SI Chemistry - Full Discipline Demo

Calculating Carbohydrate Content

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Chemistry - Full Discipline Demo
Course	SI Chemistry - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Rank the drinks from least to greatest concentration of Calories.

≡ Arizona Lemon Ice Tea - 90 Cal in 240 mL

1 **Correct answer:**

Capri Sun - 70 Cal in 200 mL

≡ Capri Sun - 70 Cal in 200 mL

2 **Correct answer:**

Mike’s Hard Lemonade - 120 Cal in 330 mL

≡ Mike’s Hard Lemonade - 120 Cal in 330 mL

3 **Correct answer:**

Arizona Lemon Ice Tea - 90 Cal in 240 mL

≡ Minute Maid Orange Juice - 96 Cal in 240 mL

4 **Correct answer:**

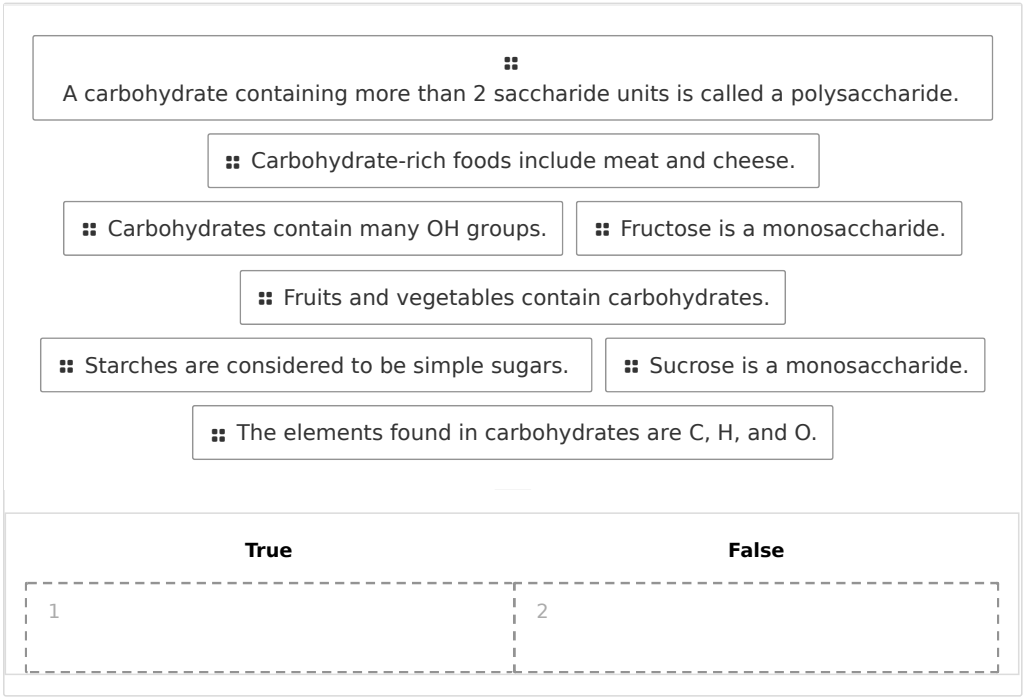
Minute Maid Orange Juice - 96 Cal in 240 mL

≡ Nesquik Chocolate Milk - 116 Cal in 240 mL

5 **Correct answer:**

Nesquik Chocolate Milk - 116 Cal in 240 mL

Classify each statement as true or false.



Correct answers:

1 Carbohydrates contain many OH groups. Fructose is a monosaccharide.

Fruits and vegetables contain carbohydrates.

The elements found in carbohydrates are C, H, and O.

2 Carbohydrate-rich foods include meat and cheese.

A carbohydrate containing more than 2 saccharide units is called a polysaccharide.

Starches are considered to be simple sugars. Sucrose is a monosaccharide.

Complete each sentence.

carbohydrates | density | distilled water | hydrometer | juice | test substance

A 1 [ ] is a tool used to compare the density of a 2 [ ] to the density of a standard substance.

As sugar (carbohydrate) content increases in a test substance, the 3 [ ] of the substance increases.

4 [ ] can act as a standard substance because it contains no carbohydrates.

Test liquids can include 5 [ ].

Thus, a hydrometer can be used to draw conclusions about the amount of 6 [ ] in drinks.

Correct answers:

1 hydrometer 2 test substance 3 density 4 distilled water 5 juice 6 carbohydrates

Exploration

Carbohydrates are composed of _____.

- carbon
- carbon and hydrogen
- carbon, hydrogen, and oxygen ✔
- carbon, nitrogen, oxygen, and hydrogen

An example of a starch is sucrose, a combination of fructose and glucose.

- True
- False ✔

Methods of carbohydrate analysis include _____.

- taste methods
- enzymatic methods ✔
- smell methods
- calculation methods

A hydrometer is a tool used to compare the _____ of a test liquid to the _____ of a standard substance.

- density; density ✔
- volume; volume
- volume; density
- density; volume

Exercise 1

Using the graph that you created in Graph 1 as a reference, where should the reference graduated pipet float if the solution was a 13.0% sugar solution? How do you know this?

For our results, it should float at 15.0 mL. Students answers will vary based on their values recorded in Data Table 1.

Using the graph that you created in Graph 1 as a reference, determine the carbohydrate content of the three beverages that you measured with your hydrometer.

Using our data, the Mountain Dew was measured as an 13.2% carbohydrate solution; the apple juice was also measured as a 10.4% carbohydrate solution, and the Diet Mountain Dew was measured as a 4.5% carbohydrate solution. Student answers will vary based on their data.

Describe how your results compare to those listed on the food labels for the three beverages (recorded in Data Table 2). Calculate the percent error for each and show your work.

Student answers will vary depending on the beverages that the student chooses. Use the graph in Graph 1 and the data from Data Table 2 to confirm their answer to this question. Our data resulted in an average carbohydrate percent of 13.2% compared to the food label statement of 10.0% for Mountain Dew®; an average carbohydrate percent of 10.4% compared to the food label statement of 9.0% for apple juice; and an average carbohydrate percent of 4.5% compared to the food label statement of 0.0% for Diet Mountain Dew®.

Percent Error for Mountain Dew®: |13.2-10.0|/10.0 x100% = 32.0%

Percent Error for apple juice: |1.04-9.0|/9.0 x100% = 15.6%

Percent Error for Diet Mountain Dew®: |4.5-0.0|/0.0 x100% = undefined (due to division by zero)

What is a monosaccharide and what is its chemical composition?

The simplest form of a carbohydrate, or one unit of a sugar. A typical monosaccharide consists of an aldehyde (R-CHO) orketone R-C(=O)-R’ with many hydroxyl groups, usually with a hydroxyl group on each carbon that is not part of the aldehyde or ketone group.

Why do food industries need to determine carbohydrate content? How many Calories are in 1 gram of carbohydrates?

The FDA requires carbohydrate content to be shown on food labels. Four Calories are in 1 gram of carbohydrates.

How are carbohydrates separated from fats and proteins in foods that contain all three macronutrients?

Fats can be separated from carbohydrates and proteins because fats are insoluble in water. Then, monosaccharides and oligosaccharides can be separated from proteins and polysaccharides because they are soluble in a hot 80% ethanol solution.

Describe two methods for calculating carbohydrate content that were not used in this laboratory.

Methods of carbohydrate analysis include chromatographic methods (color tests), electrophoretic methods (electrical separation tests), enzymatic methods (using an enzyme to cause a reaction and then quantify it), physical methods (using polarization, refractive index, density, and infrared absorption), and immunoassays (antibodies from animals used to determine concentrations of carbohydrates).

Define the relative density of a substance. Describe how you used the relative density to determine the carbohydrate content of the three unknown substances.

The relative density is the ratio of the density of a substance to the density of a “standard” substance. Students created a simple hydrometer to compare the density of a liquid to the density of water.

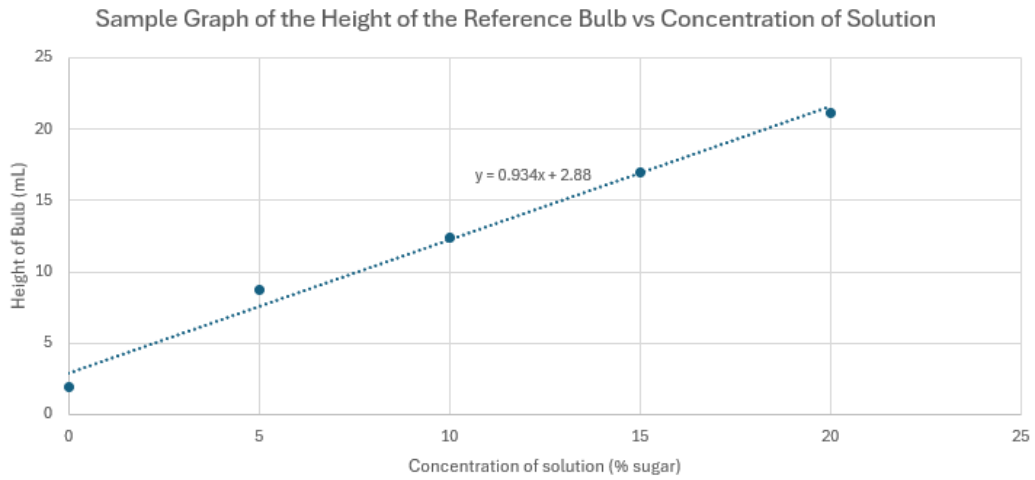
Data Table1: Height (mL) for Stock Sugar Solutions

(SAMPLE ANSWER BELOW)

Sugar Solution Concentration	Trial 1	Trial 2	Trial 3	Average of Trials
0.0% Solution	1.9	1.8	2.0	1.9
5.0% Solution	8.3	9.0	8.9	8.7
10.0% Solution	12.6	12.1	12.6	12.4
15% Solution	17.2	16.9	17.0	17.0
20.0% Solution	21.4	20.7	21.2	21.1

Graph 1: Sugar Solution Concentration vs. Bulb Height Volume

(SAMPLE ANSWER BELOW)



Data Table 2: Height (mL) for Test Substances
(SAMPLE ANSWER BELOW)

Beverage Description and % Carbohydrate (according to Label)	Trial 1	Trial 2	Trial 3	Average of Trials
Regular Soda Description: Mountain Dew % Carb: 10.0	11.2	11.0	11.1	11.1
Juice Description: Apple % Carb: 9.0	8.5	8.4	8.3	8.4
Diet Soda or Juice Description: Diet Mountain Dew % Carb: 0.0	1.5	2.0	1.7	1.7

Competency Review

An example chemical formula for a carbohydrate is _____.

- $C_3(6H_2O)_{12}$
- $C_4(H_3O)_{12}$
- $C_2(H_2O_2)$
- $C_6(H_2O)_5$ ✔

A carbohydrate is a(n) _____ substance.

- hydrophobic
- metallic
- inorganic
- organic ✔

Glucose and fructose bond together to form the disaccharide ____.

- sucrose ✔
- fructase
- glucase
- starch

A single-unit sugar molecule is called a ____.

- disaccharide
- polysaccharide
- glycogen
- monosaccharide ✔

One method for measuring the carbohydrate content of foods is to ____.

- use peptide indicators
- perform taste tests
- use electrophoretic methods (electrical separation tests) ✔
- use sodium hydroxide

The first step in analyzing carbohydrate content is ____.

- to separate fats and proteins from the food being analyzed ✔
- performing a qualitative test
- using enzymes to cause reactions to occur and then quantifying results
- using a refractive index to quantify results

A hydrometer is a tool used to compare the _____ of solutions.

- volume
- mass
- specific gravity ✔
- weight

The homemade hydrometer used in this lab uses _____ as a standard.

- soda
- distilled water ✔
- diet soda
- juice

A scientist would like to create a calibration curve that will help estimate the concentration of carbohydrates in various sodas. To create the curve, the scientist must collect data using known amounts of _____.

- salt and water
- acids and bases
- food coloring
- sugar and water ✔

Jan is creating a homemade hydrometer out of a graduated cylinder and a long-stem pipet. She wants to determine how much sugar is in Bing energy drink. What liquid should she put in the pipet?

- the energy drink
- distilled water ✔
- a stock sugar solution
- tap water

Extension Questions

A student calculated the carbohydrate content of an unopened refrigerated soft drink instead of one that had remained opened at room temperature as instructed. What effect would the difference in temperature and the gas bubbles have on the determination of sugar content in the soft drink? Be very specific in your answer, explaining why the sugar content will be artificially high or low when this error is made. (SAMPLE ANSWER BELOW)

There are two factors to consider: the temperature of the soft drink and the presence of gas bubbles. The colder temperature will result in a higher density and cause the hydrometer to float a bit higher and give a high % sugar. However, the presence of gas in the solution lowers the density a bit and would lead to a lower % sugar. In addition, the gradual release of gas bubbles during the measuring process will make it challenging to read the hydrometer level accurately. Overall, I believe that the impact of the gas bubbles is greater than that of the temperature and the % sugar determination will be artificially low.