

Name:

Date:

Class:

Sunscreen Showdown Worksheet **Example**

Sunscreen “Brand” Name (Cannot be one that already exists): **Safe Screen**

Step 1: Define your criteria and constraints.

How do we know we will be successful? How will you know you are making a good sunscreen emulsion?

Write your class success criteria here:

We have UV protection that is just as good as name brands.

Your group must also choose one extra goal based on who the sunscreen is for. For example, it could be safe for sensitive skin or rub in clear without leaving a white cast. This goal should help guide your design choices.

Write your extra goal below. Write your group’s success criteria here:

Our sunscreen will smell better than leading brand sunscreens so people will prefer to wear it.

What is your engineering group limited by? List your constraints here:

- We only have a few class periods to get this made, so we need to work efficiently.**
- We also are limited by the amount of resources, so we need to be careful not to spill in lab.**

Step 2: Choose your ingredients. Place an “X” in the box next to each ingredient your group will use from the table below.

Component	Sunscreen Emulsion Ingredient Options	Amount Needed
Mineral UV Filter	☒ Zinc Oxide ☐ Titanium Dioxide	0.25 g
Oil Phase	☐ Coconut Oil ☒ Sunflower Oil	2 g
Aqueous Phase	☐ Aloe Vera ☒ Glycerin ☐ Distilled Water	2 g
Emulsifier	☒ Tween 80 ☐ Olivem 1000	0.75 g

Step 3: As a class, collect your control data. Your teacher will now test the UV beads with zero sunscreen for 60 seconds under the UV lamp. Using the UV Scale, you will determine the amount of UV exposure the beads received. Record this below:

Level of UV exposure with no sunscreen: **UV 10**

You will also do this with a name-brand sunscreen using a non-mineral UV filter. Record those results below.

Level of UV exposure with name-brand sunscreen: **UV 1**

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Step 4: Make and test your own sunscreen emulsion. Follow the steps below to make and test your group's sunscreen using the ingredients from Step 2. Record your data for each trial in the table. You may adjust ingredients if your sunscreen doesn't meet your criteria—note any changes in the table. Up to 3 trials are allowed.

Making your sunscreen emulsion:

1. Weigh 0.25 g of your chosen UV filter (like zinc oxide) into a small cup.
 - a. *Tip: "Tare" the scale after placing the cup so you only measure the powder.*
2. Add 2 g of your chosen oil to the same cup.
 - a. *"Tare" the scale again before adding the oil.*
3. Stir thoroughly with a popsicle stick until the UV filter is fully mixed into the oil.
 - a. *This is your "oil phase."*
4. In a new cup, add 2 g of your chosen water-based ingredient (e.g., aloe vera).
 - a. *"Tare" the scale with the empty cup first.*
5. Add 0.75 g of your chosen emulsifier to the same cup.
 - a. *"Tare" the scale again before adding.*
6. Stir well with a clean popsicle stick until the emulsifier is completely mixed in.
 - a. *This is your "aqueous phase."*
7. Combine the two mixtures. Pour the oil phase into the aqueous phase and stir thoroughly with a clean popsicle stick until fully blended. You have made mineral sunscreen! It is now time to test it!

Testing your sunscreen emulsion:

1. Measure 2 g of your finished sunscreen and place it in a clear plastic bag. Spread it out evenly so it forms a thin, smooth layer inside the bag. Zip the bag closed so no air gets in.
2. Place the bag over 10 UV beads. Hold a UV lamp about 5 inches above the bag.
 - a. **Important:** Make sure no one has bare skin under the UV light while it is on.
3. Turn the lamp on for 60 seconds, making sure not to move the bag once it's in place.
4. Turn the lamp off and observe the color of the UV beads. Use the UV Exposure Scale to estimate how much UV light passed through the sunscreen.
5. Record your results in the data table in the correct trial column.
6. Use the remaining sunscreen to test on your skin. Each person in your group should apply a small amount to their arm (only if not allergic to any of the ingredients). Wait 5 minutes, then evaluate the sunscreen:
 - a. Is it sticky?
 - b. Does it leave a white cast?
 - c. Does it meet your success criteria?
7. Record your observations in the data table in the proper trial column.

Estimate your sunscreen SPF

Use the following formula to estimate your sunscreen's SPF and record in the data table:

Estimated SPF = Level of UV Exposure with No Sunscreen 15 ÷ Your Sunscreen Level _____

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Step 5: Record and Analyze your Data

Sunscreen Emulsion Data Table		
Emulsion Trial 1	Emulsion Trial 2	Emulsion Trial 3
Box left intentionally blank	List any changes you made to your emulsion here: Swapped sunflower oil with coconut oil	List any changes you made to your emulsion here: - Swapped zinc oxide with titanium dioxide - Swapped Tween 80 with Olivem 1000
UV Exposure Level: 5	UV Exposure Level: 5	UV Exposure Level: 1
Describe how the sunscreen feels on your skin: - Very chalky - Lots of white chunks - Almost feels like a powder	Describe how the sunscreen feels on your skin: - A little oily but improved from last time - Still some white chunks - Smells much better	Describe how the sunscreen feels on your skin: - Very little to no white chunks - Smells amazing - Does not leave a white paste on the skin
Estimated SPF: $10/5 = 2$	Estimated SPF: $10/5 = 2$	Estimated SPF: $10/1 = 10$
Reflect: Did your sunscreen emulsion meet all of your criteria? Why or why not? What will you change to improve your emulsion? - No, our SPF was not as good as the leading brand we tested. - It also did not smell nice. - We want to change from sunflower oil to coconut oil, as coconut oil smells better.	Reflect: Did your sunscreen emulsion meet all of your criteria? Why or why not? What will you change to improve your emulsion? - Our sunscreen feels and looks better on the skin, though it is still a little chalky - We noticed it smelled very good, so we are sticking with coconut oil. - We want the SPF to improve and get rid of the chunks, so we are switching to titanium dioxide and Olivem 1000 next time. - We are also going to mix for longer.	Reflect: Did your sunscreen emulsion meet all of your criteria? Why or why not? What would you change if you had another trial? We loved our last trial, but we think if we do a combination of zinc oxide and titanium dioxide ($\frac{1}{2}$ and $\frac{1}{2}$) we could eliminate all white chunks, which would make our sunscreen more competitive with leading brands.

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