

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Design a Mexican Lemonade (lim-onade)



Lemonade clipart (2020). Collection of lemonade cliparts. Retrieved on Nov 25, 2019 from: <http://clipart-library.com/lemonade-cliparts.html>

**Food engineers** use ingredients from nature, such as limes and sugar, which may have a natural variability in the amount of taste-inducing particles they contain. For example, one lime might be sourer than another. Then, how can food engineers reproduce a lemonade taste over and over again if the ingredients show variations? **The secret lies in the instruments they use.** An engineer focuses on precision and prefers more exacting instruments than the measuring spoons and cups that a typical cook uses. A scale and a graduated cylinder are examples of these instruments. The scale measures the mass of sugar and the graduated cylinder the volume of lime juice, which are directly related to the number of particles that will give taste to the lemonade (Science Buddies, 2016). Therefore, coming up with an exact formulation for a product is an important task for a food engineer.

**Your engineering design challenge** (Teach Engineering, 2019):

Design the **formula and process** of a **12 oz Mexican lemonade (lim-onade)** with **less than 130 calories** using Mexican limes. The lemonade should be able to compete (e.g., look alike, cheaper, taste better) with other brands in the market such as *Hubert's lemonade* or *Minute Made*. The organization asking for the Mexican lemonade conducted a market investigation and knows there is a niche in the Latino community for this product. Also, this organization follows environmental justice principles (e.g., fair trade, support high-needs communities, environmentally friendly).

 <p>Clipart library (2020). Safety clip art. Retrieved on Nov 5<sup>th</sup> 2019 from: <a href="http://clipart-library.com/work-safety-cliparts.html">http://clipart-library.com/work-safety-cliparts.html</a></p>	<ul style="list-style-type: none"> <li>• Wash your hands repeatedly, especially when start and finish manipulating ingredients.</li> <li>• Clean all the material and surfaces often.</li> <li>• Use clean water.</li> <li>• Wear a mouth cover and cap (or tie your hair in a bun). Avoid talking while you are manipulating ingredients.</li> <li>• All the ingredients are environmentally friendly. You can throw them away in the regular trash. Remember to separate your residuals.</li> </ul>
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### INDIVIDUAL WORK (10'):

1. **Ask:** Every investigation starts with a problem. Define your problem and identify needs and constraints.





6. **Test and evaluate: Measure and record:** Assign a number to your lemonade prototype (use three figures, e.g., 436). We will evaluate all groups' prototypes together (APPENDIX B). We will make a blind comparison between the competitors and the groups' prototypes.

What was your criteria for success?

Blind comparison. Register your results:

What did you learn after the blind comparison?

7. **Improve:** After assessing your Mexican lemonade, plan an improved design. Describe the changes you will implement to your new prototype.

## NEW PROTOTYPE

8. **Test and evaluate: Measure and record:** Assign a number to your NEW lemonade prototype (use three figures, e.g., 436). We will evaluate all groups' prototypes together (APPENDIX B). We will make a blind comparison between the competitors and the groups' prototypes.

What was your criteria for success?

Assessment 2. Blind comparison. Register your results:

What did you learn after the blind comparison?

### Reference:

Teach Engineering (2019). *Engineering design process*. Retrieved on Nov 05, 2019 from: <https://www.teachengineering.org/k12engineering/designprocess>

## APPENDIX A

## FORMULATION REGISTRATION

**List** the ingredients and exact quantities to prepare your lemonade. **Describe** the step-by-step process to prepare it in the following chart.

Names: \_\_\_\_\_

Prototype # \_ \_ \_

<b>Formula</b> <ul style="list-style-type: none"><li>• List of ingredients</li><li>• Weigh → grams</li><li>• Volume → mL</li></ul>	
<b>Process</b> (Step by step) (You can use a flow chart)	

## APPENDIX B

## BLIND COMPARISON – EVALUATION OF PROTOTYPES

**Procedure for the evaluation of prototypes:**

1. Each group will give a number (using three figures) to their original formulation and provide the calculated calories and cost of their prototype.
2. At least three judges will drink all the lemonades (including the competitor) and assess them.
3. We will provide water to the judges to drink after assessing each lemonade.

JUDGE # \_\_\_\_\_

1. Assess each lemonade. You should consider its organoleptic properties, taste, and cost.
2. Use the following scale to assess each lemonade. 4 is excellent and 1 is bad.

Product	Organoleptic properties (e.g., look, smell)				Taste				Cost				Calories			
	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
Prototype (#_ _ _)	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
Prototype (#_ _ _)	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
Prototype (#_ _ _)	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
Prototype (#_ _ _)	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1

3. Which prototype would you prefer to buy in case you want a lemonade? \_\_\_\_\_

APPENDIX C  
"FACTS" SHEETS

**FACT SHEET 1. Other similar products (competitors)**

Competitor	Ingredients	Nutrition facts																																																								
<p>Hubert's lemonade</p>  <p>16 FL oz (473 ml)</p> <p>\$1.79 – Online \$2.29 – Grocery store (QFC)</p>	<p>Pure filtered water, lemon juice from concentrate, cane sugar, citric acid. Natural flavors, stevia leaf extract.</p>	<table border="1"> <thead> <tr> <th colspan="4"><b>Nutrition Facts</b></th> </tr> <tr> <td colspan="4">2 servings per container</td> </tr> <tr> <td colspan="4"><b>Serving Size 8 fl oz (240 mL)</b></td> </tr> <tr> <th></th> <th colspan="2">Per serving</th> <th>Per container</th> </tr> <tr> <td><b>Calories</b></td> <td><b>60</b></td> <td><b>130</b></td> <td></td> </tr> <tr> <td></td> <td>% DV*</td> <td></td> <td>% DV*</td> </tr> <tr> <td><b>Total Fat</b></td> <td>0g</td> <td>0%</td> <td>0g 0%</td> </tr> <tr> <td><b>Sodium</b></td> <td>0mg</td> <td>0%</td> <td>0mg 0%</td> </tr> <tr> <td><b>Total Carb.</b></td> <td>17g</td> <td>6%</td> <td>33g 12%</td> </tr> <tr> <td>Total Sugars</td> <td>15g</td> <td></td> <td>29g</td> </tr> <tr> <td>Incl. Added Sugars</td> <td>15g</td> <td>30%</td> <td>29g 58%</td> </tr> <tr> <td><b>Protein</b></td> <td>0g</td> <td></td> <td>0g</td> </tr> </thead> <tbody> <tr> <td colspan="4"><small>Not a significant source of saturated fat, trans fat, cholesterol, dietary fiber, vitamin D, calcium, iron and potassium.</small></td> </tr> <tr> <td colspan="4"><small>* %DV = %Daily Value</small></td> </tr> </tbody> </table>	<b>Nutrition Facts</b>				2 servings per container				<b>Serving Size 8 fl oz (240 mL)</b>					Per serving		Per container	<b>Calories</b>	<b>60</b>	<b>130</b>			% DV*		% DV*	<b>Total Fat</b>	0g	0%	0g 0%	<b>Sodium</b>	0mg	0%	0mg 0%	<b>Total Carb.</b>	17g	6%	33g 12%	Total Sugars	15g		29g	Incl. Added Sugars	15g	30%	29g 58%	<b>Protein</b>	0g		0g	<small>Not a significant source of saturated fat, trans fat, cholesterol, dietary fiber, vitamin D, calcium, iron and potassium.</small>				<small>* %DV = %Daily Value</small>			
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<p>Minute Maid</p>  <p>12 FL oz</p> <p>\$4.89 12 pack/12 fl oz Can (Target).</p>	<p>Pure filtered water, high fructose corn syrup, lemon juice from concentrate, less than 0.5% of: natural flavors, citric acid (provides tartness), modified corn starch, glycerol ester of rosin, sodium benzoate and potassium sorbate and calcium disodium EDTA (to protect taste), yellow #5.</p>	<table border="1"> <thead> <tr> <th colspan="2"><b>Nutrition Facts</b></th> </tr> <tr> <td colspan="2">1 Serving Per Container</td> </tr> <tr> <td colspan="2"><b>Serving Size 1 can</b></td> </tr> <tr> <td colspan="2">Amount Per Serving</td> </tr> <tr> <td>Calories</td> <td>150</td> </tr> <tr> <td colspan="2">% Daily Value</td> </tr> <tr> <td>Total Fat 0g</td> <td>0%</td> </tr> <tr> <td>Sodium 50mg</td> <td>2%</td> </tr> <tr> <td>Total Carbohydrate 42g</td> <td>15%</td> </tr> <tr> <td>Total Sugars 40g</td> <td></td> </tr> <tr> <td>Includes 40g Added Sugars</td> <td>80%</td> </tr> <tr> <td>Cholesterol 0mg</td> <td>0%</td> </tr> <tr> <td>Protein 0g</td> <td></td> </tr> <tr> <td>Vitamin D</td> <td>0%</td> </tr> <tr> <td>Calcium</td> <td>0%</td> </tr> <tr> <td>Iron</td> <td>0%</td> </tr> <tr> <td>Potassium</td> <td>0%</td> </tr> <tr> <td>Vitamin C</td> <td>4%</td> </tr> </thead> </table>	<b>Nutrition Facts</b>		1 Serving Per Container		<b>Serving Size 1 can</b>		Amount Per Serving		Calories	150	% Daily Value		Total Fat 0g	0%	Sodium 50mg	2%	Total Carbohydrate 42g	15%	Total Sugars 40g		Includes 40g Added Sugars	80%	Cholesterol 0mg	0%	Protein 0g		Vitamin D	0%	Calcium	0%	Iron	0%	Potassium	0%	Vitamin C	4%																				
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## FACT 2. Lime juice nutrition information

Amount per 1 cup (242 g)

Calorie Information		
Amounts Per Selected Serving		%DV
Calories	60.5 (253 kJ)	3%
From Carbohydrate	55.7 (233 kJ)	

[More details](#)

Carbohydrates		
Amounts Per Selected Serving		%DV
Total Carbohydrate	20.4 g	7%
Dietary Fiber	1.0 g	4%
Starch	0.0 g	
Sugars	4.1 g	

[More details](#)

Fats & Fatty Acids		
Amounts Per Selected Serving		%DV
Total Fat	0.2 g	0%
Saturated Fat	0.0 g	0%
Monounsaturated Fat	0.0 g	
Polyunsaturated Fat	0.1 g	
Total trans fatty acids	~	
Total trans-monoenoic fatty acids	~	
Total trans-polyenoic fatty acids	~	

[More details](#)

Protein & Amino Acids		
Amounts Per Selected Serving		%DV
Protein	1.0 g	2%

[More details](#)

Vitamins		
Amounts Per Selected Serving		%DV
Vitamin A	121 IU	2%
Vitamin C	72.6 mg	121%
Vitamin D	~	~
Vitamin E (Alpha Tocopherol)	0.5 mg	3%
Vitamin K	1.5 mcg	2%
Thiamin	0.1 mg	4%
Riboflavin	0.0 mg	2%
Niacin	0.3 mg	2%
Vitamin B6	0.1 mg	5%
Folate	24.2 mcg	6%
Vitamin B12	0.0 mcg	0%
Pantothenic Acid	0.3 mg	3%
Choline	12.3 mg	
Betaine	0.5 mg	

[More details](#)

Minerals		
Amounts Per Selected Serving		%DV
Calcium	33.9 mg	3%
Iron	0.2 mg	1%
Magnesium	19.4 mg	5%
Phosphorus	33.9 mg	3%
Potassium	283 mg	8%
Sodium	4.8 mg	0%
Zinc	0.2 mg	1%
Copper	0.1 mg	3%
Manganese	0.0 mg	2%
Selenium	0.2 mcg	0%
Fluoride	~	

Sterols		
Amounts Per Selected Serving		%DV
Cholesterol	0.0 mg	0%
Phytosterols	~	

[More details](#)

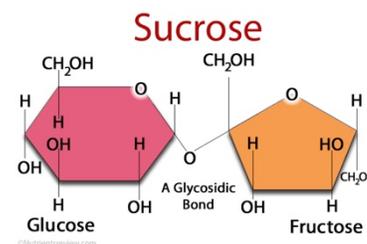
Other		
Amounts Per Selected Serving		%DV
Alcohol	0.0 g	
Water	220 g	
Ash	0.8 g	
Caffeine	0.0 mg	
Theobromine	0.0 mg	

**Reference:** Self nutrition data (2018). *Lime juice. Raw nutrition facts & calories*. Retrieved on Nov 04, 2019 from: <https://nutritiondata.self.com/facts/fruits-and-fruit-juices/1943/2>

### FACT 3. Sucrose nutrition information.

What is sucrose?

Sucrose or saccharose is a **disaccharide** (carbohydrate) composed of **glucose** and **fructose**. Sucrose is a chemical name for table sugar, which can appear as white (purified) or brown sugar.



#### Nutrition Facts:

Calories per gram = 3.9 (1 table spoon = 4 g = 16 Cal)

Glycemic index (GI) = 58-84

Sweetness: more sweet than glucose but less than fructose

Net carbs = 100%

Solubility = It is very soluble in water (1 gr dissolves in 0.5 ml water) and methanol; slightly soluble in ethanol; semi-soluble in lime solutions; insoluble in ethyl ether.

Reference: Nutrients review.com (2016). Sucrose. Retrieved on Nov 04, 2019 from:  
<http://www.nutrientsreview.com/carbs/disaccharides-sucrose.html>

### FACT 4. Packaging

Container (12 oz)	Percentage of total weight	Cost (approx.) (USD per piece)
Aluminum can	5%	\$0.14
Plastic bottle (PET)	7%	\$0.10
Glass bottle	37%	\$0.75
Aseptic package (Tetra pak)	4%	\$0.30*

\* More than a can. The packaging equipment and process should be added.

## FACT 5. Sugar (sucrose) price

Sucrose price: \$0.2619 USD/Kg for Sep 2019.



**Reference:** YCharts (2019). Sugar price. Retrieved on Nov 04, 2019 from: [www.ycharts.com/indicators/world\\_sugar\\_price](http://www.ycharts.com/indicators/world_sugar_price).

## FACT 6. Mexican lime prices and trading margins

Between January and May 2018, the average price paid to lime producers in the citrus regions of Tecoman, Col, went from 9.28 in January to 13.87 in February, it peaked in March when it reached 19.46, and started to decrease in April with 11.87, until reaching the lowest price in the month of May, i.e., 4.45 pesos per kilo. Prices increased in the first months of the year because the fruit is scarce. Meanwhile, in the months of high production (June-October), the price paid to producers falls drastically causing profitability issues.  
Currency: \$1 USD - \$19.17 Mexican peso (11/05/2019)

**Reference:** Freshplaza.com (2019). *Mexican lime prices and trading margins*. Retrieved on Nov 04, 2019 from: [www.freshplaza.com/article/2196241/mexican-lime-prices-and-trading-margins/](http://www.freshplaza.com/article/2196241/mexican-lime-prices-and-trading-margins/)

## FACT 7. Water rates

Base Service Charge per month, per meter  
Effective January 1, 2020:

<b>Water pipe diameter</b>	<b>Inside Seattle</b>	<b>Outside Seattle</b>	<b>Shoreline &amp; Lake Forest Park*</b>
3/4" and less (Most common residential size)	\$18.45	\$21.05	\$22.40
1"	\$19.00	\$21.65	\$23.05
1-1/2"	\$29.35	\$33.45	\$35.60
2"	\$32.50	\$37.05	\$39.40
3"	\$120.30	\$137.15	\$135.90

Residential Commodity Charge per CCF (100 cubic feet)

Effective January 1, 2020:

<b>Seasonal water usage</b>	<b>Inside Seattle</b>	<b>Outside Seattle</b>	<b>Shoreline &amp; Lake Forest Park*</b>
Off-Peak Usage (Sept. 16 - May 15)	\$5.40	\$6.16	\$6.55
Up to 5 CCF per month during peak usage (May 16 - Sept. 15)	\$5.55	\$6.33	\$6.73
Next 13 CCF per month during peak usage (May 16 - Sept. 15)	\$6.86	\$7.82	\$8.32
Over 18 CCF per month during peak usage (May 16 - Sept. 15)	\$11.80	\$13.45	\$14.31

**Reference:** Seattle.gov (2020). Residential Drinking Water Rates. Retrieved on Nov 5, 2019 from: <https://www.seattle.gov/utilities/services/rates/water-rates/residential-water-rates>

## FACTS 8- How do you calculate food calories?

How many calories have your food?

What we commonly call “calorie” refer to **kilocalories** (Kcal).

1 Kcal = 1000 calories.

**Calorie:** the amount of heat needed to elevate 1 gr of water 1 degree Celsius.

Macronutrient	Caloric equivalent
Protein (1 gr)	4 Kcal
Carbohydrates (1 gr)	4 Kcal
Fat (1 gr)	9 Kcal

For example, if your food has 20 gr of protein, 35 gr of CHO, and 15 gr of fat, this is how you calculate the calories:

Macronutrient	Caloric equivalent
Protein (20 gr)	4 Kcal/gr
Carbohydrates (35 gr)	4 Kcal/gr
Fat (15 gr)	9 Kcal/gr

**Solution:**

Macronutrient	Caloric equivalent
Protein	$20 \text{ gr} * 4 \text{ Kcal/gr} = 80 \text{ Kcal}$
Carbohydrates	$35 \text{ gr} * 4 \text{ Kcal/gr} = 140 \text{ Kcal}$
Fat	$15 \text{ gr} * 9 \text{ Kcal/gr} = 135 \text{ Kcal}$
<b>TOTAL</b>	<b>= 625 Kcal</b>

If you sum up all those numbers, you will found that the food has **625 calories** (625 Kcal).

**FACTS 9- How do you convert units?**

$$1 \text{ Kg} = 1000 \text{ g}$$

$$1 \text{ gr} = 1000 \text{ mg}$$

$$1 \text{ L} = 1000 \text{ mL}$$

If you have 350 mL of milk and you want to know how much that in liters (L) is:

$$350 \text{ mL} \cdot \frac{1 \text{ L}}{1000 \text{ mL}} = 0.35 \text{ L}$$