Format for your lesson

Assignment	Description	Used materials	Level of education
Boosting bioeconomy in your school with your biofuel and soap lab.	*The detailed description of the scenario.* **Number of Students: 15** **Instructor: 1** **Time: 5 lessons (40 min each)** **Teams: 5** **<u>1st Activity: Introduce the idea of Bioeconomy</u>** Duration: 1 lesson (40 min) Learning space: School Class Aim: Provoking learners to think critically on bioeconomy topics Educational material: Power point presentation **1. Organise students in groups of four.** **2. Discuss about environmental issues nowadays.** Use a video as a trigger to introduce environmental issues. "The girl who silenced the world/20th Anniversary - Best Quality" https://www.youtube.com/watch?v=FlQn1KwW4Es&t=1s Reflect on the video and use the Bloom ppt presentation to discuss with students the following questions (Think-pair-share) a. What would you like to change in the world? b. Which are the main environmental issues nowadays? c. Is there anything we can do? **3. Introducing the idea of Bioeconomy** - Use pictures of biobased products as a trigger to introduce biobased products from the ppt presentation. - Discuss with students plants role in our ecosystem. Plants are great engines of creating energy for us. - Define what biomass and biofuels are. - Discuss with students the importance of bioeconomy and circular economy. Extra: The Bioeconomy starts here: https://www.youtube.com/watch?v=2xvXkOMRTs4 The Bioeconomy in our everyday lives: https://www.youtube.com/watch?v=ir3MgOSmvLg Key ideas: - What do we do with the plants? - What do we do with the parts of the plants we do not eat? - Can we use plants as a fuel? - What is used to create biomass fuels? - Why do biofuels have an advantage? - Besides fuel, what can biomass be used to create?	**1st Experiment:** • 100 mL graduated cylinder • 10 ml pipette • Large separatory funnel with ring stand • Waste (vegetable) cooking oil • Alcohol (methanol) • Potassium hydroxide solution (KOH) 0.6M in ethanol • Beakers • Alcohol thermometer **2nd Experiment:** • Glass rod • Clay triangle • Tripod stand • Forceps • Ring stand with ring attached • 1 crucible • beakers • 250 ml graduated cylinder • 10 ml graduated cylinder • 3 pieces of foil • 3 pieces of wick • 5- 10 ml biofuel (e.g. biodiesel) • 5-10 ml fuel A (e.g. ethanol) • 5-10 ml fuel B (e.g. petrol) • Lighter • Alcohol thermometer • Scale accurate to 0.1g (Weight capacity: ~500 g) • Ruler • Stopwatch	Age/Level: 16-17 years old students Number of students: 15

	- How can biofuels reduce the amount of petroleum we use without entirely replacing it? - How are biofuels created? - Why are biofuels favorable? **3. Homework Project**(optional)**:** *Biobased products of our market* - Go to the supermarket and find as many bio-based material as possible. Take a picture of them. - Find biofuels and biobased material that is already used in different countries. Work with your team and collect all the information. - Create a poster to present your results. **<u>2nd Activity: Making your Biodiesel</u>** Duration: 1 lesson (40 min) Learning Space: Experimental Laboratory 1st Experiment (worksheet 1) **<u>3rd Activity: Testing your Biodiesel</u>** Duration: 1 lesson (40 min) Learning Space: Experimental Laboratory 2nd Experiment (worksheet 2) **<u>4th Activity: Producing Soaps from Glycerin</u>** Duration: 1 lesson (40 min) Learning Space: Experimental Laboratory 3rd Experiment (worksheet 3) Homework Project: Create in groups a 1 min advertisement of a biobased material, which your company will introduce in the market. **<u>5th Activity: Presenting your advertisement</u>** Duration: 1 lesson (30 min) The advertisements of the students will be presented in class and uploaded in youTube (optional). The rest of the class will have to find arguments whether this is a good product to use or not. (Examples of videos uploaded) Key ideas: - Recycling PLA endlessly - Eco-friendly - Differently Quality - Economy	**3rd Experiment:** • Glycerin (Methanol Removed) • Essential Oil (optional) • Coconut Oil • Citric Acid • 250 mL graduated cylinder • Potassium Hydroxide solution (KOH) 9M • 1,000 mL beaker • 250 mL beaker x 2 • Pot • Burner • Lighter • Thermometer • Silicon molds	
Quiz	**Questions**	**Answers**	**Explanation**
Quiz is about bioeconomy	Questions 1: How would you define bioeconomy?	Answer 1: The bioeconomy is a circular economy that uses renewable biological resources from land and sea – such as crops, forests, fish, animals and microorganisms – to produce food, materials and energy.	The European Commission defines the bioeconomy as the production of renewable biological resources and the conversion of these resources and waste streams

		Answer 2: Bioeconomy is the circular economy based on biological products. Answer 3: Bioeconomy is the circular economy that uses biomass.	into value added products, such as food, feed, bio-based products and bioenergy. Its sectors and industries have strong innovation potential due to their use of a wide range of sciences, enabling and industrial technologies, along with local and tacit knowledge.
	Question 2: Could you give one example of applied bioeconomy in your everyday life?	Answer 1: Biobased straws from sugar cane. Answer 2: Biobased plates from starch. Answer 3: Biofuels from cooking oil.	More: A Bio-Economy in Everyday Life (http://www.bio-step.eu)
	Question 3: Could you mention a difference between petrol and the bioethanol we produced?	Answer 1: Bioethanol is a biofuel produced by biomass, whereas petrol is produced by fossil fuels. Answer 2: Bioethanol is less energy efficient compared to petrol. Answer 3: Bioethanol is ecofriendly as it is a biofuel, compared to petrol.	Ethanol is produced by fermenting sugar, grain, yeastsi. It is a renewable resource unlike the fossil fuel-based petrol, which is non-renewable. On a simple litre-per-litre basis, ethanol produces 1.5kg of carbon dioxide (CO2) compared to 2.2kg produced by petrol. However, ethanol produces less energy than petrol so 1.4L of ethanol (which produces 2.15kg of CO2) contains the same amount of energy as 1L of petroliv. While this suggests the difference to the environment is small, the CO2 produced by ethanol-blended

			fuel use is countered somewhat by the CO2 consumed by the plants used to produce the ethanol, with estimates attributing a carbon dioxide saving of 70% once all production and distribution factors have been taken into.
	Question 4: Did you observe any combustion taking place during the labs?	Answer 1: Petrol reacting with oxygen during the 2nd lab, was an example of combustion. Answer 2: Ethanol reacting with oxygen during the 2nd lab, was an example of combustion. Answer 3: Biodiesel reacting with oxygen during the 2nd lab, was an example of combustion.	Combustion involves a series of chemical reactions between a fuel (i.e. a hydrocarbon, or an organic compound containing only carbon and hydrogen) and oxygen. The result is a major reorganization of both matter and energy.
	Question 5: Can glycerin from biodiesel be turned into a liquid soap?	Answer 1: Yes, by mixing glycerin with NaOH or KOH. Answer 2: By mixing glycerin with NaOH. Answer 3: By mixing glycerin with KOH.	Biodiesel glycerin is actually a mixture of free fatty acids (FFA) that were neutralized during transesterification, soaps, water, catalyst (NaOH or KOH depending on what was used to make the biodiesel), methanol, and glycerin. Once the methanol is removed, the glycerin is safe to handle and is suitable for making soap.
Video / Animation	**Script**	**Text**	**Image**
Create a video or animation (max. 2	Sugarcane Plates https://youtu.be/4iomFNhFggI	Students produce their own 1min video advertisement of a	

minutes). Submit your video via a You Tube link.		biobased product.	
Resources (video, publication / online/ magazine,	**Worksheets:** The pictures of the worksheets were data captured during during the implementation of the learning scenario. **Videos:** The Bioeconomy starts here: https://www.youtube.com/watch?v=2xvXkOMRTs4 The Bioeconomy in our everyday lives: https://www.youtube.com/watch?v=ir3MgOSmvLg The girl who silenced the world/20th Anniversary - Best Quality: https://www.youtube.com/watch?v=FlQn1KwW4Es&t=1s **Articles:** A Bio-Economy in Everyday Life (http://www.bio-step.eu); Biodiesel Lesson Plans, Institute of Environmental Sustainability, LOYOLA University Chicago (http://www.luc.edu/sustainability/initiatives/biodiesel/high-schools/lesson-plan/); Derry, N., Victorian Curriculum and Assessment Authority, 2007, *What are Biofuels?*, http://www.vcaa.vic.edu.au/Documents/vce/chemistry/biofuelschemistry.doc; Office of Biofuels, New South Wales Government, 2013, *Biofuels in New South Wales*, http://www.biofuels.nsw.gov.au/ and United, 2012, *Ethanol 85*, http://www.unitedpetroleum.com.au/united/fuel/ethanol-85		

NAME: _____

DATE: _____

GROUP: _____

SCHOOL: _____

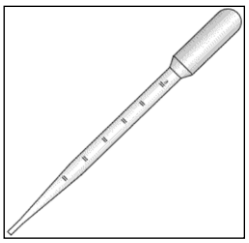
Introductory Vocabulary

Match each picture with the correct scientific terminology.

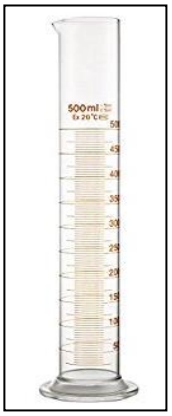
Equipment:

- Pipette

- Graduated cylinder



- Beaker



- Large separatory funnel with ring stand

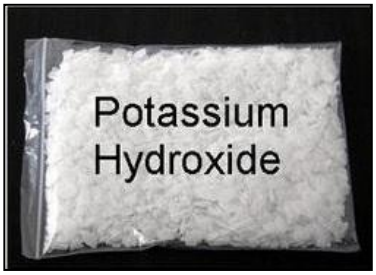
1st Experiment: *Making your Biodiesel*

Question: **Can biodiesel be produced by vegetable cooking oil?**

Background:

Biodiesel is a mixture of methyl esters of fatty acids. It can be made very easily from vegetable cooking oil. The synthesis is a simple chemical reaction that produces biodiesel and glycerol. Cooking oil is mixed with methanol and potassium hydroxide. The products separate into two layers, with the biodiesel on the top. The biodiesel is separated and washed and is then ready for further experimentation.

Materials:



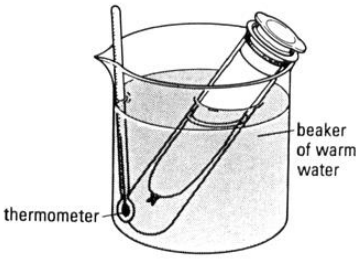
- 100 mL graduated cylinder
- 10 ml pipette
- Large separatory funnel with ring stand
- Waste (vegetable) cooking oil
- Alcohol (methanol)
- Potassium hydroxide solution (KOH) 0.6M in ethanol
- Beakers
- Alcohol thermometer

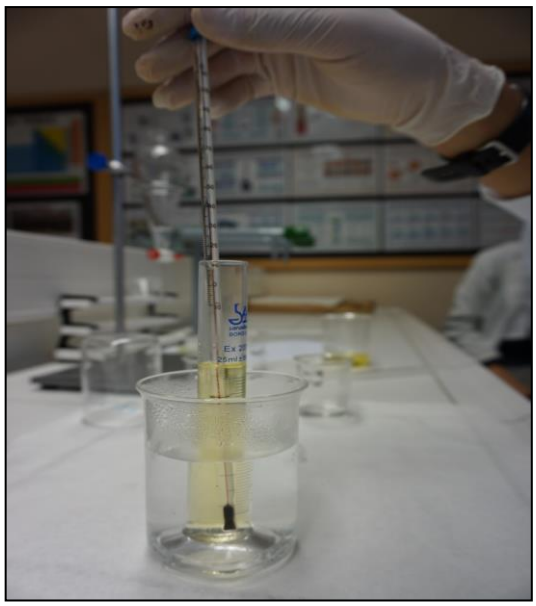
Safety Rules:

- ✓ You must wear goggles, gloves and an apron.
- ✓ Alcohol is flammable.
- ✓ Potassium hydroxide is corrosive.

Procedure:

1. Measure 18 ml of methanol, using a graduated cylinder, and pour it into the separating funnel.
2. Using a pipette, carefully add 3ml of the KOH solution into the funnel as well.
3. Swirl gently.
4. Measure 72 ml of waste cooking oil using the cylinder.
5. Warm the cooking oil up to 40^0C, using a water bath and an alcohol thermometer. A water bath is made from a container, such as a big beaker, filled with heated water. (approx. 100ml of heated water)
6. Add the 72ml of cooking oil into your separating funnel.





7. Swirl and sake the mixture for 10 minutes. Occasionally release any pressure.
8. Transfer the mixture into a beaker.
9. Let the mixture stand.

10. Record your observations (eg. color, viscosity, odor of the mixture).
    Data collection should include observations before, during and after the reaction.
11. Allow the mixture to sit and separate for one day.
12. Next day record your observations again.
13. Remove the top layer (biodiesel) by using a pipette and store it for next lab day.
14. Carefully remove the bottom layer (glycerin) by using a beaker and store the glycerin for next lab day, as well.

Data collection:

Mixture	Starting Observations	Interim observations (optional)	Final Observations
Color			
Viscosity			
Other			

Questions:

1. Which were the reagents and which were the products in this experiment?

_____

_____

_____

2. Why did you use as a catalyst?

_____

_____

_____

3. What did you observe as you mixed the oil with the alcohol?

_____

_____

_____

4. Why do the biodiesel and the glycerin separate?

_____

_____

_____

NAME: _____

DATE: _____

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2nd Experiment: *Testing your Biodiesel*

Question: **How does biodiesel compare with other fuels?**

Background:

Combustion involves a series of chemical reactions between a fuel (i.e. a hydrocarbon, or an organic compound containing only carbon and hydrogen) and oxygen. The result is a major reorganization of both matter and energy.

Materials:

- Glass rod
- Clay triangle
- Tripod stand
- Forceps
- Ring stand with ring attached
- 1 crucible
- 2 beakers
- 250 ml graduated cylinder
- 10 ml graduated cylinder
- 3 pieces of foil
- 3 pieces of wick
- 5- 10 ml biofuel (e.g. biodiesel)
- 5-10 ml fuel A (e.g. ethanol)
- 5-10 ml fuel B (e.g. petrol)
- Lighter
- Alcohol thermometer
- Scale accurate to 0.1g (Weight capacity: ~500 g)
- Ruler
- Stopwatch

Safety Rules:

- ✓ You must wear goggles, gloves and an apron.
- ✓ Alcohol is flammable.
- ✓ You should not use fuels such as petrol on your own, they are really flammable!!!

Procedure:

Making a fuel burner:

In this part you will make the fuel burner you will use for the combustion.

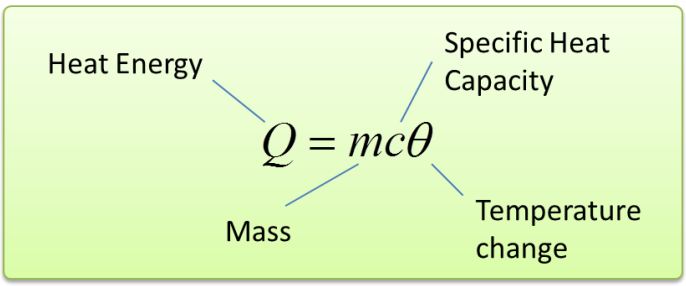
1. Measure 10ml of the biodiesel, you created during the 1st experiment, using a graduated cylinder.
2. Soak entire the wick into the fuel.
3. Use the glass rod to submerge the wick.
4. Position the wick in a crucible in a way that part of it (1/4) is outside the crucible.
5. Cover the top of the crucible with foil so as only the wick is exposed.
   The foil must completely cover the opening.
6. Light the wick and wait for the flame to die down.

Combustion

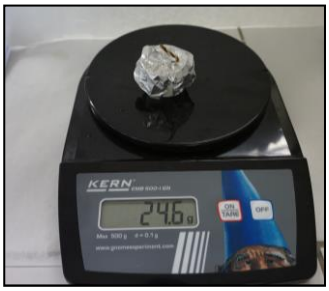
7. Record the mass of the fuel burner, using the scale, on the data table.
8. Measure 200 ml of water using a graduated cylinder.
9. Pour the water into a beaker.
10. Record the mass of water in the beaker on the data table.
    Note: 1 ml H_2O = 1 g H_2O at room temperature
11. Place the beaker on the ring stand carefully.
12. To measure the initial temperature of the water, hold an alcohol thermometer in the water so that it does not touch the sides of the beaker. Record the temperature in the data table.

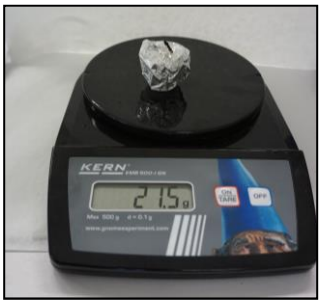
13. Place your fuel burner on a tripod stand under the beaker.
14. Adjust the ring height so that the top of the wick is a measured 3 cm below bottom of the beaker. Center the fuel burner under the beaker.
15. Light the wick using a lighter.
16. Use a thermometer to measure the temperature of the water.
17. Use the thermometer to stir the water periodically.
18. As you burn your fuel make observations on your data table about associated smells, and the nature of the flame and smoke.
19. Continue heating and stirring the water until the temperature has increased by ~25˚C. At that point, record the maximum temperature the water reaches.
20. Remove the beaker from the ring and quickly extinguish the flame by placing another beaker over the wick.

21. Calculate the heat transferred in water by using the formula: Q=mcΔT,
    Specific heat capacity of water: c = 4.186 J/g °C
    Mass of water: m (g)
    ΔT= Change in Temperature (°C)



22. Record the final mass of the fuel burner (with the cap, wick and the remaining fuel) using the balance.
23. Calculate the used mass of the fuel burner.
24. Repeat steps 1- 23 with another fuel (e.g. petrol or ethanol).
25. Answer questions 1-5.





Data collection:

	Biodiesel	**Fuel A** _____	**Fuel B** _____
Initial water temperature			
Final water temperature			
Change in water temperature (ΔT)			
Heat (Q = m c ΔT) (J) c = 4.186 joule/gram °C			
Initial mass of fuel burner			
Final mass of fuel burner			
Mass of fuel burner			
Observations			

Questions:

1. Where did the energy you measured as heat come from?

_____

_____

_____

2. Did you witness complete or incomplete combustion of diesel and biodiesel? How do you know?

_____

_____

_____

3. What did you observe as you mixed the fuel with the alcohol?

_____

_____

_____

4. Can you explain the differences in the combustion results described above?
   (Hint: Look at the molecular formulas of diesel and biodiesel!)

_____

_____

_____

5. What are the comparative advantages of using biodiesel instead of regular diesel?

_____

_____

_____

NAME: _____

DATE: _____

GROUP: _____

SCHOOL: _____

3rd Experiment: *Making your Soap*

Question: **Can glycerin from biodiesel be turned into a liquid soap?**

Background:

By-products retain both financial and environmental value that we can capture through other chemical processes. Biodiesel glycerin is actually a mixture of free fatty acids (FFA) that were neutralized during transesterification, soaps, water, catalyst (NaOH or KOH depending on what was used to make the biodiesel), methanol, and glycerin.
Once the methanol is removed, the glycerin is safe to handle and is suitable for making soap. The remaining contaminates are all ingredients in soap making soap production the easiest way to capture the value of the glycerin. The following lab is designed to show how glycerin, from biodiesel made with KOH, can be turned into a liquid soap with a multitude of uses from hand soap to stainless steel cleaner.

Materials:

- Glycerin (Methanol Removed)
- Essential Oil (optional)
- Coconut Oil
- Citric Acid
- 250 mL graduated cylinder
- Potassium Hydroxide solution (KOH) 9M
- 1,000 mL beaker
- 250 mL beaker x 2
- Pot
- Burner
- Lighter
- Thermometer
- Silicon molds

Safety Rules:

- ✓ You must wear goggles, gloves and an apron.
- ✓ Alcohol is flammable.
- ✓ Potassium hydroxide is corrosive.

Procedure:

1. Heat glycerin and coconut oil in a pot.
2. Stir your mixture.
3. Pour 40ml of hot glycerin into a beaker.
4. Add 40ml of KOH solution into the beaker as well.
5. While stirring you can put essential oil and color to your mixture. (Optional)
6. Pour the mixture into the silicon molds.

Questions:

1. What is the purpose of adding glycerin to the soap? What is the purpose of adding an essential oil?

_____

_____

_____

2. What would happen if we dissolved the soap paste in water?

_____

_____

_____

3. What could this soap be used for?

_____

_____

_____

4. How does making soap fit in with making biodiesel?

_____

_____

_____