

## GENERAL BREAKDOWN OF MARKS

- Manipulation, Measurements and Observation **MMO** (40% MARKS)
  - Set up apparatus correctly
  - Following instructions
  - Collecting an appropriate quantity of data (e.g. no. of titrations performed)
  - Making the correct measurements, precision etc
  - Correct range of data (e.g. rate of reaction, where mass or quantity of substance is changed)
  - Suggesting further tests or experiments
  - Make the correct salt analysis observations, and distinguish subtle differences (e.g.  $\text{Mn}^{+2}$ ,  $\text{Mg}^{+2}$ )
- Presentation of data and observations (Tabulations etc) **PDO** (30% MARKS)
  - Making appropriate tables
  - Filling the table correctly
  - Unambiguous column headings that include units
  - Consistency of precision and readings
  - When performing calculations, show each step clearly and use 3 significant figures in calculations.
  - Figure out whether graphs should be plotted using straight lines or curved (free hand) lines.
  - Quality of best fit lines on graphs

- Analysis, Conclusions, Evaluations (**ACE**) (30% MARKS)
  - Describe patterns and trends shown in graphs or tables
  - Determining gradient of a straight line on a graph  
**(IMPORTANT: SHOW A CLEAR DESCRIPTION)**
  - Calculating uncertainty
  - Understand differences between systematic errors and random errors. Identify these sources of errors
  - Explain and justify your salt analysis conclusions.
  - Suggest modifications to an experiment.

Remember that almost 70% marks are for writing the correct observations, taking the correct readings and making the right tables. Only, 30% marks are for calculations and evaluations. 30% of the marks are free if you make the right tables and graphs, 40% of the marks can easily be obtained if you take the correct readings and observations. Only, the remaining 30% marks require some sort of calculations.

## TITRATION

- **Precision of Burette:** All burette readings should be calculated to the nearest  $0.05 \text{ cm}^3$ . Hence all burette readings shown in the table should be 2 decimal places (**1 mark**).
- Rough titre can be included in the titration table.
- **Headings and Labels:** Never use ambiguous headings and labels.
- **Readings in a single table:** All readings should be in a single organized table. **1 MARK** would be deducted otherwise.

	Titration 1	Titration 2	Titration 3	Titration 4
1 <sup>st</sup> /Initial Burette reading/ $\text{cm}^3$	48.90	47.50	29.05	
2nd/Final Burette reading/ $\text{cm}^3$	24.80	23.90	25.05	
Volume of FA X used/ $\text{cm}^3$	24.10	23.60	24.00	
		<b>TICK</b>	<b>TICK</b>	

- **Accuracy of Titration:** Generally 6 marks are awarded if candidates titre is

within  $0.1 \text{ cm}^3$  of examiners titre. 5/6 marks are awarded if it is between  $0.1 \text{ cm}^3$  and  $0.3 \text{ cm}^3$ , and so on.

- **Selecting two best titres:** Two best titres should be within  $0.1 \text{ cm}^3$  of each other (**1 MARK**). Candidates can cheat her, but cheat intelligently, because accuracy of your titration carries a lot of marks. Don't risk 6 marks of accuracy to get this one mark.
- **Number of Titration:** Perform as many titration as necessary to get two titres within  $0.1 \text{ cm}^3$ . If the first two titrations provide two readings within  $0.1 \text{ cm}^3$  then no more experiments should be carried out, marks will be penalized if more titrations are carried out after you have obtained your two best titres.
- **Placing TICKS:** Always show which titres have been used as the best titres by placing a tick underneath them, this carries 1 mark. You should always choose two best titres that have a difference of  $0.01 \text{ cm}^3$ , this also carries 1 mark.
- **Normal water and Distilled water:** If you are told to add distilled water, then always use distilled water, never use tap water otherwise your titration results will be incorrect

### TITRATION INVOLVING METHYL ORANGE

Weak Base and Strong Acid Titration

In Acid ( $\text{pH} < 3.5$ ) → Dark Orange/Red

In Base ( $\text{pH} > 3.5$ ) → Yellow/light orange

Metal Carbonates, although a salt, is weakly basic and can be titrated against a strong acid.

## TITRATING TO DETERMINE PURITY OF SUBSTANCE OR WATER OF CRYSTALLIZATION.

### DOUBLE TITRATIONS

## MEASURING MASS

Using the Electronic Balance

- **Tare button on electronic balance:**  
Press the “tare” button to make sure that the initial reading is “0”.
- **Keep the electronic balance clean:**  
Make sure that the electronic balance is clean with no residues on it. Blow lightly on top of the balance to remove any residues. When you are adding substance to empty weighing bottle, then, never do it on top of the balance, as some of it might fall onto the balance and will affect your readings.
- Remember to take a calculator with you when you want to add substance to empty weighing bottle, this requires rough calculations.
- The precision of the electronic balance is up to 2 decimal places e.g 12.01 g, 12.34 g etc.
- **UNITS:** Electronic balance measures in grams, always write units ( “g”, “/g”, or “grams”).
- All recordings should preferably be in a single table. (1 MARK).
- **Headings and Labels:** Never use ambiguous headings and labels. They should be very clear.

Table for Recording Mass

	Exp 1	Exp 2	Exp 3
Mass of Empty Weighing Bottle /g	12.56g		
Mass of Empty Weighing Bottle + FA X /g	18.40g		
Mass of Bottle + Residual FA X /g	13.00g		
Mass of FA X used /g	18.40g – 13.00g		

## Measuring Temperature

- When measuring temperature, make sure that the thermometer is not taken out from the solution.
- Most thermometers have a graduation of 1 c, and be careful because thermometer graduations are confusing, 10 C reading can be confused with 1.0 C.

## PRECISION OF INSTRUMENTS

- **Calculating precision:** Precision is half the smallest graduation.
  - **Burette:** 2 decimal places, and error is  $\pm 0.5$
  - **Cylinders:** Should be calculated based on the smallest graduation
  - **Thermometers:** Most thermometers have a smallest

graduation of 1 C, hence the smallest reading possible is 0.5 C with an error of  $\pm 0.5$ .

- Precision of instruments with no graduation: Example pipette or cylindrical flask have no graduation and they are used to measure precise volumes like  $25.0 \text{ cm}^3$  etc, hence their precision is upto 1 decimal place. There is no method for calculating the error in these instruments.

## Calculations

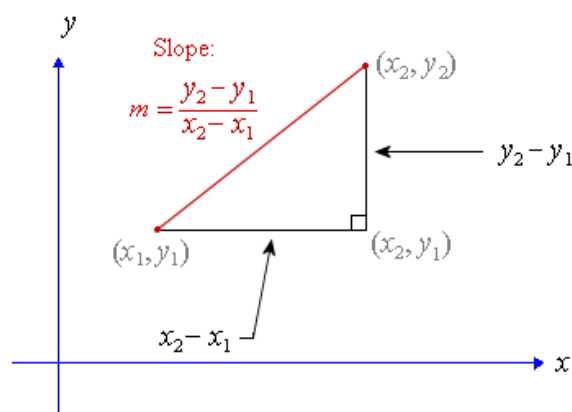
- **3 significant figures**: Calculations should be done 3 significant figures. Remember that there's a difference between 3 significant figures and 4 significant figures. 22.1 is 3 significant figures and 22.100 is 3 decimal places. 22.459 is 22.5 when read to 3 significant figures. (1 MARK)
- **Calculations involving enthalpy**: Remember to put a (-) / (exothermic) sign or (+) / (endothermic) sign when calculating energy for reactions.

## Errors

- Enthalpy Errors
  - Heat loss to surrounding
  - Thermometer does not have good precision
- Enthalpy Error (improvements)
  - Use a lid to stop heat loss
  - Increased insulation, use a calorimeter or vacuum flask

## PLOTTING GRAPHS

- **Labelling Axis**: X-axis and Y-axis should be labeled correctly, with appropriate units. Example, Y-axis: temperature (C) vs X-axis time (s). (1 mark)
- **Scale for Graph**: Appropriate scale should be used. Each large square has 10 divisions. These 10 divisions can represent 10 units, or 5 units, or 4 units or 2 units, depending on how spread out your graph is. Units should be assigned properly, 10 divisions should not be used to represent 3 units or 6 units or 7 units. (1 mark)
- **Graph should cover more than half the graph paper.**
- **Gradient**: When Calculating gradient for a line. Always remember to draw a large triangle on the graph paper (1 mark). The following triangle should be drawn next to the point where the gradient has to be calculated.



## Salt Analysis

- **Writing Observations:** Always write observations by looking at observations mentioned in the salt analysis data sheet. Copy the observation which matches closely with your observation. There would be rare exceptions to this scenario. Don't be creative and never try writing your own observations. (1 mark)
- **Writing Reagents:** When reagents are asked, never write  $H^{+1}$  ions, instead a proper bench reagent is required like HCl (aq) or  $HNO_3$  (aq). If the reagent is  $Cr_2O_7^{-2}$ , then a proper bench reagent like  $K_2Cr_2O_7$  or  $Na_2Cr_2O_7$  should be mentioned. (1 mark)
- **Tables:** Tables for Salt Analysis should be constructed keeping in mind that separate columns are required for "1 cm<sup>3</sup> of reagent X" and "reagent X is in excess".
- **Distinguishing between  $Pb^{+2}/Al^{+3}$** 
  - NaOH/ $NH_3$  reagents have similar tests for  $Pb^{+2}/Al^{+3}$
  - $PbCl_2$ ,  $PbI_2$ ,  $PbSO_4$ ,  $PbCr_2O_7$  or  $PbCrO_4$  is insoluble. Use the following reagents; HCl, KI,  $K_2CrO_4$ ,  $K_2CrO_7$  or any reagent that contains the ions mentioned above. Always mention actual bench reagents, rather than ions when asked. Also, take care about other possible precipitates that might confuse your results. For example,  $BaCl_2$  (aq) contains  $Cl^{-1}$

and can be used to test for  $Pb^{+2}$  ions but the presence of  $Ba^{+2}$  ions makes precipitates of its own, so always use reagents which have  $Na^{+1}$ ,  $K^{+1}$ , or  $H^{+1}$  ions which always make soluble compounds, reducing the possibility of any other precipitates, except for the precipitates formed by  $Pb^{+2}$ .

- **Distinguishing between  $Ba^{+2}/NH_4^{+1}$** 
  - Both give no precipitate with NaOH or  $NH_3$  except that  $NH_3$  is produced on warming  $NH_4^{+1}$  with NaOH.  $Ba^{+2}$  can be identified by  $H_2SO_4$ , it will give white precipitate.
- **Test for Manganese  $Mn^{+2}$** 
  - $Mn^{+2}$  tests with  $NH_3$ /NaOH has a white/pale/light brown ppt which turns brown when in contact with air and are insoluble in excess. There would be brown residues floating on the top surface, and on the sides of the test tube, and white ppt/light brown ppt at the bottom. Copy the observation from the salt analysis sheet.
- **Tests for  $Cu^{+2}$** 
  - With NaOH: pale blue ppt insoluble in excess
  - With  $NH_3$ : Blue ppt which dissolves and forms a dark blue solution in excess. It will be hard to dissolve the precipitate if too much  $Cu^{+2}$  are present in the test tube, so use very small quantity of  $Cu^{+2}$  (less than 1  $cm^3$ ) or use a lot of  $NH_3$  (fill the

entire test tube) and shake vigorously to dissolve this precipitate.

- **Problems with  $Al^{+3}$  ions test with NaOH.**
  - The precipitate formed by  $Al^{+3}$  is very soluble and disappears very quickly. Students can easily make the mistake of not noticing any precipitate. Use a very tiny quantity of NaOH at first, just a few drops, and a small white ppt will form floating on top, which would dissolve very quickly if a very small amount of NaOH is added.

## When to look for gases

- **Presence of Gas:** One way to check if a gas is being liberated is by putting your thumb on top of the test tube and check if pressure builds up in the tube.
- **If an ACID is used.**
  - $CO_2$  might be given off if a carbonate is present
  - NO gas liberated by dilute acids, if  $NO_2^{-1}$  is present, which turns pale brown  $NO_2$  in air.
  - $SO_2$  gas is liberated by dilute acids if sulfite  $SO_3^{-2}$  is present. See problems with identifying  $SO_2$  gas.
- **NaOH is added followed by Aluminum foil and heat.**
  - $NH_3$  is liberated if  $NO_3^{-1} / NO_2^{-1}$  is present.
- **Problems when testing for  $NH_3$** 
  - Always use damp red litmus paper, by making the litmus paper wet. And make sure that



the litmus paper never touches the test tube, because the test tube might contain an alkali which will turn the litmus paper blue. A lot of students make the mistake of allowing the litmus paper to touch the top of the test tube, and in many cases an alkali is present in the test tube which makes the litmus paper blue. So, keep the litmus paper a fair distance (1 cm) away from the test tube.

- Students should be able to distinguish between a red litmus paper from a blue litmus paper. Red litmus paper is pale pink, and blue litmus paper is pale blue. Some students also make the mistake of using the cover paper of the litmus paper stack which is also pink (Avoid silly mistakes)
- **Detection of Pale brown NO<sub>2</sub>:** Pale brown NO<sub>2</sub> is very hard to distinguish and is only produced if dilute acids are added to NO<sub>2</sub><sup>-1</sup> ions. Put your thumb on top of the tube, and allow pressure to build up. The tube will turn pale brown and when you release your thumb and allow gas to escape, then a pale brown plume will release. This pale brown gas is also very visible if seen in front of a white background. The gas is especially very visible when the reactants are thrown in the white sink and you will notice brown vapors in the sink easily.
- **Problems when testing for SO<sub>2</sub> gas:** SO<sub>2</sub> gas is colorless and acidic and is produced when dilute acid is added to sulfite SO<sub>3</sub><sup>-2</sup> ions. If a damp blue litmus paper is placed at the mouth of the

tube then it will turn red. Damp litmus paper must not touch the test tube itself as it might contain an acid. Note, that damp blue litmus paper will turn red when NO<sub>2</sub> gas is produced but NO<sub>2</sub> is pale brown and can be distinguished from SO<sub>2</sub>.

- Another test for SO<sub>2</sub> gas is that it smells of rotten eggs or burnt matches
- It can also be distinguished by dipping a paper in K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> and then placing it at the mouth of the test tube. This paper will turn from orange to green.
- **Identification for H<sub>2</sub> gas**
  - Metal + Acid → Salt + H<sub>2</sub>
  - If you are adding metal, and a gas is produced, then you don't necessarily need to test for Hydrogen gas, if you see effervescence, then it is obviously hydrogen.
  - Hydrogen gas produces pop sound when burnt with a lighted splint. The only way it produces a pop sound when enough pressure is built up in the test tube. Put your thumb on top of the test tube and allow pressure to build up and only then light it.
- **Testing for CO<sub>2</sub> gas.**
  - Effervescence is produced, similar to gas bubbles in coke
  - Generally produced when metal carbonates react with acids

## Chromate VI ( $\text{CrO}_4^{2-}$ ) and DiChromate VI ( $\text{Cr}_2\text{O}_7^{2-}$ )

- $\text{K}_2\text{CrO}_4$  is yellow in color,  $\text{K}_2\text{Cr}_2\text{O}_7$  is orange in color. Both of them turn green when  $\text{Cr}^{+6}$  is reduced to  $\text{Cr}^{+3}$ .
- The speed with which they get reduced or oxidized depends on the reducing agent used. In most cases, Chromate and DiChromate will change color rapidly.
- But, if Aldehydes or Alcohols are mixed with these then the color change will be very gradual and in many cases won't even be visible. The color change occurs rapidly if the mixture is slightly heated, but remember, too much heat will evaporate alcohol/aldehyde and its concentration will decrease. As a precaution when testing for both these substances, use a small amount of Chromate/Dichromate, because if it is used in excess then some Chromate/Dichromate will be left which would still be orange and the color change will not be that visible.

## Organic Chemistry

- Testing for Carbonyl compounds, ketones and aldehydes
  - **Tollens Reagent:** Tollens reagent is made by mixing  $\text{AgNO}_3$  and  $\text{NH}_3$ . It gives a black precipitate with Aldehyde which has a silvery mirror floating on top. The observation should be that silver mirror is obtained with Tollens Reagent. Most of the time this silver mirror will not be visible, so black precipitate is enough to

test for the presence of aldehyde.

- **Fehling Solution:** Fehling solution also tests for the presence of Aldehyde. Aldehyde is added to Fehling Solution and heated lightly. A red/brown precipitate is obtained.
- **2,4 DNP:** This is an orange colored solution, which has a strong acid in it. Be careful when using this. 2,4 DNP has forms a yellow or orange precipitate with carbonyl compounds (both ketones and aldehydes). Remember that anything when it is added to 2,4 DNP will turn yellow because it has a yellow color. So you should be looking for yellow precipitates and ignore the color of the solution.
- **Potassium Di Chromate** will turn from orange to green with alcohols and aldehydes but the mixture has to be gently heated otherwise the color change wouldn't be visible. If it is strongly heated then aldehyde and alcohols will evaporate. You should also not add Potassium di chromate in excess, as a lot of it will not get reduced and you will get a mixture of green and orange which would be very hard to distinguish.

## Heat/Enthalpy Experiments

- In Enthalpy experiments, you will sometimes be asked to add a solid (e.g.  $\text{Na}_2\text{CO}_3$ ) into a solution (e.g.  $\text{HCl}$ ). If the reaction is highly exothermic, and effervescence is given off then there are



chances of spilling the solution. To prevent that, always add the solid a little at a time and not all of it together.

- Never take the thermometer out of the Styrofoam cup during the experiment and stir vigorously to record the highest possible temperature reading.
- Errors
  - Due to thermometer graduation, precision/graduation should be increased
  - Due to heat loss, can be prevented by using insulation around the cup or by putting a lid and reducing heat loss to the surrounding.

## Water of Crystallization

When calculating water of crystallization, you would be asked to heat a hydrous salt and until all the water evaporates and then calculate the mass of water that has evaporated.

- **Preventing Decomposition of Salt:**  
When heating salt in a boiling tube, heat it gently, otherwise salt would decompose and vapors of other gasses will escape. Repeated heating and cooling would ensure that all the water has escaped.
- **When to stop:** After repeated heating, cooling and then reweighing, once the mass of salt becomes constant (heating to constant mass), then stop as no more water is left in the salt.

## Rate of Change

## ON EXAM DAY

- Divide your time carefully. If there are two questions then don't think that 1 hour should be given to two questions. Try and see the divisions of marks. If the first question is of 25 marks and the second question is of 15 marks then the first question should be given 1 hour 15 minutes and the second question should be given 45 minutes.
- Don't waste time, try and do multiple things at the same time. If you are heating something or doing something which is taking a long time then you can try and do salt analysis observations. (Be careful with multi-tasking, not everyone is good at it).
- Manage your time well. You don't need to do 3 titrations if you are running out of time. One titration would be enough and you can make up two readings.
- Heating should be done carefully at low flame. If you think that the hot apparatus is manageable then try and hold it with your bare hands, as tongs can be cumbersome.
-