Young Ambassadors for Chemistry (YAC) Kuching 2023

Course Book

Organised by

Institut Kimia Malaysia

In collaboration with

Jabatan Kimia Malaysia Negeri Sarawak

Jabatan Pendidikan Negeri Sarawak

IKM Sarawak Branch

Institut Pendidikan Guru Kampus Batu Lintang

Universiti Malaysia Sarawak

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INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

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BUSINESS EVENTS SARAWAK

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Programme Overview

From 2004 to 2022, the Young Ambassadors for Chemistry (YAC) projects used a 'Train the Trainers' approach with teachers and students in 17 countries across Asia, Africa, Latin America, and Europe, with partial IUPAC/CCE funding and external funding from local organizations, Chemical Societies, Ministries of Education, and industry (see former IUPAC projects 2003-055-1-050, 2007-005-2-050, 2015-058-2-050, 2018-015-2-050 and 2021-031-2-050 for write-up and references).

This year, in July 2023, we hope to incorporate the meaningful YAC project in conjunction with the 9th International Conference on Network for Inter-Asian Chemistry Educators (9NICE) at Kuching, Sarawak, Malaysia (28-30 July 2023) by bringing together teachers and students from Malaysia and neighboring countries to take part in the project. The event will last for 1.5 days where the first day (28 July) will be filled with hands-on practical training at Institut Pendidikan Guru Kampus Batu Lintang (IPG KBL) and will showcase how each of the experiments can be done with ease alongside their SDG attainments. The remaining half-day (30 July) will be filled with two YAC 2023 Workshops, one by Prof Uday Maitra from the Indian Institute of Science, Bangalore, India entitled "Chemistry is Fun!" and another by Mr Liao Hsu-Mao from Taichung Municipal Dajia Senior High School, Taiwan entitled "Design and Application of the Mini Stirrer Modules".

SDG Goals

The activities and experiments planned will revolve around UN SDG goals where Chemistry plays a crucial role in, particularly **SDG 6 on Clean Water and Sanitation** (water analysis experiment), **SDG 7 on Affordable and Clean Energy** (the making of solar cell and water electrolysis experiment), **SDG 9 on Industry, Innovation and Infrastructure** (testing the strength of materials and corrosion protection experiment), **SDG 12 on Responsible Consumption and Production** (the making of bio-plastic experiment) and **SDG 13 on Climate Action** (waste to wealth experiment: biodiesel synthesis from used cooking oil). We envision that the exposure will enable participants to visualize the impact that Chemistry has in multiple areas of life and to provide them with the necessary skills and knowledge to conduct workshops within their communities/schools to further extend our reach as Young Ambassadors for Chemistry.

Booth 1: Water Analysis Experiments

5 types of water sources are provided and students are required to carry out 3 tests to determine the cleanest water.

1.1 Observation and Turbidity Test

Learning Objective(s)

- ☑ To showcase the importance of Chemistry in maintaining good water quality via the use of water analysis and purification for better wellbeing

Precautions

Make sure all moisture is thoroughly wiped from the outside of the sample cell prior to placing the cell in the instrument for measurement.

Procedure

1. Gently agitate the sample. Fill the sample cell to the line (≅ 30 mL). Handle the sample cell by the top. Cap the sample cell.
2. Hold the sample cell by the cap and wipe water spots and fingerprints.
3. Place the sample cell into the cell compartment and close the cell cover.
4. Read and record the result.

Hach Turbidimeter 2100N

1.2 pH Test

Learning Objective(s)

- ☑ To qualitatively determine the pH of a solution by observing the color change of different water samples by employing the pH indicator
- ☑ To explain, using scientific terms, what makes a solution acidic or basic

Procedure

1. In this experiment, students will test the pH of different solutions using a universal indicator and a purple cabbage juice indicator.
2. Compare the color with the pH scale range in Figure 1, 2 & 3.

Chemistry Concepts

- Acids change the universal indicator solution from green to red.
- Bases change the universal indicator solution from green to blue or purple.
- Water molecules (H_2O) interact with one another to form H_3O^+ ions and OH^- ions.
- At a pH of 7, there is an equal concentration of H_3O^+ ions and OH^- ions in water, so it is called a neutral solution.
- A pH below 7 on the pH scale indicates acidic solutions, while a pH above 7 on the pH scale indicates basic solutions.
- The solution will be acidic if there are more H_3O^+ ions and will be basic when the solution has more OH^- ions.
- $pH = -\log [H_3O^+]$, where $[H_3O^+]$ is the concentration of hydrogen ions.

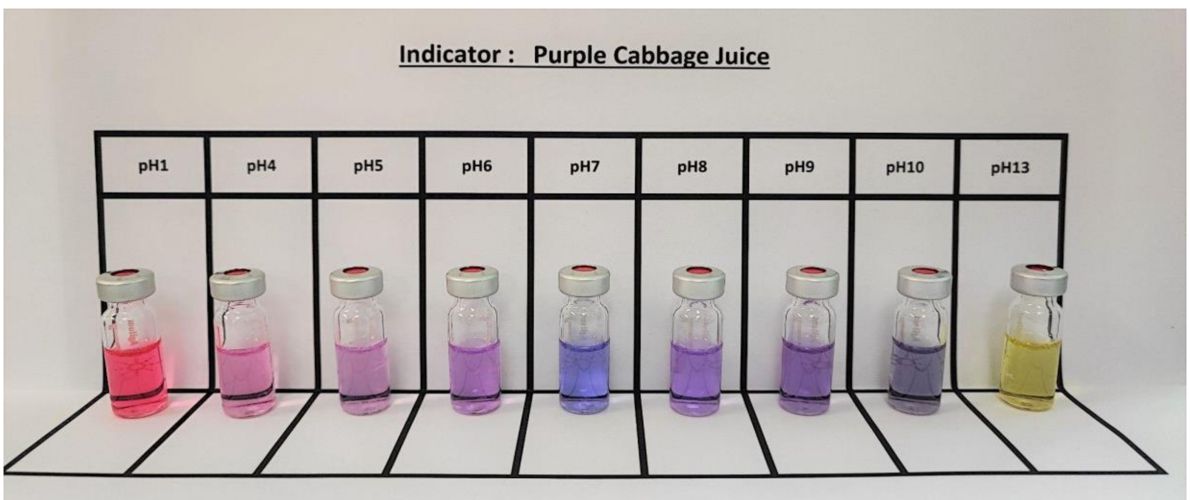


Figure 1. Purple Cabbage Juice

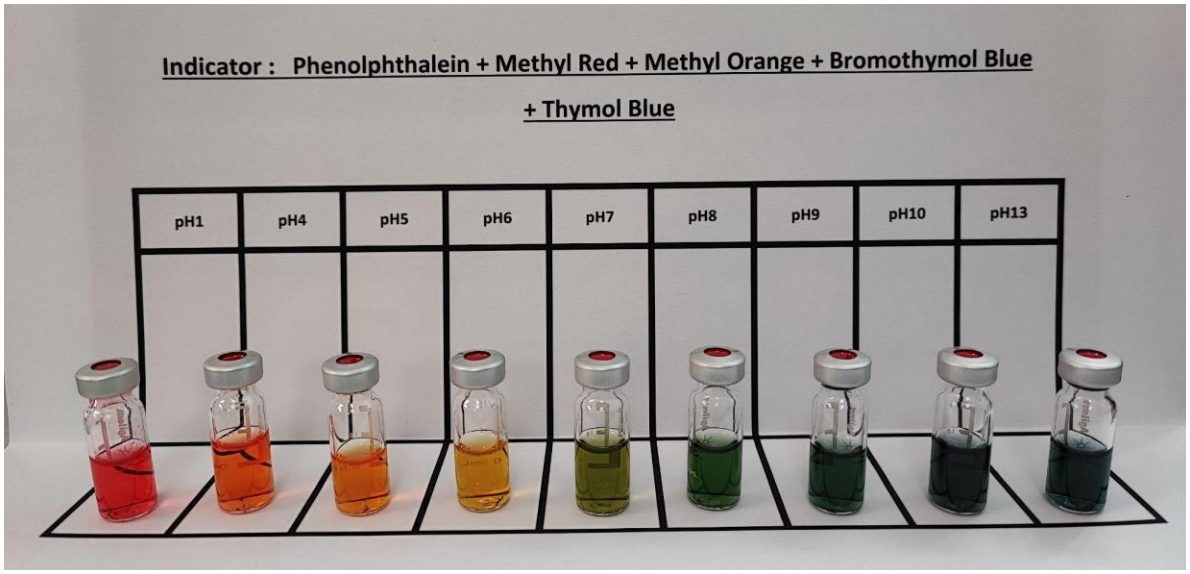


Figure 2. Universal Indicator 1

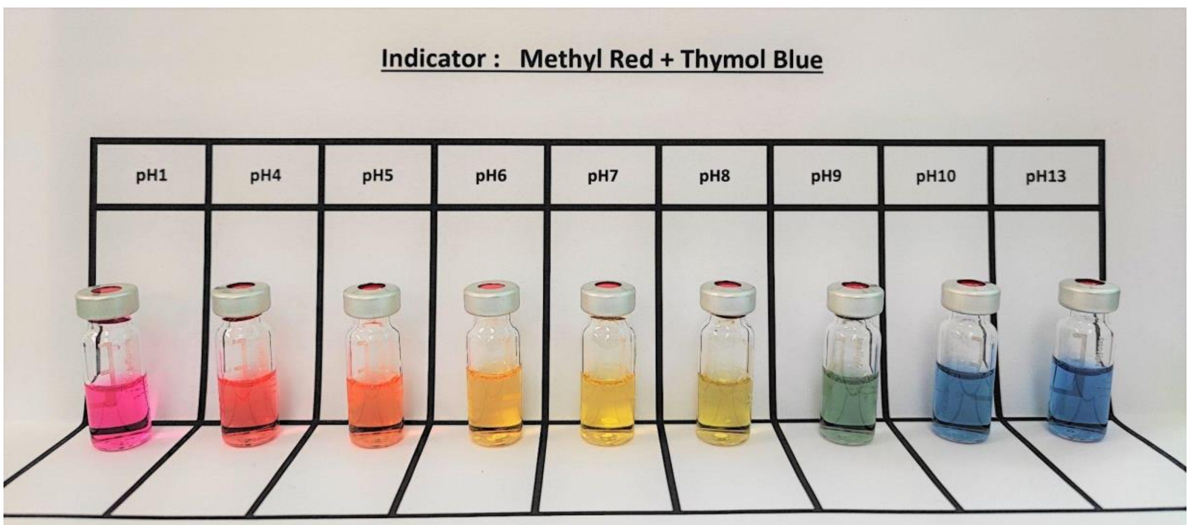


Figure 3. Universal Indicator 2

1.3 Identification of Dissolved Ions

(I) Cations

Procedure (Addition of 4 M sodium hydroxide solution)

1. Place 2 drops of water sources in each circle across the central line.
2. Along the top row, add one drop of 4 M sodium hydroxide solution. Stir with a pointed wooden splint.

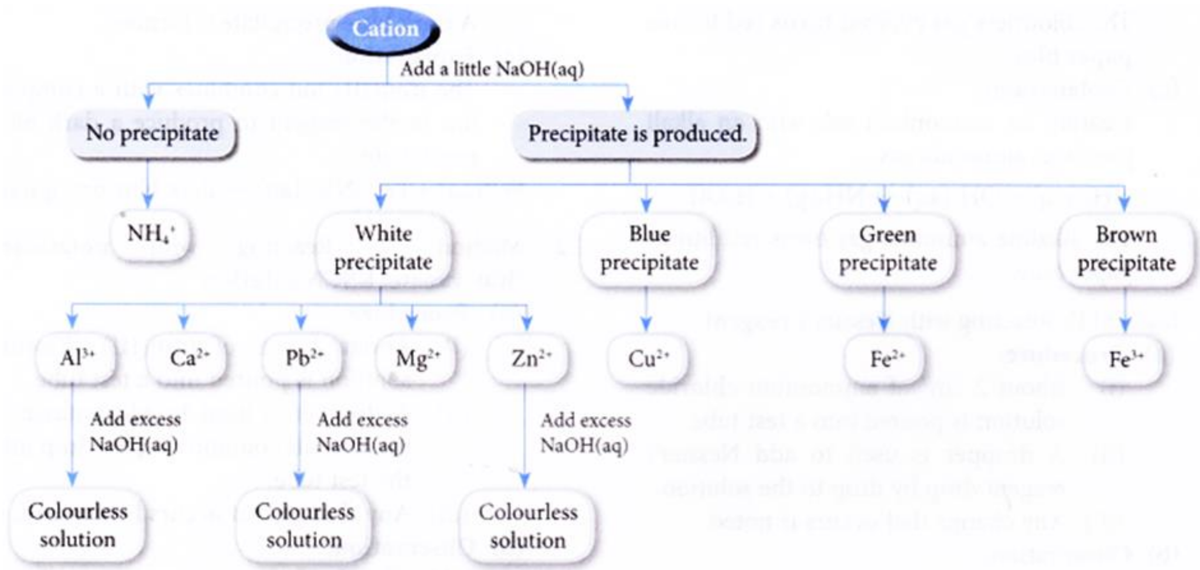


Figure 4. Summary of Test on Cations using Sodium Hydroxide Solution

(II) Anions (CO_3^{2-}, Cl^-)

Procedure (Addition of 0.05 M silver nitrate solution)

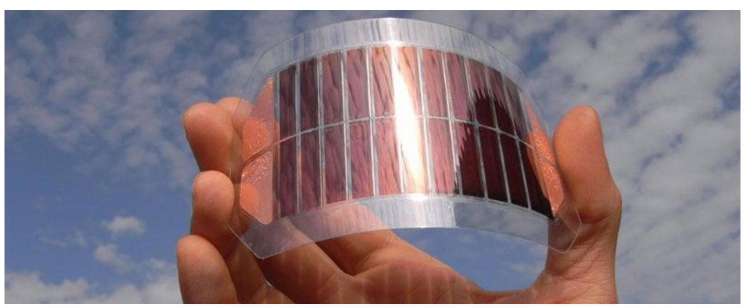
1. Place 2 drops of water sources in each circle across the central line.
2. Along the top row, add one drop of 0.05 M silver nitrate solution. Stir with a pointed wooden splint.

ANION	TEST	RESULT
Cl^-	SILVER NITRATE	WHITE PRECIPITATE OF $AgCl$
Br^-	SILVER NITRATE	CREAM PRECIPITATE OF $AgBr$
I^-	SILVER NITRATE	YELLOW PRECIPITATE OF AgI
CO_3^{2-}	HYDROCHLORIC ACID	CO_2 PRODUCED
SO_4^{2-}	BARIUM CHLORIDE	WHITE PRECIPITATE OF $BaSO_4$

Booth 2: The Making of Solar Cell and Water Electrolysis Experiment

What is the goal of SDG 7?
By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology.

Dye-sensitized solar cells (DSSCs) use an organic dye to absorb incoming sunlight to create solar energy which is then transferred to an inexpensive material, such as titanium dioxide (TiO_2). From there, the energy is collected on a transparent conducting surface. The dyes in the cell can be optimized for a range of lighting conditions making it suitable for indoor applications and outdoor applications. This solar energy provides affordable and clean energy.



During **electrolysis of water**, ionization breaks the water molecule into hydrogen and oxygen gas, which creates an enormous amount of energy that can be turned into useful electricity to power our homes and cars.

Learning Objective(s)

☑ To showcase the basic concept behind exciting chemistry research on renewable energy (e.g. solar cells, fuel cell/water splitting, etc.)

2.1 The Making of Veg-based Dye-Sensitized Solar Cells (DSSC)

Materials and Apparatus

- Working Electrode: 1 ITO Coated Glass Slide with TiO_2 layer (4 cm x 3 cm)
- Counter Electrode: 1 ITO Coated Glass Slide (4 cm x 3 cm)
- Double sided Tape
- Small piece of tissue paper (spacer)
- Iodine-based electrolyte
- Natural Dye/Artificial Dye Solution (Dye Bath) or Crushed Local Veg
- 1 Beaker with Distilled Water
- 1 Beaker for Ethanol Washing
- Tissue Paper to dab dry
- Tweezers
- Graphite Pencil
- Crocodile clip with wire (x 2)
- Digital Multimeter

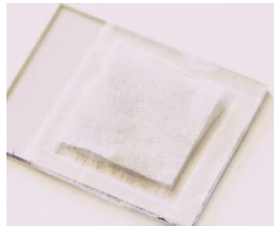
Precautions

As the ITO coated glass slides are not professionally sectioned, there may be sharp edges protruding on the sides, kindly be careful when handling them and ensure that you do not exert too much force that may cause the glass to break/shatter. Wear gloves for extra protection.

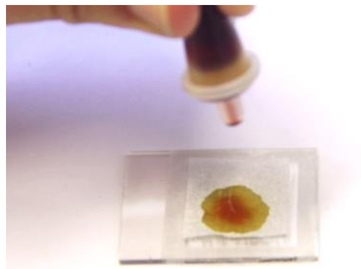
Procedure

1. Soak 1 ITO (Indium Tin Oxide) coated glass slide with TiO_2 layer into the dye bath of your choice, making sure the entire white TiO_2 layer is covered in the juice. This will be the ‘working electrode’.
2. Leave it in the dye bath to soak for 5-15 minutes. The longer you leave the cell in the dye, the better it will works!
3. Use graphite pencils to shade the conducting side of another ITO glass (already prep with double sided tape). Be sure to cover all of the conducting side of the glass in pencil. Carefully remove the tape cover from the glass slide once done. This will be the ‘counter electrode’.

4. Once it is shaded in, place a small piece of tissue paper (spacer) on top of the shaded part of the glass.

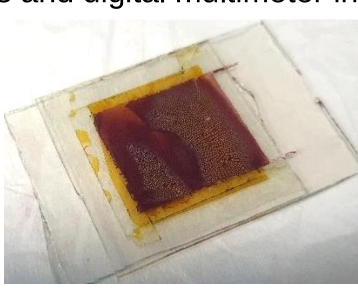
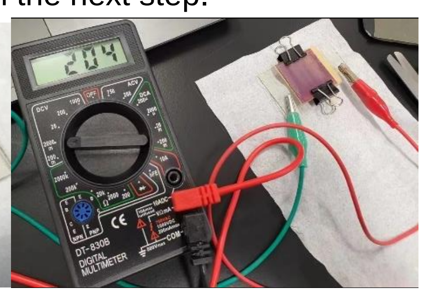


5. Using a pipette/dropper, add 2 drops of iodine-based electrolyte solution to the top of the spacer.



6. Use a tweezer to remove the 'working electrode' from the dye bath and rinse off any excess dye by dipping it in the ethanol beaker. (Do not scratch the TiO_2 layer)

7. Leave the glass slide to dry for 2 minutes (alternatively, use tissue paper to dab dry. (Be gentle, do not rub on glass slide as it will remove the TiO_2 layer)
8. Take the 'counter electrode' and place it graphite side down on top of the 'working electrode', so that the graphite and the dyed TiO_2 are touching.
9. The position of the slides should be slightly offset as this will allow you to connect crocodile clips and digital multimeter in the next step.

10. Using a digital multimeter, the current and voltage of the cell will be recorded and an attempt will be made to collectively power something "small".

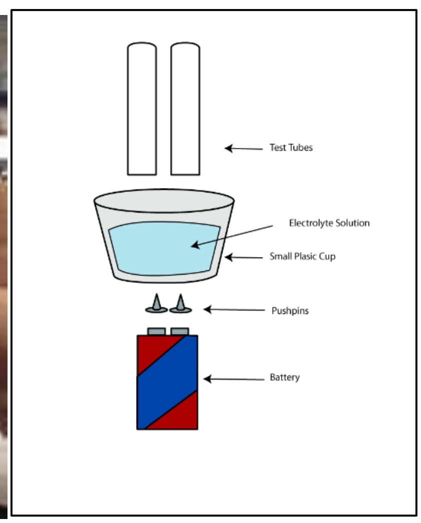
2.2 Water Electrolysis Experiment

Materials and Apparatus

- Distilled water
- Baking soda
- 1 Transparent plastic cup
- Thumb pin (x 2)
- 2 x test tubes
- 9V battery
- Bluetac

Procedure

1. Push through thumb pins through a small plastic cup. Secure the pins in place with bluetac.
2. Fill both test tubes and plastic cup with distilled water containing dissolved baking soda. Invert the test tubes to cover the thumb pins.
3. Carefully place the cup with each thumb pins touching the + and - poles of a 9V battery, respectively.Observe!



Booth 3: Testing the Strength of Materials and Corrosion Protection

(Write something about the experiment overall, one or two short paragraph(s) will do, aim to link it to the SDG goal, feel free to insert pictures if necessary)

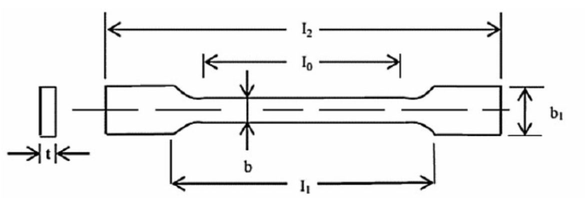
Learning Objective(s)

- ☑ To showcase the need for chemist in the making, testing and protection of existing materials used in industry, innovation and infrastructure

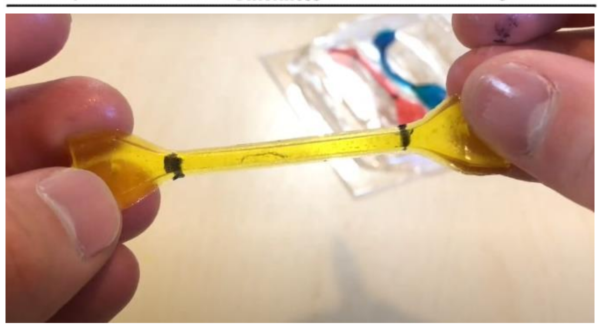
3.1 Preparation of Materials for Tensile Test

Procedure

1. Gather 1 piece of each materials provided (cardboard, aluminium foil, rubber glove, plastic bag, etc.).
2. Cut the materials following the template/shape provided. Be careful when using the scissors as they can be very sharp!
3. Label the materials accordingly and set them aside. While waiting for all of the materials to be prepared, try to predict the ranking of these materials based on their tensile strength and stretchability.



Symbol	Description	Dimension(mm)
I_0	Gauge length	25
I_1	Grip distance	66
I_2	Overall length	88
b	Width of narrow parallel portion	8
b_1	Width at ends	12
t	Thickness	3



4. Mark and measure the gauge length with marker pens and ruler. Then the values are recorded.

3.2 Tensile Test

Procedure

1. Pierce a hole on each end of the same material.
2. Insert a rod through one of the holes in the material whilst the other end will be hooked to a spring balance.
3. Use a phone camera to record the process of pulling the material. Please ensure that both the spring balance scales and the material being pulled in two halves are captured within the video.
4. Import the video to a laptop and use an online tool to analyse it: https://www.pjl.ucalgary.ca/studentResources/videoAnalysis/pjlVideoAnalysis.html
5. Export the data to an Excel Spreadsheet for further analysis.
6. In Excel, plot Stress-Strain Curves to decide which material has better tensile properties.

3.3 Corrosion and Protection of Nails

Procedure

1. Prepare 5 nails and 5 petri dish. Each nail will be treated with differently (e.g. one coated in paint, one wrapped in aluminium foil, one wrapped in magnesium ribbon, one coated with oil and one being untreated).
2. Mix together hot water, agar gel, KNO_3, Potassium ferrocyanide $K_4[Fe(CN)_6]$ and phenolphthalein).
3. Pour the agar solution into the petri dish containing a nail each.
4. Observe and record colour changes.

Booth 4: The Making of Bioplastic

The way we currently produce and consume plastics is not sustainable. Mass production and consumption of (synthetic) plastic, especially that of single-use packaging plastic, are major contributors to plastic pollution in the sea and on land. The pollution has a negative influence on the functioning of ecosystems and endangers animal lives as well as the food supply of large groups of people. Burning the plastic as a form of waste-management contributes to toxic air pollution. The stimulation and improved effectiveness of recycling are not sufficient and do not present a realistic solution to the plastic soup at this point in time.

The best way to promote SDG 12 (responsible consumption and production) is through reduction in plastics and single-use consumption. Another SDG12 initiative is through gradual substitution of the plastics with bioplastics. Bioplastic is a biodegradable material that is made from renewable sources (plant or animal based) and can reduce the problems of plastic waste that is suffocating the Earth.

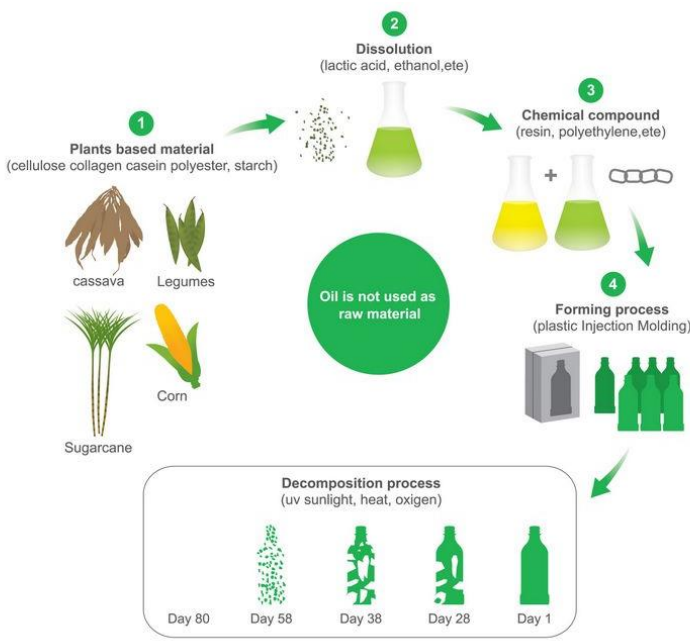


Figure 5. Synthesis and decomposition of bioplastics.

(Source: https://ecofriend.com/bio-plastics-good-bad-ugly.html)

Learning Objective(s)

- ☑ To showcase the effort chemists are making in materials development (e.g. biodegradability, toxicity, etc.) and their application in other sectors (e.g. biomedicine, food packaging, etc.)

4.1 The Making of Bioplastics

Procedure

1. Add corn starch (1 tablespoon) into a 250-mL beaker, and add then water (7 tablespoons), vinegar (2 teaspoons) and glycerin (2 teaspoons).
2. Stir the mixture homogeneously using a glass rod/spatula.
3. Transfer the beaker to the hot plate, heating at 150 – 190 ^{o}C.
4. Stir the mixture continuously using the spatula on the hot plate until the mixture boils, gradually turns viscous and translucent (estimated time: 10 – 20 mins). Be careful with the hot beaker and hot surface of the hotplate.
5. Remove the hot beaker from the hot plate, and then gradually transfer the still hot viscous bioplastic to the baking paper and cast it out carefully and evenly.
6. Leave the bioplastic to cool down at room temperature for 1 day. Normally the bioplastic will be completely dried after 3 – 5 days.
7. Peel off the completely dried bioplastic carefully from the mould.
8. You can try to investigate its elasticity by stretching, pulling and rolling the bioplastic, rolling. You can also test the water resistance of the bioplastic according to the method here: https://www.youtube.com/watch?v=DGp1-hdExMY

Tips:

To dry the samples, you can either air dry the samples overnight, or dry the samples in the oven at 150 °C for 1 hour. Air drying creates more flexible samples with a higher water content, and oven dried samples are stronger but more brittle.

Question:

1. Why is glycerin added to the corn starch bioplastic?
2. What is the purpose of adding acetic acid (vinegar) to the starch?

Booth 5: Waste to Wealth Experiment

Biodiesel Synthesis from Used Cooking Oil
Biodiesel is a renewable biomass energy source. There are many feedstocks of biodiesel which are either from vegetable or animal oils. Indeed, biodiesel also can be synthesized from used cooking oil (UCO) which turns the waste to wealth.

The reaction of biodiesel synthesis involves the conversion of glyceride (fatty acid) to fatty acid methyl ester (FAME) and glycerol (Figure 6) in the presence of catalyst. As shown in Figure 6, there is an ester group presents in triglyceride and FAME, respectively. Due to this reason, the reaction is called transesterification because conversion of one ester group to another ester group.

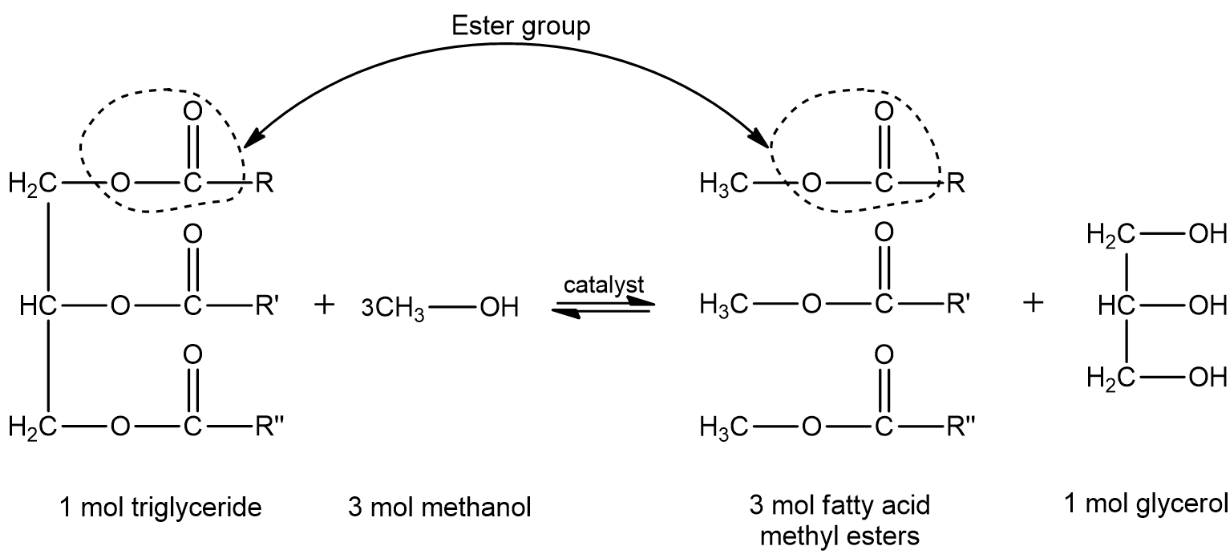


Figure 6. Chemical reaction of biodiesel synthesis

Learning Objective(s)

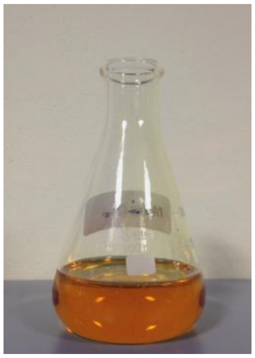
- ☑ To demonstrate the conversion of UCO to biodiesel
- ☑ To synthesize your own biodiesel

5.1 Biodiesel Synthesis

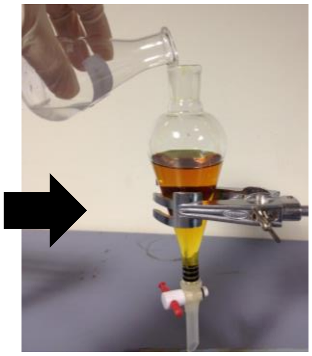
Procedure

1. You are given an empty COD vial with its' lid.
2. Add 5 mL UCO into the COD vial.
3. Add 1 mL of KOH methanol solution into the COD vial.
4. Close the lid and shake the COD vial for 10 minutes.

5. Label the COD vial with your nick name and the date.
6. After 1 hour, the mixture in the COD vial will appear in two layers. The top layer is biodiesel, whereas the bottom layer is glycerol.



Used cooking oil



Add in KOH methanol solution

Shake for 10 minutes

The top layer is biodiesel and bottom layer is glycerol