Name: _____ Group: _____

# THE PROBLEM

### Oxygen, not always an ally

As vital as oxygen is to life, it can nevertheless cause no end of problems both big and small, such as rusted vehicles, split rubber, spoiled fruit and aging skin. Hoping to discover solutions for these problems, research scientists have long looked to antioxidants, which are substances capable of inhibiting the effects of oxidation.

It is now known that certain nutrients, such as vitamins C and E, act as antioxidants in the human body. This prompts the often asked question: why not add them to the food we eat?

Putting antioxidant molecules into food poses a sizeable challenge. There is, for instance, the heat sensitivity of vitamin C, one of the most powerful antioxidants around, or the light sensitivity of vitamin E, another incomparable antioxidant. Solubility is an additional factor when it comes to choosing an antioxidant. Although vitamin E is fat soluble, and therefore highly effective in oils, it is not a wise choice for water soluble foods such as fruit. Vitamin C is soluble in water and therefore a better choice in these cases. A word of caution about ingesting antioxidants, however: excessive intake can lead to immunodeficiency.

Adapted from Carole Brodeur, *The New Role of Antioxidants*. Agriculture and Agri-food Canada *[Translation]*

**JOB OFFER**

### Department Head, Food Conservation Research Unit

**Responsibilities:** Design an experiment to determine whether soaking pieces of apple in a vitamin C solution is an effective method to prevent them from oxidizing. Apply the soaking method of food conservation and meet agro-food standards for the use of vitamin C.

**Requirements:** Expertise in dissolution and dilution techniques for preparing solutions. Familiarity with lab safety rules. Ability to use measuring instruments.

**Desirable personal qualities:** Intellectual rigour, methodical approach to work.

In this LES, you are to solve the problem described in this job offer by using dissolution and dilution techniques to prepare at least two vitamin C solutions of different concentrations. You will also prepare two controls. Observations must be made at two different times spaced 24 hours apart or more.

Here is some other information you will need.

**Soaking method of food conservation**

- Prepare the soaking solution at the desired concentration.
- Place the food to be treated in 100 mL of the prepared solution.
- Let sit 15 min.
- Remove and drain the food.

**Agro-food standard for vitamin C concentration of soaking solution**

Up to 5 g/L

**Lab materials**

Here are the materials you will need for your experiment:

- Two 500-mg tablets of vitamin C
- apple
- paper plate

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# CREATING THE CONTEXT

## I ask myself questions

**1.** What is a solution?

_____

_____

_____

**2.** What is a concentration?

_____

_____

**3.** What substance is used as the solute in this situation?

_____

**4.** What substance is used as the solvent in this situation?

_____

**5.** What units can be used to measure concentration in this situation?

_____

**6.** How is a solution prepared?

_____

_____

_____

**7.** What is dissolution?

_____

_____

_____

**8.** What is dilution?

_____

_____

Name: _____ Group: _____

# CREATING THE CONTEXT (*continued*)

**9.** What is an antioxidant? Give some examples.

## I must

**10.** What is the goal of the problem to be solved?

## I think

**11.** How do you think oxidation affects the pieces of apple?

**12.** Which observation criteria do you think will help achieve the goal of the problem you have been assigned?

## Reflection

| Do I clearly understand: | Yes | No |
|---|---|---|
| • homogeneous and heterogeneous mixtures? | ☐ | ☐ |
| • the properties of solutions (concentration, solute, solvent)? | ☐ | ☐ |
| • dilution? | ☐ | ☐ |
| • dissolution? | ☐ | ☐ |

Name: _____ Group: _____

# PLANNING THE PROBLEM SOLVING

## I plan

**1.** Using a separate sheet of paper, calculate quantities for the substances you will use to prepare your solutions. Remember that you must prepare at least one solution by dissolution and at least one solution by dilution.

**Table 1: Preparing solution by dissolution**

| Concentration | Mass | Volume |
|---|---|---|
| | | |

**Table 2: Preparing solutions by dilution**

| Concentration | Volume of concentrate | Volume of solvent to add |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**2.** Complete the list of materials and substances you need for your experiment.

- 2 500-mg vitamin C tablets
- apple
- knife
- paper plate

Name: _____ Group: _____

# PLANNING THE PROBLEM SOLVING (*continued*)

**3.** List the steps of the procedure for conducting your experiment. Remember that you must have two controls and that the solutions must be at different concentrations.

Name: _____ Group: _____

# PLANNING THE PROBLEM SOLVING (*continued*)

**4.** Prepare a table for recording your observations. Remember to title your table.

Title: _____

**5.** What safety rules must you follow during your experiment?

_____

_____

_____

_____

_____

_____

_____

## Reflection

| | Yes | No |
|---|---|---|
| Have I considered different possibilities? | ☐ | ☐ |

Name: _____ Group: _____

# INITIATING THE PROBLEM SOLVING

## I experiment

1. Conduct the experiment according to your established protocol. Clearly record all results and observations in the table that was prepared in the planning stage.

2. Did you alter your plan of action during the experiment? If so, explain your answer.

3. Did you prepare your solutions properly? Justify your answer. Provide at least two justifications.

4. Did you use safe work methods during the experiment? Justify your answer. Provide at least two justifications.



## Reflection

| | Yes | No |
|---|---|---|
| Did I record and justify each change to my plan of action? | ☐ | ☐ |

Name: _____ Group: _____

# ANALYZING RESULTS AND DRAWING CONCLUSIONS

## I analyze my results

**1.** Is soaking pieces of apple in a vitamin C solution a good method to prevent them from oxidizing? If so, is the vitamin C concentration of the solutions an important factor?

**2.** Are there advantages to this food conservation method. If so, name them.

**3.** Are there disadvantages to this food conservation method? If so, name them.

**4.** What were the sources of error in your experiment? Suggest improvements in each case.

## I draw my conclusions

**5.** What conclusion can you draw from your experiment? Did you achieve the goal of the experiment? Would you recommend this food conservation method?

Name: _____ Group: _____

# MY EVALUATION

Use the evaluation grid on the next page for your self-evaluation. Enter A, B, C, D or E in the appropriate space on that table.

| SSC1 Seeks answers or solutions to scientific or technological problems | | | | |
|---|---|---|---|---|
| **Criteria*** | **Observable indicators** | **Me** | **Teacher** | **Comments** |
| **1** | **Creating the context**<br>Definition of the goal and formulation the observation criteria | | ☐ With help | |
| **2** | **Planning the problem solving**<br>Suitability of the elements in the plan of action: materials and procedure | | ☐ With help | |
| **3** | **Initiating the problem solving**<br>Accuracy of the observations and preparation of the solutions | | ☐ With help | |
| **4** | **Analyzing results and drawing conclusions**<br>Summary of the advantages and disadvantages of vitamin C treatment and drawing of a conclusion | | ☐ With help | |

*** Evaluation criteria**

**1** Appropriate representation of the situation
**2** Development of a suitable plan of action for the situation
**3** Appropriate implementation of the plan of action
**4** Development of relevant conclusions, explanations or solutions

# EVALUATION GRID

Name: _____ Group: _____

## SSC1 Seek answers or solutions to scientific or technological problems

| Criteria* | Observable indicators | A | B | C | D | E |
|---|---|---|---|---|---|---|
| 1 | **CREATING THE CONTEXT**<br>Definition of the goal and formulation of the observation criteria | The goal and the observation criteria are very clearly formulated and relevant to the problem. | The goal and the observation criteria are clearly formulated and relevant to the problem. | The goal and the observation criteria are formulated more or less clearly or are not relevant to the problem. | The goal and the observation criteria are not clearly formulated and are not relevant to the problem. | The work needs to be redone. |
| 2 | **PLANNING THE PROBLEM SOLVING**<br>Suitability of the elements in the plan of action: materials and procedure | The list of materials is complete. The procedure is very clearly formulated and relevant. | The list of materials is almost complete. The procedure is clearly formulated and relevant. | The list of materials is missing several items OR the procedure is more or less clearly formulated and more or less relevant. | The list of materials is missing several items AND the procedure is poorly formulated or not relevant. | The work needs to be redone. |
| 3 | **INITIATING THE PROBLEM SOLVING**<br>Accuracy of the observations and preparation of the solutions | All of the recorded observations are relevant and the solutions were properly prepared. | All of the recorded observations are relevant, but there were a few minor mistakes in preparing the solutions. | Several of the recorded observations are relevant, and there were a few minor mistakes in preparing the solutions. | Several of the recorded observations are relevant, and there were major mistakes in preparing the solutions. | The work needs to be redone. |
| 4 | **ANALYZING RESULTS AND DRAWING CONCLUSIONS**<br>Summary of the advantages and disadvantages of vitamin C treatment and drawing of a conclusion | The advantages and disadvantages of vitamin C treatment are relevant. The conclusion is very clearly stated and relevant to the problem. | The advantages and disadvantages of vitamin C treatment are relevant. The conclusion is clearly stated and relevant to the problem. | The advantages and disadvantages of vitamin C treatment are more or less relevant OR the conclusion is more or less clearly stated and more or less relevant to the problem. | The advantages and disadvantages of vitamin C treatment are more or less relevant AND the conclusion is not clearly stated or is not relevant to the problem. | The work needs to be redone. |

### * Evaluation criteria

**1** Appropriate representation of the situation

**2** Development of a suitable plan of action for the situation

**3** Appropriate implementation of the plan of action

**4** Development of relevant conclusions, explanations or solutions