Ministry of Education

Ontario

The Ontario Curriculum

Exemplars

Grade 9

Science

Samples of Student Work:
A Resource for Teachers

2000

Contents

Une publication équivalente est disponible en français sous le titre suivant :
Le curriculum de l'Ontario : Copies types de 9e année – Sciences, 2000.

This publication is available on the Ministry of Education's website
at http://www.edu.gov.on.ca.

Introduction

In 1999, the Ministry of Education published a new curriculum for Ontario secondary school students in Grades 9 and 10. The new curriculum is more specific than previous curricula with respect to both the knowledge and the skills that students are expected to develop and demonstrate in each grade. In the curriculum policy document for each discipline, teachers are provided with the curriculum expectations for each course within the discipline and an achievement chart that describes four levels of student achievement to be used in assessing and evaluating student work.

The document entitled *The Ontario Curriculum, Grades 9–12: Program Planning and Assessment, 2000* states that "assessment and evaluation will be based on the provincial curriculum expectations and the achievement levels outlined in this document and in the curriculum policy document for each discipline" (p. 13). The document also states that the ministry is providing a variety of materials to assist teachers in improving their assessment methods and strategies and, hence, their assessment of student achievement. The present document is one of the resources intended to provide assistance to teachers in their assessment of student achievement. It contains samples ("exemplars") of student work at each level of achievement.

Ontario school boards were invited by the ministry to participate in the development of exemplars. Forty-seven district school boards responded to this invitation. Teams of subject specialists from across the province were involved in developing the assessment materials. They designed the performance tasks and scoring scales ("rubrics") based on selected Ontario curriculum expectations, field-tested them in classrooms, suggested changes, administered the final tasks, marked the student work, and selected the exemplars used in this document. During each stage of the process, external validation teams reviewed the subject material to ensure that it reflected the expectations in the curriculum and that it was accessible to and appropriate for all students. Ministry staff who had been involved in the development of the curriculum policy documents also reviewed the tasks, rubrics, and exemplars.

The selection of student samples that appears in this document reflects the professional judgement of teachers who participated in the project. No students, teachers, or schools have been identified.

The procedures followed during the development and implementation of this project will serve as a model for boards, schools, and teachers in designing assessment tasks within the context of regular classroom work, developing rubrics, assessing the achievement of their own students, and planning for the improvement of students' learning.

The samples in this document will provide parents[1] with examples of student work to help them monitor their children's progress. They also provide a basis for communication with teachers.

Use of the exemplar materials will be supported initially through provincial in-service training. A variety of additional opportunities (e.g., discipline- or subject-specific workshops and summer institutes) will be available to secondary school teachers to support the use of the exemplars.

Purpose of This Document

This document was developed to:

- show the characteristics of student work at each of the four levels of achievement for Grade 9;
- promote greater consistency in the assessment of student work across the province;
- provide an approach to improving student learning by demonstrating the use of clear criteria applied to student work in response to clearly defined assessment tasks;
- show the connections between what students are expected to learn (the curriculum expectations) and how their work can be assessed using the levels of achievement described in the curriculum policy document for the subject.

Teachers, parents, and students should examine the student samples in this document and consider them along with the information in the Teacher's Notes and Comments/Next Steps sections. They are encouraged to examine the samples in order to develop an understanding of the characteristics of work at each level of achievement in Grade 9 and the ways in which the levels of achievement reflect a progression in the quality of knowledge and skills demonstrated by the student.

The samples in this document represent examples of student achievement obtained using only one method of assessment, called performance assessment. Teachers will also make use of a variety of other assessment methods and strategies in evaluating student achievement in a course over a term or school year.

Features of This Document

This document contains the following:

- a description of each performance task, as well as the curriculum expectations related to the task
- the task-specific assessment chart, or rubric
- two samples of student work for each of the four levels of achievement
- Teacher's Notes, which provide some details on the level of achievement for each sample
- Comments/Next Steps, which offer suggestions for improving achievement
- the Teacher Package that was used by teachers in administering the task

It should be noted that *each sample* for a specific level of achievement represents the characteristics of work at that level of achievement.

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1. In this document, *parent(s)* refers to parent(s) and guardian(s).

The Tasks

The performance tasks for science were based directly on curriculum expectations selected from the Grade 9 courses in the policy document for science. The tasks encompassed the four categories of knowledge and skills in science (i.e., Knowledge/ Understanding, Inquiry, Communication, and Making Connections), requiring students to integrate their knowledge and skills in meaningful learning experiences. The tasks gave students an opportunity to demonstrate not only how well they had learned to use the required knowledge and skills in one context, but how well they could use their knowledge and skills in another context.

Teachers were required to explain the scoring criteria and descriptions of the levels of achievement (i.e., the information in the task rubrics) to the students before they began the assignment (for the rubrics, see pages 14 and 56).

The Rubrics

In this document, the term *rubric* refers to a scoring scale that consists of a set of achievement criteria and descriptions of the levels of achievement for a particular task. The scale is used to assess students' work; this assessment is intended to help students improve their performance level. The rubric identifies key criteria by which students' work is to be assessed, and it provides descriptions that indicate the degree to which the key criteria have been met. The teacher uses the descriptions of the different levels of achievement given in the rubric to assess student achievement on a particular task.

The rubric for a specific performance task is intended to provide teachers and students with an overview of the expected final product with regard to the knowledge and skills being assessed as a whole.

The achievement chart in the curriculum policy document for science provides a standard province-wide tool for teachers to use in assessing and evaluating their students' achievement over a period of time. While the chart is broad in scope and general in nature, it provides a reference point for all assessment practice and a framework within which to assess and evaluate student achievement. The descriptions associated with each level of achievement serve as a guide for gathering and tracking assessment information, enabling teachers to make consistent judgements about the quality of student work while providing clear and specific feedback to students and parents.

For the purposes of the exemplar project, a single rubric was developed for a performance task in each course. This task-specific rubric was developed in relation to the achievement chart in the curriculum policy document.

The differences between the achievement chart and the task-specific rubric may be summarized as follows:

– The achievement chart contains broad descriptions of achievement. Teachers use it to assess student achievement over time, making a summative evaluation that is based on the total body of evidence gathered through using a variety of assessment methods and strategies.

– The rubric contains criteria and descriptions of achievement that relate to a specific task. The rubric uses some terms that are similar to those in the achievement chart but focuses on aspects of the specific task. Teachers use the rubric to assess student achievement on a single task.

The rubric contains the following components:

– an identification (by number) of the expectations on which student achievement in the task was assessed
– the four categories of knowledge and skills
– the relevant criteria for evaluating performance of the task
– descriptions of student performance at the four levels of achievement (level 3 on the achievement chart is considered to be the provincial standard)

As stated earlier, the focus of performance assessment using a rubric is to improve students' learning. In order to improve their work, students need to be provided with useful feedback. Students find that feedback on the strengths of their achievement and on areas in need of improvement is more helpful when the specific category of knowledge or skills is identified and specific suggestions are provided than when they receive only an overall mark or general comments. Student achievement should be considered in relation to the criteria for assessment stated in the rubric for each category, and feedback should be provided for each category. Through the use of a rubric, students' strengths and weaknesses are identified and this information can then be used as a basis for planning the next steps for learning. In this document, the Teacher's Notes section indicates the reasons for assessing a student's performance at a specific level of achievement, and the Comments/Next Steps section indicates suggestions for improvement.

In the exemplar project, a single rubric encompassing the four categories of knowledge and skills was used to provide an effective means of assessing the particular level of student performance in the performance task, to allow for consistent scoring of student performance, and to provide information to students on how to improve their work. However, in the classroom, teachers may find it helpful to make use of additional rubrics if they need to assess student achievement on a specific task in greater detail for one or more of the four categories. For example, it may be desirable in evaluating an oral report to use one rubric for the content (Knowledge/Understanding), one for the research (Inquiry), one for the writing of the report and the delivery of the oral presentation (Communication), and one for relating aspects of science to specific issues (Making Connections).

The rubrics for the tasks in the exemplar project are similar to the scales used by the Education Quality and Accountability Office (EQAO) for the Grade 3, Grade 6, and Grade 9 provincial assessments in that both the rubrics and the EQAO scales are based on the Ontario curriculum expectations and the achievement charts. The rubrics differ from the EQAO scales in that they were developed to be used only in the context of classroom instruction to assess achievement in a particular assignment in a course.

Although rubrics were used effectively in this exemplar project to assess responses related to the performance tasks, they are only one way of assessing student achievement. Other means of assessing achievement include observational checklists, tests, marking schemes, or portfolios. Teachers may make use of rubrics to assess students' achievement on, for example, essays, reports, exhibitions, debates, conferences, interviews, oral presentations, recitals, two- and three-dimensional representations, journals or logs, and research projects.

Development of the Tasks

The performance tasks for the exemplar project were developed by teams of subject specialists in the following way:

– The teams selected a cluster of curriculum expectations that focused on the knowledge and skills in the course that are considered to be of central importance in the subject. Teams were encouraged to select a manageable number of expectations to enable teachers to focus their feedback to students. The particular selection of expectations ensured that all students in the course would have the opportunity to demonstrate their knowledge and skills in each category of the achievement chart in the curriculum policy document for the subject. Different tasks were developed for the academic courses and applied courses.

– For each course, the teams drafted two tasks that would encompass all of the selected expectations and that could be used to assess the work of all students in the course. (Only one of these tasks would eventually be used for the final administration of the task.)

– The teams established clear, appropriate, and concrete criteria for assessment, and wrote the descriptions for each level of achievement in the task-specific rubric, using the achievement chart for the subject as a guide.

– The teams prepared detailed instructions for both teachers and students participating in the assessment project.

– The two tasks were field-tested in classrooms across the province – one in the fall of 1999, the other in the winter of 2000 – by teachers who had volunteered to participate in the field test. Student work was scored by teams of teachers of the subject. In addition, classroom teachers, students, and board contacts provided feedback on the task itself and on the instructions that accompanied the task. Suggestions for improvement were taken into consideration in the revision of the tasks, and the feedback helped to determine which of the two tasks would actually be used for the final administration of the tasks in May 2000.

In developing the tasks, the teams ensured that the resources needed for completing the task – that is, all worksheets and support materials – were provided. It was also suggested that students could consult the teacher-librarian at the school about additional print and electronic materials.

Prior to both the field tests and the final administration of the tasks, a team of validators – including research specialists, gender and equity specialists, and subject experts – reviewed the instructions in the teacher and student packages, making further suggestions for improvement.

Assessment and Selection of the Samples

After the final administration of the tasks, student work was scored by trained board personnel. The student samples were then forwarded to the ministry, where a team of teachers from across the province, who had been trained by the ministry to assess achievement on the tasks, scored and selected the student samples that would serve as the exemplars for each level of achievement.

The rubrics were the primary tool used to evaluate student work at both the district school board level and the provincial level. The samples that appear in this document were selected in the following way:

- At the district school board level, after some training was provided, teachers of the subject evaluated and discussed the student work until they were able to reach a consensus regarding the level to be assigned for achievement in each category. This evaluation was done to ensure that the student work being selected clearly illustrated that level of performance.
- Student work was then sorted into two groups: (1) work that demonstrated the same level of achievement in all four categories; and (2) work that demonstrated achievement at more than one level over the four categories.
- All the samples were submitted to a provincial selection team of teachers, who re-scored and validated the samples of work that demonstrated the same level of achievement in all four categories, and chose, through consensus, two samples that best represented the characteristics of work at that level.

The following points should be noted:

- Two samples of student work are included for each of the four achievement levels in each subject for which there is written work. The use of two samples is intended to show that the characteristics of an achievement level can be exemplified in different ways.
- Although the samples of student work in this document were selected to show a level of achievement that was largely consistent in the four categories of Knowledge/Understanding, Inquiry, Communication, and Making Connections, teachers using rubrics to assess student work will notice that students' achievement frequently varies across the categories (e.g., a student may be achieving at level 3 in Knowledge/Understanding but at level 4 in Communication).
- Although the student samples show responses to most questions, students achieving at level 1 and level 2 will often omit answers or will provide incomplete responses or incomplete demonstrations.
- Students' effort was not evaluated. Effort is evaluated separately by teachers as part of the "learning skills" component of the Provincial Report Card.
- This document does not include any student samples that were assessed using the rubrics and judged to be below level 1. (Work judged to be below level 1 is work on which a student achieves a mark of less than 50%. A student whose overall achievement at the end of a course is below 50% will not obtain a credit for the course.) Teachers are expected to work with students whose achievement is below level 1, as well as with their parents, to help the students improve their performance.

Use of the Student Samples

Teachers and Administrators

The samples of student work included in this document will help teachers and administrators by:

– providing student samples and criteria for assessment that will enable them to help students improve their achievement;

– providing a basis for conversations among teachers, parents, and students about the criteria used for assessment and evaluation of student achievement;

– facilitating communication with parents regarding the curriculum expectations and levels of achievement for each subject or course;

– promoting fair and consistent assessment within subjects and courses.

Teachers may choose to:

– use the teaching/learning activities outlined in the performance tasks;

– use the performance tasks and rubrics in this document in designing comparable performance tasks;

– use the samples of student work at each level as reference points when assessing student work;

– use the rubrics to clarify what is expected of the students and to discuss the criteria and standards for high-quality performance;

– review the samples of work with students and discuss how the performances reflect the levels of achievement;

– adapt the language of the rubrics to make it more “student friendly”;

– develop other assessment rubrics with colleagues and students;

– help students describe their own strengths and weaknesses and plan their next steps for learning;

– share student work with colleagues for consensus marking;

– partner with other schools to design tasks and rubrics, and to select samples for other performance tasks and other subject areas.

Administrators may choose to:

– encourage and facilitate teacher collaboration regarding standards and assessment;

– provide training to ensure that teachers understand the role of the exemplars in assessment, evaluation, and reporting;

– establish an external reference point for schools in planning student programs and for school improvement;

– facilitate sessions for parents and school councils using this document as a basis for discussion of curriculum expectations, levels of achievement, and standards;

– participate in future exemplar projects within their district school boards or with the Ministry of Education.

Parents

The performance tasks in this document exemplify a range of meaningful and relevant learning activities related to the curriculum expectations for Grade 9 science courses. In addition, this document invites the involvement and support of parents as they work with their children to improve their achievement. Parents may use the samples of student work and the rubrics as:

– resources to help them understand the levels of achievement;
– models to help monitor their children's progress from level to level;
– a basis for communication with teachers about their children's achievement;
– a source of information to help their children monitor achievement and improve their performance;
– models to illustrate the application of the levels of achievement.

Students

Students are asked to participate in performance assessments in all curriculum areas. When students are given clear expectations for learning, clear criteria for assessment, and immediate and helpful feedback, their performance improves. Students' performance improves as they are encouraged to take responsibility for their own achievement and to reflect on their own progress and "next steps".

It is anticipated that the contents of this document will help students in the following ways:

– Students will be introduced to a model of one type of task that will be used to assess their learning, and will discover how rubrics can be used to improve their product or performance on an assessment task.
– The performance tasks and the exemplars will help clarify the curriculum expectations for learning.
– The rubrics and the information given in the Teacher's Notes section will help clarify the assessment criteria.
– The information given under Comments/Next Steps will support the improvement of achievement by focusing attention on two or three suggestions for improvement.
– With an increased awareness of the performance tasks and rubrics, students will be more likely to communicate effectively about their achievement with their teachers and parents, and to ask relevant questions about their own progress.
– Students can use the criteria and the range of student samples to help them see the differences in the levels of achievement. By analysing and discussing these differences, students will gain an understanding of ways in which they can assess their own responses and performances in related assignments and identify the qualities needed to improve their achievement.

Science

Academic

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 $density = \frac{mass}{volume}$ 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
Knowledge/Understanding					
	The student:				
1	– demonstrates an understanding of the concept of density	– demonstrates a limited understanding of the concept of density	– demonstrates some understanding of the concept of density	– demonstrates a considerable understanding of the concept of density	– demonstrates a thorough understanding of the concept of density
	– applies formula ($D = \frac{m}{V}$) to determine density competently	– applies formula with limited competence	– applies formula with some competence	– applies formula with considerable competence	– applies formula with a high degree of competence
Inquiry					
	The student:				
2, 3, 4	– interprets data on density/ranking/layering accurately	– interprets data with limited accuracy	– interprets data with some accuracy	– interprets data with considerable accuracy	– interprets data with a high degree of accuracy
	– uses technical skills and procedures accurately to determine density	– uses skills and procedures with limited accuracy	– uses skills and procedures with some accuracy	– uses skills and procedures with considerable accuracy	– uses skills and procedures with a high degree of accuracy
	– draws a conclusion that is supported by the data	– draws a conclusion supported in a limited way by the data	– draws a conclusion supported to some degree by the data	– draws a conclusion supported to a considerable degree by the data	– draws a conclusion supported to a high degree by the data
Communication					
	The student:				
3, 4	– communicates observations and information clearly	– communicates observations and information with limited clarity	– communicates observations and information with moderate clarity	– communicates observations and information with considerable clarity	– communicates observations and information with a high degree of clarity
	– displays data in complete, well-organized charts	– makes incomplete charts that show limited organization	– makes partially complete, partially organized charts	– makes mostly complete, mostly organized charts	– makes very complete, very well organized charts
	– uses scientific terms and SI units/styles appropriately and accurately	– uses scientific terms and SI units with limited appropriateness and accuracy	– uses scientific terms and SI units with some appropriateness and accuracy	– uses scientific terms and SI units with considerable appropriateness and accuracy	– uses scientific terms and SI units with a high degree of appropriateness and accuracy

Expectations*	Criteria	Level 1	Level 2	Level 3	Level 4
Communication (cont.)					
	The student:				
	– 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
Making Connections					
	The student:				
2, 5	– analyses production requirements	– provides a limited analysis of requirements	– provides some analysis of requirements	– provides an adequate analysis of requirements	– provides a thorough analysis of requirements
	– shows awareness of the skills required for the occupation of quality control technician	– shows limited awareness of the skills required	– shows some awareness of the skills required	– shows considerable awareness of the skills required	– 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).

A

Confederation Maple Syrup Company
Quality Control Report

A. Hourly Qualitative Check of Samples

1. What are the technicians trying to find out with their test?

They are [trying] to find out if it is true maple syrup or not.

2. (a) What observation, from the layered solutions, would indicate that one of the solutions is denser than the other?

The one closer to the bottom is more dense

(b) Explain

The more dense it is the further to the bottom it will go. The lighter it is the higher it will go.

B

3. (a) Prepare a data table in which you can record your qualitative data for each test that you do. Include a column in which you indicate your conclusion on the test (e.g. "Therefore, Red is more dense than Green, R>G). Enter all of your data in your table.

substance	mixed with			most dense		
blue	red	Green	Yell	Blue	Blue	=
Green	blue	red	Yellow	Blue	=	Yellow
red	Green	blue	Yellow	=	Blue	Yello
Yellow	blue	Green	red	=	Yellow	Yellow

3. (b) State what you found out.

I found out that blue and yellow have the same density and red and green also have the same. Yellow and blue are more dense than red and green

4. (a) Rank the densities of the three "unknown" sample solutions

Blue is most dense
= { red is next
then green.

(b) Which "unknown" solution has the same density as the yellow "standard" solution? The blue unknown substance has the same a yellow,

C

5. Why would "Confederation" want their product to have a minimum density of 1.1 g/mL, BUT no higher or lower than this value?

Because if it was dense or more dense than 1.1 it would not be real maple syrup So the company might not get any one to buy it or it will not be good quality.

B. Daily Quantitative Tests

Density = mass ÷ volume

6. (a) Use the equipment necessary to find the density of the "unknown" solution that has the same density as the yellow "standard" solution. Prepare a chart in the space below and enter your quantitative measurements in it.

Solution	Mass	Volume	Density ÷ (25ml of each)
Blue	9.20-6.72 = 2.48g	25ml	.01
Yellow	9.20 - 6.72 = 2.48g	25ml	.01
Red	8.63 - 6.72 = 1.91	25	.08
Green	8.68 - 6.72 = 1.96	25	.08

cylinders mass ~ 6.72

6. (b) Use the data from 6(a) to calculate the density of the solution, showing all work.

Density = mass ÷ volume

Blue = 2.48g ÷ 25ml = .00992 or .01

Yellow = 2.48g ÷ 25ml = .00992 or .01

red - 1.91g ÷ 25ml ~ .076 or .08

Green - 1.96g ÷ 25ml 7 ~ .0784 or .08

D

7. (a) Did the results from the layering activity in 4 (a) and 4(b) match your calculated results? Yes because when I said Blue and yellow and Then red and green had same densities I was right

7. (b) Account for any errors that could have occurred.

I could have put to much or a little solution in at one time so my density's could be different. also the scale could have been off.

E

Daily Tours

8. (a) A tour of Grade 5 students from an elementary school has just arrived at your laboratory. Explain, in language they can understand, how you used the equipment in 6(a) to determine the actual density of one of the unknown sample solutions.

When I did this experiment to measure the density I found out the mass and then I found out the volume. To get density you take the mass and subtract the volume.

8. (b) Explain to the students what skills are necessary for a quality control technician AND why your job is important to the company.

A quality control person needs good Science skills and is important because we make sure the syrup is the right density

9

Teacher's Notes

Knowledge/Understanding

- The student demonstrates a somewhat limited understanding of the concept of density (e.g., in question 2a, states "The one closer to the bottom is more dense", but in question 2b, fails to explain the concept).
- The student applies the density formula with some competence (e.g., includes the formula and substitutes correctly, but omits density units).

Inquiry

- The student has interpreted the data based on his or her observations, although the observations contain some inaccuracies.
- The student uses technical skills and procedures with limited accuracy (e.g., in question 6a, makes a major error in measuring the cylinder's mass – the mass of 6.72 g is much too low).
- The student draws conclusions with limited support (e.g., in question 7a, does not support or justify the conclusions; does not identify or comment on the fact that the calculated densities are far below the expected value of 1.1 g/mL).

Communication

- The student communicates observations and information with limited clarity (e.g., in question 3a, the table of observations is confusing; the conclusion in question 4a that blue is most dense is contradicted by the density calculation of .01 g/mL for blue in question 6b).
- The student uses scientific terminology with limited appropriateness and accuracy, and omits the SI unit for density in question 6b.
- The student communicates with a limited sense of audience (e.g., in question 8a, the description of the process is much too vague for Grade 5 students to understand).

Making Connections

- The student shows limited understanding of the skills required for the occupation of a quality control technician (e.g., in question 8b, does not identify or explain the importance of specific skills; misses the connection between skills for this particular task and the general skills of a quality control technician – "we make sure the syrup is the right density").

Comments/Next Steps

- The student should work on recording observations in a well-organized format.
- The student needs to practise technical skills of measuring.
- The student should work on developing scientific terminology to communicate more effectively and with more clarity.
- The student should consider that unreasonable results are a clue to major source(s) of error.

A

A. Hourly Qualitative Test

1. One of the coloured solutions has the same density as the yellow "standard" solution.

Procedure A

2. Add 25 drops of solution #1 to one of the thin test tubes. **Without shaking the test tube,** carefully allow one drop at a time of solution #2 to run down the inside of the test tube until it hits the surface of solution #1. Make sure that you wait ten seconds between each drop. Observe carefully as the added drops interact with solution #1. You will have to add at least five drops of solution #2 to see the result.

3. Prepare a chart in the Quality Control Report (Question 3(a)) to record the results when each pair of liquids is mixed.

4. Repeat the steps until you have tested and recorded <u>all possible combinations of the four solutions</u>. To observe all possibilities, make certain that you test each pair of solutions in two ways: put 25 drops of solution #1 in the test tube, then add five drops of solution #2; put 25 drops of solution #2 in a second test tube, then add five drops of solution #2, etc.

Solutions	
#1	Blue
#2	Red
#3	Green
Standard	Yellow

5. Record your data in Question 3(a) of the Quality Control Report.

Mix #1	Mix #2	Solution/observation
Blue	red	The red settles to top of blue
Blue	yellow	The yellow settles on blue
Blue	green	The green settles on Blue
Red	green	green settles ontop of red
Red	yellow	two substances mix together
green	yellow	green settles on yellow.

4

B

Confederation Maple Syrup Company
Quality Control Report

A. Hourly Qualitative Check of Samples

1. What are the technicians trying to find out with their test?

The technicians are trying to find which syrup (colour) has the same density as the standard (yellow).

2. (a) What observation, from the layered solutions, would indicate that one of the solutions is denser than the other?

The observations from the layerd solutions indicated that the first substance put into the test tube was more dense, it stayed on the bottom.

(b) Explain

The mixture that showed no layering was the red and yellow, both substances were the same density.

5

C

3. (a) Prepare a data table in which you can record your qualitative data for each test that you do. Include a column in which you indicate your conclusion on the test (e.g. "Therefore, Red is more dense than Green, R>G). Enter all of your data in your table.

mix #1	Mix #2	Observations
Blue	red	Blue > red
Blue	yellow	Blue > yellow
Blue	green	Blue > green
Red	green	Red > green
Red	yellow	Red = yellow
green	yellow	green < yellow

3. (b) State what you found out.

I found that the first mixture in each expirement seemed to be more dense, except green was less dense than yellow and the red and yellow mixed.

4. (a) Rank the densities of the three "unknown" sample solutions

graduated cylindar = 48.46 g.
green – V = 1.5 = 49.27 g
D = .81/1.5 = 0.54

Pink – V = 1.5 = 49.32 g D = .86/1.5 = .573̄ → 0.66
blue – V = 1.5 = 49.45 g D = .99/1.5

(b) Which "unknown" solution has the same density as the yellow "standard" solution?

yellow – D = 1.5 = 49.42 g
D = 0.80/1.5
D = 1.875 → Red seems to be the closest to the original solustance (yellow)

D

5. Why would "Confederation" want their product to have a minimum density of 1.1 g/mL, BUT no higher or lower than this value?

Confederation would want their syrup to have a 1.1 density, no higher or lower because they want their syrup to have the same density as the yellow, the syrupe would be noticably natural.

B. Daily Quantitative Tests

6. (a) Use the equipment necessary to find the density of the "unknown" solution that has the same density as the yellow "standard" solution. Prepare a chart in the space below and enter your quantitative measurements in it.

V = 1.5 =

Solution	Mass	volume	Density
Green	.81	1.5	0.54
Red	.86	1.5	0.573̄
blue	.99	1.5	0.66
yellow	.80	1.5	1.875

6. (b) Use the data from 6(a) to calculate the density of the solution, showing all work.

Red
0.5733̄3

.81 ÷ 1.5 = 0.573̄

E

7. (a) Did the results from the layering activity in 4 (a) and 4(b) match your calculated results?

No These expirements did not match, in the layering activity the solutions (red, yellow) mixed, when I calculated the density, they did not match.

7. (b) Account for any errors that could have occurred.

- Calculations weren't done correctly.
- More than the 2 colours were mixed
- wrong ammounts of syrup wee used.

8

F

Daily Tours

8. (a) A tour of Grade 5 students from an elementary school has just arrived at your laboratory. Explain, in language they can understand, how you used the equipment in 6(a) to determine the actual density of one of the unknown sample solutions.

- we found the actual density by first finding the mass, then the volume and used the formula D = M/V which means density = mass devided (÷) by volume.
  - This gave the density of the unknown substances.

8. (b) Explain to the students what skills are necessary for a quality control technician AND why your job is important to the company.

Skills
- math
- language

→ your job is important because if the density is wrong you can cause failure for the busness.

9

Teacher's Notes

Knowledge/Understanding

- The student demonstrates limited understanding of the concept of density (e.g., explanations are limited to simple observations that do not give evidence of conceptual understanding).
- The student applies the density formula with limited competence (e.g., performs most calculations correctly, but does not state the formula or show the major steps in the calculations).

Inquiry

- The student interprets the data with limited accuracy (e.g., does not correctly identify the relative densities of the solutions in some of the sample mixtures).
- The student uses technical skills and procedures with limited accuracy (e.g., in question 8a, does not provide details of the procedures followed in the experiment).
- The student draws conclusions that are supported by the data in a limited way (e.g., data tables are only partially complete).

Communication

- The student communicates observations and information with limited clarity (e.g., "I found that the first mixture in each experiment seemed to be more dense, except green was less dense than yellow and the red and yellow mixed").
- The student displays some data with limited organization (e.g., in question 4a, does not display ranking clearly).
- The student uses SI units with limited appropriateness (e.g., uses correct units for observations of mass, but omits volume and density units).

Making Connections

- The student provides a limited analysis of production requirements (e.g., in question 5, suggests only that the company would want the syrup to be natural).
- The student demonstrates limited awareness of the skills required for the occupation (e.g., in question 8b, mentions only "math" and "language" as required skills).

Comments/Next Steps

- The student needs to recognize the importance of recording observations when conducting experiments.
- The student should focus on the consistent and appropriate use of units, and ensure that data charts incorporate all the information required.
- The student should concentrate on answering questions with greater clarity, and on attention to detail

A

Confederation Maple Syrup Company
Quality Control Report

A. Hourly Qualitative Check of Samples

1. What are the technicians trying to find out with their test?

IN THE TECHNICIANS TEST THEY ARE TRYING TO FIND OUT IF THE UNKNOWNS HAVE A DENSITY GREATER EQUAL TO, OR LESS THAN THE STANDERED SOLUTION.

2. (a) What observation, from the layered solutions, would indicate that one of the solutions is denser than the other?

FROM THE OBSERVATIONS YOU CAN TELL IF ONE SOLUTION IS DENSER THAN THE OTHER BY WHICH EVER SOLUTION IS ON THE BOTTOM IS DENSER THAN THE SOLUTION ON THE TOP.

(b) Explain

THE SOLUTION THAT IS ON THE BOTTOM IS DENSER THAN THE SOLUTION ON THE TOP. THAT IS HOW TO TELL WHICH SOLUTION IS DENSER.

5

B

3. (a) Prepare a data table in which you can record your qualitative data for each test that you do. Include a column in which you indicate your conclusion on the test (e.g. "Therefore, Red is more dense than Green, R>G). Enter all of your data in your table.

COLOUR	BLUE	RED	GREEN	YELLOW
BLUE	X	B > R	B > G	B > Y
RED	B > R	X	R > G	Y > R
GREEN	B > G	R > G	X	Y > G
YELLOW	B > Y	R = Y	Y > G	X

1) B
2) Y
3) R
4 G

3. (b) State what you found out.

I FOUND OUT THAT BLUE HAS THE HIGHEST DENSITY, YELLOW HAS THE SECONED GREATEST DENSITY, RED HAS THE THIRD GREATEST DENSITY AND GREEN HAD THE LOWEST DENSITY.

4. (a) Rank the densities of the three "unknown" sample solutions

(HIGHEST DENSITY TO LOWEST DENSITY)

1. BLUE
2. YELLOW
3. RED
4. GREEN

(b) Which "unknown" solution has the same density as the yellow "standard" solution?

I THINK THAT THE RED UNKNOWN SOLUTION HAS THE SAME OR CLOSEST DENSITY TO THE STANDERED YELLOW SOLUTION.

6

C

5. Why would "Confederation" want their product to have a minimum density of 1.1 g/mL, BUT no higher or lower than this value?

THE CONFERATION WOULD WANT THEIR PRODUCT TO HAVE NO MORE OR LESS THAN A 1.1 DENSITY. BECAUSE THEY WANT THEIR SYRUP TO ALL HAVE THE SAME THICKNESS AND NOT ALL DIFFERENT DENSITIES.

B. Daily Quantitative Tests

6. (a) Use the equipment necessary to find the density of the "unknown" solution that has the same density as the yellow "standard" solution. Prepare a chart in the space below and enter your quantitative measurements in it.

liquid	volume	mass	density
blue	10 ml	11.3 G	1.13 G
green	10 ml	9.8 G	0.98 G
yellow	10 ml	10.2 G	1.02 G
red	10 ml	10 G	1 G

6. (b) Use the data from 6(a) to calculate the density of the solution, showing all work.

DENSITYS: (M) ÷ (V) = (D)

BLUE = 11.3 ÷ 10 = 1.13G

GREEN = 9.8 ÷ 10 = 0.98G

YELLOW = 10.2 ÷ 10 = 1.02G

RED = 10 ÷ 10 = 1G

D

7. (a) Did the results from the layering activity in 4 (a) and 4(b) match your calculated results?

YES THE RESULTS FROM THE LAYERING ACTIVITY MATCHED MY CALCULATED RESULTS BECAUSE. ALL THE DENSITIES ARE PROOF OF 4A.

7. (b) Account for any errors that could have occurred.

SOME ERRORS THAT COULD OF OCCURED ARE:

1) DROPPING THE SOLUTION INTO ANOTHER SOLUTION TO FAST.

2) CALCULATING THE DENSITY WRONG.

3). MIXING THE WRONG SOLUTIONS.

4) FORGETTING TO SUBTRACT THE WEIGHT OF THE GRADUATED CYLINDER FROM THE MASS OF THE SOLUTION COMBINED WITH THE GRADUATED CYLINDER.

E

Daily Tours

8. (a) A tour of Grade 5 students from an elementary school has just arrived at your laboratory. Explain, in language they can understand, how you used the equipment in 6(a) to determine the actual density of one of the unknown sample solutions.

WITH THE EQUIPMENT WE USED IN 6(A) WE DETERMINED THE DENSITY TAKEING THE AMOUNT OF COLOURFULL LIQUID AND DIVIDING THAT AMOUNT BY HOW MUCH THE COLOURFUL LIQUID WEIGHED.

8. (b) Explain to the students what skills are necessary for a quality control technician AND why your job is important to the company.

THE SKILLS THAT ARE NESESSARY FOR A QUALITY CONTROL TECHNICIAN ARE BEING ABLE TO KNOW HOW TO USE ALL OF THE EQUIPMENT AND TO KNOW WHAT YOU ARE DOING AT ALL TIMES. ALSO YOU MUST BE CAREFUL NOT TO BREAK THE EQUIPMENT. MY JOB IS IMPORTANT BECAUSE YOU ALWAYS WANT THE SYRUP TO BE THE SAME AND NOT DIFFRENT.

9

Teacher's Notes

Knowledge/Understanding

- The student demonstrates some understanding of the concept of density (e.g., shows understanding that the "denser solution is at the bottom"), but does not explain his or her answers fully.
- The student applies the density formula with some competence (e.g., substitutes and calculates correct values, but does not include the formula or use correct units in density calculations).

Inquiry

- The student interprets the data with some accuracy.
- The student uses technical skills and procedures with some accuracy (e.g., in question 8a, omits major steps in the procedure for determining density quantitatively, but addresses some sources of error in question 8b).
- The student enters conclusions in the qualitative chart, but does not include the observations on which they are based.

Communication

- The student displays data in charts that are only partially complete and partially organized (e.g., fails to include complete set of observations in qualitative chart).
- The student uses scientific terms and SI units with some appropriateness (e.g., understands that volume is measured in millilitres and mass in grams, but uses incorrect SI units).
- The student demonstrates some sense of audience and purpose (e.g., by trying to use simple language), but does not include sufficient detail to make the explanation clear to Grade 5 students.

Making Connections

- The student shows some awareness of the skills required for the occupation (e.g., refers to generalized skills and comments on the importance of ensuring consistency in the product).

Comments/Next Steps

- The student should include all observations on which conclusions are based, and should provide more details to justify explanations.
- The student should work on identifying and using correct SI units.
- The student should work on skills for communicating to a particular audience and for a particular purpose.

A Check on the Density of Maple Syrup Level 2, Sample 2

A

Confederation Maple Syrup Company
Quality Control Report

A. Hourly Qualitative Check of Samples

1. What are the technicians trying to find out with their test?

The technicians are trying to find out which one of the "unknown" is as dense as the yellow (standard) solution.

2. (a) What observation, from the layered solutions, would indicate that one of the solutions is denser than the other?

From my observations of the layered solutions of which one was denser if they were either on the bottom or layered on the top.

(b) Explain

Well Green is on the top, blue is on the bottom therefore blue would be denser than green.

5

B

3. (a) Prepare a data table in which you can record your qualitative data for each test that you do. Include a column in which you indicate your conclusion on the test (e.g. "Therefore, Red is more dense than Green, R>G). Enter all of your data in your table.

chart

[see following page]

3. (b) State what you found out.

I found out, Green is the lightest Red is as dense as the standard & blue is the densest.

4. (a) Rank the densities of the three "unknown" sample solutions (densest to lightest)

① Blue
② Red
③ Green

(b) Which "unknown" solution has the same density as the yellow "standard" solution?

Red has the same density as yellow.

6

C

Conclusions	Observations	Solution	solution added
B > R	the red solution rises to the top	Blue	Red
B > G	the green solution forms a layer on top.	Blue	Green
B=B	the two similar/same solutions mixed	Blue	Blue
B > Y	the yellow formed a layer on top.	Blue	Yellow
R=R	the two solutions mixed	Red	Red
R > G	the green rised to form a layer on top	Red	Green
R=Y	the two solutions mixed together	Red	Yellow
R < B	the blue sunk to the bottom below the red.	Red	Blue
G < R	the red sunk to the bottom	Green	Red
G < Y	the yellow sunk to the bottom	Green	yellow
G < B	the blue sunk to the bottom	Green	Blue
G < G	they mixed	Green	Green
Y = Y	the two solutions mix.	yellow	yellow
Y = R	the two solutions mixe	yellow	Red
Y > G	green formed a layer on top	yellow	Green
Y < B	the blue sunk to the bottom	yellow	blue

[back of page 6]

D

5. Why would "Confederation" want their product to have a minimum density of 1.1 g/mL, BUT no higher or lower than this value?

The "Confederation" would want to have the minimum density of 1.1 g/ml, because they would want to have "genuine maple syrup" so that they would get more people to buy they're syrup.

B. Daily Quantitative Tests

6. (a) Use the equipment necessary to find the density of the "unknown" solution that has the same density as the yellow "standard" solution. Prepare a chart in the space below and enter your quantitative measurements in it.

solution	mass	volume
Red	64.6 g	64 ml
Blue	–	–
Green	–	–

6. (b) Use the data from 6(a) to calculate the density of the solution, showing all work.

$D = \frac{M}{V}$ $D = \frac{64.6\ g}{64\ ml}$ $D = 1.01$

7

E

7. (a) Did the results from the layering activity in 4 (a) and 4(b) match your calculated results?

The calculated results matched the results from the layering activity in 4(a) & 4(b). Because we chose Red & red is what matched the standard solution

7. (b) Account for any errors that could have occurred.

The test tube may not have been thoroughly cleaned therefore leaving some substances still within the test tube. Also some calculation could have been wrong if past mistakes were unknowingly made.

8

F

Daily Tours

8. (a) A tour of Grade 5 students from an elementary school has just arrived at your laboratory. Explain, in language they can understand, how you used the equipment in 6(a) to determine the actual density of one of the unknown sample solutions.

The way the equipment in 6(a) was used was we measured the mass & volume of the "Red" solution & then use the mathimatical equation $D = \frac{m}{v}$ to get the needed density which should equal the standard solution.

8. (b) Explain to the students what skills are necessary for a quality control technician AND why your job is important to the company.

Some skills that are nessesary for this job are accuracy, safety, checking it over, prior knowledge & education in math. must be able to calculate accurately & quickly. must also know Science.

9

Teacher's Notes

Knowledge/Understanding

- The student demonstrates some understanding of the concept of density (e.g., states that "blue would be denser than green"), but does not express density as mass per unit volume.
- The student applies the density formula with some competence (e.g., displays the formula and substitutes correctly, but omits units for density).

Inquiry

- The student interprets data on density and ranks unknown densities accurately.
- The student uses technical skills and procedures with some accuracy (e.g., displays all possible combinations of solutions in the observation chart, but fails to show the masses that gave 64.6 g, and performs only one trial).
- The student draws conclusions supported by the data and identifies some potential sources of experimental error.

Communication

- The student creates charts that display partial organization (e.g., organizes the first chart in a somewhat logical sequence).
- The student uses scientific terms with some accuracy (e.g., uses appropriate language for density comparisons, with the exception of the term "lightest" in conjunction with density ranking), and uses SI units and styles with some appropriateness (e.g., generally uses appropriate units, but makes some errors in notation).

Making Connections

- The student demonstrates some awareness of the skills required for the occupation (e.g., addresses several skills but does not connect them to the importance of the job).

Comments/Next Steps

- The student should make sure to include all steps in a procedure.
- The student should try to communicate with greater clarity and should work on skills for communicating appropriately to a particular audience.

A

Confederation Maple Syrup Company

Quality Control Report

A. Hourly Qualitative Check of Samples

1. What are the technicians trying to find out with their test?

The technicians are trying to find out if the density is correct for Maple Syrup.

2. (a) What observation, from the layered solutions, would indicate that one of the solutions is denser than the other?

The observation, from the layered solutions that would indicate that one of the solutions is denser than the other is because their layered.

(b) Explain

this happens because one of the solutions has a greater mass per volume and it sinks while the lighter one sits on top of the heavier one.

5

B

3. (a) Prepare a data table in which you can record your qualitative data for each test that you do. Include a column in which you indicate your conclusion on the test (e.g. "Therefore, Red is more dense than Green, R>G). Enter all of your data in your table.

Qualitative Data Chart on back of page

←

[see following page]

3. (b) State what you found out.

I found out through our experiments which solutions were more dense then others because they were layerd and the substance that was the same mixed together.

4. (a) Rank the densities of the three "unknown" sample solutions

Least dense to most dense.

Green, Red / Yellow, Blue

same.

(b) Which "unknown" solution has the same density as the yellow "standard" solution?

The "unknown" solution that has the same density as the yellow "standard" solution is solution #2 Red.

6

C

Qualitative Data For Each Test

Starting Liquid	Liquid Added	Observation	Conclusion
Solution #1 Blue	Solution #2 Red	Red sat on top of Blue	Blue is more dense than Red
Solution #1 Blue	Solution #3 Green	Green sat on top of blue	Blue is more dense than Green.
Solution #1 Blue	Standerd Solution Yellow	Yellow sat on top of Blue	Blue is more dense than Yellow
Solution #2 Red	Solution #1 Blue.	Blue sank to under Red	Red is less dense than Blue
Solution #2 Red	Solution #3 Green	Green stayed on top of Red	Red is more dense than Green
Solution #2 Red	Standerd Solution Yellow	Red and Yellow mixed together to make orange	Red and Yellow have equal density
Solution #3 Green	Solution #1 Blue	Blue sank to bottom under Green	Green is less dense than Blue
Solution #3 Green	Solution #2 Red	Red sank to bottom under Green	Green is less dense than Red
Solution #3 Green	Standerd Solution Yellow	Yellow sank to bottom under Green	Green is less dense than Yellow.
Standerd Solution Yellow	Solution #1 Blue	Blue sank to bottom under Yellow	Yellow is less dense than Blue
Standerd Solution Yellow	Solution #2 Red	Red and Yellow mixed to make an orange colour	Red and Yellow have equal density
Standerd Solution Yellow	Solution #3 Green	Green stayed on top of Yellow	Yellow is more dense than Green

[back of page 6]

D

5. **Why would "Confederation" want their product to have a minimum density of 1.1 g/mL, BUT no higher or lower than this value?**

"Confederation" would most likly want their product to have a density of 1.1 g/mL because anything under that would be too "runny" and tastless and anything over that would be too "thick" or it would be too stickey and sweet.

B. Daily Quantitative Tests

6. **(a) Use the equipment necessary to find the density of the "unknown" solution that has the same density as the yellow "standard" solution. Prepare a chart in the space below and enter your quantitative measurements in it.**

Standard Solution (Yellow) 1.1g

Tare Weight 40.5g

Solution Number	Mass	Volume	Density
Solution #1 (Blue)	11.1g	10mL	1.11
Solution #2 (Red)	10.1g	10mL	1.1
Solution #3 (Green)	9.6g	10mL	0.96

6. **(b) Use the data from 6(a) to calculate the density of the solution, showing all work.**

	Density
Solution #1 (Blue)	$D = \frac{M}{V} = \frac{11.1g}{10mL} = 1.11 g/mL$
Solution #2 (Red)	$D = \frac{M}{V} = \frac{10.1g}{10mL} = 1.1 g/mL$ *
Solution #3 (Green)	$D = \frac{M}{V} = \frac{9.6g}{10mL} = 0.96 g/mL$
Standard Solution (Yellow)	$D = \frac{M}{V} = \frac{10.1g}{10mL} = 1.1 g/mL$ *

7

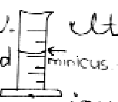
E

7. (a) Did the results from the layering activity in 4 (a) and 4(b) match your calculated results?

Yes, the results from the layering activity in 4(a) and 4(b) matched my calculated results in 6(a) and 6(b). Solution #2 (Red) has equal density to the Standard Solution (Yellow) which is 1.1g/mL.

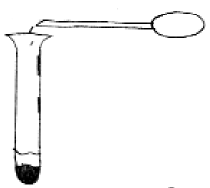
7. (b) Account for any errors that could have occurred.

Some errors that may have occurred were; the minicus.



It was hard to fill the graduated cylinder to 10mL because of the minicus. Also the "Tare" weight on the triple beam balance scale could have been off a little.

When I was doing the "qualitative data chart" I could have put more or less than 25 drops of the starting solution and more or less than 5 drops of the solution added.



8

F

Daily Tours

8. (a) A tour of Grade 5 students from an elementary school has just arrived at your laboratory. Explain, in language they can understand, how you used the equipment in 6(a) to determine the actual density of one of the unknown sample solutions.

First we weigh the empty graduated cyclinder on the "Triple Beam Blance Scale," then we write the calulation down on paper. Next we fill the graduated cyclinder with 10mL of the first unknow solution. We then weigh this and subtract the number from the number of the empty graduated cyclinder. We then recorde this number under "Mass" on our chart. Also we write the volume (10mL) under the coloum "volume". We then do this for each unknown solution. We this is done we used the formula $D=\frac{M}{V}$ and calculate each solutions density. Since the standard solutions density is 1.1g/mL we know that the right solution's density is 1.1g/mL.

8. (b) Explain to the students what skills are necessary for a quality control technician AND why your job is important to the company.

The skills that are necessary for a quality control technician is science and math. Since each hour the syrup has to be tested like I explained in 8(a) they should also be fast at what they do. A quality control technician job is important because they find out if the syrup is good enough to be labeled and sold as "Genuine Maple Syrup". If something goes wrong they have to tell someone so it can be fixed. If they don't do there job right the company could go out of business.

9

Teacher's Notes

Knowledge/Understanding

- The student demonstrates considerable understanding of the concept of density (e.g., explains the concept accurately in question 2b, but uses the terms "lighter" and "heavier" in the explanation).
- The student applies the density formula with considerable competence (e.g., applies the formula correctly but makes a simple arithmetic error in calculating the density of the red solution).

Inquiry

- The student interprets the data and uses technical skills with considerable accuracy.
- The student conducts the necessary quantitative measurements, as well as some that are not required (e.g., compares green and blue to the standard).
- The student draws conclusions that are mostly supported by the data (e.g., rankings are directly related to the observations).

Communication

- The student communicates observations and information with considerable clarity (e.g., communicates observations in qualitative chart very clearly and precisely; provides diagrams and relevant details to enhance clarity of error analysis in question 7b) and in a mostly organized way (e.g., makes a detailed chart with appropriate headings).
- The student uses SI units with considerable appropriateness (e.g., most quantitative measurements have accompanying units).
- The student communicates with a considerable sense of purpose and audience (e.g., in question 8a, provides a detailed, step-by-step explanation geared to Grade 5 students).

Making Connections

- The student demonstrates considerable awareness of the importance of the role of a quality control technician (e.g., refers to such factors as efficiency and the function of reporting back to production).

Comments/Next Steps

- The student should review his or her answers to questions 1–4, with a view to making them more specific and providing more complete explanations.
- The student should include units in the headings of all charts.
- The student could discuss in more detail the skills required for the occupation of a quality control technician.
- The student should proofread his or her work to correct errors in spelling and grammar (e.g., uses "their" for "they are"; misspells "meniscus").

A

Confederation Maple Syrup Company
Quality Control Report

A. Hourly Qualitative Check of Samples

1. What are the technicians trying to find out with their test?

The tecnicians are trying to find out if today's shipment of syrup samples are going to be less dense, as dense as, or more dense than the standard solution, by doing their tests.

2. (a) What observation, from the layered solutions, would indicate that one of the solutions is denser than the other?

From the layered solutions, to indicate that one of the solutions may be denser than the others, if (the solution) may rest on top, indicating that the dropped solution was more dense, or it may fall through the stationary solution to the bottom, and that would prove that the stationary solution was denser.

(b) Explain

The solution that falls to the bottom, is more dense. It is a heavier, more compact substance. If the dropped solution stayed on top, it would prove that it is less dense-lighter and less compact.

5

B

3. (a) Prepare a data table in which you can record your qualitative data for each test that you do. Include a column in which you indicate your conclusion on the test (e.g. "Therefore, Red is more dense than Green, R>G). Enter all of your data in your table.

← *[see following page]*

3. (b) State what you found out.

I found out that the liquid solutions went either on top or sunk to the bottom of another solution. This represents that some liquids are denser than the others. Blue is denser than yellow. Red and yellow are the same. Red and yellow and blue, are all denser than green.

4. (a) Rank the densities of the three "unknown" sample solutions

Blue is the densest, then red, and then green is the less dense.

(b) Which "unknown" solution has the same density as the yellow "standard" solution?

The red solution has the same density as the yellow "standard" solution

6

C

Solutions	Observations	Conclusion	
#1 + #2	#2 sat ontop of #1	∴ Blue's more dense than red	B>R
#1 + #3	#3 sat on top of #1	∴ Blue is more dense than green	B>G
#1 + #4	#4 sat ontop of #1	∴ Blue is more dense than yellow	B>Y
#2 + #1	#1 sat on # 2	∴ Blue is denser than red	B>R
#2 + #3	#3 sat on # 2	∴ Red is denser than green	R>G
#2 + #4	They mixed	They are the same	R=Y
#3 + #1	#3 sat on #1	∴ Blue is denser than green	B>G
#3 + #2	#3 sat on # 2	∴ Red is denser than green	R>G
#3 + #4	#3 sat on #4	∴ yellow is denser than green	Y>G
#4 + #1	#4 sat on #1	∴ Yellow is denser than green	Y>G
#4 + #2	They mixed	∴ They are the same	R=Y
#4 + #3	#3 sat on 4	∴ Yellow is denser than green	Y>G

(Solution #4 is the yellow standard solution)

[back of page 6]

D

5. Why would "Confederation" want their product to have a minimum density of 1.1 g/mL, BUT no higher or lower than this value?

"Confedaration" may want their product to have a density of 1.1g/mL so it would mala the syrup pour out at a good rate. They also would want all of their products to be the same density so they wouldn't have 1 bottle of liquidy syrup, and another bottle that was teo thick to pour out. It also abtermines how high the sugar content is, in order for it to be labelled as "Genuine maple syrup"

B. Daily Quantitative Tests

6. (a) Use the equipment necessary to find the density of the "unknown" solution that has the same density as the yellow "standard" solution. Prepare a chart in the space below and enter your quantitative measurements in it.

graduated cylinder
28.3g

$D = \frac{m}{v}$

Solution	Mass(g)	Volume	Density
yellow "standard"	50 drops 30.1 − 28.3 = 1.8; 1 drop − 0.036g	2mL	??
red "unknown"	50 drops 30.1 − 28.3 = 1.8; 1 drop 0.036g	2mL	??

50 = 30.1g
2.0mL

6. (b) Use the data from 6(a) to calculate the density of the solution, showing all work.

yellow − $D = \frac{m}{v}$ − Given: m − 1.8g, V − 2mL, D − ?? Solution: $D = \frac{m}{v} = \frac{1.8g}{2mL} = 0.9g/mL$ ∴ The density for the yellow solution is 0.9 mL/g

red − $D = \frac{m}{v}$ − Given: m − 1.8, V − 2mL, D − ?? Solution − $D = \frac{m}{v} = \frac{1.8g}{2mL} = 0.9g/mL$ ∴ The density for the red is 0.9g/m

E

7. (a) Did the results from the layering activity in 4 (a) and 4(b) match your calculated results?

Yes, the results from the layering activity did match my calculated results. the red and yellow solutions mixed together when the layering activity was done. And they both have the same calculated densities.

7. (b) Account for any errors that could have occurred.

*The number of drops could be inacurate- which would throw of the mass, and the volume.

*There could have been a liquid already present in the graduated cylinder, which would alter the mass and the volume.

*Calculations could be incorrect.

F

Daily Tours

8. (a) A tour of Grade 5 students from an elementary school has just arrived at your laboratory. Explain, in language they can understand, how you used the equipment in 6(a) to determine the actual density of one of the unknown sample solutions.

To determine the density of this solution, I first weighed the empty graduated cylinder. I then, placed 50 drops of the "unknown" solution into the cylinder (without any touching the sides) Then I weighed how much the cylinder was when it contained the solution. To determine how much the solution actually weighed, I subtracted the weight of the cylinder from the weight of the cylinder and liquid combined. I took a reading of the solution, still while it was in the graduated cylinder. In order to find the actual density, - the simple equasion, of Density = mass(g) ÷ Volume (mL) comes into play. The mass and volume are substituted in, and the result is the density of the solution in g/mL.

8. (b) Explain to the students what skills are necessary for a quality control technician AND why your job is important to the company.

In order to be a quality control technician, you must be able to know how to find density. So that means, to read measurements accurately and to weigh solutions accurately. You also need math skills inorder to carry out equasions.

This job is important to the company because, if noone could find out how dense each batch of syrup was- the other workers wouldn't know how much sugar and other ingredients to add inorder to make the solution thick enough. If they weren't the same density, there would be thicker syrup and thinner syrup for sale at the same time consumers would not be satisfyied with their product also.

Teacher's Notes

Knowledge/Understanding

- The student demonstrates considerable understanding of the concept of density, as illustrated in his or her answer to question 3, but gives evidence of some misconceptions (e.g., describes solution as being "more compact", but equates "heavier" with "more dense").
- The student applies the density formula with considerable competence (e.g., almost all the calculations are correct).

Inquiry

- The student interprets the data with considerable accuracy.
- The student uses technical skills and procedures with considerable accuracy (e.g., gives a detailed account of the procedures followed, but uses a sample of the "unknown" solution that is too small [50 drops] for an accurate measurement of volume, and this in turn leads to an inaccurate density calculation).
- The student draws conclusions that are supported to a considerable degree by the data.

Communication

- The student communicates observations and information with considerable clarity (e.g., gives many relevant details in response to question 8a, though the response requires some interpretation).
- The student displays data in charts that are mostly complete and well organized (e.g., most of the relevant information is included in the observation chart).
- The student uses scientific terms with considerable accuracy (but uses the term "weight" instead of "mass"), and also uses SI units with considerable appropriateness (e.g., includes units in most answers).

Making Connections

- The student analyses production requirements to a considerable degree, addressing both higher and lower density values, but describes some factors vaguely (e.g., "… so they wouldn't have 1 bottle of liquidy syrup, and another bottle that was too thick to pour out").
- The student shows considerable awareness of skills required for the occupation, addressing more than one aspect of the job (e.g., "… you must be able … to read measurements accurately and weigh solutions accurately. You also need math skills …").

Comments/Next Steps

- The student must learn to distinguish clearly between mass and density.
- The student displays full solutions when calculating density.
- The student should take care when transcribing results (e.g., "0.9mL/g").
- The student accounts for several areas that could have led to errors in the investigation, but should also recognize that the small volume of the liquid sample used is a potential source of error.
- The student should proofread to catch spelling errors (e.g., misspells "throw off" and "equation").

A Check on the Density of Maple Syrup Level 4, Sample 1

A

Confederation Maple Syrup Company
Quality Control Report

A. Hourly Qualitative Check of Samples

1. What are the technicians trying to find out with their test?

With their test, the technicians are trying to find out if the samples in their 3 different evaporators are the same as, more dense, or less dense than their standard syrup which has a density level of 1.1 g/mL in accordance to government regulations. They test to see if the density is correct in all the maple syrup that their company is producing.

2. (a) What observation, from the layered solutions, would indicate that one of the solutions is denser than the other?

When mixed, if one substance stays on top, it is less dense than the other. Therefore, the substance on the bottom is more dense. If the solutions mix, they both have the same density or the one dropped in has a density slightly higher.

(b) Explain

This matter can be explained perfectly with the particle theory. Such a thing happens because when a substance is denser, the particles are held closer together. When a dense substance is dropped into a not as dense substance, the particles of the denser one have room to make their way through the other substance. The particles of the dense substance fit in between the spaces in the less dense substance. This causes the dense substance to sink to the bottom of the less dense substance. However, when a less dense substance is dropped into a dense substance, the substance in stays on top because it's particles are spread apart and cannot fit between the closely compacted →

5

B

particles of the denser substance. Therefore causing the substance to remain on the surface. When 2 substances have the same density, their particles interlock perfectly causing the substance to mix.

[back of page 5]

C

3. (a) Prepare a data table in which you can record your qualitative data for each test that you do. Include a column in which you indicate your conclusion on the test (e.g. "Therefore, Red is more dense than Green, R>G). Enter all of your data in your table. Qualitative Colour Layering and Density

Solution (25 drops)	Solution Added (5 drops)	Observations	Conclusion About Density
BLUE	RED	Red stays on top	Blue > Red
BLUE	GREEN	Green stays on top	Blue > Green
BLUE	YELLOW	Yellow stays on top	Blue > Yellow
RED	BLUE	Blue sinks to the bottom	Red < Blue
RED	GREEN	Green stays on top	Red > Green
RED	YELLOW	Solution mixes	Red = Yellow
GREEN	BLUE	Blue sinks to the bottom	Green < Blue
GREEN	RED	Red sinks to the bottom	Green < Red
GREEN	YELLOW	Yellow sinks to the bottom	Green < Yellow
YELLOW	BLUE	Blue sinks to the bottom	Yellow < Blue
YELLOW	RED	Solution mixes	Yellow = Red
YELLOW	GREEN	Green stays on top	Yellow > Green

3. (b) State what you found out.

I found that all these substances had different densities except for RED and YELLOW which had a density of 1.1 g/mL because their solution mixed. The densest solution is BLUE because it sank to the bottom in all solutions. The lightest density is GREEN because it stayed on the surface of all the solutions.

4. (a) Rank the densities of the three "unknown" sample solutions

The densest solution is BLUE, the middle one is RED, and lightest is GREEN.

(b) Which "unknown" solution has the same density as the yellow "standard" solution?

RED has the same density (1.1 g/mL) as the YELLOW standard solution. We know this because the two solutions mixed.

6

D

5. Why would "Confederation" want their product to have a minimum density of 1.1 g/mL, BUT no higher or lower than this value?

"Confederation" doesn't want their product to have a higher or lower density than 1.1 g/mL because the density of their product needs to be consistent for people to know what to expect when they buy their product. It is also regulated by government that the minimum density of a product must be 1.1 g/mL, indicating a specific sugar concentration, in order to be labelled "Genuine Maple Syrup".

B. Daily Quantitative Tests

6. (a) Use the equipment necessary to find the density of the "unknown" solution that has the same density as the yellow "standard" solution. Prepare a chart in the space below and enter your quantitative measurements in it.

Quantative Density Measurement of Maple Syrup

	Sample	Mass of liquid, m (g)	Volume of liquid, V (mL)	Calculation M/V (g/mL)	Density (g/mL)	Average (g/mL)
Blue	1	23.0	19.9	23.0 / 19.9	1.1558	1.1635 ~ 1.2
	2	39.9	33.8	39.9 / 33.8	1.1805	
	3	40.4	35.0	40.4 / 35.0	1.1543	
Red	1	26.3	24.7	26.3 / 24.7	1.0648	1.0617 ~ 1.1
	2	29.9	27.9	29.9 / 27.9	1.0717	
	3	25.9	24.7	25.9 / 24.7	1.0486	
Green	1	39.9	40.0	39.9 / 40.0	0.9975	0.9944 ~ 1.0
	2	31.7	32.0	31.7 / 32.0	0.9906	
	3	40.8	41.0	40.8 / 41.0	0.9951	
Yellow	1	32.9	31.0	32.9 / 31.0	1.0613	1.0730 ~ 1.1
	2	23.7	21.8	23.7 / 21.8	1.0871	
	3	10.6	9.9	10.6 / 9.9	1.0707	

Red has the same density as the yellow standard solution.

6. (b) Use the data from 6(a) to calculate the density of the solution, showing all work. (see chart above)

$D_{B1} = M/V$
$D_{B1} = 23.0g / 19.9mL$
$D_{B1} = 1.1558 g/mL$

$D_{B2} = M/V$
$D_{B2} = 39.9g / 33.8mL$
$D_{B2} = 1.1805 g/mL$

$D_{B3} = M/V$
$D_{B3} = 40.4g / 35.0mL$
$D_{B3} = 1.1543 g/mL$

$D_{R1} = M/V$
$D_{R1} = 26.3g / 24.7mL$
$D_{R1} = 1.0648 g/mL$

$D_{R2} = M/V$
$D_{R2} = 29.9g / 27.9mL$
$D_{R2} = 1.0717 g/mL$

$D_{R3} = M/V$
$D_{R3} = 25.9g / 24.7mL$
$D_{R3} = 1.0486 g/mL$

$D_{G1} = M/V$
$D_{G1} = 39.9g / 40.0mL$
$D_{G1} = 0.9975 g/mL$

$D_{G2} = M/V$
$D_{G2} = 31.7g / 32.0mL$
$D_{G2} = 0.9906 g/mL$

$D_{G3} = M/V$
$D_{G3} = 40.8g / 41.0mL$
$D_{G3} = 0.9951 g/mL$

$D_{Y1} = M/V$
$D_{Y1} = 32.9g / 31.0mL$
$D_{Y1} = 1.0613 g/mL$

$D_{Y2} = M/V$
$D_{Y2} = 23.7g / 21.8mL$
$D_{Y2} = 1.0871 g/mL$

$D_{Y3} = M/V$
$D_{Y3} = 10.6g / 9.9mL$
$D_{Y3} = 1.0707 g/mL$

$\bar{x} = \frac{1.1558 g/mL + 1.1805 g/mL + 1.1543 g/mL}{3}$, $\bar{x} = 1.1635 g/mL$ | $\bar{x} = \frac{1.0648 g/mL + 1.0717 g/mL + 1.0486 g/mL}{3}$, $\bar{x} = 1.0617 g/mL$ | $\bar{x} =$ [illegible], $\bar{x} = 0.9944 g/mL$ | $\bar{x} =$ [illegible], $\bar{x} = 1.0730 g/mL$ *

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* The last two lines show the student's accurate calculations of the average density of the three samples for each of the solutions.

E

7. (a) Did the results from the layering activity in 4 (a) and 4(b) match your calculated results?

Yes, results from both experiments matched perfectly. The layering of the solutions, and the quantative measuring of the densities gave the exact same order of densities. They both pointed out evidently that the RED solution was the one with the matching density to the standard solution of 1.1 g/mL. Nevertheless, the quantative measuring of the densities was much more precise and was less likely to have mistakes occur. It gave the exact density of each substance while in the layering of the solutions experience, we simply noted what we saw to decide which solution was densegt between the ones mixed.

7. (b) Account for any errors that could have occurred.

Many errors could have occured during the course of these two experiments. In the first, the qualitative experiment of the layering of the solutions, the drops could have been added to the solution too quictly causing it to mix. Too many or too little drops could have also altered the results. In the second experiment, the quantatative measuring of the densities, the volume of the liquid could have not been measured precisely enough. The graduated cylinder might not have been cleaned and dried between each test, therefore making it heavier. There also could have included mathematical errors. Many other small mishaps could have also altered the results in both experiments.

8

F

Daily Tours

8. (a) A tour of Grade 5 students from an elementary school has just arrived at your laboratory. Explain, in language they can understand, how you used the equipment in 6(a) to determine the actual density of one of the unknown sample solutions.

Hello children, here at "Confederation" we measure the density of our maple syrup very precisely so that we can always keep it at the same density of 1.1 g/mL. We can then call it "Genuine". First of all, we take a dry and clean graduated cylinder and place it on the electronic balance. We then press the "tear" button so that the balance automatically subtracts the weight of the cylinder from the total weight. We then add the liquid which is being tested in the graduated cylinder. Now, we record accurately the mass of the syrup in grams and the volume in millilitres. We test each solution three times. We take all three densities of the same syrup and get the average so that the calculation is even more precise. To find the average, we add all three numbers up and devide the result by three. Then, we show the management our results. They can then make decisions to adjust the concentration of sugar to make it more dense or less dense. It must have the 1.1 g/mL density level required by the goverment. Next time your parents buy "Confederation" maple syrup, remember that it will always be "genuine."

8. (b) Explain to the students what skills are necessary for a quality control technician AND why your job is important to the company.

If you kids would like to be a quality control technician, later on, it is very important to be very good in mathematics and science. You must also pay very close attention to small details and be very precise in all you do. You must then be able to correctly analyse and interpret the data you collect. For example, here at "Confederation", you have to be able to measure the volume and the mass of liquids very precisely since a small blunder could affect the outcome of the density of the syrup. Customers expect to buy a "genuine" syrup with a consistent density. Therefore, the whole company's reputation could be affected if the product sold was not according to government regulations. The jobs of all the other employees here at "Confederation" depend in some way on the quality control technicians. This is why we have to work hard all the time because we are a very important asset to our company.

9

Teacher's Notes

Knowledge/Understanding

- The student demonstrates a thorough understanding of the concept of density (e.g., provides a detailed, accurate explanation in question 2).
- The student applies the density formula with a high degree of competence.

Inquiry

- The student interprets data with a high degree of accuracy.
- The student uses technical skills with a high degree of accuracy (e.g., uses three trials to calculate density and takes their average).
- The student draws conclusions supported to a high degree by the data (e.g., discusses the similarities between the qualitative and quantitative data and accounts for any errors).

Communication

- The student communicates observations and information with a high degree of clarity.
- The student displays data in charts that are very complete and very well organized, with detailed headings and titles.
- The student uses SI units with a high degree of appropriateness.
- The student communicates with a strong sense of audience, using phrases appropriate for Grade 5 students (e.g., "Hello children"; "Next time your parents buy …").

Making Connections

- The student shows a high degree of awareness of the skills required for the occupation, and includes rationales and examples from beyond the realm of the lab (e.g., "good in mathematics and science … pay very close attention … analyse and interpret").

Comments/Next Steps

- The student was able to use previous knowledge concerning the particle theory to explain the layering effect of the solutions.
- Although the student makes few errors in spelling and grammar, he or she should proofread for consistency in the use of scientific language.

A Check on the Density of Maple Syrup   Level 4, Sample 2

A

Confederation Maple Syrup Company
Quality Control Report

A. Hourly Qualitative Check of Samples

1. What are the technicians trying to find out with their test?

The technicians are attempting to find out which of the samples is more dense or less dense than the standard by watching which floats or sinks in the standard, They need to know which is less dense so they increase the density to be able to sell it. If it is above the standard they would want to make it less dense to save money

2. (a) What observation, from the layered solutions, would indicate that one of the solutions is denser than the other?

To find out which solution is denser they would have to place 2 or more in a beaker together, at the very bottom would be the most dense and the very top would be the least dense.

(b) Explain

Density is the amount of matter per unit of volume for an object or liquid. The more dense something is, the more matter that is packed into it, The liquid that is most dense would contain more matter, making it heavier and causing it to sink

5

B

3. (a) Prepare a data table in which you can record your qualitative data for each test that you do. Include a column in which you indicate your conclusion on the test (e.g. "Therefore, Red is more dense than Green, R>G). Enter all of your data in your table.

Table 1: Tests of the Three Samples

Test	Colours Used	Colour on Top	Colour at Bottom	Conclusion
# 1	25 Blue, 5 Red	Red	Blue	Blue is more dense than red
# 2	25 Red, 5 Blue	Red	Blue	Red is less dense than blue
# 3	25 Blue, 5 Green	Green	Blue	Blue is more dense than green
# 4	5 Blue, 25 Green	Green	Blue	Green is less dense than blue
# 5	25 red, 5 green	Green	Red	Red is more dense than green
# 6	25 green, 5 red	Green	Red	Green is less dense than red
# 7	25 red, 5 yellow	Yellow	Red	Red is less dense than yellow
# 8	25 yellow, 5 red	Red	Yellow	Red is more dense than yellow

Table 1: Tests of the Three Samples (cont'inued)

Test	Colours Used	Colour on Top	Colour on Bottom	Conclusion
# 9	25 blue, 5 yellow	Yellow	Blue	Blue is more dense than yellow
# 10		Yellow	Blue	Yellow is less dense than blue
# 11		Green	Yellow	Green is less dense than yellow
# 12		Green	Yellow	Yellow is more dense than green

3. (b) State what you found out.

By completing this experiment I found out that Blue is more dense than the standard, Green is less dense than the standard, and that red is very close to the standard therefore making it the best choice for sale.

4. (a) Rank the densities of the three "unknown" sample solutions

Most Dense - Blue

Middle - Yellow and Red

Least Dense - Green

(b) Which "unknown" solution has the same density as the yellow "standard" solution?

The unknown solution that has the same density as the standard is Red. The two solutions were mixed twice, and once yellow came out on top and red was on top the other time

6

C

5. Why would "Confederation" want their product to have a minimum density of 1.1 g/mL, BUT no higher or lower than this value?

It is best for the company to be as close to the minimum density as possible in order to make as much money as possible. If there is too much sugar in the maple syrup, it is wasting sugar and costing Confederation more money. If the density is below the minimum density level the maple syrup will not be classed as genuine and the customer's will buy real maple syrup instead of Confederation maple syrup

B. Daily Quantitative Tests

6. (a) Use the equipment necessary to find the density of the "unknown" solution that has the same density as the yellow "standard" solution. Prepare a chart in the space below and enter your quantitative measurements in it.

Table 2: The densities of the three samples

* We used the Rezero function on the electronic balance

Sample	Volume (mL)	Mass (g)
Yellow	1	0.8
Blue	1	1.0
Red	1	0.8
Green	1	0.9

6. (b) Use the data from 6(a) to calculate the density of the solutions showing all work.

Yellow
G. m=0.8g V=1mL
U. D=?
E D=$\frac{m}{V}$
S D=$\frac{m}{V}$=$\frac{0.8}{1}$=0.8g/mL
S The density of the standard solution is 0.8 g/mL

Blue
G m=1.0g V=1mL
U D=?
E D=$\frac{m}{V}$
S D=$\frac{m}{V}$=$\frac{1.0}{1}$=1g/mL
S The density of solution #1 is 1g/mL

Red
G m=0.8g V=1mL
U D=?
E D=$\frac{m}{V}$
S D=$\frac{m}{V}$=$\frac{0.8}{1}$=0.8g/mL
S The density of solution #2 is 0.8g/mL

Green
G m=0.9g V=1mL
U D=?
E D=$\frac{m}{V}$
S D=$\frac{m}{V}$=$\frac{0.9}{1}$=0.9g/mL
S The density of solution #3 is 0.9g/mL

7

D

7. (a) Did the results from the layering activity in 4 (a) and 4(b) match your calculated results? The results did not match exactly, but they were relatively close. The red and yellow samples seemed to have an equal density value while working on the layering activity and after completing the calculations, the densities of the red and yellow solutions came out at 0.8g/mL making them even. In the layering activity blue always sank to the bottom and when I did my calculations blue had the highest density at 1.0g/mL. The only problem was the density of the green solution. In the layering activity the green always floated to the top but in the calculations green's density came out at 0.9g/mL which was higher than that of the red and yellow solutions. The calculations showed that the green solution was the second most dense.

7. (b) Account for any errors that could have occurred.

There are quite a few things that could be accounted for creating errors in the data. The first thing was the electronic balance. It seemed to range its measurements for a certain samples by 0.5, one time it would be 0.5g, the next 1.1g after that 0.7g, and so on. Sometimes it didn't even register anything at all. I believe that the electronic balance can be blamed for most of the errors in the data. One other thing that could account for some errors is the water in the test tubes. The test tubes were all full of water droplets and it was impossible to get this water out. Some test tubes may have had more water than others. If this water got into any of the solutions, it would cause the solution to become less dense.

8

E

Daily Tours

* Words in brackets are what would be said to the students

8. (a) A tour of Grade 5 students from an elementary school has just arrived at your laboratory. Explain, in language they can understand, how you used the equipment in 6(a) to determine the actual density of one of the unknown sample solutions.

Always wear Goggles and Gloves

Take the graduated cylinder (tube with the yellow pieces) and put in on the electronic balance (scale), wait a few seconds then press the button that says "Rezero"

First of all you then you take the bottle of red liquid and put 1mL (25 drops approx.) of this liquid into one of the graduated cylinders (tubes with the yellow pieces attached). The place the tube with the red liquid in it onto the balance (scale), after doing this you will find the mass (like weight) of the liquid, Next, we divide the mass of the liquid by the volume of liquid to get our density

8. (b) Explain to the students what skills are necessary for a quality control technician AND why your job is important to the company.

you really need to keep everything organized and know how to find the density of a liquid and what that number means, you need to know how to use all equipment. My Job is very Important because the company need's the density as close to 1.1g/mL as possible in order to make the maximum amount of money possible. Being a quality control technician is very cool.

9

Teacher's Notes

Knowledge/Understanding

- The student demonstrates a thorough understanding of the concept of density (e.g., provides a clear and accurate explanation in question 2).
- The student applies the density formula with a high degree of competence, using the "GUESS" method of showing steps.

Inquiry

- The student interprets data with a high degree of accuracy.
- The student is able to draw conclusions supported by the data to a high degree, and reflects an understanding that errors in data cause inconsistencies (e.g., acknowledges that the quantitative and qualitative data do not match and suggests reasons for the differences).

Communication

- The student communicates observations and information with a high degree of clarity and organization.
- The student uses scientific terms with a high degree of accuracy (e.g., uses "per unit of volume" for density and "heavier" in the proper context in question 2b), and uses SI units and styles with a high degree of appropriateness (e.g., includes units wherever they are required).
- The student communicates with a strong sense of audience (e.g., includes safety reminders when explaining how to find density to Grade 5 students, and puts certain words in parentheses – "mass [like weight]" – to indicate equivalent Grade 5 language).

Making Connections

- The student analyses the requirements of production thoroughly, focusing on several different factors (e.g., mentions cost as well as quality in question 5, when explaining why the density cannot be higher or lower than 1.1 g/mL).

Comments/Next Steps

- The student should be careful to complete charts fully.
- The student uses comparison to support the Grade 5 students' understanding of mass (e.g., "like weight").
- The student could include a more extensive list of the skills required for the occupation.
- The student should be encouraged to inform the teacher of problems with equipment (e.g., electronic balance).

Teacher Package

Science Exemplar Task
Grade 9 Science – Academic

Teacher Package

Title: A Check on the Density of Maple Syrup

Time Requirement: 2–3 classroom periods of 60 minutes each

Description of the Task*
The following scenario and instructions are to be provided for students.

A Check on the Density of Maple Syrup

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 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 requirements. 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 in Question 8.

*This task has been adapted from Unit 1, Activity 3: "Properties of Water Density", in the course profile for Science, Grade 9, Academic (Public).

1

Final Product
- Completed student booklet

Assessment and Evaluation
- The entire student booklet, which contains the student's written answers, will be submitted for assessment. It will be scored using the task rubric.*
- Laboratory skills, working collaboratively, and laboratory safety can be assessed by teacher observation.

Expectations Addressed in the Exemplar Task

Students will:
1. solve density problems – given any two of mass, volume, and density, determine the third – using the formula *density = mass/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.

Teacher Instructions

Prior Knowledge and Skills Required
- The expectations being assessed come from the strand Chemistry: Atoms and Elements and focus on density. For many classes, this task will serve as a review of expectations addressed earlier in the year.
- *The Ontario Curriculum, Grades 1–8: Science and Technology, 1998* addresses both solutions and density. Any deficits in the background from Grades 8 and 9 should be identified and reviewed as necessary.
- To complete this task, students should 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 $D = m/V$ and using it to calculate density
  - the relationship between density and floating or sinking
  - the production of maple syrup
  - the economic costs involved in the production of a product

2

The rubric is reproduced on page 14 of this document.

SI Metric Style

- You should model good metric style for students. A resource is *Science: Intermediate/Senior Divisions (1987): Part 1, Program Outline and Policy,* Appendix B: Physical Quantities, and Appendix C: Metric Editorial Practice, pp. 79–98.
- The accepted symbol for density is ρ and an italic *m* and *V* are the symbols for mass and volume, respectively. Since some Canadian texts use $D = m/V$, either designation will be accepted for this task.

Accommodations

Accommodations that are normally provided in the regular classroom for students with special needs should be provided in the administration of this performance task.

You may wish to review the relevant course profile for specific suggestions for accommodations appropriate for students in special education programs.

Working in Pairs and Individually

- Students can work individually for the entire task, or if equipment and space limitations require it, they can work in pairs in the laboratory to conduct qualitative comparisons of solutions. The quantitative density measurement of the "unknown" solution should be carried out individually.
- After collecting laboratory data, students are to complete their reports individually, so that they may be assigned individual scores.

Materials and Resources Required per Student or Student Pair

- 4 test tubes (to hold samples)
- 12 test tubes, small diameter (to mix samples)
- 4 eyedroppers
- pencil/paper/ruler
- waste bucket
- paper towels
- beaker or test tube rack (to hold test tubes)
- 4 different coloured sugar solutions described below
- balance (minimum of one per four students)
- graduated cylinder (25 mL)

Preparation

- Show a bottle of maple syrup for any students who may not know what it is. The term "genuine" has been used instead of "pure" to avoid confusion with "pure substance".

Preparation of Solutions

- Prepare the solutions, using warm water to speed the dissolving of the sugar.
- Each class requires a minimum of 500 mL of each of the solutions and twice this volume of solution #2.
- For students who have difficulty with colour, the solutions should be labelled as *Solution #1, Blue*, etc. The colour designations could also be shown on the chalkboard.

Solutions	
#1	Blue
#2	Red
#3	Green
Standard	Yellow

- If prepared as directed, the standard solution (yellow) has a density of 1.1 g/mL. The red solution also has a density of 1.1 g/mL. The blue solution has a density of 1.2 g/mL and the green solution has a density of 1.0 g/mL.
- Prepare four different solutions of the following densities:
  - ➢ 150 g of sugar in 500 mL of water with blue food colouring (*solution 1, blue*)
  - ➢ 150 g of sugar in 1.0 L of water, to be **divided into two** 1 L samples:
    - – one with yellow food colouring (*standard solution, yellow*)
    - – one with red food colouring (*solution 2, red*)
  - ➢ 500 mL of tap or distilled water with green food colouring (*solution 3, green*)
- You may want to make solutions more extreme so that students find a larger quantitative difference (i.e., make the blue solution more concentrated).

Test the Solutions and Procedure Before Administering the Task

Perform the task in advance of the day of administration to become familiar with the observations and to verify densities. Determine the amount of food colouring required for best visibility on mixing. If the solutions are too dark, it will not be possible to see mixing of colours.

Rubric

Introduce the task-specific rubric to the students at least one day prior to the administration of the task. Review the rubric with the students and ensure that each student understands the criteria and the descriptions for achievement at each level.

Allow ample class time for a thorough reading and discussion of the assessment criteria outlined in the rubric.

Some students may perform below level 1. It will be important to note the characteristics of their work in relation to the criteria in the assessment rubric and to provide feedback to help them improve.

Student Tasks and Proposed Answers

Procedure A for Hourly Testing involves using an eyedropper to transfer twenty-five drops of solution 1 to a small-diameter test tube (10-12 mm in diameter). Students then slowly and carefully add three or more drops, if required, of solution 2, waiting ten seconds between drops. The drops should be allowed to run down the side of the test tube to maximize the effect. If the two solutions mix, then solution 2 has a density equal to or greater than the density of solution 1. If the three drops of solution 2 form a narrow ring above solution 1, then solution 1 is more dense than solution 2.

Note: Column 4 is requested in the instructions. **Do not** remind the students to include column 4 or that one of the options is X = Y. All you can do is remind them to read the instructions carefully.

Proposed Answers (Questions 2, 3, 4)

Solution in Tube	Solution Added on Top	Result	Meaning/Conclusion
Yellow	Blue	Blue sinks	B > Y
Blue	Yellow	Yellow floats or coloured ring forms	Y < B
Yellow	Green	Green floats or coloured ring forms	G < Y
Green	Yellow	Yellow sinks	Y > G
Yellow	Red	Mixes	R > Y or R = Y
Red	Yellow	Mixes	Y > R or Y = R
Blue	Red	Red floats or coloured ring forms	R < B
Red	Blue	Blue sinks	B > R
Blue	Green	Green floats or coloured ring forms	G < B
Green	Blue	Blue sinks	B > G
Red	Green	Green floats or coloured ring forms	G < R
Green	Red	Red sinks	R > G

Qualitative Hourly Check

The student should state that:

- blue is more dense than yellow (the standard) or B > Y or Y < B;
- green is less dense than yellow (the standard) or Y > G or G < Y;
- blue is the most dense liquid;
- green is the least dense liquid;
- yellow and red are equal in density or Y = R.

Why Is There a Need to Control Sugar Concentration? (Question 5)

- Students should indicate that a density below government regulation will not allow Confederation Maple Syrup Co. to label and sell the product as "Genuine Maple Syrup".
- Factors influencing Confederation to keep the density no greater than 1.1 g/mL could include its having to spend extra money, energy, and time, as well as use extra raw product, in evaporating off extra water to make a more concentrated sugar solution.

Procedure B for Daily Test (Questions 6, 7)

- Students take the sample that they have identified as equal in density to the standard and use the balance and graduated cylinder to gather the data necessary to calculate the density of the sample.
- Students make measurements and record them in neat format or in a labelled chart.
- Calculations are to show all steps and include units.

Example:

mass of empty graduate = 53.65 g
mass of liquid + graduate = 65.20 g
mass of liquid = (65.20 – 53.65) g = 11.55 g
volume of liquid = 10.50 mL

$D = m/V$
D = 11.55 g / 10.50 mL
= 1.10 g/mL

If prepared as directed, the standard solution (yellow) should have a density of 1.10 g/mL or 1.1 g/mL. The red solution should also have a density of 1.10 g/mL or 1.1 g/mL. The blue solution should have a density of 1.2 g/mL and the green solution a density of 1.0 g/mL.

Procedure C for Explaining to Grade 5 Students on Tour (Question 8a)

- Students describe the steps required to determine the mass of a measured volume of solution. They should find the mass of the empty graduated cylinder. They should measure out a certain volume of liquid and determine its mass by subtracting the mass of the graduated cylinder from the mass of the liquid and graduated cylinder. Mass divided by volume provides the mass per unit volume or the density.
- Since this explanation is to a touring Grade 5 class, appropriate language, clarity, completeness, and a logical sequence are required.

Skills Necessary for Technician (Question 8b)

- Student should indicate the laboratory skills necessary to obtain an accurate result.
- Additional qualities such as communication, working with others, promptness, etc., are expected at levels 2–4. Since this explanation is to a touring Grade 5 class, appropriate language, clarity, completeness, and a logical sequence are required.

Science Applied

Chemical and Physical Change

The Task

In the first part of the task, students worked in pairs to:

- observe the physical and chemical changes that produce carbon dioxide gas, and record their observations;
- examine the properties of the gas.

In the second part of the task, students were to work individually to design a container (on paper) to hold two chemical compounds that make carbon dioxide gas, and explain the process involved in designing the container, on the basis of their understanding of physical and chemical change. The container was to be such that:

- the chemical compounds would not come in contact with each other when the carbon dioxide product was not required for any application;
- when required, a fairly simple manipulation of the container would result in the two chemical compounds' coming into contact to produce the necessary carbon dioxide to extinguish a flame.

Each student was required to complete questions 1–7 in the student booklet.

Expectations

This task gave students the opportunity to demonstrate achievement of the following selected expectations from the strand Chemistry: Exploring Matter.

Students will:

1. describe, using their observations, the evidence for chemical changes;
2. demonstrate knowledge of laboratory, safety, and disposal procedures while conducting investigations;
3. determine how the properties of substances influence their use;
4. demonstrate the skills required to plan and conduct an inquiry into the properties of substances, using apparatus and materials safely, accurately, and effectively;
5. communicate scientific ideas, procedures, results, and conclusions using appropriate language and formats;
6. investigate the properties of changes in substances, and classify them as physical or chemical based on experiments;
7. explain how a knowledge of the physical and chemical properties of elements enables people to determine the potential uses of the elements and assess the associated risks.

Prior Knowledge and Skills

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

- distinguishing between chemical and physical properties (elements and compounds)
- recording observations (including creating appropriate headings for the task) in a table, chart, or other suitable organizer, by hand or using spreadsheet software
- accurately drawing and labelling a diagram using a pencil and ruler, and writing a clear, concise explanation of what the diagram represents
- writing, using appropriate vocabulary, observations concerning colour, texture, density, and combustibility

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 pages 58–59 and the Teacher Package reproduced on pages 92–95.

Task Rubric – Chemical and Physical Change

Expectations*	Criteria	Level 1	Level 2	Level 3	Level 4
Knowledge/Understanding					
	The student:				
1, 3, 6	– demonstrates an understanding of the concepts of physical and chemical change and physical and chemical property	– demonstrates limited understanding of the concepts	– demonstrates some understanding of the concepts	– demonstrates considerable understanding of the concepts	– demonstrates a thorough understanding of the concepts
Inquiry					
	The student:				
3, 4, 6	– draws valid inferences from data	– draws inferences that have limited validity	– draws inferences that have some validity	– draws inferences that have considerable validity	– draws inferences that have a high degree of validity
	– follows the identified procedures	– follows a few of the identified procedures	– follows some of the identified procedures	– follows most of the identified procedures	– follows all/almost all of the identified procedures
Communication					
	The student:				
1, 5	– provides details that are consistent with data	– provides details often not consistent with data	– provides details sometimes consistent with data	– provides details mostly consistent with data	– provides details entirely consistent with data
	– communicates required information clearly and in an organized manner	– communicates information with limited clarity and organization	– communicates information with some clarity and organization	– communicates information with considerable clarity and organization	– communicates information with a high degree of clarity and organization
	– prepares diagram with neatness and appropriate detail	– prepares diagram with limited neatness and detail	– prepares diagram with some neatness and detail	– prepares diagram with considerable neatness and detail	– prepares diagram with a high degree of neatness and detail
	– displays data in complete and well-organized chart	– makes incomplete chart with limited organization	– makes partially complete, partially organized chart	– makes mostly complete, well-organized chart	– makes very complete, very well organized chart
	– uses scientific terminology accurately	– uses scientific terminology with limited accuracy	– uses scientific terminology with some accuracy	– uses scientific terminology with considerable accuracy	– uses scientific terminology with a high degree of accuracy

Expectations*	Criteria	Level 1	Level 2	Level 3	Level 4
Making Connections					
	The student:				
7	– proposes a course of practical action (container design) in response to a problem involving physical/chemical change	– proposes a course of action with limited effectiveness	– proposes a course of action with some effectiveness	– proposes a course of action with considerable effectiveness	– proposes a course of action with a high degree of effectiveness

* The expectations that correspond to the numbers given in this chart are listed on page 54. Although all of the expectations were addressed through instruction relating to the task, student achievement of expectation 2 was not assessed in the final product.

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

Chemical and Physical Change

The Task

Congratulations on your new position as a summer student working with Chemwide Industries. You will work with a fellow student on the following two-part project:

- Observe a variety of physical and chemical changes that produce carbon dioxide gas. At the end of each of the required procedures, you will pour the carbon dioxide over a lit candle to establish an important physical property of the gas that makes it useful for extinguishing fires.
- Design a container that will:
  - keep two chemical substances that produce carbon dioxide apart for as long as required;
  - allow for the substances to mix when carbon dioxide is needed to extinguish a flame.

Each summer student will be required to submit to the supervisor a chart of observations and a work plan that includes the design for the container (questions 1 to 7 in the student booklet).

Materials

Make certain that the following materials are available at your work station:

- safety goggles – one pair for each student
- small amount of Bromoseltzer crystals or crushed Alka-Seltzer tablets
- small amount of sodium bicarbonate
- 1 bottle of soda pop – 600 mL (cola works best)
- 3 balloons, round, about 30 cm in diameter
- 3 test tubes, large
- 50 mL of water
- 50 mL of vinegar
- 1 candle
- tin can with lid removed
- matches
- can containing sand in which to extinguish matches

Instructions for Question 1

1. You and your partner will be asked to follow each of the procedures listed below to produce carbon dioxide gas. In each case, record all observations in an appropriate table or chart that you have made.

a)

- Place the candle in the tin can and light it carefully.
- Add 25 mL of water to a test tube
- Prepare the balloons by stretching their necks and inflating them several times so they will expand when they should. Open the neck of one balloon and place a pinch of Bromoseltzer inside.
- Attach the balloon to the lip of the test tube and hold it in place. Then hold the balloon upright so that the Bromoseltzer falls into the water.
- When effervescence ceases, tightly pinch the neck of the balloon closed and remove it from the test tube. Place the neck of the balloon just inside the rim of the can containing the burning candle and slowly push the contents out of the balloon so that they pour onto the flame.

b) Add 25 mL of vinegar to the second test tube and a pinch of sodium bicarbonate to a second balloon. Repeat the steps above.

c) Attach a third balloon to the neck of a recently opened bottle of pop and use your fingers to hold the balloon in place while you shake the bottle. Pour the contents of the balloon over a burning candle.

d) Sprinkle a pinch of sodium bicarbonate directly onto the flame of a burning candle.

Instructions for questions 2–7 are contained in the pages of the student booklet reproduced in the samples that follow.

Chemical and Physical Change Level 1, Sample 1

A

Data Table Fri. 26

Expieramen#	Substances	Properties	Descriptions
1. Part A	1 Bromoseltzer, 2 Ballon, 3 candle, 4 matches, 5 water,	1 Solid, 2 Solid, 3 Solid, 4 Solid, 5 water = liquid,	Bromo: white, Pieces, rough surface; Ballon; rubber, candle; wax, water: clear liquid.
1 Part B	1 Sodium Bicarbonate, 2 candle, 3 matches, 4 vinegar 5 Ballon.	1. Solid, 2 Solid, 3. Solid, 4. liquid, 5. Solid.	Sodium: white, powderish, smooth surface, candle: wax matches: wooden sticks, vinegar, clear liquid, Ballon: rubber.
Part C	1. Bottle of Pop; 2. candle, 3. ballon.	1. liquid in Solid, 2. Solid, 3. Solid	Pop: liquid, brown candle, Solid, wax ballons; rubber, colaured.

Descriptions

Expirement	Before	During	After
#1 Part A	lit candle, streched ballon, Bromo in ballon, water in test tube.	Bromo put in test tube while top of ballon was still on top of it.	Substance in ballons put out the lit candle.
#1 Part B	lit candle, streched ballon, sodium in ballon. vinegar in test tube	sodium was put in test tube, with ballon still attached to it.	Substance in ballon put out the candle.
Part C.	ballon was streched over bottle top,	bottle was shaken while ballon was on top.	Substance in Ballon put out candle.

B

Expirement#	Physical change	Chemical change	Why?
#1 Pt. A		chemical change	because, heat and light was given off.
#1 Pt. B		Chemical change	Chem. because heat and light were given off
Pt. C.	Physical change		no new state formed.
Pt. D	Physical change		no new substance formed.

	Sustances	Properties	Descriptions
Part D.	1. Matches, 2. Sodium, 3. candle.	1. Solid, 2. Solid 3. Solid.	macthes, wooden sticks sodium, white, powderish cande, wax

	Before	During	After
Part. D.	lit candles, Sodium.	scoop of sodium.	put out lit candle.

C

2. In the space below, indicate whether each of the four procedures resulted in a *physical change*, or a *chemical change*. In each case justify your answer based on observations you made.

a) Part A was a chemical change ~~because light and fast~~ ~~[illegible]~~ Because new state appeared.

b) this was Chemical change, also because new state

c) Physical change, because no new state appeared.

d) Physical change, because it isn't difficult to reverse.

3. Based on your observations, state one physical and one chemical property of carbon dioxide gas.

a) physical:
because gas bubbles form.

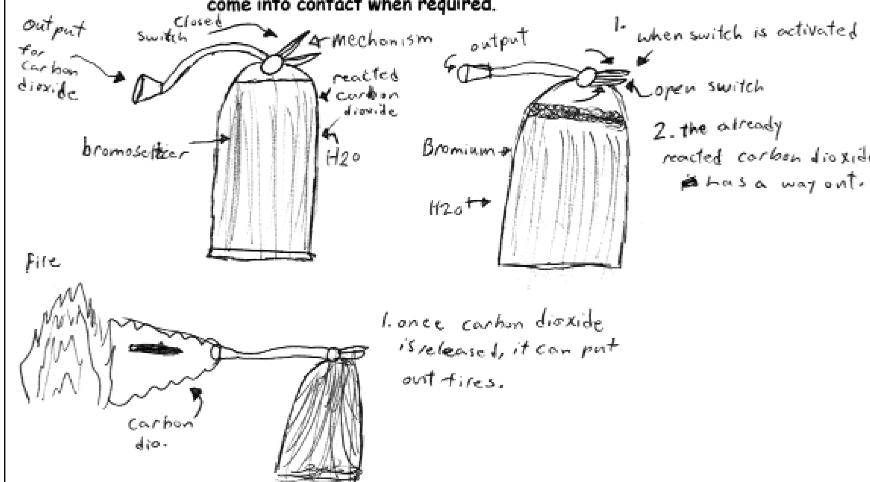
D

b) chemical: If all the carbon dioxide is gone in pop, then change is difficult to reverse.

4. Use the space below to draw and label a container will hold two chemical substances that when mixed together form carbon dioxide gas. Your container must:

a) keep the chemical substances apart until the carbon dioxide is required, and

b) must include a simple mechanism that allows the chemical substances to come into contact when required.



E

5. **Write a brief description of why the container is designed the way it is, and how your container design meets the two design criteria.**

My container is a fire-extinguisher tipe design, first the bottom container part is filled with bromium alkaseltzer and water, and we know those two substances react. The second switch part is for when you squeze the switch the reacted carbon dioxide will come out.

My design meets the criteria. My container has a switch to release the carbon dioxide, and has also has the Bromium and water in a controlled state.

6. **Explain why the carbon dioxide released by your device is able to put out a fire.**

Because in the first part of my expierament, I mixed Bromium and water together and put it in a ballon. The reacted carbon dioxide put out a lit candle. So if I mixed more of that then I would be able to put out fires.

6

F

7. **Write a brief description of the planning process you used to produce your design for the container. Include in your description**
   - **problems that you encountered**
   - **how successful you were in finding solutions to these problems**
   - **what you would do differently next time**

Description 5/30/00

The first problems I encountered were how am I gonna design a container to put 2 reacted substances in? But then I thought of the expierement I did earlyier in how I put out the lit candle with the bromium and water. I think I was fairly sucessfull in finding a solution for my problem, because I realized that I had already done this stuff and it was just a matter of looking back and remembering it. My first step was to draw a small container to hold my two substances then I attached a switch next to it so I could control the 2 substances and also so that I could relase it to put out fires whenever I wanted. The next time I do this I would certainly have an easier time because I have already had experience with it. I would think out and apply a different and better strategy.

Teacher's Notes

Knowledge/Understanding

- The student demonstrates limited understanding of the properties of substances and of the concept of physical and chemical change (e.g., provides limited justifications in question 2).

Inquiry

- The student draws inferences that have limited validity (e.g., has difficulty classifying the observed changes/reactions as physical or chemical changes).
- The student follows a few of the identified procedures (e.g., has difficulty designing a container that will allow the chemical compounds to come into contact by simple manipulation).

Communication

- The student makes a limited attempt to include required details (e.g., does not show clearly whether lines drawn in diagram indicate separation barriers).
- The student gives information with limited clarity (e.g., in questions 5 and 6, gives detailed ideas and information, but in a manner that is difficult to understand).
- The student makes incomplete charts with limited organization (e.g., produces three data tables that should have been combined into a single table; does not space information accurately).
- The student uses scientific terminology with limited accuracy (e.g., in question 2, uses the term "state" inaccurately; repeatedly refers to "Bromoseltzer" as "bromium").

Making Connections

- The student proposes a course of action with limited effectiveness (e.g., the container does not meet the stated requirements because it does not keep the chemicals apart).

Comments/Next Steps

- The student should work on recording observations and should improve charting skills by setting up columns appropriately to indicate the order of reactions.
- The student should work on using appropriate scientific terms and chemical names.
- The student should clarify the definition of chemical and physical properties, and the explanation of how to identify when a chemical or physical change has occurred.
- The student shows signs of careful observation in the chart, and should work on developing explanations for the observations.

Chemical and Physical Change — Level 1, Sample 2

A

observations

Baking soda and vinegar - you mix the two to put out the flame

water + Alkaseltzer = also mixes together and produces CO_2 and then put ~~out~~ out the flame

B

2. In the space below, indicate whether each of the four procedures resulted in a *physical change,* or a *chemical change.* In each case justify your answer based on observations you made.

a) chemical - Water and Alkaseltzer it make CO_2 and blows up the ballon and puts the fire out when you let the CO_2 out on it

b) chemical change - baking soda - vinegar fizzes up and blows up ballon then you let the carbon dioxide on the fire and it goes out

c) Pop - Physical change shook the pop and it blew up the ballon. blow it out on the fire and it goes out

d) Sprinkle - Physical sprinckeld baking soda on fire and it went out.

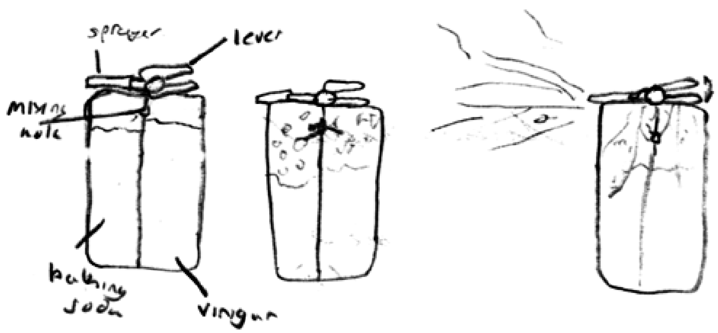
3. Based on your observations, state one physical and one chemical property of carbon dioxide gas.

a) ~~physical:~~ chemical: Baking Soda - vinegar it fizzes up and blows up the ballon

C

b) ~~chemical~~ Physical sprinkle baking soda on fire puts it out

4. Use the space below to draw and label a container will hold two chemical substances that when mixed together form carbon dioxide gas. Your container must:
   a) keep the chemical substances apart until the carbon dioxide is required, and
   b) must include a simple mechanism that allows the chemical substances to come into contact when required.



5

D

5. Write a brief description of why the container is designed the way it is, and how your container design meets the two design criteria.

I got the design from the fire extinguisher caus I thout it was good. And I thought it was good that you shake it first then the chemicals mix and you press the lever and it comes out. And if it gets punctured it wont explode.

6. Explain why the carbon dioxide released by your device is able to put out a fire.

because carbon dioxide has no oxygen in it and it takes away oxygen away from the fire.

6

E

7. Write a brief description of the planning process you used to produce your design for the container. Include in your description

- problems that you encountered
- how successful you were in finding solutions to these problems
- what you would do differently next time

• hard to get a good design and how it works.

• I was successfull in finding solutions to these problems by making a good extinguisher thing.

• Next time I would put a safety lock on it so kids couldent mess with it and stuff

7

Teacher's Notes

Knowledge/Understanding

– The student demonstrates limited understanding of the concepts of physical and chemical change and physical and chemical properties (e.g., in questions 2c and 2d, confuses physical change with the physical action of mixing substances; recognizes that CO_2 displaces O_2 to extinguish a flame, but does not recognize a clear link between physical and chemical properties).

Inquiry

– The student makes appropriate, if simple, observations, but needs to draw valid inferences from the data (e.g., that chemical change is indicated by a new state).

– The student follows few of the identified procedures (e.g., observations in the chart give little evidence that procedures were followed).

Communication

– The student gives details that often are not consistent with data (e.g., gives explanations that lack support or justification).

– The student presents information with limited clarity and organization (e.g., does not provide explanations or meet other requirements of questions).

– The student makes an incomplete chart with limited organization (e.g., uses only two rows with no columns or headings, describing two observations).

– The student uses scientific terminology with limited accuracy (e.g., does not recognize the difference between "properties" of and "changes" in matter).

Making Connections

– The student proposes a course of action with limited effectiveness (e.g., designs a container in which the two reactants are separated, but does not clearly show the mechanism to mix them and to release the gas produced).

Comments/Next Steps

- The student needs to communicate more details in answers to adequately present ideas.
- The student should place more emphasis on recording observations and interpreting data in a systematic way.
- The student made an attempt to use appropriate chemical formulae (e.g., "CO^2"), but did not write the symbols correctly; needs to work on increased accuracy.

Chemical and Physical Change Level 2, Sample 1

A

Observations

	what you did	what happened	physical chemical change
a) H_2O Alka-seltzer candle	filled beaker 50ml H_2O Alka-seltzer into balloon. took balloon and held over candle. let out slowly	the candle melted faster. when mixed it bubbled a lot.	chemical
b) Vinegar sodium bicarbonate candle	50ml of vinegar (5% acetic acid) sodium bicarbonate In. Balloon, mixed it. held over candle let out slowly	It blew the candle out. when mixed it bubble quite a bit	chemical
c) Pepsi candle	put balloon onto pepsi bottle and shook pop took balloon and held it over candle let CO_2 out slowly	pop fizzed a lot nothing happened blew flame around but not out	physical
d) sodium bicarbonate candle	sprinkled baking soda over candle flame	flam- went big, and never went out.	physical

B

2. **In the space below, indicate whether each of the four procedures resulted in a *physical change*, or a *chemical change*. In each case justify your answer based on observations you made.**

a) Chemical - it was a chemical change, because we mixed two differenced substances together to make a new one.

b) Chemical - it was a chemical change, because again we mixed two differenced substances to gether to burnout the fire.

c) Physical - it was a Physical change, because we only use one substance, not two. And it didn't blow the flame out

d) Physical - it was a physical change, because there was only one substance and the flame did not go out.

3. **Based on your observations, state one physical and one chemical property of carbon dioxide gas.**

a) **physical:** It's clear and it fizzes with didn't substances.

4

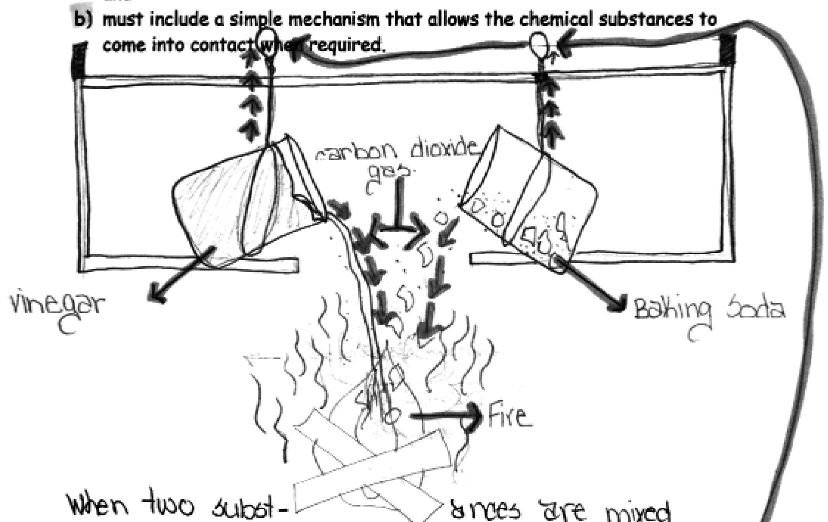
C

b) **chemical:** It put out the fire with it's flame.

4. **Use the space below to draw and label a container will hold two chemical substances that when mixed together form carbon dioxide gas. Your container must:**

a) **keep the chemical substances apart until the carbon dioxide is required, and**

b) **must include a simple mechanism that allows the chemical substances to come into contact when required.**



When two subst- ances are mixed together like bakingsoda and vinegar and it is suppose to put a fire out. You pull the two wires, and then the two substanaes mix together.

D

5. **Write a brief description of why the container is designed the way it is, and how your container design meets the two design criteria.**

The container is designed the way it is, because you want to saparate the two substance apart and then have them pord into a fire. So, you put one substance (vinegar) into one container and another (baking soda) in another container, to saparate the two substances. Then you need to mix them together but you can't have them touching eachother. Then you pour them, but one by one to form, carbon dioxide gas.

6. **Explain why the carbon dioxide released by your device is able to put out a fire.**

The carbon dioxide releaed by my device is able to put out a fire, because it has two substances mixing together and it has no oxygen to hold the fire going.

E

7. Write a brief description of the planning process you used to produce your design for the container. Include in your description

- problems that you encountered
- how successful you were in finding solutions to these problems
- what you would do differently next time

Description

The planning process I used to produce my design for the container, wasn't hard at all because doing the expriment gave me different ideas, and when it was time to draw it, there was no problem what so ever.

7

Teacher's Notes

Knowledge/Understanding

– The student demonstrates some understanding of the properties of substances and of the concept of physical and chemical change (e.g., in questions 2a and 2b, identifies that two substances are required, but misses the point of a physical change in 2c and 2d by relating it to the number of substances being used).

Inquiry

– The student follows most of the identified procedures and then draws inferences that have some validity (e.g., in question 2a, states that mixing two substances together to make a new one is a chemical change; in 2d, however, states that it is a physical change "because there was only one substance", but relates this to the result "and the flame did not go out").

Communication

– The student pays some attention to details and neatness in the diagram (e.g., illustrates the separation of the reactants, but not the mechanism for mixing).

– The student makes a chart that is partially complete but lacks detail and includes no observations of initial properties of the reactants.

– The student uses scientific terminology with some accuracy (e.g., in question 2, shows some understanding of key terms; however, uses colloquial expressions such as "burnout", "blow the flame out", and "fizzes" to describe properties and changes).

Making Connections

– The student proposes a course of action with some effectiveness (e.g., in explanation of container design, indicates that oxygen is required for combustion, but does not describe the role of CO_2 in preventing oxygen from reaching the fire; in container design itself, does not resolve how the chemicals are to react together when kept in two separate containers).

Comments/Next Steps

– The student is starting to understand the need for recording observations in an organized manner, but needs to work on incorporating more accurate scientific terminology.
– The student needs to develop better design features on the basis of observations and pay greater attention to explanation of details.
– The student needs to present inferences and observations when stating the physical and chemical properties of carbon dioxide gas.
– The student gives good partial justifications for the answers in question 2, but should continue to work on understanding key terms.

Chemical and Physical Change   Level 2, Sample 2

A

	Things	Observation
a)	candle and Bromoseltzer, water	- the flame just went out after a couple of seconds. It didn't change any colour or anything. It worked just like a fire extinguisher.
b)	candle and sodium bicarbonate, vinegar.	- same thing happened as the first one but there were more bubbles and the candle flame just went out.
c)	candle and diet coke.	- the balloon wasn't really filled up with alot of gas, but same thing happened as everything else.
d)	candle and sodium bicarbonate	- when I pinched some sodium bicarbonate on the flame, the first time it didn't go out because I didn't take alot, but the next time when I did it again, I took more and pinched it on the flame it went out!

B

2. **In the space below, indicate whether each of the four procedures resulted in a *physical change*, or a *chemical change*. In each case justify your answer based on observations you made.**

a) Chemical Change: when I put some bromoseltzer into water, the water turned white and it was all bubbly, but there was alot of gas and not alot of bubbles.

b) Chemical Change: when I put some sodium bicarbonate into vinegar, there were alot of bubbles that the were overflowing and the balloon was the same size as the first one but after the water had small bubbles.

c) Chemical change: When I put the pop in the beaker and put a balloon on top, there wasn't really alot of gas in the balloon, but when I put the pop in the beaker, there was alot of gas that it was overflowing.

d) Physical change: when the sprinkled a little bit of sodium bicarbonate on the flame it just went out, there was totally no reaction or anything else but you need alot in order for the flame to go out because a little pinch isn't alot.

3. **Based on your observations, state one physical and one chemical property of carbon dioxide gas.**

a) physical:

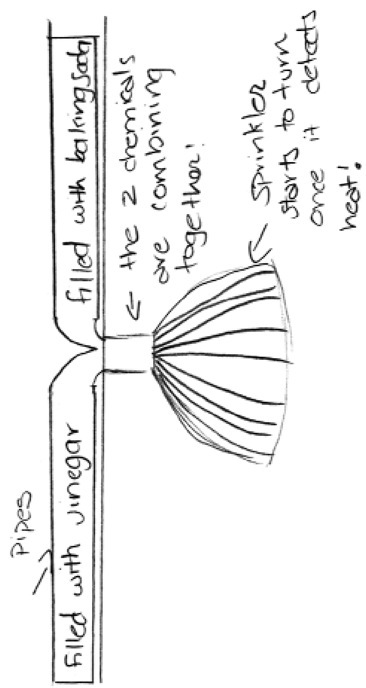
Evaporating water: in the lakes, the clouds attract the water like a magnet and evaporates, it turns into gas and then when the clouds are too heavy the water falls.

C

b) chemical: Baking Soda and vinegar: it starts bubbling, changes colour from opague to white, starts to overflow and it gives out gas!

4. Use the space below to draw and label a container will hold two chemical substances that when mixed together form carbon dioxide gas. Your container must:

a) keep the chemical substances apart until the carbon dioxide is required, and
b) must include a simple mechanism that allows the chemical substances to come into contact when required.



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D

5. Write a brief description of why the container is designed the way it is, and how your container design meets the two design criteria.

This answer is for question # 6 and # 5 is written on question # 6!

My container is different because it up in the ceiling and above the ceiling there are 2 different pipes, one is filled with vinegar and the other is filled with baking soda. once it detects fire the small pipe between the ceiling and the sprinkler the pipe with start to combine the 2 chemicals together and the sprinkler starts to turn and give out carbon dioxide gas. I think its very easy to use and you don't need to use your hands, the sprinkler will do all the work!

6. Explain why the carbon dioxide released by your device is able to put out a fire.

This answer is for # 5

My fire extinguisher is different from others and is very easy to use because you don't need to use your hands and when it detects fire it will start spinning and my 2 chemicals are in different pipes. The sprinkler detects fire when the fire reaches approximately ceiling height and the sprinkler starts to melt in a way!

6

E

7. **Write a brief description of the planning process you used to produce your design for the container. Include in your description**

- **problems that you encountered**
- **how successful you were in finding solutions to these problems**
- **what you would do differently next time**

- when I thought of my sprinkler it was easy to draw but when I had to combine the 2 chemicals together it was very hard because it was hard to figure out how the 2chemicals will have to be seperated!

If the next time I do this I will get help from some professionals so that they actually make my device and put it in every house and etc.

- I thought of it again and figured how it actually might seperate the chemicals.

7

Teacher's Notes

Knowledge/Understanding

– The student demonstrates some understanding of the concept of physical and chemical change (e.g., in 2a, recognizes chemical change, but in 2c, gives incorrect response), but does not give evidence of understanding the meaning of a "property".

Inquiry

– The student follows some of the identified procedures and draws inferences that have some validity (e.g., comments that no reaction is observed, but believes the flame goes out because the sodium bicarbonate smothers the flame).

Communication

– The student communicates information with some clarity (although the description of the container requires some effort to understand) and some degree of organization (although the answers to questions 5 and 6 are virtually identical).
– The student shows some attention to neatness in the diagram.
– The student creates a chart that is partially complete but does not differentiate between observations and inferences (e.g., "It worked just like a fire extinguisher").
– The student uses scientific terminology with some accuracy (e.g., "Baking soda and vinegar: it starts bubbling, changes colour from opaque to white … and it gives out gas!").

Making Connections

– The student proposes a course of action with some effectiveness (e.g., indicates in the diagram a mechanism for the required mixing of the chemicals).

Comments/Next Steps

– The student needs to work on providing clear observations and on identifying and communicating important details (e.g., should state more clearly the quantity of solid sodium bicarbonate used to extinguish the flame).
– The student needs to work on drawing effective diagrams: the diagram should clearly show design features that are to be explained later (i.e., in questions 5 and 6).
– The student needs to work on the use of appropriate scientific terminology in explanations.

Chemical and Physical Change Level 3, Sample 1

A

Exemplar Test Chart

Task	Observations	Physical change	Chemical change
Add 25mL of H_2O and a pinch of Bromselzer and mix	They created CO_2 but it did extinguished the flame.	NO!	It's a chemical change because you cannot turn the substance back to Bromoselzer and H_2O.
Add 25mL of vinegar and pinch of sodium bicarbonate and mix	It also created CO_2 and it extinguished the flame in a matter of seconds	NO!	It's a chemical change because you cannot reverse the gas into the solution.
Put a balloon over the bottle of pop and shake.	It created CO_2 also put out the flame	Yes it is because your taking gas out of solution	NO!
Pour a pinch of sodium bicarbonate onto the flame	It also put out the flame	Yes because the sodium did not turn into anything else.	NO!

B

2. In the space below, indicate whether each of the four procedures resulted in a *physical change*, or a *chemical change*. In each case justify your answer based on observations you made.

a) When we put a balloon over a test tube with bromoseltzer and water, and poured it over the flame, it did not blow out.

b) When we did the vinegar one the flame went out instantly with out a flinch. the balloon was also cold.

c) When we did the pop the flame also blew out but it took longer than the rest of them.

d) When I poured a pinch of sodium bicarbonate the flame blew out and had a funny smell to it.

3. Based on your observations, state one physical and one chemical property of carbon dioxide gas.

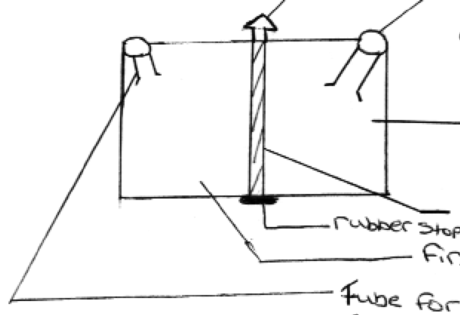
a) physical: CO_2 is odourless, colourless, it has more mass than Oxygen

4

C

b) chemical: CO_2 can distinguish a flame.

4. Use the space below to draw and label a container will hold two chemical substances that when mixed together form carbon dioxide gas. Your container must:
   a) keep the chemical substances apart until the carbon dioxide is required, and
   b) must include a simple mechanism that allows the chemical substances to come into contact when required.



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D

5. Write a brief description of why the container is designed the way it is, and how your container design meets the two design criteria.

My container is designed with 2 compartments with divider, so when I put some sodium bicarbonate into one compartement, and some vinegar into the second compartement they will not mix until I shake the container and pull the knob, once I pull the knob the chemicals will mix carbondioxide (CO_2) will create.

6. Explain why the carbon dioxide released by your device is able to put out a fire.

When the carbon dioxide is released. the hole is small so the pressure ~~compression~~. will be great (hard) so for what I know. it will put out a fire. small

6

E

7. Write a brief description of the planning process you used to produce your design for the container. Include in your description

- problems that you encountered
- how successful you were in finding solutions to these problems
- what you would do differently next time

I did not encounter any problems because, I saw the drawing in my mind, and in my mind. I worked so when I put it on paper it worked. I wouldn't do anything different because I'm a good problem solver.

7

Teacher's Notes

Knowledge/Understanding

– The student shows considerable understanding of the properties of substances and the concept of physical and chemical change (e.g., "... chemical change because you cannot turn the substance back ... ", "CO_2 extinguished the flame").

Inquiry

– The student draws inferences that have considerable validity (e.g., in question 3a, identifies two of the three physical properties but confuses mass and density).
– The student follows most of the procedures involved in scientific inquiry (e.g., applies technical skills with considerable competence and shows good observational skills).

Communication

– The student provides details that are mostly consistent with the data.
– The student communicates information with considerable clarity, precision, and organization.
– The student creates a diagram that shows considerable neatness, elegance, and simplicity of design.
– The student uses scientific terminology with considerable accuracy (e.g., uses terms such as "odourless" and "colourless" properly, but uses "distinguish" for "extinguish" in question 3b).

Making Connections

– The student proposes a course of action with considerable effectiveness, using many appropriate technological links between the design of the container and the chemical changes observed (e.g., the container has a divider that is easily removed to allow mixing and can be simply constructed using available materials).
– The student demonstrates the ability to transfer concepts relating to the behaviour of gases to the design of the container (see question 6).

Comments/Next Steps

- The student needs to provide a rationale for some of the inferences made.
- The student shows good problem-solving strategies in creating and explaining the design, but should elaborate on them by adding more detail.
- The student needs to consider and communicate the result as the CO_2 is evolved.
- The student needs to develop further his or her analysis of the planning process used.
- The student should work on the use of correct chemical terminology (e.g., sodium bicarbonate, not “sodium”).

Chemical and Physical Change Level 3, Sample 2

A

exp		Observation
4#	Sodium bicarbonate (baking sodium). Change #: physical	When I sprinkled the baking sodium (sodium bicarbonate) over the open flame candle, nothing seem to happen at first. It seemed as though the baking sodium hadn't disrupted the flame, after a couple of seconds though the flame ended up by going dead. The baking sodium ended up by smothering it

Exp.	materials	observation
1#	water, test-tube, Bromselter, balloon. change #: chemical	When we added the selter to the water it create carbon dioxide. The carbon dioxide filled up the test-tube which then enflatted the balloon. When the balloon was filled up I placed it over the open candle and slowly released the carbon dioxide. The carbon dioxide then put out the flame. This was because the flame needed oxygen to survive and carbon dioxide was the opposite.
2#	25 ml vinc., baking sod., beaker, test-tube, balloon. Change #: Chemical.	When we added the vinegar and the baking soda. Cabon dioxide formed. The carbon dioxide started to fizz and enflated the balloon. When we placed the balloon over the open and released some of the carbon dioxide it blew out the flame.
3#	pop, funnel, beaker, balloon. chemical physical	When we placed the balloon over the pop and shook it fizz was create. The balloon was enflatted a little. but not as much as the other 2 experiment. When we placed the balloon over a open flame, there was no change in the flame. It wasn't like the other 2 experiments, the pop didn't affect the flame. A smell though was created when the pop was placed over the open flame.

B

2. **In the space below, indicate whether each of the four procedures resulted in a *physical change*, or a *chemical change*. In each case justify your answer based on observations you made.**

a) Chemical change this was because a new substance was formed when we mixed the powder selter and water together. which was carbon dioxide.

b) Chemical change this was also like experiment one a new substance was created with the vinegar and the baking sodium which was called carbon dioxide.

c) physical change this was because nothing change nothing was created when we added the pop. The pop already contained carbon dioxide.

d) physical change: nothing new was created when we placed the baking sodium over the candle

3. **Based on your observations, state one physical and one chemical property of carbon dioxide gas.**

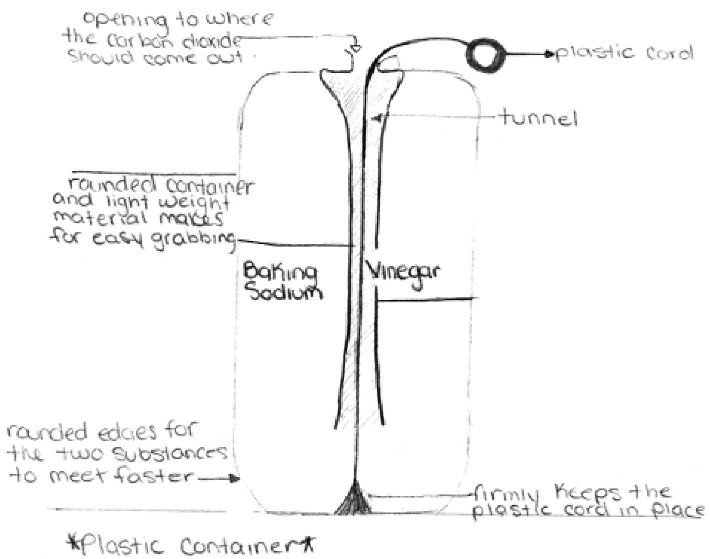
a) physical: The substance had an odour, it was clear and transparent.

4

C

b) chemical: The substance is a mixture of Carbon atoms and oxygen atoms

4. Use the space below to draw and label a container will hold two chemical substances that when mixed together form carbon dioxide gas. Your container must:
   a) keep the chemical substances apart until the carbon dioxide is required, and
   b) must include a simple mechanism that allows the chemical substances to come into contact when required.



5

D

5. **Write a brief description of why the container is designed the way it is, and how your container design meets the two design criteria.**

The container that I have created has a long plastic cord that is attached to the bottom of the container to seperate the two substances vinegar and baking sodium. When carbon dioxide is needed the plastic cord is pulled on and removed to start the formation of carbon dioxide. When the two substance have met the pressure from them forming causes them to be pushed up through the tunnel and ecsape through the opening.
The container meets the design criteria because it has a seperation barrier (plastic cord) and it also has a simple mechanism that seperates the substances (vinegar & baking sodium)

6. **Explain why the carbon dioxide released by your device is able to put out a fire.**

The carbon dioxide in my device puts out fires because in order for fire to burn it relies on oxygen, when the device is attivated and carbon dioxide is release it surronds are covers the air and kills off any oxygen in the surrounding area.

6

E

7. **Write a brief description of the planning process you used to produce your design for the container. Include in your description**

- **problems that you encountered**
- **how successful you were in finding solutions to these problems**
- **what you would do differently next time**

The planning process I used to start the design of my container was to follow the format that was given to us (on page 5). From there I decide on what substances I was going to use to create the carbon dioxide. I also had to consider the seperation device I was going to use to seperate the substances.
The only problem I had throughout designing the container was how to figure out where the carbon dioxide would exit from. I solved my problem by going back and seeing how the 2 substances were going to join together, that helped me figure out that if I used a tunnel to help escort the carbon dioxide substance out of the container. the tunnel would have to end somewhere and that would be at the very top of the container.
Next time I would see if I could use more then just the 2 substances I used this time. I would see if I could encoporate a different substance with the vinegar and baking sodium

7

Teacher's Notes

Knowledge/Understanding

– The student demonstrates considerable understanding of the properties of substances and the concept of physical and chemical change (e.g., provides detailed explanations in question 2, although the answer to 3b is inaccurate).

Inquiry

– The student draws inferences that have a considerable to high degree of validity, as seen in the reasons given for designating changes as chemical or physical in question 2 (e.g., physical change: "this was because nothing change nothing was created when we added the pop. The pop already contained carbon dioxide").
– The student follows most of the identified procedures (e.g., the construction of an observation chart, the preparation of the design, and the analysis of the design in the conclusion, in question 7).

Communication

– The student provides details that are mostly consistent with the data.
– The student communicates information with considerable clarity.
– The student prepares the diagram with considerable neatness.
– The student uses scientific terminology with considerable accuracy (e.g., states that CO_2 was "transparent" [question 3]; comments that "… in order for fire to burn it relies on oxygen …" [question 6]), but makes a few errors (e.g., refers to baking soda as "baking sodium").

Making Connections

– The student proposes a course of action with considerable effectiveness, producing a design that meets requirements (although it is not entirely clear how the plastic card separates the two substances) and making clear connections, in questions 5 and 6, between the experimental situation and the final design.

Comments/Next Steps

- The student should continue to work on drawing valid inferences from data.
- The student could be more precise in the design details (e.g., would need to clearly indicate how the release mechanism works in order to construct a working model of the design).
- The student should be careful to use correct scientific terms.

Chemical and Physical Change Level 4, Sample 1

A

Physical and Chemical Change 05•26•00

Experiment #	Description: Be.	Du.	Af.	Physical or Chemical Change	Evidence
a)	candle-lit, water-clear	water in test tube fizzed when bromo was put in	when gas in balloon was poured, candle went out	chemical	it was lit and went out
b)	candle-lit, vinegar-clear	when S.b was put in, it fizzed up	when gas in ballon was poured, candle went out	chemical	-candle lit and went out, gas fizzed
c)	candle-lit, pop-opaque	pop fizzed when shaken	when gas poured on ballon candle went out	~~chemical~~ physical	gas ~~fizzed~~, and a new gas was ~~made~~ in balloon changed form.
d)	candle-lit, s.b-white, opaque		candle went out as soon as ~~po~~ s.b was on it	physical	- no new substance was made

B

2. **In the space below, indicate whether each of the four procedures resulted in a *physical change*, or a *chemical change*. In each case justify your answer based on observations you made.**

a) This was ~~the~~ a ~~physical~~ chemical change, because The bromoseltzer and water created carbon dioxide gas.

b) Vinigar and sodium bicarbonate also created Carbondioxide gas. That qualifies as a chemical change

c) The carbon dioxide created by the pop was a physical change because it was intentionally ~~created~~ added.

d) Sodium bicarbonate has high concentrations of carbon dioxide. When added to the flame it depletes the oxygen putting out the flame. This is a physical change

3. **Based on your observations, state one physical and one chemical property of carbon dioxide gas.**

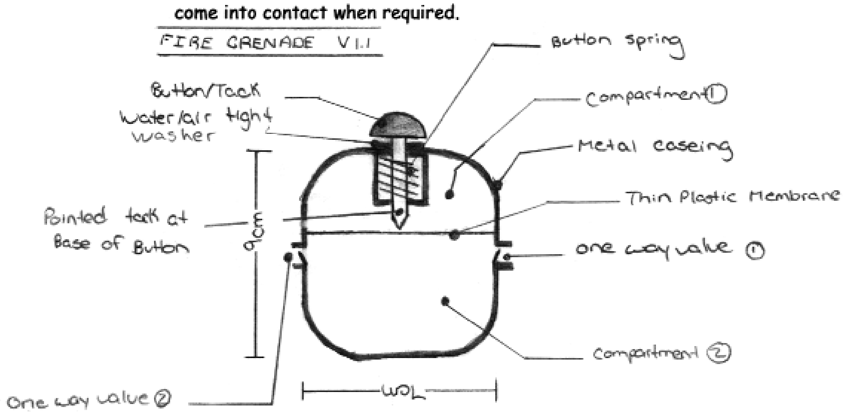
a) physical: Carbon dioxide gas is an opaque gas with no smell

4

C

b) chemical: Carbon dioxide is Co², 1 part Carbon and 2 part oxogen. Carbon dioxide gas, extinguishes fire.

4. Use the space below to draw and label a container that will hold two chemical substances that when mixed together form carbon dioxide gas. Your container must:
   a) keep the chemical substances apart until the carbon dioxide is required, and
   b) must include a simple mechanism that allows the chemical substances to come into contact when required.



Instructions: The Fire Grenad V1.1 works like this. Compartment 1 is filled with acidic acid. When the Button is pressed, the sharp point at the Bottom Peirces the plastic membrane. This reales the contents of compartment 1 (acidic acid) in to compartment 2 which is filled with sodium bicarbonate. This causes a chemical reaction, which creates Co² gas. The presure builds inside the metal caseing. The gas is forced out of the values with other liquids, smothering the fire. This unit is designed to be hand held, and thrown into the fire.

D

5. Write a brief description of why the container is designed the way it is, and how your container design meets the two design criteria.

I designed my container so that it could be carried around, like on a hiking or camping trip incase a small fire breaks out. I also designed it to be simple to use. You just press the button and you throw it in. My container also clearly meets the design criteria.
The two chemicals are devided by a plastic membrane, and can't be reelesed until Co² is required, and I have a simpe mechanism that realeases the chemicals when needed.

6. Explain why the carbon dioxide released by your device is able to put out a fire.

Carbon Dioxide's chemical properties do not react well with fire. So if you add high concentrations of Co² on a fire, depleting it oxogen supply, you can put it out.

E

7. **Write a brief description of the planning process you used to produce your design for the container. Include in your description**

- **problems that you encountered**
- **how successful you were in finding solutions to these problems**
- **what you would do differently next time**

The planning I had to do for this was to think of a way to design a container which would hold the two chemicals needed to produce carbon dioxide. Vinegar (acidic acid) and sodium bicarbonate will mix to form carbon dioxide.

So I decided to have the two chemicals in separated parts of the container. They would be separated by a divider and when it comes mixing time you just have to peirce the divider.

Some problems I encountered were I had to ~~keep~~ think what two chemicals produced carbon dioxide and how will I keep them separate. and then use a simple mechanism to mix them.

I was very successful in solving these difficult problems. If I could do it again I would like to be able to build my container and test it.

7

Teacher's Notes

Knowledge/Understanding

– The student demonstrates a thorough understanding of the properties of substances and the concept of physical and chemical change.

Inquiry

– The student draws inferences that have a high degree of validity with respect to the observed data (e.g., includes a column in the observation chart outlining evidence supporting his or her classification of a change as chemical or physical).

– The student follows all of the identified procedures (e.g., records observations in organized format; meets all criteria for the design problem).

Communication

– The student provides details that are entirely consistent with the data.

– The student communicates information with a high degree of clarity (e.g., provides a description in question 5 and instructions in question 4 that are clear and completely consistent with the design).

– The student creates a diagram that displays a high degree of neatness and detail in the labelling.

– The student creates a very complete and very well organized chart.

– The student demonstrates a thorough knowledge of scientific terminology, using it in a clear and understandable manner.

Making Connections

– The student proposes a course of action with a high degree of effectiveness, producing a unique and highly inventive design (e.g., note the "button/tack" with the "water/air tight washer"), and forming extensive links between the experimental data and other situations (e.g., "if you add high concentrations of CO^2 on a fire, depleting it oxogen supply, you can put it out").

– The student demonstrates in the design an understanding of the application of knowledge in a real-world context.

– The student indicates what should be done next (e.g., build the container and test it).

Comments/Next Steps

- The student’s design captures the spirit of the activity, relating back to the original task
- The student could work on expanding the answers given to justify designating changes as physical or chemical.

Chemical and Physical Change Level 4, Sample 2

A

Observations - Part 1

Reactants	Initial Appearance	During Mixing	Product Appearance	Effect on Combustion
1. Alta Setter + water	Alta Setter - white powder; Water - clear colourless	Bubbles of Gas; Cloudy	Gas - clear colourless invisible	the flame went out with the Combustion
2. Sodium bicarbonate + vinegar	Sodium bicarbonate - white powder; Vinegar - clear colourless	Bubble of Gas; Cloudy	Gas - clear colourless invisible	The flame went out with the Combustion
3. Pepi	Pepi - liquid dark Brown	Bubbles of Gas; dark brown	Gas - clear colourless invisible	The flame went out with the combustion
4. Sodium bicarbonate + flame	Sodium bicarbonat - white powder.	No mixing	No product Appearance	The flame went out with the Combustion.

B

2. In the space below, indicate whether each of the four procedures resulted in a *physical change*, or a *chemical change*. In each case justify your answer based on observations you made.

a) Alta Seltzer and water was a chemical change - becaus bubble formed clear, colourless gas was produced

b) Sodium bicarbonate and vinegar chemical change - bubbles were formed, clear, colourless gas was produced.

c) Pepsi was a chemical change - because bubble formed clear, colourless gas was produced

d) Sodium bicarbonate was a physical change - no gases were produced, candle went out

3. Based on your observations, state one physical and one chemical property of carbon dioxide gas.

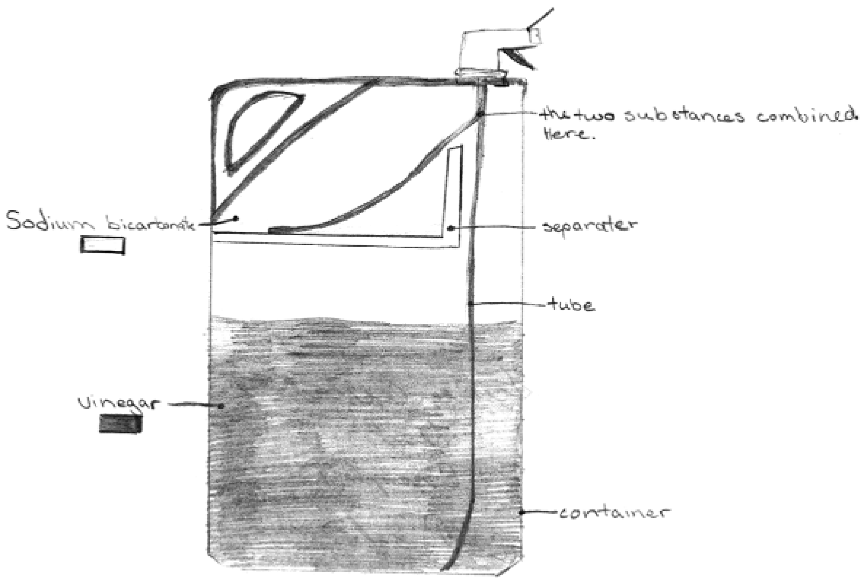
a) physical: carbon dioxide gas is clear and colourless invisible

4

C

b) chemical: In this experiment, two substances are mixed together to form bubbles of gas.

4. Use the space below to draw and label a container will hold two chemical substances that when mixed together form carbon dioxide gas. Your container must:
   a) keep the chemical substances apart until the carbon dioxide is required, and
   b) must include a simple mechanism that allows the chemical substances to come into contact when required.



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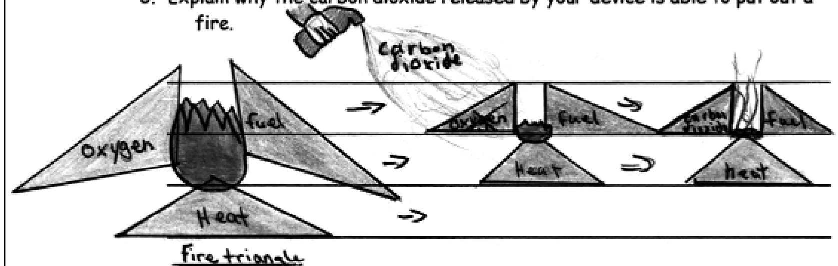
D

5. Write a brief description of why the container is designed the way it is, and how your container design meets the two design criteria.

My container is designed the way it is because my two chemical substances are held in two different deporments until used. You have to hold down the handle and as you are spraying the fire shake the container to mix the two chemical in the container. The two chemicals in the container are mixed they make carbon dioxide which will but out the fire.

6. Explain why the carbon dioxide released by your device is able to put out a fire.



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E

7. Write a brief description of the planning process you used to produce your design for the container. Include in your description

- problems that you encountered -No
- how successful you were in finding solutions to these problems – No
- what you would do differently next time – No

The reason I came up with my container was beause we had to think of a way to keep the two chemical apart unilt put into use.

7

Teacher's Notes

Knowledge/Understanding

– The student demonstrates a thorough understanding of the properties of substances and the concept of physical and chemical change (e.g., in answers to questions 2 and 3, although the answer to question 3b could be phrased more accurately).

Thinking/Inquiry

– The student draws inferences that have a high degree of validity with respect to the observed data (e.g., in questions 2a and 2b, lists physical properties with clarity).
– The student follows almost all of the task procedures, as illustrated by the observation chart.

Communication

– The student gives information with a high degree of clarity and organization (e.g., in response to question 5).
– The student creates a diagram that displays a high degree of neatness and detail.
– The student makes a very well organized chart with almost all responses linked consistently to the evidence presented.
– The student uses scientific terminology with a high degree of accuracy in the observation chart (e.g., reactant and product observations are clear).

Making Connections

– The student proposes a course of action with a high degree of effectiveness, producing a functional atomizer design and forming numerous links between the experimental observations, chemical principles, and the design of the device (e.g., see the diagram labelled "fire triangle").

Comments/Next Steps

- The student's description of the design (in question 5) could be more consistent with the diagram.
- The student could analyse the design planning process in more detail, to reflect on the strategies used (question 7).
- The student could continue to work on links between observations and conclusions, and to other situations that involve physical and chemical changes.

Teacher Package

Science Exemplar Task
Grade 9 Science – Applied

Teacher Package

Title: Chemical and Physical Change

Time Requirement: Two classroom periods of 70 minutes each

Description of the Task*
Students will assume the role of summer students working for a chemical company. Initially, they will be part of a team, working in pairs. In the first part of this task, the team of students will observe a variety of physical and chemical changes that produce carbon dioxide gas. In each case, the carbon dioxide gas or solid baking soda will be "poured" over a lit candle to establish an important physical property and an important chemical property of the gas.

In the second part of the task, students will individually design a container (on paper) to hold two chemical compounds that make carbon dioxide gas, and explain the process involved in designing the container on the basis of their understanding of physical and chemical change. The container should be such that:
- the chemical compounds cannot come in contact with one another when the carbon dioxide product is not required for any application;
- when required, a fairly simple manipulation of the container will result in the two chemical compounds coming into contact to produce the necessary carbon dioxide to extinguish a flame.

Final Product
Each student will submit his or her table or chart, the design, and a work plan for the container consisting of the answers to questions 1–7 in the booklet.

Assessment and Evaluation Components
The criteria on which the written work will be assessed are outlined in the task-specific rubric.**

Teachers can choose to use the task rubric to assess the students' laboratory skills as they work.

*This task has been adapted from Activity 3: "Chemical and Physical Changes" (Unit 1-8-10) in the course profile for Science, Grade 9, Applied (Catholic).

Expectations Addressed in the Exemplar Task

Students will:
1. describe, using their observations, the evidence for chemical changes;
2. demonstrate knowledge of laboratory, safety, and disposal procedures while conducting investigations;
3. determine how the properties of substances influence their use;
4. demonstrate the skills required to plan and conduct an inquiry into the properties of substances, using apparatus and materials safely, accurately, and effectively;
5. communicate scientific ideas, procedures, results, and conclusions using appropriate language and formats;
6. investigate the properties of changes in substances, and classify them as physical or chemical based on experiments;
7. explain how a knowledge of the physical and chemical properties of elements enables people to determine the potential uses of the elements and assess the associated risks.

Teacher Instructions

Prior Knowledge and Skills Required
Students should have some experience in:
- distinguishing between chemical and physical properties;
- recording observations (including creating appropriate headings for the task) in a table, chart, or other suitable organizer, by hand or using spreadsheet software;
- accurately drawing and labelling a diagram using a pencil and ruler, and writing a clear, concise explanation of what the diagram represents;
- writing, using appropriate vocabulary, observations concerning colour, texture, density, and combustibility.

Students in the initial years of this project will not have had the background in Grades 5 and 7 that will be in place once the new Ontario curriculum has been fully implemented from Kindergarten to Grade 12.

If the chemistry unit has not been covered yet, it will be necessary to carry out diagnostic activities to determine what the students know and are able to do. Review or supplement as necessary.

Accommodations
Accommodations that are normally provided in the regular classroom for students with special needs should be provided in the administration of this performance task.

You may wish to review the relevant course profile for specific suggestions for accommodations appropriate for students in special education programs.

**The rubric is reproduced on page 56 of this document.*

Materials Required (per Student Pair)

- small amount of fresh Bromoseltzer crystals (or crushed Alka-Seltzer tablets)
- small amount of fresh sodium bicarbonate
- 1 bottle of soda pop – 600 mL (cola works best)
- 3 balloons, round, approximately 30 cm in diameter
- 3 test tubes, large
- 50 mL of water
- 50 mL of vinegar
- 1 candle
- 1 soup can with the lid removed (or a 250 mL beaker)
- matches
- can containing sand in which to extinguish matches
- safety goggles – one pair per student

Preparation

- Perform the task before the day it is administered to the students so that you will be familiar with the observations.
- Students should be required to wear safety goggles while at the work stations.
- Experiment with the amounts of water and fresh Bromoseltzer, and vinegar and fresh sodium bicarbonate, to give the desired results.
- If available, tea candles (very short candles in metal containers) are ideal. Place the candle at the bottom of an empty soup can or 250 mL beaker so that the gas will not dissipate too quickly. Candles can be ignited with fireplace matches.

Rubric

Introduce the task-specific rubric to the students at least one day prior to the administration of the task. Review the rubric with the students and ensure that each student understands the criteria and the descriptions for achievement at each level.

Allow ample class time for a thorough reading and discussion of the assessment criteria outlined in the rubric.

Some students may perform below level 1. It will be important to note the characteristics of their work in relation to the criteria in the assessment rubric and to provide feedback to help them improve.

Task Instructions

Students will be given the following context for their task:

Congratulations on your new position as a summer student working with Chemwide Industries. You will work with a fellow student on the following two-part project:

- *Observe a variety of physical and chemical changes that produce carbon dioxide gas. At the end of each of the required procedures, you will pour the carbon dioxide over a lit candle to establish an important physical property of the gas that makes it useful for extinguishing fires.*
- *Design a container using one of the above procedures that will:*
  - *keep two chemical substances that produce carbon dioxide apart for as long as required;*
  - *allow for the substances to mix when carbon dioxide is needed to extinguish a flame.*

Each summer student will be required to submit to the supervisor a chart and a work plan that includes the design for the container (questions 1 to 7 in the student booklet).

DAY 1

Students work in pairs to investigate ways in which carbon dioxide gas can be produced:

- They will need to prepare the balloons by stretching their necks and inflating them several times to ensure they will expand as required.
- Place a pinch of Bromoseltzer crystals inside a balloon.
- Attach the balloon to the lip of a test tube containing 25 mL of water.
- Tip the crystals into the water.
- When effervescence ceases, “pour” the gaseous contents of the balloon over a burning candle.
- Place a pinch of sodium bicarbonate inside a second balloon.
- Attach the balloon to the lip of a test tube containing 25 mL of vinegar.
- Tip the powder into the vinegar.
- When effervescence ceases, “pour” the contents of the balloon over a burning candle.
- Place a balloon over the top of a recently opened bottle of pop with its contents shaken.
- Pour the contents of the balloon over a burning candle.
- Sprinkle a pinch of sodium bicarbonate over an open candle flame.
- Students, working in pairs, observe and record the appearances of each substance before, during, and after the activity described above.

- Observations are recorded by *each* student in his or her *own* student booklet, using a suitable organizer of the student's own design.
- Students will write a conclusion for the observed data, listing those properties associated with physical changes, and those properties associated with chemical changes.

DAY 2

- Students individually design a single container to hold two chemicals that, when mixed together, produce carbon dioxide gas. The challenge is to keep the chemicals separate until the carbon dioxide is needed. At this point, a simple manipulation of the container would cause the two chemicals to mix and produce carbon dioxide, which then can be used to extinguish a flame, as already observed. While it is intended that the container resemble a fire extinguisher, the instructions are purposely general so as not to be limiting.

- Although the task concludes at this point, it is strongly recommended that students construct a working model of their design and then be given a period of time to evaluate its performance. They should then make design changes that will allow them to make a better product.

Potential Responses

Question 1:

Reactants	Initial Appearance	During Mixing	Product Appearance	Effect on Combustion
Bromoseltzer + water	Bromo: *small white crystals* Water: *clear, colourless liquid*	*Effervescence*	*Fine white residue Balloon inflates with gas*	*Extinguishes flame*
Sodium bicarbonate + vinegar	Sodium bicarbonate: *white powder* Vinegar: *clear, colourless liquid*	*Effervescence*	*Fine white residue Balloon inflates with gas*	*Extinguishes flame*
Soda pop	*Some fizzing when cap opened*	*Balloon expanded*	*No fizzing in soda pop*	*Extinguishes flame*
Sodium bicarbonate	*Coarse white powder*			*Extinguishes flame*

Question 2:

a) Chemical – A gas is produced when Bromoseltzer and water are mixed.
b) Chemical – A gas is produced when sodium bicarbonate and vinegar are mixed.
c) Physical – The gas is released from the soda pop. It was already there.
d) Chemical – A gas is released when the sodium bicarbonate is heated.
or
Physical – The solid smothers the flame, and oxygen cannot reach the candle wick.

Question 3:
a) clear, colourless, heavier than air, etc.
b) will not support combustion

Question 4:
The diagram should be neat and labelled appropriately.

Question 5:
The answer should clearly indicate how the chemicals are kept apart and how they are mixed when needed.

Question 6:
The carbon dioxide is denser than air and falls onto the flame, cutting off the oxygen supply and smothering it.

Question 7:
- The answer should discuss some of the thinking skills used in answering questions 5 and 6, as well as those areas that needed to be planned carefully in light of the results observed in the experiments in Part 1.
- An attempt should be made to explain the difficulties anticipated, and how the choice of design would solve these problems.
- A brief plan for future changes to the container design should be included.

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