LES 6

O B S E R V A T O R Y
SCIENCE AND TECHNOLOGY (ST)
APPLIED SCIENCE AND TECHNOLOGY (AST)
Teacher's Guide A
Second Year of Secondary Cycle Two

HOME COMFORT

STUDENT LOG

WORKING DOCUMENTS

EVALUATION DOCUMENTS

PROCEDURE AND EVALUATION: SSC1 – SCIENCE

Observatory / Guide
11129-A

Name: _____ Group: _____ ST AST

The problem to solve

INCREASING DEMAND FOR "GREEN" PRODUCTS

The results of a market study in Québec reveal that residents of the province are favouring companies that sell environmentally friendly products. Increasing numbers of green products are being offered to satisfy the growing consumer demand.

Gatineau, May 16, 2009

Ms. Madeleine Forsythe
Director, XYZ Consulting Engineers

Dear Ms. Forsythe:

We have noticed a growing concern among our clients for environmental protection, so we would like to offer them new models of homes that are more energy-efficient. Since a well-insulated house can be heated more efficiently, we want to install the best thermal insulation available. We are therefore commissioning your firm to test various types of thermal insulation to determine which product will best meet our needs. We are looking for a product that provides the most efficient insulation possible, with minimal impact on the environment and on indoor air quality. We believe our clients deserve a product that has proven its worth, so your tests must demonstrate that the selected thermal insulation effectively reduces heat loss.

We look forward to hearing your recommendations.

Yours truly,

Peter Bingham

Peter Bingham
Real estate developer

In this context, you will play the role of a consulting engineer in the XYZ firm. Your recommendations must take into account your test results. You must recommend the thermal insulation that is the most efficient while affecting the environment and indoor air quality as little as possible. You will test two of the following types of thermal insulation:

1. mineral wool
2. fibreglass
3. cellulose insulation

The problem to solve (*continued*)

The Environmentally Responsible Construction and Renovation Handbook PRODUCTS DIRECTORY

Thermal insulation

- Some brands of cellulose, fibreglass and mineral wool insulations include a percentage of recycled material.
- The off-gassing of dust suppressors, binders and fire retardants added to insulation varies greatly among manufacturers and should be kept out of living areas through the use of vapour barriers.

Thermal insulation pays for itself financially and environmentally by saving energy. Any renovation project involving the outside walls or ceilings of a building should include an increase in the amount of insulation appropriate to the climate, building size and type, and heating and cooling system. The choice of insulation type may be difficult to determine since several important factors vary significantly from one product to another, even for the same type of insulation.

Most insulation gives off some volatile organic compounds (VOCs) which are a problem for indoor air quality (IAQ). In the case of fibreglass, mineral wool, and cellulose insulations, VOC emissions result mainly or entirely from the dust suppressors, binders and fire retardants added, and these vary greatly from one manufacturer to another.

Cellulose insulation

Cellulose insulation is made from recycled newsprint and other papers. It is available as a loose fill and can be sprayed into place wet or dry. It is treated with fire retardants and may contain other chemicals for rodent resistance or to prevent settling. These chemicals may affect IAQ.

Renewable resources: Some cellulose insulation is treated with borax for fire retardation. Currently there are only two reserves where borax is being mined, one in California and one in Turkey. Under these circumstances, borax content should be avoided.

Recycled content: Many cellulose insulations are manufactured with post-consumer newsprint. The Environmental Choice Program calls for a minimum of 75 percent recycled content in licensed cellulose insulation.

Energy savings: This product is designed to improve the thermal value of the building. Increasing the thermal value provides energy savings when heating and cooling. The greatest energy savings will be achieved if other aspects of the building envelope are designed to prevent exterior air infiltration.

Indoor air quality: Since printing ink residues and additives can be toxic and produce an odour, all cellulose insulation should be well sealed behind air and vapour barriers.

The problem to solve (*continued*)

Recycled fibreglass insulation

Some manufacturers are currently producing fibreglass insulation products with 75 to 80 percent recycled glass. The products include bats, blowing wool, exterior sheathing and acoustical ceiling tiles. The recycled glass is purchased from brokers and contains an unknown ratio of pre- and post-consumer waste. This is one of the few processes that can use recycled coloured glass.

Recycled content: Some products contain up to 75 to 80 percent industrial and pre- or post-consumer glass waste.

Energy savings: This product is designed to improve the thermal value of the building. Increasing the thermal value provides energy savings during both the heating and cooling cycle. The greatest energy savings will be achieved if other parts of the building envelope are designed to prevent exterior air infiltration.

Indoor air quality: Fibreglass fibres are possibly carcinogenic and may emit pollutants. Binders used in the manufacture can release VOCs and can increase toxic emissions in the event of fire. All insulation should be well-sealed behind air and vapour barriers.

Reusable product: When carefully dismantled, these products can be reused. Many used building materials facilities redistribute materials of this type.

Recyclable product: This product is theoretically recyclable although facilities do not currently exist.

Mineral wool insulation

Mineral wool insulation consists of spun-type fibre, similar to fibreglass. It is made primarily from slag, a waste product resulting from the production of iron and steel. Slag comprises up to 99.5 percent of the final product. Approximately 0.5 percent is oil to prevent dust, and the remainder is rock. Mineral wool is also used as a fire retardant and is not affected by moisture.

Recycled content: Mineral wool insulation is manufactured from mining waste, which is an industrial waste.

Energy savings: This product is designed to improve the thermal value of the building. Increasing the thermal value provides energy savings during both the heating and cooling cycle. The greatest energy savings will be achieved if other parts of the building envelope are designed to prevent exterior air infiltration.

Indoor air quality: Mineral fibres may be irritating if released into the interior cavity of a building and may emit pollutants. Depending on the source of the raw materials, trace heavy metals may be present. All insulation should be well-sealed behind air and vapour barriers.

Reusable product: When carefully dismantled, these products can be reused. Many used building materials facilities redistribute materials of this type.

Recyclable product: This product is theoretically recyclable although facilities do not currently exist.

Source: Public Works and Government Services Canada, *The Environmentally Responsible Construction and Renovation Handbook* [online], 2008 (accessed May 8, 2009).

Name: _____ Group: _____ ST AST

Creating the context

I ask myself questions

1. a) What is thermal insulation?

b) How can thermal insulation be efficient?

c) What is thermal energy?

d) What is heat?

e) What is temperature?

f) In terms of the law of conservation of energy, how does thermal insulation affect energy?

g) What factors affect the amount of thermal energy in a substance?

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Creating the context (*continued*)

h) What is energy efficiency?

i) What role does thermal insulation play in the energy efficiency of a heating system?

j) What are the benefits of improving the energy efficiency of a heating system?

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Creating the context (*continued*)

I must

2. a) Reformulate the goal of the problem-solving activity.

b) What is the independent variable?

c) What is the dependent variable?

I think

3. How do you think you will determine which type of thermal insulation is the more efficient?

4. Which insulator do you think will be more efficient? Formulate a hypothesis and justify it.

Reflection

	Yes	No
Do I fully understand the concepts covered in this situation?	☐	☐

Name: _____ Group: _____ ST AST

Planning the problem solving

I plan

1. Make a list of materials you will need to conduct your experiment.

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

2. Write out the protocol for the experiment. Remember to prepare a control test.

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Planning the problem solving (*continued*)

I plan

3. Prepare a table for recording your results, and give it a title.

4. What safety rules should you follow during your experiment?

_____

_____

_____

_____

_____

_____

Reflection

	Yes	No
Have I considered other approaches?	☐	☐

Name: _____ Group: _____ ST AST

Initiating the problem solving

I experiment

1. Conduct the experiment. Record your observations in the table you have prepared.

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

3. Did you work safely during the experiment? Justify your answer with at least two examples of safety-conscious behaviour.

Reflection

	Yes	No
Did I record and justify each of the changes I made to my plan of action?	☐	☐

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Analyzing results and drawing conclusions

I analyze my results

1. a) Which type of thermal insulation is the more efficient? Explain your answer.

b) What are the advantages of the test insulators? Name at least two advantages for each insulator.

c) What are the disadvantages of the test insulators? Name at least two disadvantages for each insulator.

Name: _____ Group: _____ ST AST

Analyzing results and drawing conclusions (*continued*)

d) What are the possible sources of error in your experiment? Suggest a way to eliminate them.

I draw my conclusions

2. Was your hypothesis correct? Explain your answer.

3. What conclusion can you draw from your experiment? Which thermal insulator do you recommend? Explain your answer.

Name: _____ Group: _____ ST AST

My evaluation

Use the evaluation grid on the following page to evaluate yourself. Write A, B, C, D or E in the "Me" column of the chart below.

SSC1—Seeks answers or solutions to scientific or technological problems				
Criteria*	**Observable indicators**	**Me**	**Teacher**	**Comments**
1	**Creating the context** Definition of the goal and the dependent and independent variables		☐ With help	
2	**Planning the problem solving** Relevance of the elements of the plan of action: materials and procedure		☐ With help	
3	**Initiating the problem solving** Accuracy of the results and compliance with safety rules		☐ With help	
4	**Analyzing results and drawing conclusions** Analysis of the results and 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: _____

ST AST

SSC1 Seeks answers or solutions to scientific or technological problems

Criteria*	Observable indicators	A	B	C	D	E
1	**Creating the context** Definition of the goal and the dependent and independent variables	The goal is very clearly defined and relevant to the problem to be solved. The variables are very clearly identified and relevant.	The goal is clearly defined and relevant to the problem to be solved. The variables are clearly identified and relevant.	The goal is not very clearly defined or is irrelevant to the problem to be solved, OR the variables are not clearly identified or are irrelevant.	The goal is not very clearly defined or is irrelevant to the problem to be solved, AND the variables are not clearly identified or are irrelevant.	The work must be done again.
2	**Planning the problem solving** Relevance of the elements of the plan of action: materials and procedure	The list of materials is complete. The procedure is relevant and very clear.	The list of materials is almost complete. The procedure is relevant and clear.	Many elements are missing from the list of materials, OR the procedure is not very relevant and clear.	Many elements are missing from the list of materials, AND the procedure is irrelevant and unclear.	The work must be done again.
3	**Initiating the problem solving** Accuracy of the results and compliance with safety rules	All of the results are accurately recorded and relevant, AND the experiment was conducted safely.	Most of the results are accurately recorded and relevant, AND the experiment was conducted safely.	Some of the results are accurately recorded and relevant, AND the experiment was conducted safely.	The results are not accurately recorded and are irrelevant, OR the experiment was not conducted safely.	The work must be done again.
4	**Analyzing results and drawing conclusions** Analysis of the results and conclusion	The analysis of the results and the conclusion are very clear and relevant to the goal of the problem solving.	The analysis of the results and the conclusion are very clear and relevant to the goal of the problem solving.	The analysis of the results and the conclusion are not very clear OR are not very relevant to the goal of the problem solving.	The analysis of the results and the conclusion are not very clear AND are not very relevant to the goal of the problem solving.	The work must be done again.

*** 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