

MOLES AND MOLAR MASS: Composition of Oil

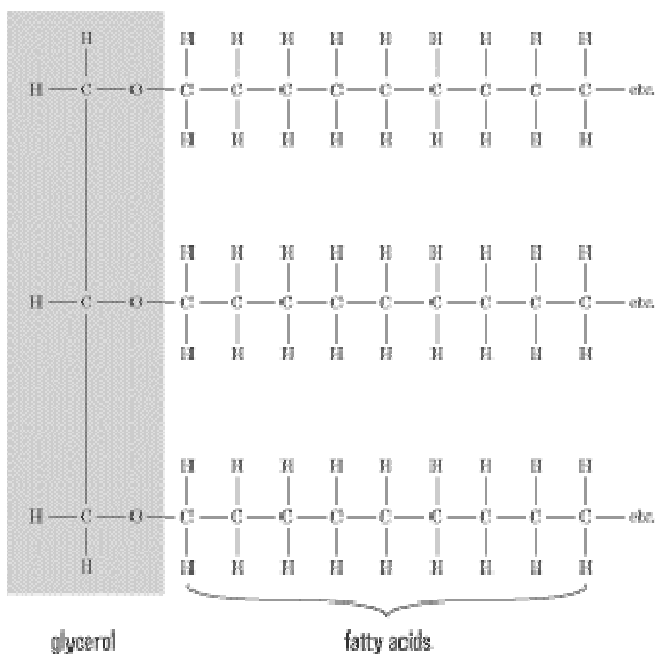
Georgia Performance Standards: SCSH3, SCSH5, SCSH6, SCSH7, SCSH8, SCSH9, SC2c

National Science Standards: Content Standards: A, B: structure and properties of matter

Objective: The students will calculate the molar mass of a specific vegetable oil by looking up the percent composition of the oil and using a weighted average to calculate the molar mass. They will then use the density to calculate how many moles of oil are in 1.0 mL. This information can be used in a future activity.

Essential Questions:

- What are vegetable oils made of?
- How does the density of vegetable oil compare to water?
- How do the molar masses of the different vegetable oils compare?



Background: Vegetable oils are made up of very large molecules called triglycerides, or fatty acids. These acids contain a large number of carbon and hydrogen atoms and may contain double bonds. Fatty acids containing double bonds are called unsaturated fats. Acids containing only single bonds are called saturated fats. Each vegetable oil contains different percentages of these large fatty acid molecules. You will often see these fatty acids listed as C18:0 or C18:1. The number after the C is the number of carbons present, and the number after the colon is

the number of double bonds present. C18:0 is Stearic Acid and C18:1 is Oleic Acid (found in olive oil). Oleic acid contains one double bond and therefore is considered an unsaturated fat (a monounsaturated fat since there is one double bond). Since each carbon atom needs four bonds, the number of hydrogen atoms in the molecule can be calculated. Each carbon is given enough hydrogen atoms to make four bonds.

Procedure: You will be calculating the average molar mass of soybean oil, canola oil, and peanut oil.

Peanut oil contains: 11% palmitic acid, 2% stearic acid, 48% oleic acid, 32% linoleic acid. The remaining 7% of the oil is composed of a mixture of behenic, lignoceric and cerotinic acids.

Soybean oil contains: 22% oleic acid, 54% linoleic acid, 7.5% linolenic acid, 11% palmitic acid, 4.1% stearic acid. The remaining 1.4% is composed of lauric, myristic, arachidic and palmitoleic acids.

Canola oil contains: 57% oleic acid, 23% linoleic acid, 15% linolenic acid, 2% erucic acid. The remaining 3% is composed of palmitic, stearic, arachidic and behenic acids.

Your first task is to use the internet to find the formulas for the molecules and then calculate the molar masses of each acid. You will then use the molar masses of each acid and the percentage to calculate the average molar mass for the whole oil. You will use a weighted average.

Your second task is to write a procedure for measuring the density of the three oils in the lab. Have your procedure checked over by your instructor and then use the lab equipment to actually measure the density of the three oils.

Your third task is to calculate the answer to: How many moles of oil are in one milliliter of that oil (there will be three calculations, one for each oil)?

Materials:

1. computers with internet connections
2. Soybean, Canola and Peanut oils
3. graduated cylinders
4. balances
5. 50 mL beakers

Assessment: Lab rubric

Questions:

1. Compare and contrast the differences in molar masses of the three oils.
2. Compare and contrast the differences in densities of the three oils.
3. Compare and contrast the amount of moles of each oil in 1.0 mL.

Lab Data Sheet – Moles (Page 1)

Peanut Oil:

Fatty Acid	Formula	Molar Mass	Percentage
Palmitic			11%
Stearic	C18:0		2%
Oleic			48%
Linoleic			32%
Behenic			7%
Lignoceric			
Ceroticinic			

Soybean Oil:

Fatty Acid	Formula	Molar Mass	Percentage
Oleic			22%
Linoleic			54%
Linolenic			7.5%
Palmitic			11%
Stearic			4.1%
Lauric			1.4%
Myristic			
Arachidic			
Palmitoleic			

Canola Oil:

Fatty Acid	Formula	Molar Mass	Percentage
Oleic			57%
Linoleic			23%
Linolenic			15%
Erucic			2%
Palmitic			3%
Stearic			
Arachidic			
Behenic			

Lab Data Sheet- Moles (Page 2)

Calculation of Average Molar Mass of the Oil:

Peanut Oil:

Soybean Oil:

Canola Oil:

Density Data:

Oil	Mass	Volume	Density
Peanut			
Soybean			
Canola			

Calculations of Densities:

Peanut Oil:	
Soybean Oil:	
Canola Oil:	

Mole Calculations: How many moles of oil are in 1.0 mL of oil?

MOLES AND MOLAR MASS: Instructor Notes

You will probably need to show them an example calculation for molar mass.

Example: Olive Oil

Fatty Acid	Formula	Molar Mass	Percentage
Oleic	C18:1	282.34 g/mol	85%
Linoleic	C18:2	280.45 g/mol	9%
Linolenic	C18:3	278.43 g/mol	1.5%
Palmitic	C16:0	256.42 g/mol	4.5%
Heptadecanoic Acid	C17:0	270.39 g/mol	
Arachidic	C20:0	312.53 g/mol	

$(\text{Palmitic} + \text{Heptadecanoic} + \text{Arachidic})/3 = (256.42 + 270.39 + 312.53)/3 = 279.78$

$(0.850 * 282.34) + (0.0900 * 280.45) + (0.0150 * 278.43) + (0.0450 * 279.78) = 282 \text{ g/mol}$

Percentages of fatty acids in oils can differ from sample to sample so information on the internet could be very different for each oil.

Suggested websites for finding information:

<http://www.wikipedia.com>

<http://www.chemfinder.com>