

CHEMISTRY

Fertiliser Investigation

Sulphate

Levels of sulphate ions need to be monitored in society for a few reasons. Particles in air form acid rain (sulphuric acid) and have mostly indirect effects on human health. It is also found in many bathroom and cleaning products, but why, when it's so dangerous? Sulphate in this form has mostly direct effects on the body.

Sulfur dioxide is the cause of acid rain. It is a colourless gas produced as a byproduct of many reactions. Approx 69% industrial combustion (combustion of fossil fuels and smelting sulfur ores) is the cause of this sulphur dioxide emission. Rotting vegetation (hydrogen sulfide produced), burning organic matter (e.g. bushfires), plankton and volcanoes/hot springs can also emit about 10% sulphur dioxide. Vehicular transpiration emits a small 3.7%. For example, Mount Isa Mines is Australia's largest emitter of Sulfur Dioxide and many other elements into the atmosphere.

Acid rain is produced when sulphur ions are released into the atmosphere (from above reasons) and react with an oxygen diatomic molecule to form sulphur dioxide. This sulphur dioxide reacts with water molecules in the air and becomes acidic.

Acid rain is absorbed into the soil and poisons the plant life. It dissolves toxic minerals and metals such as aluminium which may be absorbed by the plants and kill them. It also dissolves the important nutrients in the soil and washes them away. It may also destroy the waxy cuticle on some leaves making it vulnerable to disease, dehydration and nutrient loss. If this acid is absorbed by plants that humans eat, it provides an easy indirect pathway for sulphur into the body (although it usually enters larger food chains via plankton and phytoplankton). It will also be near impossible to start growing crops on that land again for a long time. Example, Queenstown in Tasmania.

Sulfuric acid also causes damage when it enters waterways via runoff. It alters the fish's ability to take in nutrients and oxygen, ruining the balance needed to keep them alive. This acid also forms mucous on their gills preventing them from taking in adequate oxygen. This acidity alters pH and if it reaches too low it will denature the animals' enzymes, eventually killing it. It also changes the calcium levels in fish, impairing reproductivity because the eggs become weak. It will also cause deformed and weakened bones. This lowers the level of fish in our water ways that become a part of our diet and if we do eat them, the sulphuric acid causes problems to our health.

Man made infrastructure is also at risk of acid rain corrosion. Sandstone, limestone and marble (dissolves calcium carbonate and leaves behind crystals when it evaporates, forcing a crack and breaking the stone) are at greatest risk as well as ceramics, textiles, paint and metals. Rubber and leather may deteriorate and stone carvings may lose their features. There is also risk if a structure is built on acidic land, it may corrode without us knowing and pose for many dangers. This will cost the government in paying specialists in engineering whether it is safe to build with certain materials in certain areas due to corrosion and weakening of the building.

We are also exposed to poisonous chemicals via our water ways due to the effects of acid rain. When this acidic water passes through our copper (or lead) pipes, it erodes them and leaves copper (or lead) ions in our water. We can drink this water, give it to livestock, bathe in it, or cook with it (and many more uses). Either way, the chemicals eventually come into contact with our body and may cause kidney damage or liver damage (they will also harm the animals possibly lowering availability of our food sources and altering the food chain in extreme cases).

Acid rain has direct effects on the body. If the food or water is contaminated by dissolved aluminium ions in the acid, scientists suspect it may be associated with Alzheimer's disease. Some proven effects include throat, nose and eye irritation, asthma and dry coughs because the acid affects the mucus on the surface of these areas and the lining of the lungs (similar effects to smoking). It can also cause headaches, migraines, liver problems and diarrhoea. The small sulphate particles in the air form a key component of urban smog and increase the irritation of eyes, nose and throat, asthma and dry coughs. These are usually caused by sulphur dioxide particle reacting with the moisture in our bodies and causing acid.

Sodium laureth sulfate, Sodium dodecyl sulfate or Sodium lauryl sulfate, commonly used in soaps and detergents, have direct effects on the body so why are they used? It's simple, because they're cheap. These are the most dangerous chemicals we put on our skin, and most people don't know the harm it can cause. Doctors may say 'don't use soap based cleaning products on your skin' and you think nothing of it. Well it actually breaks down the oily coating on the skin and hair that keeps them moist by causing an emulsion similar to detergent breaking down lipids in food. With this gone, the cells are exposed to drying because sodium sulfates are a salt and absorb the fluids in the cells (plasma) to satisfy concentration gradient (water moves to area of high solute concentration or low water concentration). The sulfate can also break down cell membranes and leave the skin vulnerable to bacterial infection, for example acne. This breaking of cell membranes is actually used in extracting and unraveling DNA in biomedicine.

Sulfate ions may find their way into the intestines. Here (similar to on the skin) they break down the mucus lining and make it vulnerable to bacterial growth. This results in diarrhea. If this sulfate is absorbed through the intestines and gets into the blood stream, small amounts may be removed by the kidneys but large amounts may cause damage to nerves and possibly result in brain damage (especially in children).

Sulfate ion levels need more focus on in society. Particles in air form acid rain (sulfuric acid) and make way into waterways, plants and animals and humans may ingest these. These are indirect effects. They are in everyday products such as soap, shampoo, detergents as Sodium laureth sulfate, Sodium dodecyl sulfate or Sodium lauryl sulfate, having direct effects on the body. With effects such as brain damage and bacterial infection, the ions do need to be monitored in society.

Lead

Lead ion levels need to be monitored in society because it is a neurotoxin. It has historically been found in wine making, water pipes, writing implements, makeup and ceramic glaze. More recently found in medicine, face and other paint, toys, batteries, petrol, air, soil and food. Inhalation and ingestion can damage the nervous system and major organs, cause attention disorders in children and even be fatal.

Lead was discovered before Christ and ancient documents have recorded symptoms of lead poisoning. The Greeks discovered a use for lead in wine making and the Romans soon followed suit. This exposed humans to the toxic effects of the metal. The grapes “must be boiled in a lead vessel as it created a desirable sweet taste and texture”. They believed that it was “a necessity for daily life” and this theorem made it available to everyone, not just the wealthy stature. This may have helped lead to the fall of the Roman Empire.

Romans also used lead in writing implements in the fourteenth century. The tools did not contain a lead pigment but were rather an inscribing implement the shape of a mining picks head. They were used to engrave in a wax table which could be rubbed out by reshaping the wax. This process provided easy contamination for the Romans whom could write (especially school children).

In the time of the Egyptians, lead was used extensively in makeup. They ground down galena (better known as lead sulphide) and applied it as mascara and eyeliner to darken the eyes. Throughout the middle ages the Europeans continued this method but they also idealised a pale complexion. They achieved this by bleaching their skin with a mixture of white lead and vinegar called ceruse. The Japanese geisha’s used a white lead carbonate to achieve their pale complexion. This was used like face paint.

Ceramic fluxes (used in glazes to lower the boiling point of silica- a major component in glaze) have been known to contain lead as the base component. The lead seeps out of the pottery when it is heated (dangerous vapours are released when fired). This is common with food dishes, which may contaminate the food (especially acidic food) and hence have adverse effects on the person. This is usually only the case with old pottery as lead flux is being phased out. This old pottery usually has sentimental value so it would be suggested to use as decoration only.

Lead has also historically played a role in medicine. It was recommended that the mouth of the uterus be smeared with white lead to prevent conception. This, now so obviously, had detrimental effects on the couple, especially the woman. Lead has also been found in traditional remedies from India, Middle East and Asia have been found to contain lead (historically and at present) by deliberate addition or from contamination from grinding tools when preparing.

The Romans used lead in water pipes and faucets. Rome is situated on alkaline soil and this may have deposited calcium carbonate into the lead and prevented high levels of corrosion and contamination. Through the 1920’s lead was used in household pipes and lead solder was legally being used until 1988. Newer homes have copper pipes; but there are still many old homes around today. Humans experience the worst symptoms when the water has been left standing in the pipe for one to three days.

Many types of paint have been found to contain lead. From face paint/makeup throughout history to traces in modern face paints. A case came about in 2009 when the “Campaign for Safe Cosmetics (CSC) worked to eliminate harmful chemicals from personal care products”. They tested ten face paints and all of them contained lead. These products were shipped in from China and there was no legal regulation saying that the ingredients had to be listed, or against lead being put into the paint. A case similar to this in Australia 2011 has lead the Australian competition and consumer commission to raise national standards and set fines.

Lead in house paint on the other hand has been removed over the past few decades; however old homes that are still standing will contain leaded paint. This would have posed issues for the painters and families at the time but it is still setting risks today as people renovate old homes or attempt to remove the old paint in order to repaint. As people sand off the old layer of paint they may inhale airborne particles so it is advised to wear a face mask to limit risk. Lead is used in artists' oil paint as pigment (lead chromate-yellow, lead carbonate-white), to speed drying and create more flexibility in the dried paint. Although lead was banned in house paint, oil paint may still contain it. Alternatives such as water based paint and lead free paint are available. Due to the governments refined regulations, the packaging must now state leaded or unleaded.

Lead is banned in most western countries but may still be found on products such as imported toys. A shipment of baby toys was found to contain lead in the paint in 2007. This was very detrimental for the children who placed them in their mouths and sucked on them. The toys were from China and shipped worldwide and included Barbie, Polly Pocket and 'cars'.

Car batteries are a major source of lead into the environment. The first type of rechargeable battery was invented in 1859 and contained a lead acid. These posed a problem for the workers but started causing a major problem when these now 'old' cars were dumped (or otherwise) and the batteries leaked the lead acid into the environment. Lead was also deposited into the environment through petrol. Legislation made leaded petrol illegal by 1st January 2002 in Australia. Cars built post 1986 are made to use unleaded petrol and ever since the reduction in pre-1986 cars and leaded petrol, there has been a significant reduction in the levels of airborne lead.

A specific case of increased lead levels in 2011 are causing problems for children in the mining town of Mount Isa. It is the largest atmospheric emitter of lead and has been reported that every 9 days a child is likely to exceed the acceptable level of 10 µg/dl of blood.

An unnatural lead cycle originated from, mostly, these car fumes and made way into the air creating unsafe levels. i.e. above 10µg/dl blood lead, above 1.5 µg/m³ air lead and above 50 µg/l water lead.

People that lived in cities or near highways pre 1986 were at a great risk of lead poisoning due to increase number of vehicles. People that live in these areas today are still suffering the effects as particles have deposited themselves into the soil. They have been absorbed by the plants that we eat as fruits and vegetables. This provides an easy pathway for them into our blood stream. Some foodstuffs are monitored for the presence of such metals to ensure that we are not consuming the poison.

Lead has many adverse effects on the body and no favourable ones. It is so dangerous because it accumulates in the body (because it can be broken down or used) until it reaches toxic levels and then does its damage. It can be absorbed through the digestive tract, skin or lungs and is carried by the red blood cells. It destroys the active site of the red blood cell and disables it from carrying oxygen. This will eventually cause organ damage and prevent respiration of cells for life.

Young children are especially at risk because it is absorbed four times greater than an adult and the blood brain barrier is highly permeable. It especially harms those under the age of three whose brains and nervous systems are still developing. Lead causes Encephalopathy (neurological impairments such as memory loss, brain damage, learning disruptions, disruptions in cognitive thinking, reading disabilities and attention deficit disorder and decreased concentration). It leads to decreased and slower growth, hearing problems and hyperactivity.

In adults high blood/lead levels can cause anemia (as lead replaces blood volume), interstitial nephritis (damage to kidneys), damage to reproductive (lower fertility) and other organs due to decreased respiration rates, ischemic heart disease (hypertension from obstruction of blood supply), encephalopathy, headaches, peripheral neuropathy (breakdown in sensory motor communication),

muscle and joint pain or high blood pressure. It has been known to cause cancer in experimental animals. Lead can enter a placenta via the mother and this can seriously affect the unborn child with damage to the nervous system. It can cause miscarriages in severe cases.

Lead ion levels DO need to be monitored in society because it causes damage to the nervous system and organs, learning and reproduction putting the future of the human race at risk. Main sources are from ceramic glaze, face and other paint, toys, batteries, petrol, air, soil and food. Even low levels of inhalation cause irreversible damage and even death.

Open Ended Investigation

Aim: To investigate the sulphate content in a sample of fertilizer.

Hypothesis: the results will be accurate but some of the sample may be lost in the first filtering step or when transferring beakers.

Materials:

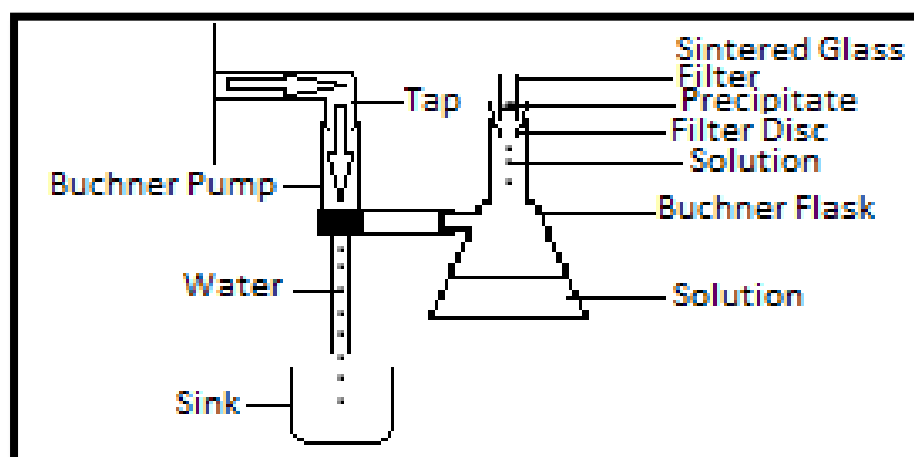
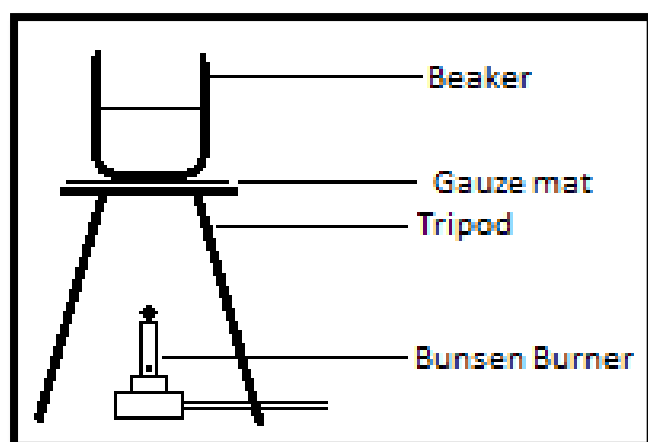
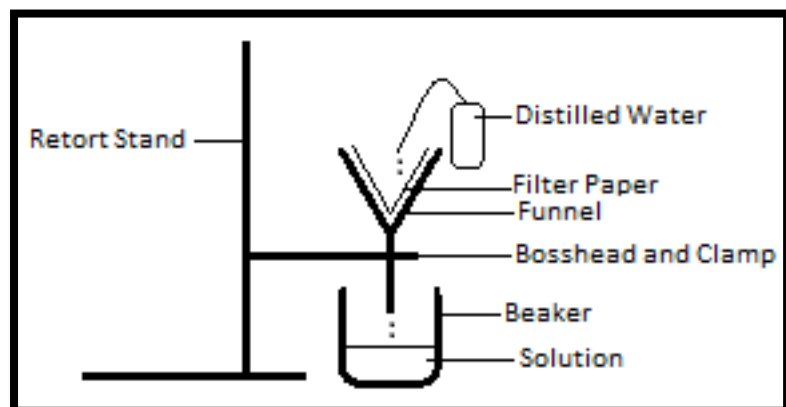
- 1.000 grams fertilizer sample
- Spatula
- 100 mL hydrochloric acid
- 150 mL beaker
- Filter paper
- Small funnel
- Retort stand
- Boss head and clamp
- 2 x 500 mL beaker
- De-ionised water
- Bunsen burner
- Tripod
- Gauze mat
- Matches
- 100 mL 0.1 M Barium Nitrate
- Ice cubes
- Tray (large enough to fit beaker in)
- Sintered glass filter
- 0.38 M Barium Nitrate
- Pipette
- Buchner/vacuum flask
- Scales
- Tap

- Filter disc
- Buchner/Vacuum pump
- Drying oven
- Safety glasses
- Lab coats

Method:

1. Accurately weigh a known sample of fertilizer into a 150 mL beaker. (For this experiment 1.000 grams was used).
2. Dissolve mixture in 100 mL of 0.1 M Hydrochloric acid (this dissolves out potassium nitrate, ammonium sulphate and magnesium sulphate).
3. Filter mixture through filter paper in a funnel and into a larger 500 mL beaker (filters out ammonium phosphate, iron EDTA and manganese EDTA – EDTA is a colourless water soluble solid).
4. Continue to rinse filter through with de-ionised water to ensure all dissolved solution is filtered through.
5. Heat solution over a Bunsen burner just below boiling (when small gas bubbles appear)- digestion stage allowing experiment to carry to completion.
6. Gradually stir in 100 mL (an excess) of 0.1 M Barium Nitrate
7. Allow to digest for a minimum of 30 minutes or overnight.
8. Cool mixture in a tray of ice cubes for approximately 5 minutes.
9. Record weight of a sintered glass filter.
10. Attach a suction tube to a Buchner flask and connect to tap.
11. Place rubber seal in the top of the flask and place sintered glass filter in it.
12. Filter mixture through a sintered glass filter rinsing beaker through filter when finished.
13. Add 2mL of 0.30 M Barium Nitrate into solution in flask.
14. If no white precipitate forms, discard. If a white precipitate does form repeat from step 2.
15. Dry precipitate of barium sulphate in a drying oven.
16. Reweigh sintered glass filter and precipitate and calculate weight of barium sulphate.
17. Calculate weight of sulphate in barium sulphate precipitate.

Diagram:



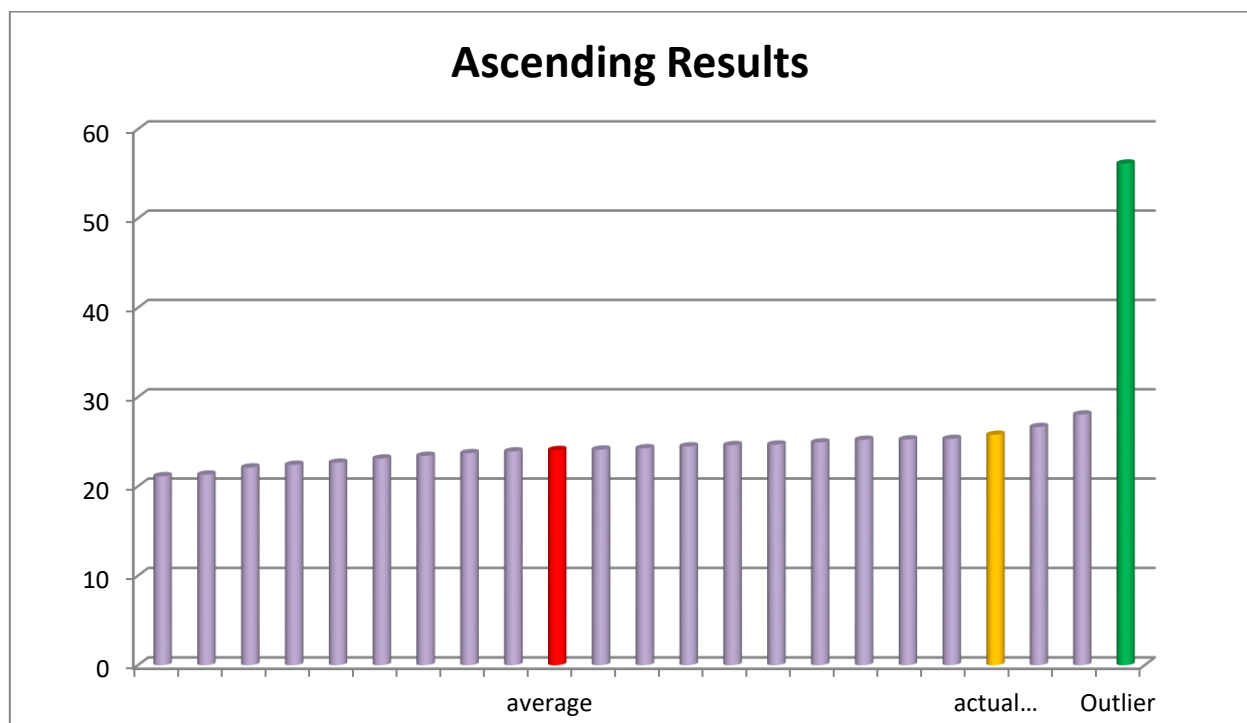
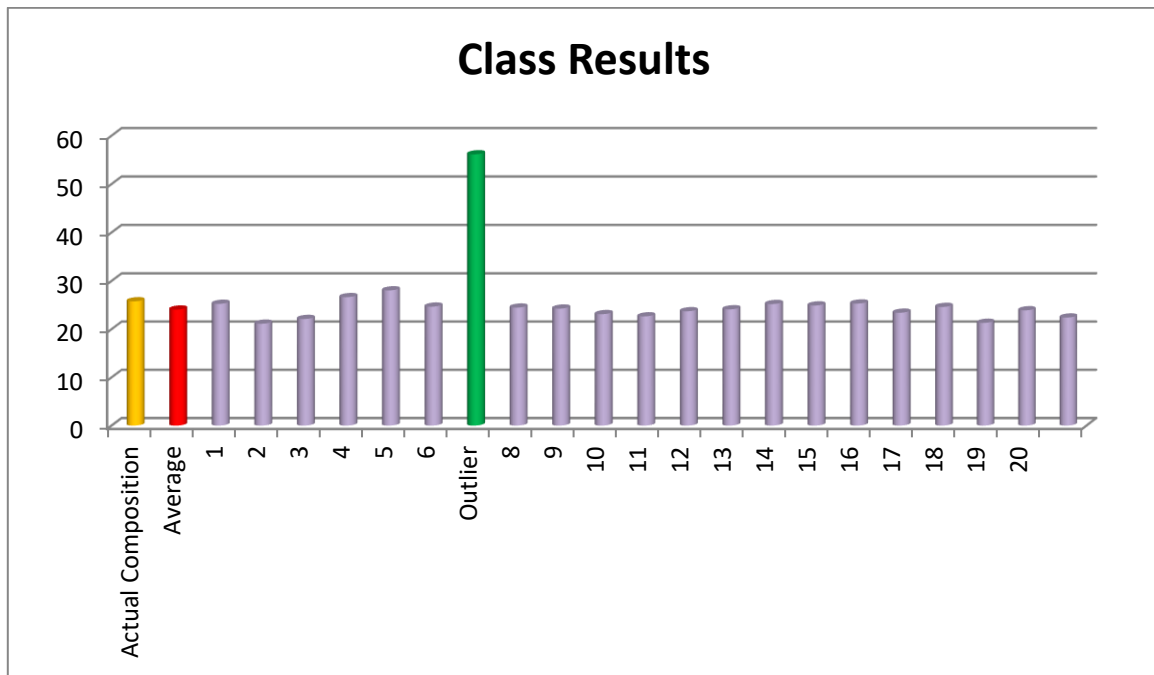
My Results:

Item	Weight (g)	Observations
Original sample	1.000	Accurately record the amount of sample you took. Write this in numerous places so you don't lose it.
Precipitate	0.550	Be sure to correctly rinse the beaker into the filter to capture all the precipitate. Correctly dry it.
Sulphate	0.226	Some may have been lost due to my mistake of losing one drop of hydrochloric acid mixture outside of the 100 mL beaker. Some was also left on the stirring rod when stirring before filtering with sintered glass.
Total Percent Sulphate in Sample	22.64 %	Accurately carry out mathematical equations to receive the correct percentage of Sulphate in sample.
Actual Percent Sulphate in Sample	25.76%	

Class Results:

(My results in red, outlier in blue)

Person No.	Percent Sulphate in Sample (%)
1	25.24
2	21.12
3	22.10
4	26.63
5	28.03
6	24.66
7	56.13
8	24.46
9	24.25
10	23.10
11	22.64
12	23.70
13	24.10
14	25.20
15	24.90
16	25.30
17	23.40
18	24.60
19	21.30
20	23.90
21	22.40



Discussion:

It can be seen from table one that some sulphate was lost in carrying out the process. This will be due to a small amount of hydrochloric acid mixture being dropped outside of the 100mL beaker. Some was also left on the stirring rod when mixing before filtering with sintered glass. There was 3.12% difference between this result and the actual result. This result was also 2.4% lower than the average. This doesn't seem a lot but it is when working with such small samples.

In regard to class results, person 16 received the closest result to the actual composition. They were slightly below the actual result and this may be due to error in leaving sulphate behind when

transferring beakers or filtering with filter paper, either way, they were accurate in obtaining the barium sulphate sample shown by the results. Person 4 was the closest to the actual composition receiving just over the result. They had a 0.88% difference and this may be due to error in using clean beakers and contaminants getting into the precipitate.

Even though the mixture was ground down and homogenous, because we were working with such small samples and relative accurate scales, different people may have actually measured slightly different amounts of sulphate containing samples. This is known as sample error. To accurately measure the content of sulphate in the mixture, the whole mixture would have to be used in the open ended investigation which is impractical, a waste of money (a new container of fertilizer will be needed for every person. Even then, there will be different amounts of sulphate in each), and a waste of time.

The school equipment is accurate but there may be error in people using the equipment. For example' not waiting for the numbers on the scales to settle, not taking accurate measurements, not properly drying beakers and equipment or careless ways of transferring situations of solutions.

As can be seen in the graphs, the outlier received just over twice the amount of sulphate than anyone else. This is due to an obvious mistake in the carrying out of this experiment. It is noted that original sample weights were lost and the nitrate/chloride sulphate precipitate was to be broken into the two components and original sample weight to be recalculated. It is almost impossible to decompose a precipitate (defined as an insoluble solid) and it didn't work very well here.

To increase reliability of the experiment, they should be compared with the rest of the class and even averaged out. Any outliers should be discarded in doing this. If the reliability is to be increased even further, the experiment can be repeated.

In preparing the reaction of the chloride precipitate, hydrochloric acid (100mL calculated for 1.000g of sample). This is known as acidifying the reaction and removes the contaminants by putting in aqueous solution, so that they won't affect weight of the precipitate.

In this experiment Barium Nitrate solution was used to form the precipitate (the barium displaces ammonium in ammonium sulphate and manganese in manganese sulphate and precipitates out but not potassium in potassium nitrate). Firstly because all nitrates are soluble, not all chlorides are soluble and in case of contaminants in the solution (silver, lead 1m copper 1, thallium 1 and mercury 1) they may also precipitate out with the barium sulphate (even though they were supposed to be acidified) and this will increase the weight and make it an incorrect reading.

Both barium chloride and barium nitrate are harmful if inhalation occurs (although nitrate is less serious because the mouth and nose don't have to be rinsed afterwards) and may produce discomfort in this area. Barium Nitrate however only may cause discomfort on the skin, Barium Chloride can be absorbed by the skin and may produce health damage. The body must be flooded with water, washed with soap and medical advice must be seen to, where as with barium nitrate the area must only be washed with soap and water and clothing removed. It is easier for skin contact to occur than ingestion. Barium nitrate may irritate the eyes but safety glasses must be worn. Cumulative effects may result in both cases. Barium chloride does not burn when barium nitrate will cause fire on contact with combustible material. Considering the pros and cons of both of these it doesn't matter which you chose as long proper preventative health hazard precautions are taken. (Barium Nitrate, MSDS work safe criteria, 4/3/2003), (Barium Chloride, MSDS work safe criteria, 4/3/2003)

0.1 Molar Hydrochloric acid used is technically non hazardous according to work safe practices, however, we assume they're hazardous and take all precautions. These involve safety glasses, PVC resistant type gloves, and ventilated space, seek medical advice if swallowed, wash eyes and skin in water and seek medical attention and a ventilated area if inhaled. (Hydrochloric Acid, MSDS work safe criteria, 21/2/2008).

Conclusion: Successful separation of sulphate in a fertilizer sample was achieved through acidification, filtration then drying. Although the results were not accurate, they were relatively reliable compared to the class average with my results only 3.12% below the actual composition.

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