

# A Check on the Density of Maple Syrup

## The Task

Students were given a standard solution and three solutions of unknown density. Their assignment was to:

- determine if the unknown solutions had a density greater than, equal to, or less than the standard solution;
- determine which one of the unknown solutions had the same density as the standard solution;
- determine numerically the density of the unknown solution that had the same density as the standard solution;
- explain clearly, using appropriate language for an audience of younger students, (a) how they used the equipment to determine the actual density of one of the unknown sample solutions, and (b) what skills are required to perform the work of a quality control technician and why that job is important.

Students recorded the results of their investigations in a student booklet.

## Expectations

This task gave students the opportunity to demonstrate achievement of the following selected expectations from the strand Chemistry: Atoms and Elements.

*Students will:*

1. solve density problems – given any two of mass, volume, and density, determine the third – using the formula  
$$\text{density} = \frac{\text{mass}}{\text{volume}}$$
 and appropriate SI units;
2. demonstrate the skills required to plan and conduct an inquiry into the properties of elements and compounds, using instruments, tools, and apparatus safely, accurately, and effectively;
3. gather and record qualitative and quantitative data using an appropriate format, and analyse the data to explain how the evidence gathered supports or refutes an initial hypothesis;
4. communicate scientific ideas, procedures, results, and conclusions using appropriate SI units, language, and formats, and evaluate the processes used in planning, problem solving, decision making, and completing the task;
5. investigate potential careers associated with an understanding of the physical and chemical properties of elements and compounds.

### **Prior Knowledge and Skills**

To complete this task, students were expected to have some knowledge or skills relating to the following:

- the concepts of density and of variables
- collecting, recording, and interpreting data
- distinguishing between qualitative and quantitative measurements
- measuring with a balance and a graduated cylinder, transferring liquids with an eyedropper, and recognizing the degree of accuracy possible in reading scales and meniscuses
- applying the mathematical formula  $D = \frac{m}{V}$  and using it to calculate density

*For information on the process used to prepare students for the task and on the materials and equipment required, see the Student Task Description on page 16 and the Teacher Package reproduced on pages 49–51.*

## Task Rubric – A Check on the Density of Maple Syrup

Expectations*	Criteria	Level 1	Level 2	Level 3	Level 4
<b>Knowledge/Understanding</b>					
<b>The student:</b>					
1	<ul style="list-style-type: none"> <li>– demonstrates an understanding of the concept of density</li> <li>– applies formula (<math>D = \frac{m}{V}</math>) to determine density competently</li> </ul>	<ul style="list-style-type: none"> <li>– demonstrates a limited understanding of the concept of density</li> <li>– applies formula with limited competence</li> </ul>	<ul style="list-style-type: none"> <li>– demonstrates some understanding of the concept of density</li> <li>– applies formula with some competence</li> </ul>	<ul style="list-style-type: none"> <li>– demonstrates a considerable understanding of the concept of density</li> <li>– applies formula with considerable competence</li> </ul>	<ul style="list-style-type: none"> <li>– demonstrates a thorough understanding of the concept of density</li> <li>– applies formula with a high degree of competence</li> </ul>
<b>Inquiry</b>					
<b>The student:</b>					
2, 3, 4	<ul style="list-style-type: none"> <li>– interprets data on density/ranking/layering accurately</li> <li>– uses technical skills and procedures accurately to determine density</li> <li>– draws a conclusion that is supported by the data</li> </ul>	<ul style="list-style-type: none"> <li>– interprets data with limited accuracy</li> <li>– uses skills and procedures with limited accuracy</li> <li>– draws a conclusion supported in a limited way by the data</li> </ul>	<ul style="list-style-type: none"> <li>– interprets data with some accuracy</li> <li>– uses skills and procedures with some accuracy</li> <li>– draws a conclusion supported to some degree by the data</li> </ul>	<ul style="list-style-type: none"> <li>– interprets data with considerable accuracy</li> <li>– uses skills and procedures with considerable accuracy</li> <li>– draws a conclusion supported to a considerable degree by the data</li> </ul>	<ul style="list-style-type: none"> <li>– interprets data with a high degree of accuracy</li> <li>– uses skills and procedures with a high degree of accuracy</li> <li>– draws a conclusion supported to a high degree by the data</li> </ul>
<b>Communication</b>					
<b>The student:</b>					
3, 4	<ul style="list-style-type: none"> <li>– communicates observations and information clearly</li> <li>– displays data in complete, well-organized charts</li> <li>– uses scientific terms and SI units/styles appropriately and accurately</li> </ul>	<ul style="list-style-type: none"> <li>– communicates observations and information with limited clarity</li> <li>– makes incomplete charts that show limited organization</li> <li>– uses scientific terms and SI units with limited appropriateness and accuracy</li> </ul>	<ul style="list-style-type: none"> <li>– communicates observations and information with moderate clarity</li> <li>– makes partially complete, partially organized charts</li> <li>– uses scientific terms and SI units with some appropriateness and accuracy</li> </ul>	<ul style="list-style-type: none"> <li>– communicates observations and information with considerable clarity</li> <li>– makes mostly complete, mostly organized charts</li> <li>– uses scientific terms and SI units with considerable appropriateness and accuracy</li> </ul>	<ul style="list-style-type: none"> <li>– communicates observations and information with a high degree of clarity</li> <li>– makes very complete, very well organized charts</li> <li>– uses scientific terms and SI units with a high degree of appropriateness and accuracy</li> </ul>

<b>Expectations*</b>	<b>Criteria</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
<b>Communication (cont.)</b>					
<b>The student:</b>					
	– communicates for different audiences and purposes	– communicates with a limited sense of audience and purpose	– communicates with some sense of audience and purpose	– communicates with a considerable sense of audience and purpose	– communicates with a strong sense of audience and purpose
<b>Making Connections</b>					
<b>The student:</b>					
<b>2, 5</b>	– analyses production requirements – shows awareness of the skills required for the occupation of quality control technician	– provides a limited analysis of requirements – shows limited awareness of the skills required	– provides some analysis of requirements – shows some awareness of the skills required	– provides an adequate analysis of requirements – shows considerable awareness of the skills required	– provides a thorough analysis of requirements – shows a high degree of awareness of the skills required

\* The expectations that correspond to the numbers given in this chart are listed on page 12.

*Note:* A student whose overall achievement at the end of a course is below level 1 (that is, below 50%) will not obtain a credit for the course.

# Student Task Description

## A Check on the Density of Maple Syrup

*You have studied the concept of density and have had practice in using the apparatus and procedures necessary to determine the density of a liquid. This task will give you the opportunity to conduct a qualitative investigation and then to confirm your findings by taking measurements in a quantitative investigation.*

Maple syrup is prepared by evaporating most of the water from sap collected from maple trees. Government regulations require that the minimum density of a product must be 1.1 g/mL, indicating a specific sugar concentration, in order to be labelled as “Genuine Maple Syrup”.

Quality control technicians at Confederation Maple Syrup Co. do qualitative checks each hour on the syrup being produced. They test to see if the density meets the minimum government regulations. They have a standard solution of the minimum density that is coloured “yellow” with food colouring.

### A. Hourly Qualitative Check

Samples from different evaporators in the factory are given identifying colours. Today, samples of unknown density from three different evaporators have just arrived. The samples are coloured to identify their source. These samples are coloured “red”, “blue”, and “green”. You, as a technician, are going to do a simple qualitative test to see if the unknowns have a density greater than, equal to, or less than the standard solution.

### B. Daily Quantitative Check

Each day the technicians also do a quantitative check on the company product. You will also be doing this test.

### C. Tours

Several times a month, school groups tour the Confederation Maple Syrup Co. Since density is a topic in Grade 5 science, these classes often stop at the quality control labs. You will be asked to make a presentation to them (see question 8).