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ABSTRACT

The purpose of this document is to provide teachers, administrators, students, and parents with samples of students' performances that exemplify standards in relation to the 1993 Grade 9 Science Performance-Based Assessment Tasks for the province of Alberta, Canada. A sample of 698 randomly selected students from 31 schools did the performance-based assessment. The quality of student works are grouped into three levels. (1) beyond grade 9 level; (2) at grade 9 level; and (3) not yet at grade 9 level. An introduction describes the procedure used and program area emphasis by topic. Samples of students' performances are presented for each of 6 activities that correspond to the topics of: (1) diversity of living things; (2) fluids and pressure; (3) heat energy: transfer and conservation; (4) electromagnetic systems; (5) chemical properties and changes; and (6) environmental quality. A summary section describes what students did for each activity, followed by a discussion of areas for improvement. Appendices contain science holistic scoring criteria, percentage of students at each level, hazardous waste data sheets and maps (used for the environmental quality topic); and science descriptive coding criteria. (LZ)

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Samples of Students' Responses from the Grade 9 Science Performance-Based Assessment Tasks June 1993

Students First!
Student Evaluation

Alberta EDUCATION

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This document was written primarily for:

Students	
Teachers	✓
Administrators	
Parents	
General Public	
Others (Specify)	

Contents

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Introduction

Purpose

The purpose of this document is to provide teachers, administrators, students, and parents with samples of students' performances that exemplify standards in relation to the 1993 Grade 9 Science Performance-Based Assessment Tasks. The commentaries that accompany the samples highlight selected features of the students' responses and show how the scoring criteria relate to students' work.

Science Assessment in 1993

The Grade 9 Science assessment in 1993 collected information and reported on a range of learning expectations. Three instruments were used to collect information: the achievement test, a survey of student attitudes, and performance-based assessment tasks. Provincial results for these assessments are reported fully in the *Achievement Testing Program Provincial Report, June 1993 Administration.* The performance-based assessment component is the specific focus of this booklet.

Selection of Samples

The samples of students' work selected for this booklet were used for training markers during the July 1993 marking session of the performance-based assessment. As such, these examples generally illustrate the quality of students' work at each of three levels: Beyond Grade 9 Level, At Grade 9 Level, and Not Yet At Grade 9 Level.

Confirming Standards

The initial work of confirming the standards that would govern the scoring of student performances was undertaken by a group of experienced Grade 9 Science teachers on June 27 and 28, 1993. Their task was to read a large enough sample of student responses to select those that exemplified the different levels of performance. At the same time, these teachers suggested adjustments to the standard descriptions in the scoring guide where needed and prepared specific notes for use during the marking session. The Holistic Scoring Criteria are given in Appendix A.

These teachers later served as group leaders during the marking session. They used the selected examples to set the scoring guidelines and to train teachers for the marking session.

Marking Process

Teachers were selected for marking on the recommendation of their superintendents. All markers were teaching Grade 9 Science in the same school year that the performance-based assessment was administered and had done so for at least two years.

Markers followed the agreed-upon standards when scoring student responses. During the marking session, each marker scored a student's response for problem-solving skills and communication skills. The overall results are given in Appendix B.

General Description of the Performance-Based Assessment

Background

The performance-based assessment was developed to assess students' higher order thinking skills in real-life problem-solving situations. The tasks assessed aspects of science that cannot be measured easily by paper-and-pencil tests.

The activities allowed students to use a variety of strategies, to use hands-on materials, and to collect information. Students were asked to explain the strategies they used and how they carried out these strategies to solve problems. Their written responses provided another picture of what they knew and were capable of doing.

Performance-based Assessment
Program Area Emphasis by Topic

Activity	Activity name	Topic	Program area	Learner expectations
1	Seed Dispersal	Diversity of Living Things	Nature of Science	Observe seeds Infer seed dispersal Predict dispersal patterns
2	Sugar Solution	Fluids and Pressure	Science and Technology	Construct and calibrate a hydrometer Use a hydrometer to measure liquid density
3	Sleeping Bags	Heat Energy: Transfer and Conservation	Science and Technology	Design and execute an experiment to test insulation effectiveness
4	Robot Arm	Electromagnetic Systems	Science and Technology	Design, test, troubleshoot, evaluate, and construct an electromagnet
5	Bulk Food Store	Chemical Properties and Changes	Nature of Science	Develop an experimental procedure to identify white powders
6	Hazardous Waste	Environmental Quality	Science, Technology, and Society	Analyze information Examine perspectives Identify alternatives Consider consequences

Sampling

Thirty-one schools were randomly selected to participate in this assessment. From these schools, 698 randomly selected students did the performance-based assessment.

Administration

This assessment was administered by trained assessors who followed standardized procedures. The assessment consisted of six real-life problems presented at six stations. Each station consisted of:

- a student activity sheet listing the problem, the materials, and the instructions
- materials

Three circuits, each with six stations, were set up. A maximum of 15 students were assigned to each session. This allowed five students to work through the six activities at each circuit. Typically, between $1\frac{1}{2}$ and 2 hours were needed for each student to complete the six tasks. Students recorded all of their work in a booklet.

Students were given as much time as necessary to complete the tasks. The assessment took place between May 25 and June 4, 1993. The schools selected provided excellent cooperation in making space and tables available for this assessment.

Samples of Students' Performance

Activity 1—Seed Dispersal

PROBLEM STATEMENT:

Jane is a biologist who is studying the effects of seed dispersal in a growing area. She prepared a field plot to investigate seed dispersal and changes in plant populations over time. New plants A, B, and C were planted in the middle of the plot. Soil and moisture conditions are good for the growth of these plants over the whole plot. The method that plants use to scatter seeds is called seed dispersal. Help Jane predict the dispersal of seeds from three different plants.

YOU SHOULD HAVE:

preserved seed specimens A, B, and C from three different plants:

Seed Specimen	Plant Name
Specimen A	Asclepias
Specimen B	Cockle Burr
Specimen C	Vicia

1 Practice Plot Map
1 Final Solution Plot Map

INSTRUCTIONS:

- Part A

  Observe each seed specimen. **Infer** the type of seed dispersal method from your observations. Record your **observations** and **inferences** for each specimen. Organize and present your information completely and clearly on page 1 of your student booklet.

- Part B

  The plot map shows two of each plant type growing in the middle of the plot. Given the following conditions, **predict** the distribution of plants after each plant type reaches its maximum population.

  Conditions

  1. There can be a maximum of 6 plants for each square metre.
  2. The plants are not diseased and are not eaten by animals or insects.
  3. The wind blows only from the northwest.
  4. The weasels and coyotes live only in the squares shown on the plot.

Using A, B, or C to represent one plant each, show your predicted plant population and distribution on the plot map. There is a Practice Plot Map and a Final Solution Plot Map. You may write directly on these maps.

On page 1 of your student booklet, provide an explanation of your predicted distribution for each plant.

This solution was scored "Beyond Grade 9 Level."

Activity 1—Seed Dispersal

Before you start Activity 1, read pages 1 to 4 in this booklet.

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

Part A:

1. Record your observations and inferences here.

seed Specimin	Observations	Inferences
A Asclepias 	- small brown flat sac - approx. 6-7mm thin, beige, long hairs streaming out the top - approx 2cm tiny brown specks in the hairs	- probably containing seeds - hairs catch in wind and are blown to other locations. sac acts as a weight. - there may be loose seeds or dirt
B Cockle Burr 	- brown capsule covered in 3-5mm spikes - approx. 2cm long - capsule is about 8mm thick - the tips of the spikes are curled	- spikes catch in the fur (or shoelaces) of passing animals and eventually drop off, growing in new location
C Vicia 	- 2 skinny spiralled rods originating at a tuft of leaf - 4 small seeds - there are 2 ends opening at one end.	- when the pods dry, the rods snap open. The seeds, inside the rod fly through the air and grow where they land

1

Part B:

1. PLOT MAP

Use the Practice Plot Map to help you determine your solution. Put your predicted population distribution on the Final Solution Plot Map.

2. Explain your predicted distribution for each plant.

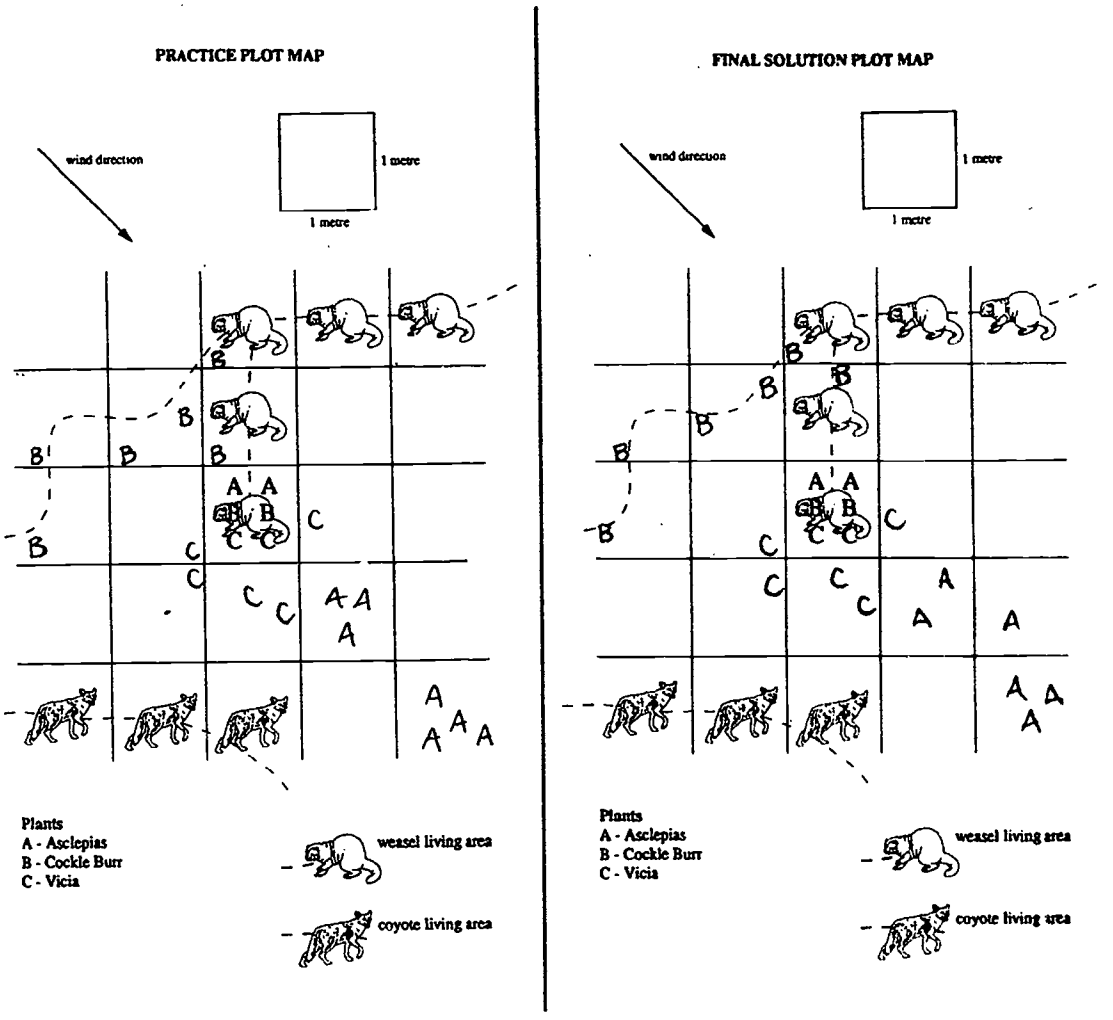
The asclepias plant only distributes its seeds by use of the wind. Because the wind only blows from the northwest, all the new plants will grow in the south east corner. (No animals cross there)

The Cockle burr plant will not be eaten by the weasle because of it's prickly spines. Instead, the seeds will catch on it's fur and later drop off when continuing on its path.

The Vicia plant's seeds will only go a short distance away because they just pop out of the pod. The plants in the center square will most likely be eaten by the weasle as well as the Asclepias in that square. Some seeds may blow in the direction of the wind

The problem is analyzed and clearly understood. Numerous extensive observations are made for each seed specimen, and drawings are used to support the observations. The observations are used to correctly infer the dispersal method of each seed type.

A chart with drawings is used effectively to communicate observations and inferences. Predictions are written clearly and logically.



The plot map shows plausible seed dispersion patterns for all three seed types and accounts for changes in plant population.

This solution was scored "At Grade 9 Level."

Activity 1—Seed Dispersal

Before you start Activity 1, read pages 1 to 4 in this booklet.

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

Part A.

1. Record your observations and inferences here

Seed A - Asclepias - light & fluffy
Dispersal method
- blown on the wind
- eaten and dispersed.

Seed B - Cockle Burr spikey
Dispersal method
- latch onto animals fur and be removed in another location.

Seed C - Vicia - "V" shaped
Dispersal method
- blown on the wind
- eaten and disposed

Part B:

1. PLOT MAP

Use the Practice Plot Map to help you determine your solution. Put your predicted population distribution on the Final Solution Plot Map

2. Explain your predicted distribution for each plant.

Seed A - because the wind will blow most of the seeds in that direction.

Seed B. the weasles will carry it on their fur and when they clean themselves it will be removed (in a new place)

Seed C - the weasle may eat it or
- it will be blown on the wind

The task is understood. Observations and inferences about the seed dispersal method are made for each specimen. Inferences are made about the dispersal method of each seed type using the information from each observation. Observations are adequate but not extensive. There is a general understanding of how dispersal would take place.

Point form lists are used appropriately to communicate observations, inferences, and predictions.

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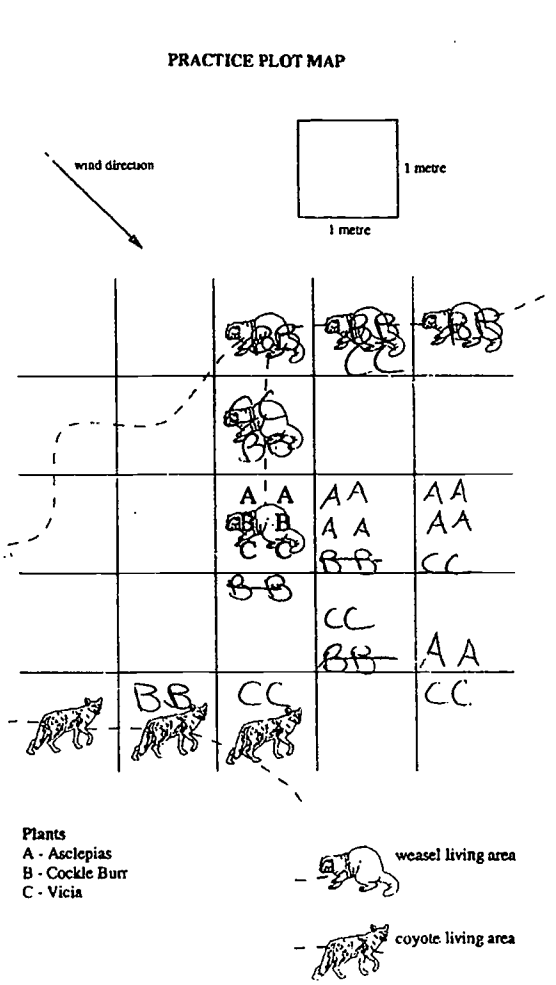
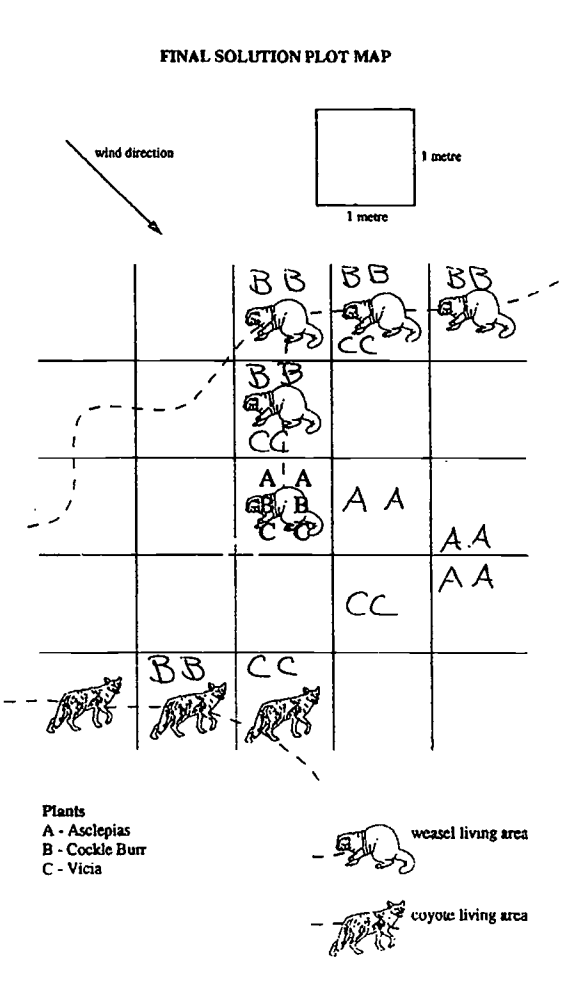




The predicted dispersions for Asclepias and Cockle Burr are plausible, however, the predicted dispersion for Vicia is not clear.

This solution was scored "Not Yet At Grade 9 Level."

Activity 1—Seed Dispersal

Before you start Activity 1, read pages 1 to 4 in this booklet.

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

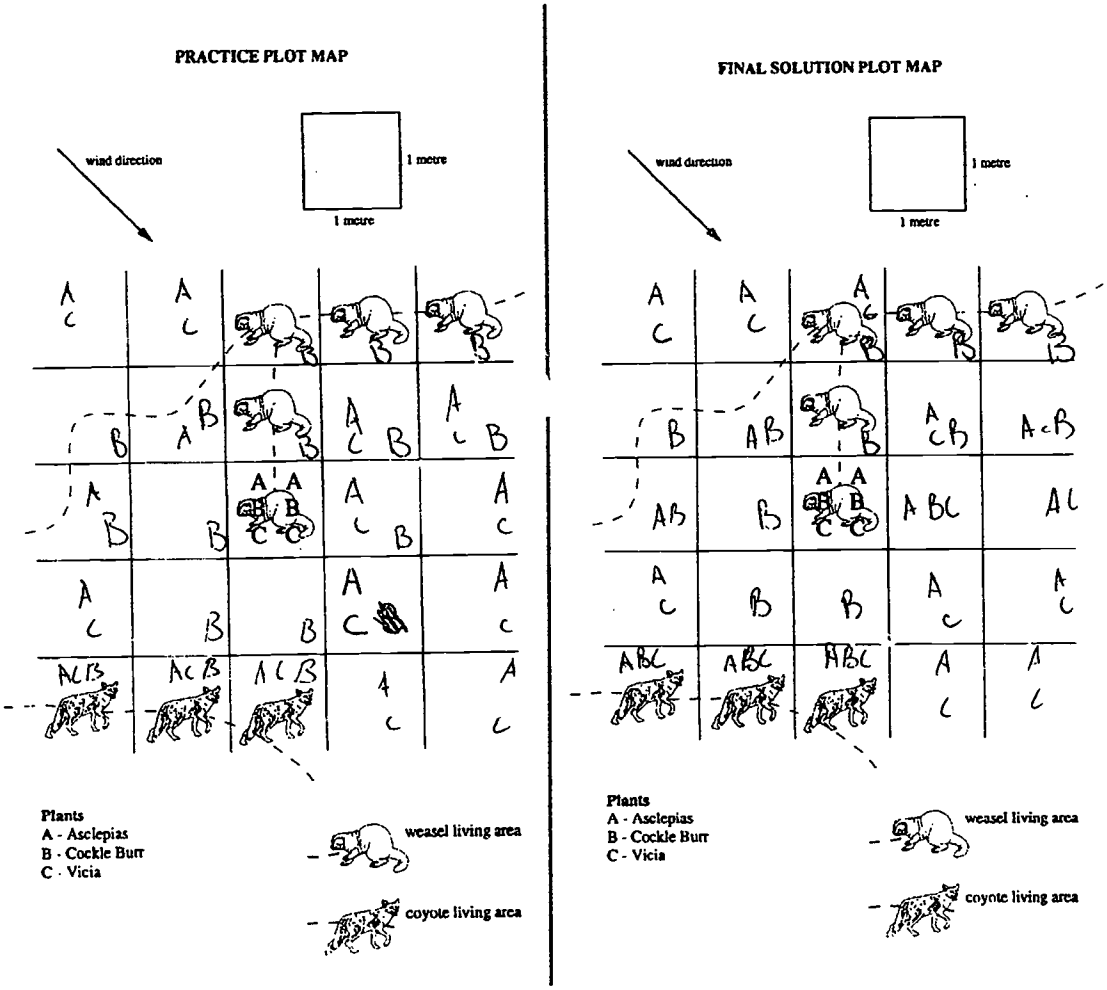
Part A:

1. Record your observations and inferences here.

A) most likly will blow in the wind
B) will stick to an animal or a human
C) Should Blow in the wind

The task is partially understood. Three inferences are made. There are no observations. Two of the inferred seed dispersal methods are correct, but there are no observations to support the inferences and the predicted distribution has no explanation.

Words and diagrams are somewhat clear but lack completeness.



The plot map is attempted but poorly done, and there is no accounting for changes in plant populations. The predicted population pattern has no evident organization.

Activity 2—Sugar Solution

PROBLEM STATEMENT:

A sugar-processing technician makes a hydrometer and uses it to measure the density of sugar solutions. Help the technician make a hydrometer and measure the density of a sugar solution.

YOU SHOULD HAVE:

straws	wooden dowels	ruler
plasticine	marking pen	scissors
lead shot	plastic bags	masking tape
screws	string	pencils
screw driver	Styrofoam chips	labels
paper towels (pink)	glue stick	sugar solution A
waste basket	plastic vials	cleaning solution

box—labelled Hydrometers

Calibration liquids: water—density = 1.0 g/mL
sugar solution (blue)—density = 1.2 g/mL

INSTRUCTIONS:

- Using the materials provided, **construct** and **calibrate** a hydrometer. To calibrate your hydrometer, measure the density of each calibration liquid.
- Use the hydrometer to measure the density of the sugar solution A.
- Explain how you used the hydrometer to measure the density of sugar solution A.
- Put your clean hydrometer in a plastic bag. **Ensure that your name and school name have been clearly added to the label** and that **all** parts are included. Put your bag in the box labelled Hydrometers.
- Leave this station as you found it.

This solution was scored "Beyond Grade 9 Level."

Activity 2—Sugar Solution

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. Construct the hydrometer.
2. Explain how you measured the density of sugar solution A.

① First I constructed my hydrometer by taping together two dowels with a screw in each end & I then wrapped the entire dowel in tape in order to prevent the dowel from absorbing the liquid & recording inaccurate results.

② I then placed the hydrometer in the water & when the hydrometer was not submerged in the liquid, I made a mark.

③ I then placed the hydrometer in the other calibration liquid & performed the same procedure as #2.

④ Next I placed my hydrometer in the test solution & where the dowel was exposed to the air & made a mark & this mark was in between my other 2 marks which gave me the density of 1.1g/mL for solution A

3. The density of sugar solution A is 1.1 g/mL.

4. Now, enclose all parts of your hydrometer in the plastic bag provided. Label it with your name and school name, and place it in the box labelled Hydrometer.

The task is analyzed and the problem is clearly understood. A hydrometer is constructed using dowels and screws for ballast, and it is calibrated correctly. The hydrometer is used to accurately measure the unknown density of sugar solution A. The explanation is complete and thorough and is communicated effectively. Density is expressed in correct units.

This solution was scored "At Grade 9 Level."

Activity 2—Sugar Solution

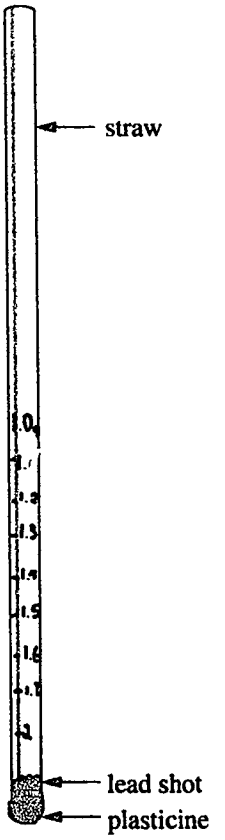
FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. Construct the hydrometer.
2. Explain how you measured the density of sugar solution A.

1- I put a screw in the wooden dowel but when I placed it in the water it fell crooked and I had trouble getting it out.
2- I pulled it apart and put plasticine at one end of a straw. This didn't stay up very well. I put some led shot over top of it. This helped to ballance it out. I pulled the straw out and marked where the water level came up to and marked that as 1.0. Then I put it in the blue sugar solution and marked where the water came up to at 1.2. Then I put it in the pink sugar solution

3. The density of sugar solution A is 1.25 g/ml.

4. Now, enclose all parts of your hydrometer in the plastic bag provided. Label it with your name and school name, and place it in the box labelled Hydrometer.



Understanding is demonstrated through the construction of a calibrated hydrometer to measure the density of solution A. The hydrometer is well constructed; however, errors were made when calibrating, which resulted in an incorrect reading of solution A. An overall explanation is given that is clear and complete, and the density has the correct units.

This solution was scored "Not Yet At Grade 9 Level."

Activity 2—Sugar Solution

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

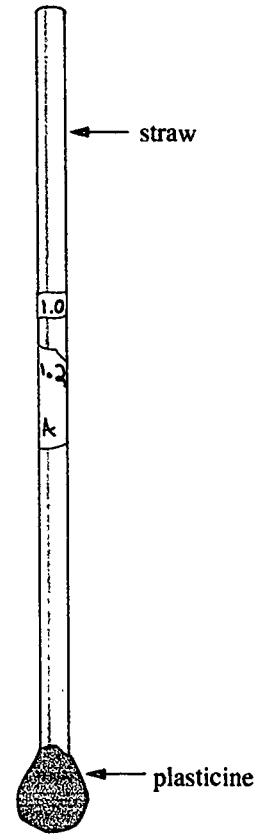
1. Construct the hydrometer.
2. Explain how you measured the density of sugar solution A.

~~don't know how to construct it.~~

I put plastersine on the end of a straw a let it float in the solution. The Density 1.0 is 2.

3. The density of sugar solution A is 2.

4. Now, enclose all parts of your hydrometer in the plastic bag provided. Label it with your name and school name, and place it in the box labelled Hydrometer.



The problem is partially understood because the hydrometer measures density. A basic hydrometer is constructed, but calibrating the hydrometer is not correctly done. An attempt is made to measure the density of the unknown sugar solution, but a correct reading cannot be made with the instrument constructed. The explanation of how the hydrometer is used to measure the density of solution A is limited. The calculated density is not reported with correct units.

Activity 3—Sleeping Bags

PROBLEM STATEMENT:

June works at an outdoor equipment factory. She is testing three different brands cf sleeping bags. She knows that an insulator reduces the transfer of heat. Help June design and conduct an experiment to evaluate the insulating effectiveness of these sleeping bags.

YOU SHOULD HAVE:

3 sleeping bag samples—A, B, C
4 thermometers
ice chest containing ice packs
timer
lamp with 60 w bulb
ruler
construction paper
masking tape
scissors
graph paper (in the student booklet)

INSTRUCTIONS:

- Determine a procedure to find out which bag, A, B, or C, is the best insulator. Describe your procedure.
- Present your results clearly and completely.
- Before leaving this station, replace all equipment to its original position. **Leave the station as you found it.**

This solution was scored "Beyond Grade 9 Level."

Activity 3—Sleeping Bags

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. Describe your procedure.

① Heat each thermometer up to 37°C (body temperature).
② Put each one into a sleeping bag and place them all in the cooler for 1:00 minute.
③ Take them out and record the temperatures.

2. Present your results clearly and completely. You may use the graph paper on the next page.

SLEEPING BAG	START TEMP.	FINISH TEMP.	DIFFERENCE IN TEMP.
A	37°C	33°C	4°C
B	37°C	33°C	4°C
C	37°C	34°C	3°C

Type C is the best sleeping back to use.

The experimental design described has a procedure that is logical and easy to follow. The effectiveness of the sleeping bags is determined by measuring heat loss. Controls and variables are accounted for in the procedure.

The starting temperature (body temperature) is noted. Data collection is complete and units are used. Results are used to correctly identify the best insulating sleeping bag. Descriptions in point form and a table are used to effectively communicate results. Information given is clear, concise, and easy to follow.

This solution was scored "At Grade 9 Level."

Activity 3—Sleeping Bags

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. Describe your procedure.

① Make Table below
② Put thermometers in sleeping bags
③ Heat thermometers to temperture over 25°C.
④ Cool thermometers and when they go to 25°C start stop watch and record temperture every 60 sec. (Ice pack is on the sleeping bags)

2. Present your results clearly and completely. You may use the graph paper on the next page.

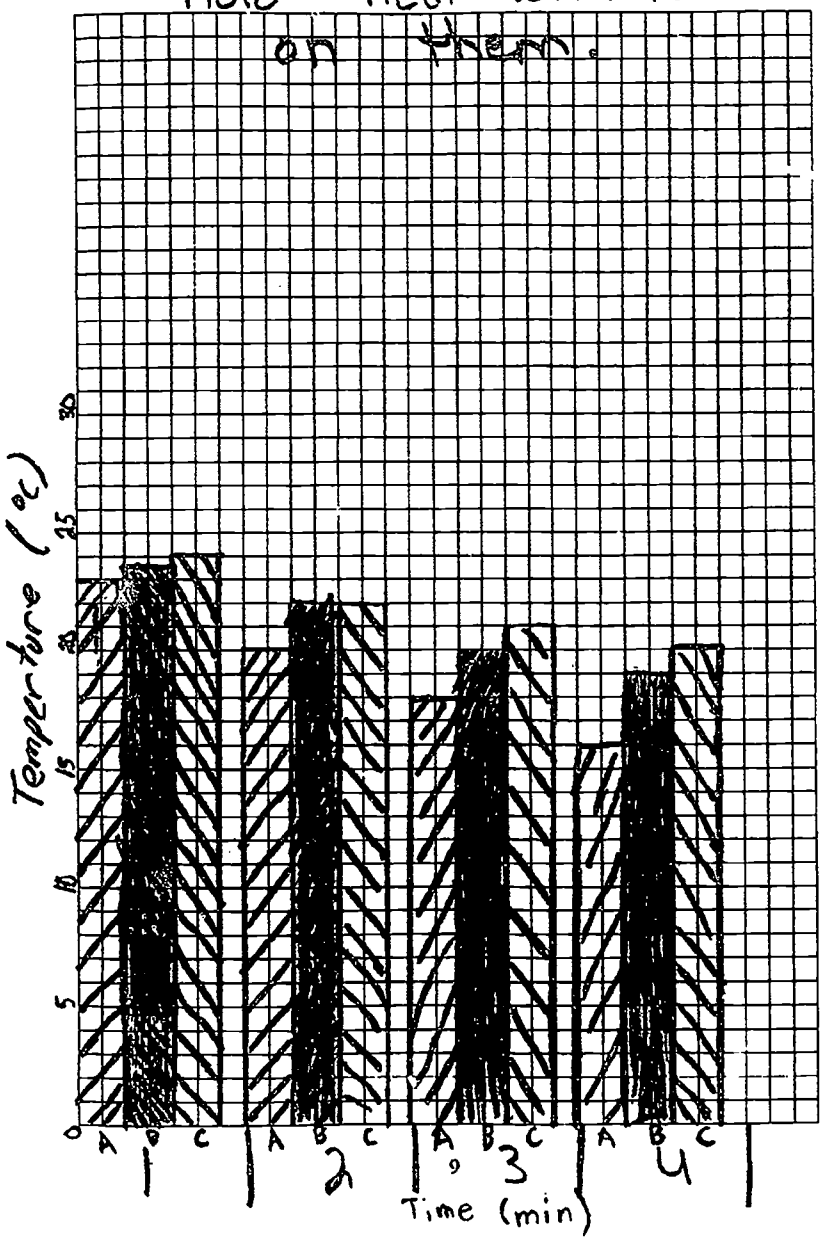
With Ice

Time(s)	Temperture (°C)		
	A	B	C
0	25	25	25
60	23	23.5	24
120	20	22	22
180	18	20	21
240	16	19	20

The experiment is designed to test the effectiveness of the insulating qualities of sleeping bags. A workable procedure for measuring heat loss of the three sleeping bags is used. Some of the controlled variables are implied.

A set of data is collected and starting temperatures are noted. Data are complete and correct units are provided. Also, a complete and well-labelled graph is used to communicate results. The best insulating sleeping bag can be inferred from the results.

How good sleeping bags hold heat with ice on them.



This solution was scored "Not Yet At Grade 9 Level."

Activity 3—Sleeping Bags

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. Describe your procedure.

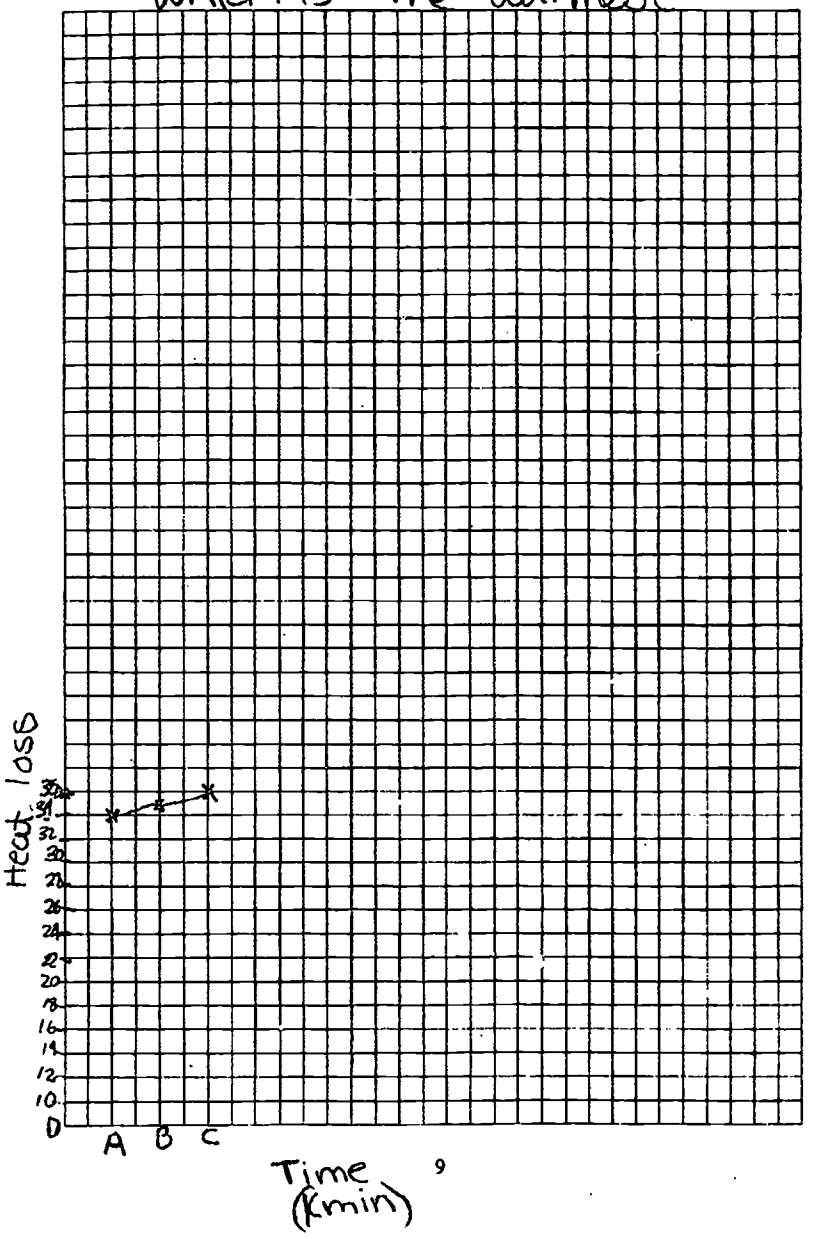
Start with your thermostats at 37°C body temperature then warm up your sleeping bag to 37°C then put in the ice pack for 1 min to see which bag looses most heat.

2. Present your results clearly and completely. You may use the graph paper on the next page.

Sleeping Bag A – after 1min 38 °C
Sleeping Bag B – after 1min 35 °C
Sleeping Bag C – after 1min 36 °C

An understanding of the problem is shown because measurements of heat loss were made. A procedure is shown to test for the insulating effectiveness of the sleeping bags that does not include controlling the variables. The method for collecting data is somewhat clear, but the readings for each of the three sleeping bags appear to be inaccurate. The units for the temperatures are correct. A graph is used to present the results; however, it does not show the starting temperatures. It is difficult to infer the best insulating sleeping bag from the results given.

Which is the warmest



Activity 4—Robot Arm

PROBLEM STATEMENT:

A designer is making a model of a robot arm that will be used to lift and deposit nails in a box. He is checking the various strengths of electromagnets required to lift different numbers of nails. Help the designer test the performance of the robot arm.

YOU SHOULD HAVE:

1 robot arm
1 6-volt battery
3 lengths of wire (70 cm each)
1 bolt
2 washers
1 nut
2 wires with alligator clips
container of nails
graph paper (in the student booklet)
scissors
tape

Please disconnect the battery to save energy.

INSTRUCTIONS:

- Using the materials provided, make an electromagnet and attach it to the robot arm so that the arm will pick up:
  a. 6 to 10 nails
  b. 16 to 20 nails
  c. 26 to 30 nails

- Organize your results clearly and completely to show how you changed the electromagnet so that it picked up different numbers of nails.

- Describe the relationship between the changes you made and the number of nails picked up.

- Describe how the robot arm operates.

- Before leaving this station, dismantle all the equipment. Leave the station as you found it.

This solution was scored "Beyond Grade 9 Level."

Activity 4—Robot Arm

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. Organize your results clearly and completely to show how you changed the electromagnet so that it picked up different numbers of nails. You may use the graph paper on the next page.

Testing an Electromagnet

# of wraps of wire	# of nails picked up
16	6
35	16
49.	26

2. Describe the relationship between the changes you made and the number of nails picked up.

as I increased the number of wraps of wire around the bolt, it was able to pick up more and more nails. (Usually about half the nails can be picked up compared to the wraps of wire)

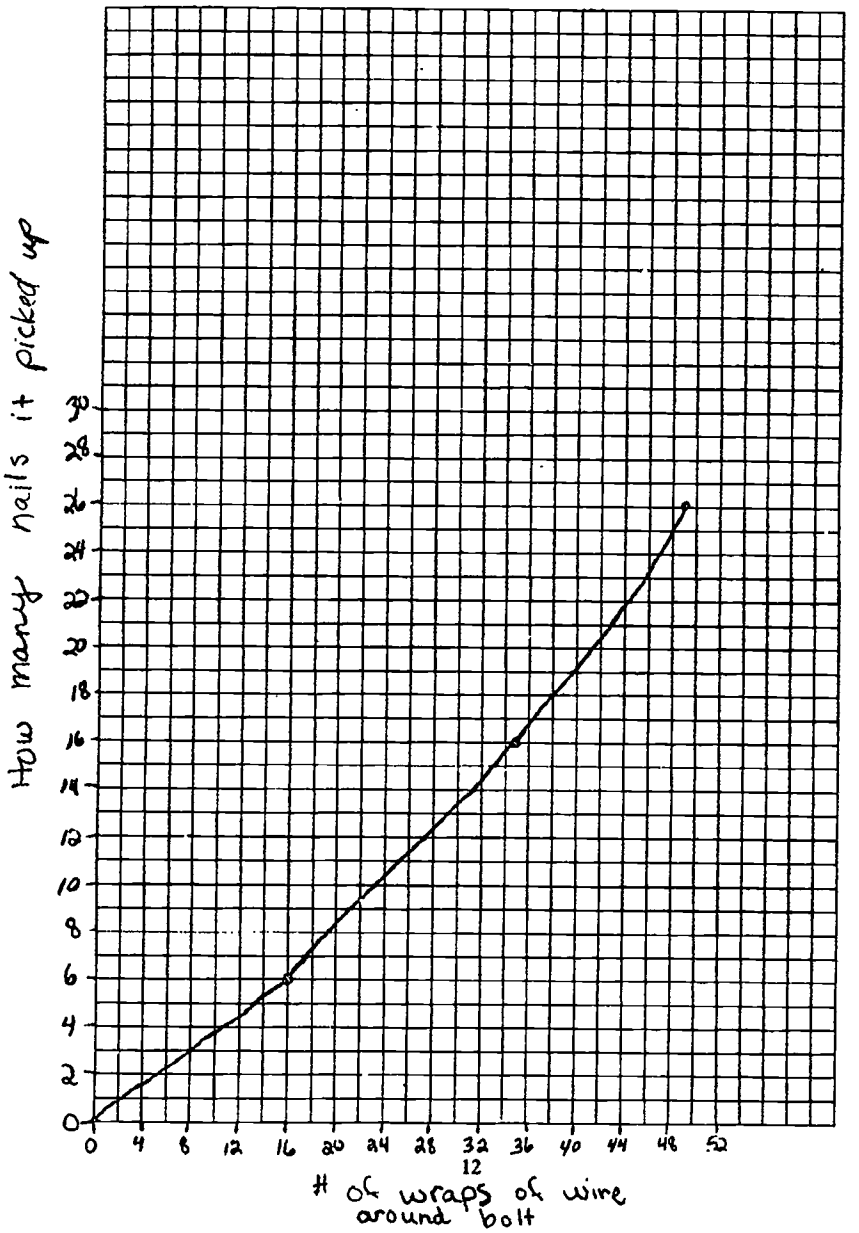
The response indicates an understanding of how an electromagnet works and how its strength can be manipulated. A complete and logical approach for testing the strength of the electromagnet is used. The data are presented in chart form, which clearly indicates the performance of the electromagnet for each change in the number of wire wraps. A conclusion is made about the relationship between the number of wraps of wire and the number of nails that can be picked up (strength).

3. Describe how the robot arm operates.

The robot arm moves down and the electromagnet picks up the nails laying under it. The arm will then move up and over to drop the nails into a container. For that to happen, the electricity flowing to the magnet must be disconnected.

The explanation of how the robot arm operates includes a description of the electromagnet's operation and the movement of the arm to pick up nails. Explanations are clear, concise, and complete.

Testing an Electromagnet



This solution was scored "At Grade 9 Level."

Activity 4—Robot Arm

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. Organize your results clearly and completely to show how you changed the electromagnet so that it picked up different numbers of nails. You may use the graph paper on the next page.

1 wire wrapped around bolt 8 nails
2 wires wrapped around bolt 37 nails
1 1/2 wires wrapped around bolt 20 nails

2. Describe the relationship between the changes you made and the number of nails picked up.

the more wraps around the nail the stronger the magnet becomes.

The response indicates an understanding of how an electromagnet works and that the problem requires the manipulation of variables that affect the strength of the magnet. The strength of the magnet is changed by changing the length of wire wrapped around the bolt. Data are collected and recorded to show the number of nails picked up for each change in wire length. The data are used to show the relationship between the manipluated and responding variables. A complete line graph is used to present the results.

3. Describe how the robot arm operates.

the magnet (bolt) is on one end and you can lift the arm on the other end. the battery can be connected to the bolt to make a magnet.

A description of how the robot arm operates is given in written and diagram form. Explanations are clear and coherent.

This solution was scored "Not Yet At Grade 9 Level."

Activity 4—Robot Arm

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. Organize your results clearly and completely to show how you changed the electromagnet so that it picked up different numbers of nails. You may use the graph paper on the next page.

I first of all wrapped the wire around the bolt in between the two washers I then conected one wire with an alligator clip to the battery and the other side to the wire and did the same with the other one-the bolt then picked up nails because of the electromagnetic current.

2. Describe the relationship between the changes you made and the number of nails picked up.

The more turns I made around the bolt, the more nails it picked up.

There is some understanding of what variables affect the strength of an electromagnet. An electromagnet is constructed but limited manipulation of variables is shown. Data are not collected regarding the number of nails the electromagnet could pick up.

3. Describe how the robot arm operates.

The arm it operates because of the current transferred through the batteries to the wires, to the bolt, and finally to the nails.

The description of the robot arm operation indicates that the electric current flows through the wires; however, it states incorrectly that the current flows to the bolt and nails.

Written text is used to communicate results; however, the response is difficult to interpret.

Activity 5—Bulk Food Store

PROBLEM STATEMENT:

A manager of a bulk food store sells different powdered foods from large containers. Sometimes, foods get mixed into other containers. If this happens, the contaminated food must be disposed of in a safe manner. The manager needs to find a way of testing for contaminates in samples from containers.

YOU SHOULD HAVE:

3 containers of pure white powdered food:

1. baking soda
2. corn starch
3. ascorbic acid (vitamin C)

3 dropper bottles:

1. iodine
2. vinegar
3. indophenol solution

contaminated sample of salt—for testing
1 spot plate
4 micro-spoons
waste pail—for test materials
waste container—for paper towels
squirt bottle
safety goggles
paper towels

Important:
- Do not touch powders with dropper bottle and use one drop at a time.
- Use a very small amount of powder for each test.

INSTRUCTIONS:

- Using the materials given, devise an identification system that will allow the manager to test for each pure food powder.
- Describe your identification system.
- Using your system, test the salt sample to see if it is contaminated with the other food powders and if it is, identify them. Explain your results.
- Before leaving this station, wash the spot plate and spoons and dry them with a paper towel. Replace all caps.

Note: Pure salt is not affected by iodine, vinegar, or indophenol.

This solution was scored "Beyond Grade 9 Level."

Activity 5—Bulk Food Store

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. Describe your identification system here. (Table)

	Cont. Salt	Corn Starch	Baking Soda	Absorbic Acid
Ind.	Turned brown	Light brown color appeared.	A thick clumpy substance Brown	Turned brown.
Iod.	Turned a clear color. No fizzing	A dark orange, yellow color	Black color. White spots are visible.	Turned a Clear color, a few bubbles.
Vin	Turned a clear substance.	White, clear color. Bubbles appeared, no fizzing	White residue appeared Clear, color around it.	Turned a clear color white in the centre. A little residue

The response indicates a clear understanding of the problem because the identification procedure includes testing powders, making observations, and using this information to test for contaminates. The identification system, in chart form, is clear and easy to follow. All of the observations are precise and accurate.

2. Test the salt sample for contaminates. Identify any contaminates. Explain your results.

Contaminated Salt turned brown with Indop.
" " yellow " Iodine
same

It seemed to me as though the absorbic acid was contamnat with the salt. It had all the same reactions and colors were identical.

The identification of the contaminate is correct and is supported by the observations in the table of results. Communication is clear, complete, and coherent.

This solution was scored "At Grade 9 Level."

Activity 5—Bulk Food Store

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. Describe your identification system here.

Salt - when mixed with Indophenol turned brown.
may have been contaminated with cornstarch.
When mixed with vinegar stayed the same
When mixed with Iodine the salt Disolved instantly and the solution turned to a clear colour.
when There is starch in a solution It may turn a different colour.

Baking soda
When Indophenol is added there was a chemical reaction and the baking soda turned brown.
when vinegar add to the baking soda It fizzed. When Iodine is added the baking soda does not mix.

Cornstarch.
when added to Indophenol It stays blue.
when added to vinegar it does not mix
when added to Iodine there is a chemical hange and the cornstarch turns blue.

Absorbic acid.
Iodine. stays yellow.
Vinegar. makes it stay the same. Idophonal turns it same.

The response indicates an understanding of the problem because the identification system includes testing powders, making observations, and using information to test for contaminates. A reasonable, clear identification system is developed showing observations for each powder and solution combination.

2. Test the salt sample for contaminates. Identify any contaminates. Explain your results.

The containinents in the salt were baking soda and the vitamin C since there was a chemical reaction in each. There was no cornstarch In the contaminated salt

Two contaminates are identified based on the identification system. Communication is somewhat effective as information is presented in a coherent list form.

This solution was scored "Not Yet At Grade 9 Level."

Activity 5—Bulk Food Store

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. Describe your identification system here.

Put 3 sampes of each power out and mix with the solutions to see what happens
The iodine turns the power yellow
The indophenol turns the power green
The vinegar smells funny
The solutions make the corn start hard

There is understanding that the identification for the powders requires testing of each powder with solutions. A partial identification system is used and some observations are made. The procedure and results are difficult to follow and understand.

2. Test the salt sample for contaminates. Identify any contaminates. Explain your results.

Yes the salt is contaminated you can tell because it smells like vinerger.

No contaminate is identified. Overall communication is confusing. Some useful information is presented in the procedural description and explanation of the results.

Activity 6—Hazardous Waste

PROBLEM STATEMENT:

Citizens of a town are dealing with an environmental issue. Chemicals that were stored by a chemical factory may have leaked into the town's ground water. If the factory is forced to clean up the chemicals and install expensive equipment, it may close. If the factory closes, many people will lose their jobs. What should be done about this issue?

YOU SHOULD HAVE:

a story that gives some information about the problem (See Appendix C)
a map of the town and plant (See Appendix C)
a chart showing the effects of different concentrations of a hazardous waste on human health (See Appendix C)
a chart showing the actual measurements of a hazardous waste at three sites in the town (See Appendix C)

INSTRUCTIONS:

- Read the story and use the information on the map and charts to answer the questions in your booklet.

This solution was scored "Beyond Grade 9 Level."

Activity 6—Hazardous Waste

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. You are a special consultant hired by the town to investigate this issue. You are to report to town council in one week's time. How would you research the problem and what would you report to town council? Explain your reasons

First of all is the pollution source pinpointed? See how severe the pollution really is, do research to see medical effects compared to previous years. The test results prove to be quite minor. To prevent further occurances the city should buy a plot of land to build a disposal site (like swan hills in Alberta). A long term clean-up should be done if nature doesn't repair itself quickly. A more drastic measure of water treatment should also be taken, the factory should dispose of goods in safe barrels and a safe disposal site. At least avoid leaching of the chemicals into the water table. The following measures are drastic but will contribute to well being and profit of this town in the future. Money could be provided by the rest of the province/state / country etc. ~~other~~ consumers use this factories products and in order to continue will probably help with the clean-up. The factory should be responsible for their actions however,

Research - Do more water testing sites, Monitor the results over a 6 month period. Supply bottled drinking water to the people.

Several questions are identified that need to be answered, including social concerns. There is thorough understanding of the information given for this issue. Indication is provided as to what given information is complete and relevant and what information is incomplete or inconsistent. Multiple suggestions for further research are provided and clear rationales are given. Analyses and explanations are clear and effective.

This solution was scored "At Grade 9 Level."

Activity 6—Hazardous Waste

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. You are a special consultant hired by the town to investigate this issue. You are to report to town council in one week's time. How would you research the problem and what would you report to town council? Explain your reasons.

In order to research this problem I would go to each site, measure the concentrations, and observe the effects that each site had on the community. I would question the families that showed symptoms about activities they had recently done, what they had recently eaten and drinken, inquire about allergies and how long they had been showing the effects for. I would go to the factory and observe how they did their jobs, how their presence has affected the community since their arrival. I would test the lake and river and see how the animal population had been affected. I would get peoples opinions from all areas of the community, and I would find many advantages and disadvantages to the factory's presence, and to the cleanup.

I don't think the town would loose many jobs if the factory closed because the job of restoring the environment would replace it.

I would get all the information that I could about the issue. Get many people's opinions and if the problems are being caused by the factory, then I would install at least one of the devices that would clean up the water supply. I would advise people to be more careful and not pollute and maybe purchas a water filter for their homes.

The response recognizes several questions that need to be answered before making a decision. Some suggestions are given for further research and, in most cases, further courses of action are supported with rationales. The information and suggestions are presented in a logical and clear manner.

This solution was scored "Not Yet At Grade 9 Level."

Activity 6—Hazardous Waste

FOLLOW THE INSTRUCTIONS FOR THIS STATION.

1. You are a special consultant hired by the town to investigate this issue. You are to report to town council in one week's time. How would you research the problem and what would you report to town council? Explain your reasons.

#2) for starter's I would test the water in site C and see how much hazardous waste there is in the water Then I would get a group together and do a major above ground clean-up I would get rid of the barrels of chemicals. I would wait about two to three weeks and then I would go back to site C and test the water again. I would hope that the water tested lower later than it did on the first test.

There is recognition of one question that needs to be investigated for this environmental issue. It is suggested that the ground be tested before doing a thorough ground cleanup, but this suggestion is limited to site C only. A recommendation is made to test for levels of hazardous chemicals before and after the ground cleanup. A solution is suggested but other factors in the issue are not accounted for. The explanation shows a partial understanding of the information, and points made are somewhat effective.

Observations Regarding Students' Skills and Knowledge

Students who participated in the performance-based assessment were motivated and stayed on task for up to two and one-half hours. Most students required approximately three to five minutes to read each problem and decide upon a strategy to solve it. Students were reminded it should take approximately 15 minutes to complete each station. Those who were having difficulty getting started were encouraged to move on to another station.

At two of the stations—Sugar Solutions and Robot Arm—it was obvious if students had previous hands-on experience constructing hydrometers and electromagnets.

At some of the schools, students who had not participated in the assessment wanted to know if they could at a later date.

The following is a description of what students could do, followed by a discussion of areas for improvement. Information from the descriptive scoring results (see Appendix D) was used for this analysis.

What Students Could Do

Activity One—Seed Dispersal

When making observations of seed specimens, students tended to make only one observation and inference for each specimen. Most students were able to predict the dispersed population distribution for the Asclepias seed (wind) and Cockle Burr (animal); however, the Vicia (mechanical) posed the greatest difficulty. Students tended to use only one factor of seed dispersion, and few used interacting factors to predict the dispersion of each seed. The majority of students were able to explain their predictions.

Activity Two—Sugar Solution

Students who constructed hydrometers preferred to use the straw with plasticine as a ballast or a wooden dowel with a screw as ballast. Of students who constructed a hydrometer, one in five could calibrate and put a scale on the hydrometer, and one in ten students put a scale on without calibration. When calibrated hydrometers were checked for performance, most floated within the calibration range.

When measuring the density of the unknown sugar solution, three out of ten students selected a strategy other than the use of a hydrometer—for example, they measured the change in the level of the solution. Of the students using a calibrated hydrometer, most used the midpoint on their calibrated hydrometer to estimate the density of the unknown sugar solution. Most students (seven of ten) correctly measured the density ($\pm$ 0.1g/mL). About one-half of the students using supporting data could explain how they measured the density of the unknown sugar solution. Most students (four out of five) who measured the density of the unknown liquid used the correct unit of measure.

Activity Three—Sleeping Bag

Approximately three out of five students measured both heat loss and heat gain when testing the insulation quality of the sleeping bags, and three out of ten students measured heat loss only.

The majority of students used one manipulated variable and accounted for controls in each test. This suggests that students have an understanding of a controlled experiment that would constitute a fair test. Approximately seven of ten students were able to choose a best-insulating sleeping bag using the data from their tests.

Many students used a chart or table in combination with written text to communicate their problem-solving strategies and results.

Activity Four—Robot Arm

Approximately one-half of the students could not construct a working electromagnet. Of the students who did, most used the number of wire wraps as the manipulated variable. A few students tested the number of wire layers or other variables in their construction. About one-half of the students connected different lengths of wire to make stronger electromagnets. Also, about one-half of the students who constructed a working robot arm collected data about the number of nails the magnet could pick up. Other students reported the relative strength of their magnets; for example, the magnet gets stronger with more wraps of wire. Of the students who constructed working robot arms, three out of five changed the strength of their magnet to meet all three performance levels.

Most students communicated their results in chart and/or written form and one out of ten students drew a diagram of their robot arm. Also, one out of ten students used a graph to show the relationship between number of wire wraps and the number of nails picked up.

Activity Five—Bulk Food Store

Most students were able to develop a systematic working strategy to test the different white powders. Of students developing a strategy, three out of five collected a full set of observations and three out of five correctly identified the contaminate in the salt powder. Most students communicated their results using a table and written text.

Activity Six—Hazardous Waste

When looking at this environmental issue, three out of five students examined one of several possible perspectives on this issue. A little more than one-half of the students suggested that more information was needed to address the problems in the issue. Some students suggested more than one alternative action to solve the problem.

Areas for Improvement

Activity One—Seed Dispersal

Students tended to make one observation for a seed specimen and, at times, to make inferences before making a complete set of observations. Students need to realize that good observing requires them to gather information with all of their senses about a specimen; then the careful study of these observations can lead to plausible inferences. Also, when students make predictions—especially in an open-ended problem—assumptions about the environment need to be included in the explanation of their predictions.

Activity Two—Sugar Solution

It was obvious in this assessment activity that many students did not have direct experience with the construction and calibration of a working hydrometer. This is an important activity for students because it helps to reinforce their understanding of what density is and how a hydrometer can be used to measure it. Students were given more materials than they needed to construct the hydrometer, which resulted in some students constructing complex hydrometers that did not perform as well as simpler designs.

Activity Three—Sleeping Bag

This activity was done well by most students; however, some students did not completely understand the problem. When solving a technological problem, it is important for the student to streamline the test to those factors that have an effect. For example, many students measured both heat loss and heat gain of the sleeping bag. This suggests that many students did not take into account the purpose of a sleeping bag—to keep heat in. Also, students need to design tests of technologies that have better controlled variables and measurement data; for example, they should have kept each sleeping bag at the same

location on each ice pack and recorded the beginning and ending temperature of each thermometer.

Activity Four—Robot Arm

Many students were not able to construct or could not remember how to construct a working electromagnet. Students need to know how electricity travels through a wire in a closed circuit and what kinds of materials will conduct electricity. Also, they should know how short circuits occur in their electromagnet and how to troubleshoot and correct them.

Activity Five—Bulk Food Store

Students need to make observations at each step of a procedure. For example, some students added liquid to a white powder but did not make observations as the liquid mixed with the powder. Many of these students made their observations after stirring the mixture. As a result, they missed some important observations. Preparation of a data chart before experimentation will help to focus student observations and provide an organized set of data from which to draw inferences and conclusions. Also, students need to be careful when using apparatus so that contamination of mixtures does not occur. Contaminated mixtures produced incorrect results for some students.

Activity Six—Hazardous Waste

When students are given information about an environmental issue, they tend to assume that it will be complete and that any opinions derived from this information will be correct. It is important that students look at data with some skepticism and explore other scientific, technological, or societal information sources. Students need to view an environmental issue from different perspectives and to acknowledge and weigh the pros and cons of these alternate perspectives before suggesting a final solution to a problem or an issue. For example, most students suggested only one alternative—clean-up the barrels and close the plant—without carefully analyzing available information, suggesting the need for more information, or acknowledging how these actions affect the community.

Appendices

Appendix A

Science Holistic Scoring Criteria

Level	Problem Solving/Inquiry	Communication
3 Beyond Grade Level	—Analyzed and readily understood the task —Developed an efficient and workable strategy —Strategy implemented effectively —Strategy supported a qualified solution —*Appropriate application of critical knowledge*	—Appropriate, organized, and effective system for display of information or data —Display of information or data was precise, accurate, and complete —Interpretations and explanations logical and communicated effectively
2 At Grade Level	—Understood the task —Developed a workable strategy —Strategy inferred (. me evidence) but not always clear —Strategy supports appropriate solution —*Evidence of application of critical knowledge*	—Appropriate, organized system for display of information or data —Display of information or data is mostly precise, accurate, and complete —Interpretations and explanations logical and mostly clear
1 Not Yet At Grade Level	—Partially understood the task —Appropriate strategy some of the time —Possible evidence of a plan, but not clear —Partial connection to appropriate solution —*Partial evidence of application of critical knowledge*	—System for display of information or data may not be clear or effective —Display of information or data was somewhat precise, accurate, and complete —Interpretations and explanations somewhat clear
0	—Misunderstood the task —Inappropriate, unworkable strategy —No evidence of carrying out a plan —No connections to solution —No evidence of critical knowledge —Blank	—Disorganized system for display of information or data —Display of information or data was not precise, accurate, or complete —Interpretations and explanations not clear —Blank

Appendix B

Percentage of Students at Each Level

These provincial results show the percentage of students demonstrating the different levels of performance for problem-solving and communication skills.

	Performance level	Activity					
		1	2	3	4	5	6
Problem Solving	3	15.5	27.7	28.0	13.7	23.0	2.2
	2	44.0	16.6	48.5	24.9	43.2	27.6
	1	29.5	30.5	19.1	27.2	25.9	64.4
	0	11.0	25.2	4.4	34.2	7.9	5.8
Communication	3	24.8	17.9	25.0	10.0	18.6	4.1
	2	39.0	21.4	49.2	25.9	39.7	26.8
	1	24.9	26.9	20.4	30.4	31.5	63.0
	0	11.3	33.8	5.4	33.7	10.2	6.1

3—Beyond Grade 9 Level
2—At Grade 9 Level
1—Not Yet At Grade 9 Level
0—Totally Misunderstood or Left Blank

Appendix C

Hazardous Waste Data Sheets and Map

Hazardous Waste

Like other children in the town, Mary has developed persistent headaches and sore muscles. Although the doctor is skeptical, Mary's father, James, wonders if these symptoms are caused by some hazardous chemicals leaking from rusting barrels into the town's water supply.

The barrels are stacked outside a factory, and some university scientists have found that toxic chemicals from them are getting into the underground water system. They made tests of the ground water at two sites and also tested the water from the lake where the citizens of the town get their drinking water.

A citizen's committee has been formed and is calling on the company to pay for a major cleanup. Such a cleanup might involve expensive work and equipment. Also, the factory would have to buy a reprocessing system and incinerator, and maybe even begin piping fresh water into town.

Mary's father, James, has attended a meeting of the citizen's committee. His wife, Rebecca, works for the chemical company, and has just been elected president of the union local. Rebecca feels her daughter's problems have nothing to do with the hazardous waste. She comments, "Mary is probably allergic to school!"

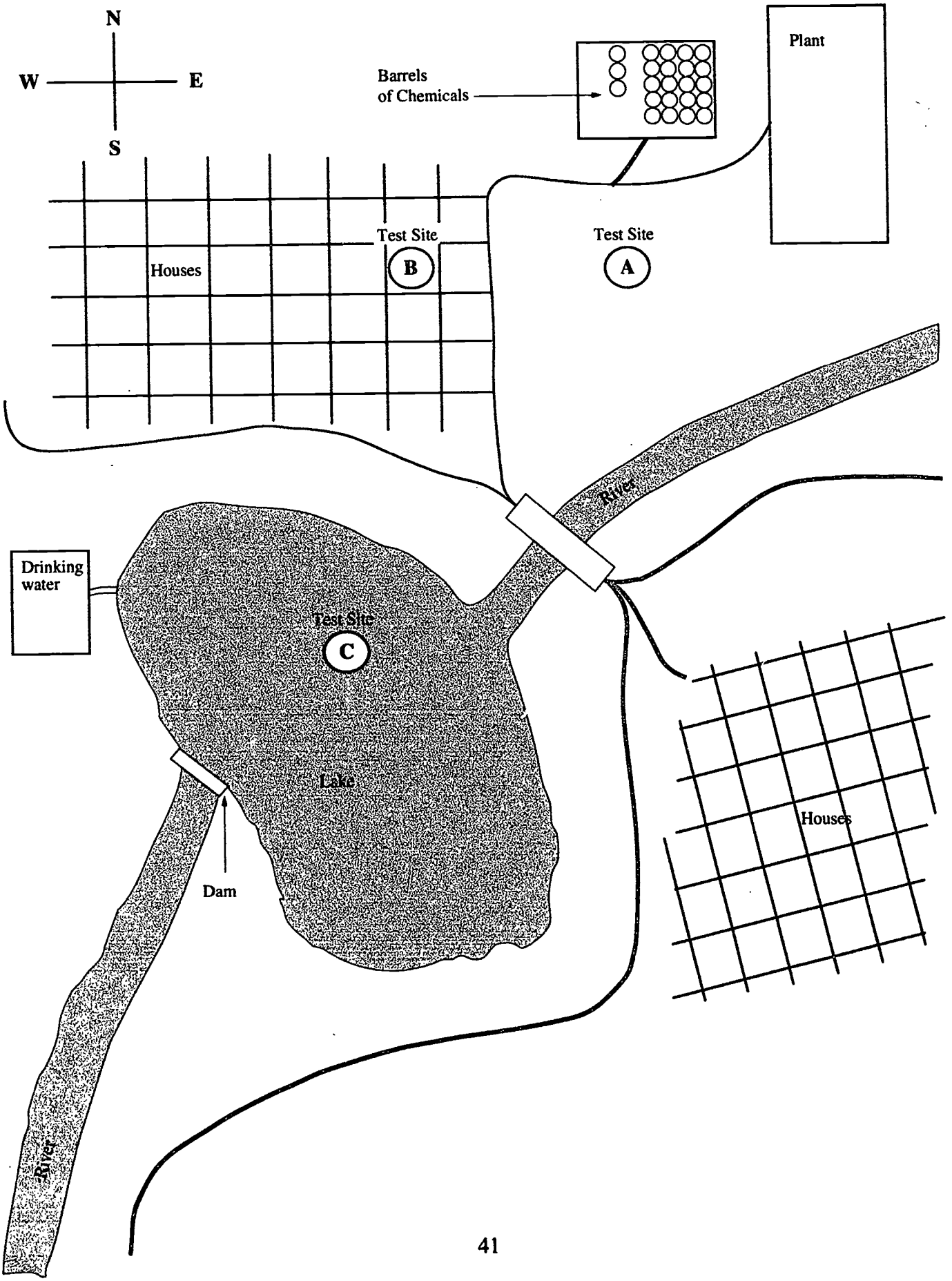
The issue comes before a meeting of the union executive. At the meeting, Nick, a member of the executive, says, "Sure, jobs are important, but so is everybody's health. We have to think about the future of the kids. I think we should support the citizen's committee in calling for a major cleanup."

Bill, another member of the executive, disagrees. "We are talking about big bucks here," he says. "Doing a major cleanup might mean the company pulling out and we'll lose our jobs. Besides, those university scientists who tested the underground water are just a bunch of do-gooders." Bill thinks there is no point in having a clean environment if you don't have a job. "Why not cleanup the surface of the dump site? It would cost less money, and would probably satisfy most people for the time being."

Nick is not convinced, and remains concerned about the health of his family.

The executive is asked to vote on the issue. Their recommendation will be sent to town council.

—adapted from *Student Points of View*


N
W
E
S
Barrels
of Chemicals
Plant
Houses
Test Site
B
Test Site
A
River
Drinking
water
Test Site
C
Lake
Houses
Dam
River

Health Problems Caused By Different Levels of Hazardous Waste

Level	Concentration	Symptoms
1	0.001 ppm	– none
2	0.005 ppm	– none
3	0.010 ppm	– minor headaches
4	0.015 ppm	– minor headaches – dizziness
5	0.020 ppm	– headaches – dizziness – fever
6	0.025 ppm	– headaches – cannot walk – high fever
7	0.030 ppm	– requires treatment at a hospital

ppm - parts per million

TEST RESULTS

Site	Measurement
A	0.010 ppm
B	0.012 ppm
C	0.001 ppm

Appendix D

Science Descriptive Coding Criteria

Activity 1—Seed Dispersal

Part A

Strategy

25.9%	no response
29.7%	less than three observations
32.4%	at least one observation for each specimen
10.0%	at least two observations for each specimen
1.7%	any other response

Implementation

12.6%	no response
35.4%	less than three inferences
43.4%	at least one supported inference for each specimen
2.4%	at least two supported inferences for each specimen
6.0%	any other response

Solution

12.3%	no response
1.4%	more than three correct inferences
43.3%	three correct inferences
26.9%	two correct inferences
10.6%	one correct inference
5.0%	no correct inferences

Communication Skills

9.2%	no response	0.7%	diagram
2.4%	chart	0.9%	list
3.3%	table	82.7%	written response
0.6%	graph		
0.1%	any other response		

Part B

Strategy

12.8%	no response
2.9%	more than three different dispersion methods
48.3%	three dispersion methods
24.2%	two dispersion methods
7.0%	one dispersion method
4.3%	any other response

Implementation

15.5%	no response
64.2%	less than six plants for each square metre
13.3%	six plants for each square metre
1.1%	exceeded maximum of six plants for each square metre
5.6%	other

17.0%	no response
59.9%	Asclepias to bottom right corner
9.6%	Asclepias not to bottom right corner
13.3%	other

18.2%	no response
35.5%	Cockle Burr along track of weasel only
1.6%	Cockle Burr along track of coyote only
16.3%	Cockle Burr along tracks of weasel and coyote
28.1%	other

19.3%	no response
20.3%	Vicia even dispersion
19.9%	Vicia dispersed to bottom right corner
40.3%	other

Solution

15.8%	no response
1.3%	more than three correct and supported solutions
23.6%	three correct and supported solutions
23.2%	two correct and supported solutions
15.5%	one correct and supported solution
20.5%	no correct and supported solutions

23.4%	no response
20.5%	weasel and coyote interacting
55.9%	weasel and coyote not interacting

Communication Skills

15.5% no response
0.9% more than three explanations are logical and complete
23.6% three explanations are logical and complete
22.6% two explanations are logical and complete
13.8% one explanation is logical and complete
23.5% no explanations are logical and complete

Activity 2—Sugar Solution

Part 1

Strategy

25.6% no response
28.8% straw
8.3% vial
35.2% dowel
0.9% pencil
0.7% other

27.8% no response
34.0% plasticine
6.6% lead shot
29.1% screw
2.4% other

Implementation

26.4% no response
20.8% hydrometer with calibration and scale
12.6% hydrometer with scale only
21.6% hydrometer with calibration only
15.6% hydrometer with no markings
2.4% any other response

Solution

26.6% no response
13.3% floats (no scale or calibration)
42.7% floats within scale and/or calibration
7.2% floats outside of scale and/or calibration
10.0% any other response

Communication Skills

43.4% no response
44.3% markings easy to read
12.0% markings not easy to read

Part 2

Strategy and Implementation

30.7% no response
42.6% measured density of sugar solution using hydrometer
18.6% did not measure density of sugar solution using hydrometer
7.9% any other response

Solution

31.4% no response
30.7% used midway point between 1.0 g/mL and 1.2 g/mL
14.3% used scale to read density
23.4% any other response
31.5% no response
45.1% measurement is correct (± 0.1g/mL)
18.2% measurement is incorrect
4.9% any other response

Communication Skills

31.9% no response
36.2% explanation supported by data
24.5% explanation not supported by data
7.2% any other response

32.7% no response
53.3% used correct units
13.6% did not use correct units

Activity 3—Sleeping Bag

Strategy

4.7% no response
30.2% measured heat loss only
8.2% measured heat gain only
55.0% measured heat loss and heat gain
1.7% any other response

Implementation

5.0% no response
89.4% only one manipulated variable for each test
2.6% more than one manipulated variable for each test
2.9% any other response

Solution

5.9% no response
55.0% best insulator supported by data
19.6% best insulator not supported by data
19.3% any other response

5.6% no response
65.5% controls evident in each test
24.9% controls not evident in each test
3.4% any other response

Communication Skills

4.6%	no response	0.1%	diagram
28.8%	chart	7.0%	list
38.3%	table	11.7%	written response
9.3%	graph	0.1%	any other response

Activity 4—Robot Arm

Strategy

9.0% no response
41.8% tested different number of wraps
48.9% did not test different number of wraps

9.0% no response
1.7% tested number of layers
89.1% did not test number of layers

9.0% no response
11.3% tested other variables (e.g., washers, position of wire)
79.5% did not test other variables

Implementation

9.2% no response
48.6% measured number of nails
42.1% did not measure number of nails
9.5% no response
50.0% measured relative strength
40.4% did not measure relative strength

38.0% no response
20.9% did one trial
40.8% did more than one trial

10.2% no response
54.7% connected wires
34.7% did not connect wires

Solution

39.1% no response
8.9% arm able to meet one performance level
6.7% arm able to meet two performance levels
28.8% arm able to meet three performance levels
15.6% any other response

31.5% no response
43.7% able to describe relationship
24.6% difficulty describing relationship

29.8% no response
44.4% constructed a working robot arm
25.6% did not construct a working robot arm

40.1% no response
30.4% able to describe how the robot arm operates
28.7% difficulty describing how the robot arm operates

Communication Skills

26.4%	no response	9.2%	diagram
10.9%	chart	1.1%	list
2.1%	table	39.4%	written response
10.5%	graph		
0.1%	any other response		

Activity 5—Bulk Food Store

Strategy

9.6% no response
34.4% recorded at least one observation for each of the tests and substances
33.4% recorded less than one observation for the tests and substances
8.5% recorded more than one observation for each of the tests and substances
13.9% any other response

Implementation

10.9%	no response
57.4%	systematically tested unknown and matched results using key
31.4%	did not systematically test unknown or match results using key

12.3%	did not test unknown
11.5%	used one test on unknown and matched with key
5.0%	used two tests on unknown and matched with key
43.0%	used three tests on unknown and matched with key
28.1%	any other response

Solution

11.7%	no response
55.2%	correctly identified unknown
32.8%	did not correctly identify unknown

Communication Skills

6.9%	no response	8.0%	diagram
8.3%	chart	15.8%	list
20.1%	table	40.8%	written
—	graph		response
—	any other response		

Activity 6—Hazardous Waste

Understanding the problem

5.4%	no response
59.2%	identified one side of the issue
29.4%	identified two sides of the issue
5.6%	identified more than two sides of the issue

1.0%	no response
26.5%	identified inconsistencies in data
72.2%	did not identify inconsistencies in data

Strategy

1.1%	no response
52.4%	suggested more information is needed
46.1%	did not suggest more information is needed

Implementation

1.0%	no response
42.4%	suggested the need for scientific information
56.3%	did not suggest the need for scientific information

1.0%	no response
5.7%	suggested the need for information on technologies
93.0%	did not suggest the need for information on technologies

1.0%	no response
18.3%	suggested the need for information on varying perspectives
80.4%	did not suggest the need for information on varying perspectives

1.0%	no response
11.7%	suggested the need for information on potential alternatives
87.0%	did not suggest the need for information on potential alternatives

Solution

4.6%	no response
17.0%	suggested one alternative with no rationale
48.6%	suggested one alternative with rationale
3.4%	suggested two alternatives with no rationale
15.5%	suggested two alternatives with rationale
1.9%	suggested more than two alternatives with no rationale
5.2%	suggested more than two alternatives with rationale
2.1%	no alternative–more information needed
1.6%	any other response

Communication Skills

3.3%	no response	0.4%	diagram
0.9%	chart	0.1%	list
0.9%	table	94.1%	written
—	graph		response
0.1%	any other response		

Credit

Adapted from the 1991 British Columbia Science Assessment, *Student Points of View*, Ministry of Education.