Leaving Certificate Agricultural Science

Laboratory Day

Oide
Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí
Supporting the Professional Learning of School Leaders and Teachers

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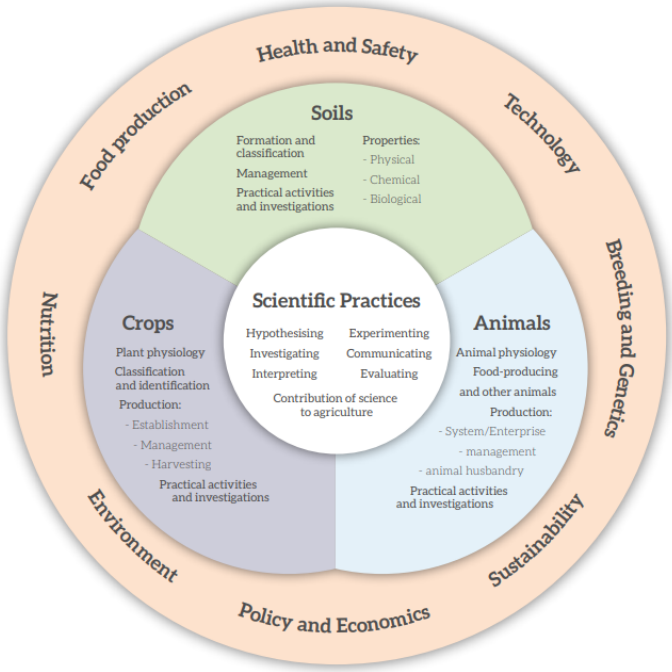
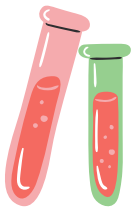
Key Messages

- Creating a safe learning environment promotes students' engagement with scientific practices.
- Conducting specified practical activities students will develop the necessary skills required to carry out their individual investigative study.
- Appreciate the role practical work and investigations have to play in the agricultural sector and how this can be used to teach the contextual strands, key skills and cross cutting themes of the course.

Structure of the Specification

(pg 11, Agricultural Science Specification)





Scientific Method

When conducting experiments it is good practice to use the scientific method it will allow students to make systematic observations, measurements and experiments which will allow for the formulation and testing of hypotheses.

Background research

Hypothesis

Prediction

Method

Variables

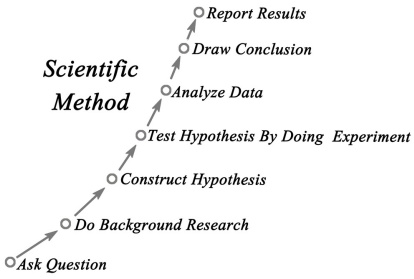
Equipment list & diagram

Results (Table & Graph)

Analysis

Conclusion

Reflection

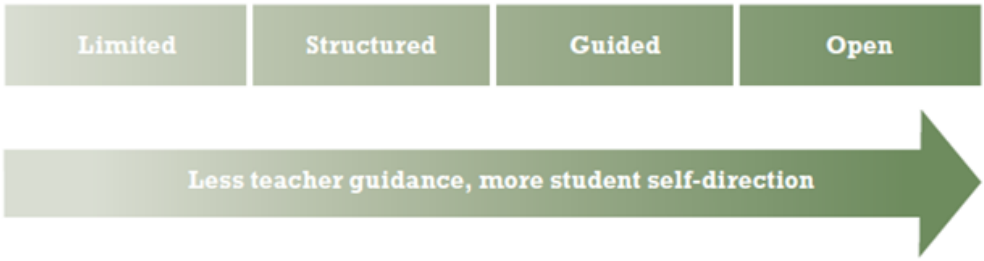


Continuum of Inquiry

Scientific inquiry

The inquiry-based design emphasises the practical experience of science for each student. It supports the use of a wide range of teaching, learning, and assessment approaches that support different levels of inquiry. Most students will need frequent practice to develop their understanding of scientific processes to use evidence to support explanations and to develop their inquiry skills to a point where they can conduct their own investigations from start to finish. Providing opportunities for students to develop a range of inquiry skills will be necessary to progress along the continuum of inquiry. The levels on the continuum are often categorised as limited inquiry, structured inquiry, guided inquiry and open inquiry.

Figure 3: Continuum of inquiry



The first two levels are lower-level inquiries but they can be used to develop students' inquiry skills so that they can engage in scientific inquiry which has less teacher guidance and more student self-direction. Students often engage with these two levels of inquiry before more open forms of inquiry are used; however, this practice merely reflects a common order of adopting inquiry approaches, and extending the range of approaches available to teaching classes; it does not suggest a progression or improvement along the way. Opportunities to apply inquiry skills in increasingly complex learning situations can be included when students have developed confidence and capacity in inquiry processes.

https://curriculumonline.ie/Junior-cycle/Junior-Cycle-Subjects/Science/Teaching-and-Learning/

How do we support students through this continuum of inquiry?

Station 1: LO - 2.2.1(b) To demonstrate cation exchange capacity

Notes on Investigation

Good scientific practices for investigation

Results and Conclusion

Links to other Learning Outcomes / Links to Real Life

What possible learning intentions and success criteria could we devise for this SPA?

Learning Intentions

Success criteria

Station 2: LO - 2.2.1(a) Show flocculation

Notes on Investigation

Good scientific practices for investigation

Results and Conclusion

Links to other Learning Outcomes / Links to Real Life

What possible learning intentions and success criteria could we devise for this SPA?

Learning Intentions

Success criteria

Station 3: LO - 2.2.3(b) Isolating and plating *Rhizobium* bacteria from clover root nodules

Notes on Investigation

Good scientific practices for investigation

Results and Conclusion

Links to other Learning Outcomes / Links to Real Life

What possible learning intentions and success criteria could we devise for this SPA?

Learning Intentions

Success criteria

Station 4: LO - 3.3.1 (d) Comparing the uniformity of a certified and uncertified seed

Notes on Investigation

Good scientific practices for investigation

Results and Conclusion

Links to other Learning Outcomes / Links to Real Life

What possible learning intentions and success criteria could we devise for this SPA?

Learning Intentions

Success criteria

Station 5: LO - 3.3.2(h)Investigate the effect of nutrients on the biomass of a plant above and below the ground

Notes on Investigation

Good scientific practices for investigation

Results and Conclusion

Links to other Learning Outcomes / Links to Real Life

What possible learning intentions and success criteria could we devise for this SPA?

Learning Intentions

Success criteria

Station 6: Demonstrating the use and benefits of using alternate equipment to exemplify the difference between accuracy and precision in obtaining primary data

Notes on Investigation

Results and Conclusion

Links to other Learning Outcomes / Links to Real Life

Personal Reflection

How will I integrate my learning from the carousel activities into my own professional practice?

How will students' engagement with SPAs develop core scientific skills to support the IIS?

How could I progressively plan across my department plan to enhance these skills?

What are my next steps?

Milk Quality

The quality of milk on farms is very important as it is the raw material for many products for human consumption. The key to producing quality milk is to have correct information, make the right decisions and carry out the recommended actions correctly. Farmers can carryout many different milk quality tests on their farms to assess the quality and rectify issues promptly. (Teagasc, 2008)

There are key elements to producing high quality milk:

1. Producing milk of low somatic cell count (SCC) - Low SCC is a reflection of good udder health and mastitis control in the herd
2. Low total bacterial count (TBC) - Low TBC is an indicator of good milking plant hygiene and milk storage
3. Low thermoduric bacterial count - indicator of number of bacteria surviving the pasteurisation process.

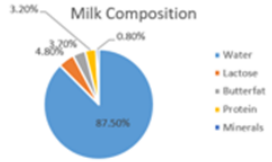
Residues in milk:

- Antibiotics
- Trichloromethane (TCM)
- Iodine
- Sediment
- Added water

In National Seminar Day 4 we looked at a Dairy Farm Case Study as an element of Inquiry based Learning (IBL)
https://www.scoilnet.ie/fileadmin/user_upload/DairyFarmCaseStudy.pdf

Milk Production - Factors affecting Content and Quality

Ireland status as the lowest carbon-emitting dairy sector in the northern hemisphere due to our grass based system is recognised across a growing global customer base. It is one of the main producers of infant milk formula in the world. Therefore we have continue to maintain our excellent standard of milk quality. Farmers are paid on the amount of fat, protein and lactose present in the milk. Dairy industry produced over 8.1 billion litres and is worth over €4 billion to economy.



Factors affecting Milk Content (Composition)	
Breed	Vary greatly between breeds and within herds e.g. Holstein Friesian – butterfat ~3.7% and protein ~ 3.2% Jersey – butterfat ~ 5.4% and protein 4.0%
Diet	Quality, quantity and type of feed will influence milk composition. • High fibre feed (silage) - increase butterfat • High DMD grass - increase protein
Stage of lactation	Milk solids are high after calving, decrease during peak yield, increase towards end of lactation
Stage of Milking	% fat increase during milking as fat globules are trapped in alveolus at start of milking
Milking Interval	Time between cows being milked → with 14 hour / 10 hour interval cows produce more milk in the morning, therefore butterfat is lower.
Health	Disease of udder (e.g. mastitis) - % fat, protein & lactose decrease & white blood cells increase
Age	% fat & protein decrease with age → identified by milk recording & culled

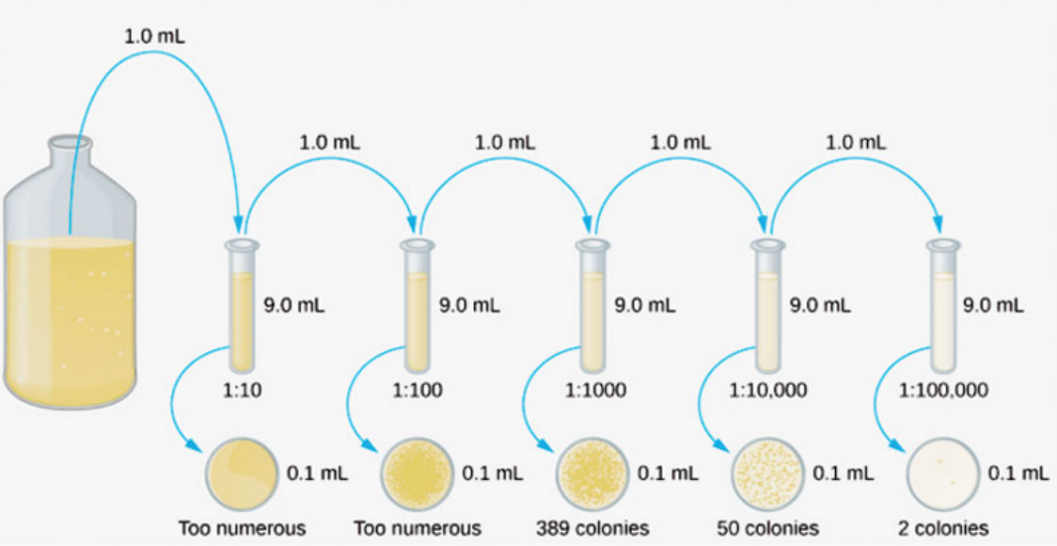
Milk Quality Standards	
Milk collected from farms must comply with quality standards of EU Regulation 583 of 2004. The sample of milk is subject to several milk quality tests:	
Total Bacterial Count (TBC)	Low level of bacteria (<50,000 / ml) - manufacture of high-quality dairy products Good hygiene is essential
Somatic Cell Count (SCC)	Level must be < 200,000 / ml to ensure good protein extraction High SCC reduces lactose content - < 4.2% cannot be processed into premium products High SCC indicates a high number of white blood cells in the milk which indicates an infection in the udder (sub - clinical mastitis) Clinical mastitis – white clots in milk – California Mastitis Test (CMT) Good hygiene is vital
Thermoduric test	Organisms that can withstand pasteurization - reducing shelf life of milk Good cow & machine hygiene essential
Excess water	Excess water - dilutes protein content
Sediment test	Sediment in milk due to soil etc. entering milk due to poor pre - milking routine Ensure new milk filter socks are used at each milking
Milk temperature	Milk only collected from refrigerated tanks & it must be < 6ºC
Antibiotic test	It is an offence to supply milk that contains antibiotics - penalised Adhere to withdrawal period indicated on antibiotics & don't send milk during that period Farmers can test milk on farm using the Delvo test
Trichloromethanes (TCM)	Chlorine comes in contact with milk – ensure machine thoroughly washed out

Procedures required to Produce Good Quality Milk	
Good Hygiene	Machine and housing
Wear clean gloves	Disinfect gloves after treating infected cows
Fore-milking	Hand milk prior to putting on machine (clusters): • Identify early cases of clinical mastitis • Removes any milk that has been in teat canal since previous milking • Quicker milking due to natural oxytocin let down
Machine is serviced & milk liners changed	Liners should be changed after 2,000 milkings / twice per year
Teat dip	Iodine
Milk infected cows at end of milking	Avoid contamination of clusters
Milk recording	Identify milk composition of each cow and SCC levels
Dry cow treatment	Long acting antibiotic / teal seal
Cool milk	<4ºC as quickly as possible – plate cooler and bulk tank
Fly control	Prevent summer mastitis

Ways to Increase Protein & Butterfat Content of Milk

Good grassland management – rotational / strip grazing	70% + DMD silage	Ensure cows are completely milked out at each milking
Addition of clover	Calve in early spring – out protein drop at turnout	Regular milking interval
Select daughters from high protein yielding cows and sires	Maintain healthy udder – control mastitis	

Total Bacterial Count (TBC)



https://microbenotes.com/serial-dilution/

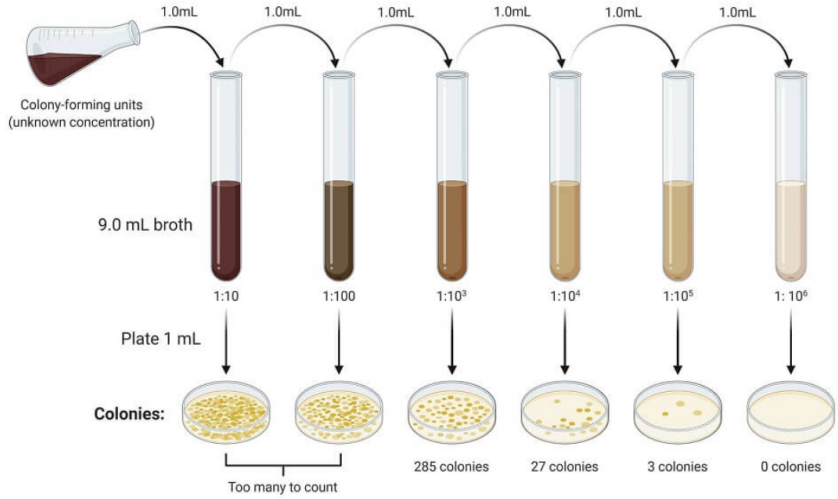
Total Bacterial Count Procedure

1. Get a sample of milk
2. Carry out a serial dilution of the milk sample by adding 1ml of milk into 9ml of distilled water & shake to mix. Then take 1ml from this test tube and add to 9ml of distilled water & shake. Repeat this for 4 more test tubes.
3. Take 1ml of milk from the last test tube & place on a prepared nutrient agar plate under aseptic conditions. Repeat this 3 times for accurate results.
4. Spread the milk around the plate using a plate spreader
5. Leave one agar plate unopened as a control.
6. Place in incubator for 72 hours at 25oC.
7. Remove plate & record number of bacteria colonies on the plate & multiply by dilution factor to get the number of CFU's / ml of milk.
8. Repeat steps 2 – 6 from same milk sample (that was left out of fridge) at 5 hours, 24 hours, 48 hours, 72 hours to determine the quality of a sample of milk over time.

Result:

There will be an increase in CFU's over - time as the number of bacteria in the sample multiply causing a decrease in quality of the milk.

Total Bacterial Count (TBC) Sample Calculation



CFU/mL = (no. of colonies x dilution factor) / volume of culture plate

Example: (285 colonies x 10^3) / 1= 2.85 x 10^5 CFU/mL in sample

Understanding the TBC Results:

https://microbenotes.com/serial-dilution/

0 – 15,000 cfu / ml	Excellent milk quality – little or no bacteria present /td>
16,000 – 50,000 cfu/ml	Good milk quality – minimal bacteria present
51,000 – 100,000 cfu/ml	Fair milk quality – bacteria present – investigate the cause and address issues
>100,000 cfu/ml	Very poor milk quality – large number of bacteria present – take immediate action to address

Understanding Thermoduric Results:

0 – 250 cfu/ml	Good milk quality – little or no thermoduric bacteria present
250 – 500 cfu/ml	Some thermoduric bacteria present – investigate the cause
>500 cfu/ml	Large number of thermoduric bacteria present – investigate the cause

(Tirlanfarmlife, 2016)

Reflection / Notes

California Mastitis Test (CMT)

Carrying out a CMT (California Mastitis Test)

- Discard the first squirt of foremilk
- Squirt milk from each quarter into a different well on the CMT test tray (approx. 2ml from each quarter)
- Mix each milk sample with an equal volume of reagent (available commercially)
- Swirl the mixture vigorously for maximum of 20 seconds and examine the degree of thickening / gelling in each sample (gelling is more visible if the test tray is tilted)

https://www.teagasc.ie/media/website/publications/2016/Dairy-Manual-Section5.pdf

https://tinyurl.com/mastitistest

***Note: The results from the CMT are qualitative and further lab analysis is required to get the quantitative SCC results**

Understanding SCC Results:

<150,000 cells/ml	Excellent mastitis and SCC control
150,000 – 200,000 cells/ml	Good mastitis and SCC control
200,000 – 400,000 cells/ml	Unstable control of mastitis and SCC. Review mastitis control
>400,000 cells/ml+	Indicates little or no mastitis control in herd and urgent action is needed. Seek help

(Tirlanfarmlife, 2016)

Reflection / Notes

Residues in Milk

Antibiotics - Delvo test

- Add 0.1ml of milk to ampule and incubate in heater / waterbath (avoid excess moisture) at 64 degrees celcius for 3 hours.

Sediment - Milk filter

- Get the mass of a milk sock prior to milking and then get sock post milking and allow to dry
- Get the mass of the dried sock post milking
- Calculate the amount of sediment present in the milk by subtracting the mass of the sock pre-milking from sock post-milking

Calculations:

Added water -

Total solids investigation (LO 4.3(i) - compare the percentage of water and solids of two different milk samples)

Calculations:

Other milk quality tests:

- % butterfat - Gerber method
- % protein - Kjeldhal method
- Trichloromethane (TCM) test
- Iodine test

Reflection / Notes

Grass Quality

The quality of a grass sward is a broad term that encapsulates the following three characteristics: palatability, productivity and digestibility. Swards that are more:

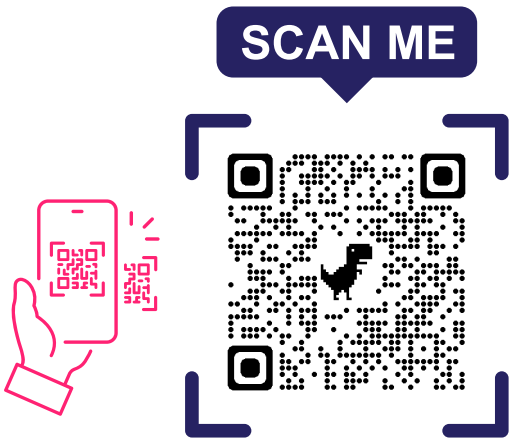
- **Palatable** encourage animals to eat more and therefore boost their productivity; either live weight gain or milk production.
- **Productive** contain higher proportions of beneficial nutrients for ruminants such as protein and easily digestible carbohydrates.
- **Digestible** result in more efficient use of nutrients and less waste production.

It is of utmost importance for farmers to ensure that their swards are of the highest quality. This ensures high production levels when animals are grazing, and also results in high quality hay and silage production. Making high quality winter forage helps maintain high production levels during winter with less dependency on concentrates. To do so farmers monitor grass quality and will reseed if the quality is not good enough.

Ways to monitor grass quality:

1. Calculating the percentage dry matter of the sward. This can be done using a 60 degree oven, 90 degree oven or microwave.
2. Calculate the percentage grass or percentage clover in their sward.
3. Calculate the percentage of leaf, stem and dead components in their swards.

In **Webinar 6, Thinking and Working Like a Scientist**, a researcher with Teagasc named Ben Lahart shared his experience of investigating the role Grass Quality plays in Methane Production. The full webinar and a suite of accompanying resources are available at https://www.scoilnet.ie/index.php?id=1687



Calculating the % DM using a microwave

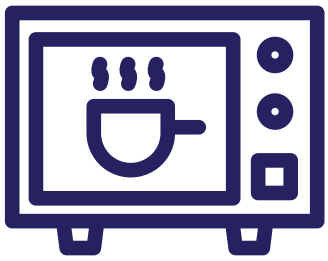
1.Gather your sample using shears from an area representative of the field.
2.Weigh 100g of this sample onto a balance, which has been previously tarred to zero with a Pyrex dish.
3.Place the cup of water in the microwave with the grass.
4.Turn on the microwave for 3 minutes on high.
5.Using the necessary PPE, remove the sample and weigh. Record its weight.
6.Place sample back in microwave and heat for another minute, remove and weigh.
7.Repeat this process until the weight no longer changes.
8.Calculate the %DM as follows:

$$\%DM = \frac{\text{Wt. of fresh sample (kg)} - \text{Wt. of dried sample (kg)}}{\text{Wt. of fresh sample}} \times 100$$

Using this %DM, you can then multiply it by 10 to calculate gDM/kg grass

Adapted from a procedure provided by Teagasc, available at:
https://www.scoilnet.ie/uploads/resources/38456/38309.pdf

Full method is available at:
https://www.scoilnet.ie/uploads/resources/38456/38309.pdf



A video of this method is available at:
https://vimeo.com/showcase/9831359

***Note: Always ensure that the water container is at least 25% full to prevent the grass heating up and catching fire**

Datasheet for calculating %Dry Matter

Sample No. _____
Sampling Date: _____
Time of day sampled: _____
Weather: _____
Field Name/Paddock Number: _____
Rotation Length: _____
Nitrogen: _____
Cover: _____

Time (minutes)	Weight (g)
0	100g

% Dry Matter: _____

Calculating the percentage clover in a grass sward on a dry matter basis

1. Gather your mixed grass/clover sample using shears from an area representative of the field.
2. Weigh 70g of this sample onto a balance.
3. Separate the sample into grass and clover components and place in steel tray.
4. Place each tray in the oven at 90°C for fifteen hours.

5. Calculate the % clover as follows:

$$\% \text{ Clover} = \frac{\text{Weight of dried clover}}{\text{Total weight of dried clover and grass}} \times 100$$

Calculating the percentage leaf, stem and dead in a grass sward on a dry matter basis

1.Using a knife/scissors carefully cut approximately 100g of grass to ground level from areas randomly selected across the paddock.

2.Secure the sample with an elastic band and place in a labelled plastic bag to preserve the vertical structure of the sample.

3.Place in the 4°C cold room laid out on paper towel (All samples should be separated within 72 hours of collection).

4.Weigh out 40 grams onto a balance (previously tared to zero with a steel tray).

5.Using a graduated ruler, chopping board and knife/scalpel, cut the sample at 3.5cm. Place the cut offs into the “dead” tray.

6.Cut off the leaf portions and place in the “leaf” tray.

7.The remaining portions of the grass go into the “stem” tray.

8.Place each tray in the oven at 90°C for fifteen hours.

9.Using relevant PPE remove from oven and allow air to equilibrate for 15mins.

10. Weigh the sample and record into appropriate database.

Reflection / Notes

Estimation of dissolved oxygen (D.O.) by Winkler titration
Adapted for Agricultural Science
Background Theory

Organic matter discharged into a watercourse serves as a food source for the bacteria present there. The bacteria will break down this matter to produce less complex organic substances, and, eventually, carbon dioxide and water. The bacteria will multiply, using up the available dissolved oxygen as they do so. If the bacterial uptake of oxygen is faster than the rate at which dissolved oxygen is replaced from the atmosphere and from the action of photosynthesis, the water will become depleted in oxygen. In these anaerobic conditions, bacteria will produce offensive products such as hydrogen sulphide and ammonia. The depletion of dissolved oxygen may result in other undesirable effects such as fish kills. The level of dissolved oxygen in a water sample is therefore an indicator of the quality of the sample.

An iodine/thiosulfate titration can be used to measure the dissolved oxygen present in a water sample. Because the dissolved oxygen does not directly react with the redox reagent, an indirect procedure was developed by Winkler. In this method dissolved oxygen through a series of reactions liberates a definite amount of free iodine which can then be reacted with a standard solution of Sodium thiosulphate. The overall reaction ratio - for calculation purposes - between the Dissolved Oxygen and Sodium thiosulphate is 1:4

$$\underset{1}{O_{2\,(aq)}} : \underset{:}{2I_{2(aq)}} : \underset{4}{4S_2O_3^{2-}{}_{(aq)}}$$

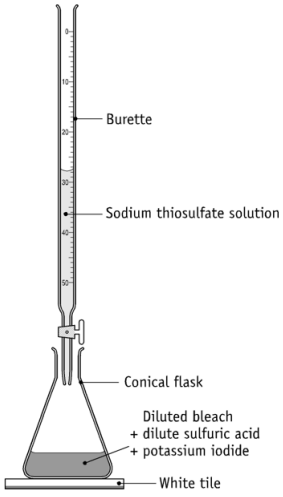
Chemicals and Apparatus

Manganese(II) sulfate solution
Alkaline potassium iodide solution
Concentrated sulfuric acid
0.005 M sodium thiosulfate solution
Starch indicator solution
Deionised (or distilled) water
Water sample
Burette (50 cm^3)
Pipette (25 cm^3) , Pipette filler, Droppers, Filter funnel, Beaker, Conical flask
Two reagent bottles (250 cm^3) with stoppers, Graduated cylinder (10 cm^3)
Retort stand,Wash bottle, White tile/card, Safety glasses

Procedure:

NB: Wear your safety glasses.

1. Rinse a 250 cm3 reagent bottle with deionised water, shaking vigorously to wet the inside and so avoid trapped air bubbles.
2. Completely fill the bottle under water with the sample, making sure that there are no trapped air bubbles.
3. Using a dropper placed well below the surface of the water, add 1 cm3 (approximately) each of manganese(II) sulfate solution and of alkaline potassium iodide solution to the bottle.
4. Stopper the bottle so that no air is trapped - a few cm3 of solution will overflow at this point.
5. Invert the bottle repeatedly for about a minute, and then allow the brown precipitate to settle out.
6. In order to dissolve the precipitate, carefully add 1 cm3 of concentrated sulfuric acid to the bottle, by running the acid down the side of the bottle.
7. Restopper the bottle - avoiding trapping any air. Invert repeatedly to redissolve the precipitate. If all the precipitate has not dissolved at this point add 0.5 cm3 of acid, invert repeatedly, and allow to stand for one minute. Continue repeating the process of inverting repeatedly followed by addition of acid until all of the precipitate has dissolved. Iodine should now be released resulting in a golden brown solution.
8. Wash the pipette, burette and conical flask with deionised water. Rinse the pipette with the iodine solution and the
burette with the sodium thiosulfate solution.
9. The free iodine can now be estimated by means of the thiosulfate titration. Measure out 50 cm3 samples into clean conical flasks and titrate each of these with 0.005 M thiosulfate solution in the usual way.



10. Add about 1 cm3 starch indicator as the end point approaches (when the solution becomes pale yellow in colour).
Titrate until the blue colour has just disappeared.
11. Record the results in the usual way taking the average of two accurate titration results, i.e. two titres within 0.1 cm3
of each other.
12. Calculate the results in (i) moles of oxygen per litre (ii) grams of oxygen per litre (iii) dissolved oxygen in p.p.m.

Table of Results:

Rough titre =
Second titre =
Third titre =
Average of accurate titres =
Volume of water sample =
Molarity of thiosulfate solution =

Calculations

Formula method

$V_{DO} \times M_{DO} \times n_{ST} = V_{ST} \times M_{ST} \times n_{DO}$ DO = dissolved oxygen (water) ST = sodium thiosulphate

V_{DO} = volume of water containing dissolved oxygen = $50cm^3$
M_{DO} = molarity of dissolved oxygen = x (our unknown)
n_{ST} = reaction ratio for sodium thiosulphate = 4

V_{ST} = volume of sodium thiosulphate used in titration, your average titre
M_{ST} = molarity of sodium thiosulphate = 0.005
n_{DO} = reaction ratio for dissolved oxygen = 1

Fill in formula and you calculate the molarity of dissolved oxygen in water

$V_{DO} \times M_{DO} \times n_{ST} = V_{ST} \times M_{ST} \times n_{DO}$

To convert Molarity of dissolved oxygen to a value expressed in parts per million (ppm) multiply molarity by 32000

Dissolved oxygen ppm = Molarity of dissolved oxygen x 32000

Preparation of Reagents

Manganese(II) sulfate solution: Dissolve 120 g $MnSO_4.4H_2O$ in 250 cm3 of deionised water.

Alkaline potassium iodide solution: Dissolve with warming 125 g NaOH and 37.5 g KI in 250 cm3 of deionised water.

0.005 M sodium thiosulfate standard solution: Dilute 50 cm3 0.1 M sodium thiosulfate standard solution (see below) with deionised water to 1 litre using a volumetric flask.

0.1 M sodium thiosulfate standard solution :
Prepare anhydrous sodium thiosulfate by refluxing about 30 g sodium thiosulfate pentahydrate crystals in methanol for about 30 minutes, and then filter. Dry in an oven at 70oC. Dissolve 15.8g anhydrous sodium thiosulfate in 500 cm3
deionised water in a beaker and make the solution up to 1 litre using a volumetric flask. To increase the stability of the solution, add 0.1 g of sodium carbonate.

Starch indicator solution: Pour with stirring a paste containing 1 g starch and a little cold water into 50 cm3 of boiling water. Boil for two minutes, and allow to cool.

Quantities needed per working group

500 cm3 of the water sample
100 cm3 of sodium thiosulfate solution
2 cm3 of alkaline potassium iodide solution
2 cm3 of manganese(II) sulfate solution
2 cm3 of concentrated sulfuric acid
10 cm3 of starch indicator solution

Safety considerations:

• The usual precautions when handling glassware for a titration should be observed.
• Pipette fillers should be used.
• Safety glasses and gloves must be worn.
• Eye wash solution should be available, in case of accidental splashing.

Chemical hazard notes:


Manganese(II) sulfate is harmful if swallowed, inhaled or absorbed through skin. Skin contact with it should be avoided. Causes eye and skin irritation. Inhalation of dust may cause manganese poisoning.


Sodium thiosulfate is an irritant to eyes.

Concentrated sulfuric acid is corrosive and causes severe burns to eyes and skin.


Sodium hydroxide is corrosive and can cause severe burns to eyes and skin. Always wear eye protection.

Disposal of wastes

Dilute with excess water and flush to foul water drain.

Notes

Q & A

Q. Why must the bottles be shaken vigorously in step 6 of the procedure?

A: To help the dissolved oxygen to react.

Q. Why are the bottles completely filled under water?

A: To prevent additional oxygen from the air dissolving in the water.

Q. If the white precipitate remains on addition of manganese (II) sulfate solution and alkaline potassium iodide solution, what does this indicate about the water sample?

A: There is no dissolved oxygen present. The sample is heavily polluted.

Q. State and explain what the letters B.O.D. mean.

A: Biochemical Oxygen Demand is the amount of dissolved oxygen consumed by biological activity when a sample of water is stored in the dark for 5 days at 20 0C.

Q. Why are the bottles used during B.O.D. measurements stored in the dark?

A: To prevent oxygen production by photosynthesis.

Q. Why are bottles stored at 20 0C.

A:Suitable temperature for microorganism to work.

Q. Why is there 5 days between tests.

A:To give sufficient time for microorganisms to consume a measurable amount of oxygen.

Q. What would you do if a white ppt appeared when carrying out the test on day 5

A: Repeat test again but this time dilute the test sample (eg 1:10) with well aerated deionised water. Take this dilution factor into consideration when doing calculations. In this case multiply the final answer by 10.

Notes

Notes

Oide

Tacú leis an bhFoghlaim
Ghairmiúil i measc Ceannairí
Scoile agus Múinteoirí

Supporting the Professional
Learning of School Leaders
and Teachers