetate solution)

Test	Observation	Deduction
To test solution, add lead (II) nitrate solution	White precipitate	$SO_4^{2-}, SO_3^{2-}, Cl^-, Br^-, C_2O_4^{2-} CO_3^{2-}, PO_4^{3-}, ClO_4^-$
	Yellow precipitate	I^-, CrO_4^{2-}
To test solution, add lead (II) nitrate solution and warm.	White precipitate soluble on warming to form a colourless solution, precipitate re-appears on cooling.	Cl^-
	White precipitate insoluble on warming	SO_4^{2-}, SO_3^{2-}
To test solution, add lead (II) nitrate solution, followed by dilute nitric acid	White precipitate insoluble in the acid.	SO_4^{2-}, Cl^-, Br^-
To test solution, add lead (II) nitrate solution, followed by dilute nitric acid.	White precipitate insoluble in the acid	SO_4^{2-}, Cl^-, Br^-
To the test solution, add lead(II) nitrate solution, followed by dilute nitric acid	White precipitate soluble in the acid with effervescence of a colourless gas which turns moist blue litmus paper red and forms white precipitate with calcium hydroxide solution.	$CO_{2\,(g)}$ evolved CO_3^{2-} Present
To test solution, add lead (II) nitrate solution, followed by dilute nitric acid.	White precipitate soluble in the acid without effervescence.	$SO_3^{2-}, C_2O_4^{2-}, PO_4^{3-}$

Action of Barium nitrate solution.

Test	Observation	Deduction
To test solution, add Barium nitrate solution.	Yellow precipitate is formed.	CrO_4^{2-} confirmed present
To test solution, add Barium nitrate solution followed by dilute nitric acid.	White precipitate, insoluble in the acid	SO_4^{2-} confirmed present
	White precipitate soluble in dilute nitric acid without effervescence	$SO_3^{2-}, C_2O_4^{2-}, PO_4^{3-}$
	White precipitate soluble in the acid with effervescence of a colourless gas which turns moist blue litmus paper red and forms a white precipitate with calcium hydroxide solution.	$CO_{2(g)}$ given off CO_3^{2-} present
	Yellow precipitate which dissolves in the acid to form an orange solution.	CrO_4^{2-}
	No observable change	$Cl^-, S_2O_3^{2-}$
To test solution, add dilute nitric acid solution, followed by Barium nitrate solution.	White precipitate insoluble in the acid	SO_3^{2-} Confirmed present.

Action of magnesium sulphate/ magnesium nitrate / magnesium chloride solution.

Test	Observation	Deduction
To test solution, add magnesium sulphate solution	White precipitate	CO_3^{2-} present
	No observable change	HCO_3^- present

Action of silver nitrate solution and excess ammonia solution.

Test	Observation	Deduction
To the test solution, add a few drops of silver nitrate solution followed	White precipitate soluble in excess ammonia solution	Cl^- confirmed present

by ammonia solution drop wise until in excess.	forming a colourless solution.	
	Yellow precipitate insoluble in excess ammonia solution.	I^-
	Pale yellow precipitate dissolves with difficulty in excess ammonia solution.	Br^-
	White precipitate soluble in excess ammonia solution.	$C_2O_4^{2-}, CO_3^{2-}$
	White precipitate insoluble in excess ammonia solution.	SO_3^{2-}
	Red precipitate soluble in excess ammonia solution to form a yellow solution.	CrO_4^{2-}
	No observable change	SO_4^{2-}

Action of silver nitrate solution with dilute nitric acid.

Test	**Observation**	**Deduction**
To the test solution, add a few drops of silver nitrate solution followed by dilute nitric acid.	White precipitate insoluble in the acid	Cl^- confirmed present
	Yellow precipitate insoluble in the acid.	Br^-
	Yellow precipitate insoluble in the acid	I^-
	Pale yellow precipitate soluble in the acid without effervescence.	PO_4^{3-}
	White precipitate soluble in the acid without effervescence.	$C_2O_4^{2-}$
	Red precipitate soluble in the acid with no effervescence to form an orange solution.	CrO_4^{2-}
	No observable change	SO_4^{2-}
	White precipitate	$CO_{2(g)}$ evolves

	dissolves in the acid with effervescence of a colourless gas which turns moist blue litmus red and forms a white precipitate with calcium hydroxide solution.	CO_3^{2-} present
To the test solution, add dilute nitric acid followed by a few drops of silver nitrate solution.	White precipitate is formed	Cl^- confirmed present
	Yellow precipitate is formed	I^-
	Pale yellow precipitate	Br^-
	No observable change	SO_4^{2-}

With potassium manganate (VII) solution

Test	**Observation**	**Deduction**
To the test solution, add acidified potassium manganate (VII) solution.	Purple solution turns colourless	$SO_3^{2-}, S_2O_3^{2-}, NO_2^-, Cl^-, Br^-, I^-$
To the test solution, add acidified potassium manganite (VII) solution and heat.	Purple solution turns colourless on heating	$C_2O_4^{2-}$ confirmed present

Trichloromethane (chloroform)

Test	**Observation**	**Deduction**
To the test solution, add a little bleaching powder. (add 1cm^3 of a solution of a bleaching agent) followed by 1cm^3 of dilute nitric acid and then 1cm^3 of chloroform and shake gently.	Orange solution in the organic layer	Br^- confirmed present
	Purple solution in the organic layer	I^- confirmed present

Devardas's Alloy

Test	Observation	Deduction
To the test solution, add Devarda's alloy followed by excess dilute sodium hydroxide solution and boil.	Colourless , pungent, chocking gas, turns moist red litmus paper blue and forms dense white fumes with concentrated hydrochloric acid	$NH_{3\,(s)}$ evolved NO_3^- confirmed present

N.B Incase Devarda's Alloy is not available, either zinc or aluminium powder with sodium hydroxide solution and warmed.

Test	Observation	Deduction
To test solution, add zinc or aluminium powder followed by excess dilute sodium hydroxide solution and warm.	Colourless, pungent, chocking gas which turns moist red litmus paper blue and forms dense white fumes with concentrated hydrochloric acid.	$NH_{3(g)}$ evolved NO_3^- confirmed present

Dilute hydrochloric acid.

Test	observation	Deduction
To the unknown solid, add 2cm^3 of dilute hydrochloric acid	Effervescence of a colourless gas which turns moist blue litmus paper red and forms white precipitate with calcium hydroxide solution.	$CO_{2\,(g)}$ evolved CO_3^{2-} $(or\ HCO_3^-)$
(In case the solution is warmed	No observable change at room temperature, but on warming there is evolution of a colourless, pungent gas which turns moist blue litmus paper red and bleaches it, and turns acidified potassium	$SO_{2(g)}$ evolved SO_3^{2-} present

	dichromate(VI) solution from orange to green.	
To the test solution, add 2cm^3 of dilute hydrochloric acid and warm.	Yellow precipitate, on warming, there is evolution of a colourless pungent gas which turns moist blue litmus paper red and bleaches it, and turns acidified potassium dichromate (VI) solution from orange to green.	$S_{(s)}$ precipitated $SO_{2\,(g)}$ evolved $S_2O_3^{2-}$ confirmed present

Neutral Iron (III) chloride solution

Test	**Observation**	**Deduction**
To test solution, add neutral Iron (III) chloride solution.	Red colouration is formed.	CH_3COO^- confirmed present
To the test solution, add neutral Iron (III) chloride solution and boil.	Brown precipitate	CH_3COO^- confirmed present

Ethanol Esterification

Test	**Observation**	**Deduction**
To the test solution, add 1cm^3 of Ethanol followed by 3 to 5 drops of concentrated sulphuric acid and warm. Pour the product in a test tube containing water.	Sweet, fruity smell	Esterification reaction CH_3COO^- confirmed present

Dilute sulphuric acid.

Test	**Observation**	**Deduction**
To test solution, add dilute sulphuric acid followed by hydrogen peroxide solution.	Yellow solution turns orange and then to an intense blue solution which quickly fades, leaving behind a green solution.	CrO_4^{2-} confirmed present

To cold test solution, add iron (II) sulphate solution followed by dilute sulphuric acid	Dark brown complex is formed	NO_2^- confirmed present

Dilute nitric acid

Test	**Observation**	**Deduction**
To test solution, add dilute nitric acid	Greenish yellow gas which turns moist blue litmus paper red and bleaches it	ClO^- confirmed present

Gases and their deductions.

Observation	**Deduction**
Colourless condensate, turns anhydrous copper (II) sulphate from white to blue and blue chloride paper to pink.	Water of crystallization hence hydrated salt.
Brown vapour, turns moist blue litmus paper red and bleaches it.	$Br_{2\,(g)}$ evolved hence Br^- suspected
Purple vaour, turns moist blue litmus paper red, sublimes to form a black solid	$I_{2\,(g)}$ evolved I^- suspected present
White fumes with a sweet smell, form a yellow precipitate with 2, 4-dinitropheny I hydrazine solution.	$CH_3COCH_{3(g)}$ evolved CH_3COO^-suspected present
Misty fumes with a chocking smell, turns moist blue litmus paper red and form dense white fumes with concentrated ammonia solution. And greenish yellow gas turns moist blue litmus paper red and bleaches it.	$HCl_{(g)}$ evolved $Cl_{2\,(g)}$ evolved Cl^-suspected present
Colourless gas turns moist blue litmus paper red and forms a white precipitate with calcium hydroxide solution.	$CO_{2\,(g)}$ evolved $CO_3^{2-}, HCO_3^-, C_2O_4^{2-}, CH_3COO^-$ suspected present
Brown vapour, turns moist blue litmus paper red and bleaches it.	$Br_{2\,(g)}$ evolved Br^- suspected present
White fumes which turn moist blue litmus paper red and form white precipitate with barium nitrate	$SO_{3\,(g)}$ evolved SO_4^{2-} suspected present

solution.	
Brown fumes with a pungent smell and turn moist blue litmus paper red with a cracking sound.	$NO_{2\,(g)}$ evolved NO_3^- suspected present
Colourless, pungent, chocking gas, turns moist red litmus paper blue and forms dense white fumes with concentrated hydrochloric acid.	$NH_{3\,(g)}$ evolved NH_4^+ suspected present