Science III Assessment (2004)
Handbook for Schools

School Achievement Indicators Program
Council of Ministers of Education, Canada

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1. School Achievement Indicators Program

1.1 What Is It?

Canadians have long been interested in how well their education systems are meeting the needs of students and society. To answer this question, the provinces and territories, through the Council of Ministers of Education, Canada (CMEC), developed the School Achievement Indicators Program (SAIP). This is the first Canadian project of its kind.

One purpose of the program is to gather current information about how well students are performing in mathematics, in reading, in writing, and in science. This information will help decision makers in education as they set priorities, develop policy, and plan for the future. The results will also provide the Canadian public with information about pan-Canadian achievement levels.

1.2 Science III Assessment (2004)

In April 2004, a random sample of 13- and 16-year-old students in schools across Canada will participate in a science assessment as part of SAIP. In jurisdictions where there are small student populations, all students in these two age groups will be tested.

The assessment will be administered between April 1 and April 30, 2004, unless specified by your jurisdictional coordinator.

CMEC will report the assessment results. The percentage of students attaining each of five performance levels described in this handbook will be reported at the provincial/territorial and pan-Canadian levels, and by language of instruction.

A general summary of results will be available to all interested parties. Each province or territory will also receive detailed technical information. Results for individual students, schools, or school jurisdictions will not be reported.

1.3 Overview of the Science Assessment

This science assessment is a written test. A list of students from your school who have been selected to participate in this assessment is enclosed with this handbook.

As well as a *Student Questionnaire* that will be completed by students participating in the assessment, there is also a *Teacher Questionnaire* to be completed by all of the science teachers currently teaching the selected students and a *School Questionnaire* to be filled out by the principal. All of these questionnaires are to be returned with the assessment materials.

School coordinators should become familiar with this *Handbook for Schools* prior to the administration of the assessment.

1.4 General Description

Although most students should be able to complete the assessment activity and questionnaire within two and a half hours, those requiring more time should be given an additional 30 minutes to complete their work.

Students will not be allowed to use computers during this assessment. However, students are permitted to use any other resources that they are accustomed to using in the science classroom.

Students are required to attend the assessment session according to the accompanying list(s) of students.

The assessment is intended to measure knowledge of science concepts and procedures, as well as competence in problem solving. It consists of a 12-question preliminary section (*Section A*) and one of *Section B* or *Section C* (66 questions), as well as a *Student Questionnaire.*

Each student will answer *Section A* and **one** of *Section B* **or** *Section C.* The student's score on *Section A* will be used to determine whether he or she will complete *Section B* or *Section C*.

2. Role of the School Coordinator

It is essential that the SAIP Science III Assessment be administered in a consistent manner across Canada. Jurisdictional coordinators assume overall responsibility for administration of the SAIP Science III Assessment within each jurisdiction. Each school selected to participate in this assessment is required to designate a school coordinator who will be responsible for administering the assessment in his or her school, according to the procedures outlined in this handbook.

2.1 Prior to Administration of the Assessment

2.1.1 Review student lists

Included with this handbook is a *List of Selected Students* for each age group participating in the assessment in your school [see example on page 13 (Appendix C)].

- **Check the *List of Selected Students*.**
- Only those students identified on the student list(s) are permitted to participate. Schools **must not** substitute other students.
- The student names listed should be a selection of those names submitted previously by your school to your jurisdictional coordinator. If a student no longer attends the school or for some other reason cannot participate, he/she will be assigned a particular participation status code [see list of participation status codes, page 12 (Appendix B)].

2.1.2 Identify students with special needs

- Students requiring Braille or large-print versions of the assessment booklets should have been previously identified when your school submitted its list of eligible students.
- If a discrepancy exists, notify your jurisdictional coordinator as soon as possible to ensure that these versions are included in your school package.
- You and other school staff must review the *List of Selected Students* **during March** to identify students with additional special needs as well as those to be exempted from participation.
- We appreciate your help in ensuring that as many students as possible participate in the assessment.

Confidentiality

Once all assessment materials have been accounted for, the jurisdictional coordinator will destroy all information that may identify individual students.

For this reason, you do not need to correct any spelling errors on the student lists, as long as you can identify the student selected.

Inclusiveness

The School Achievement Indicators Program is intended to be as inclusive as possible in order to provide a complete picture of the range of performance among 13- and 16-year-old students.

ALL students of the specified ages were included in the initial student lists from which the sample of students was selected.

Please make provisions to enable students with special needs to participate in the assessment, to the extent possible.

2.1.3 Plan support for students with special needs

- As a general guideline, you should use procedures set by your school for administering tests to students with special needs.
- Students with special needs may be given additional time to complete this assessment. As well, administration of the assessment can be spread over several sessions.
- English-as-a-Second-Language (ESL) students may require varying types of assistance. Some ESL students may require an interpreter to assist in reading the materials provided and to clarify vocabulary.
- Assistance to students should be restricted to helping with reading the materials and explaining the procedures. Do not interpret the materials provided or guide the student's responses.
- **You will be required to describe any modifications made to the administration procedures when completing the *School Coordinator's Report* included with the assessment materials.**
- **For those unable to participate, record the appropriate code in the participation status column of the *List of Selected Students* and on the front cover of the *Response Booklet* assigned to the student [see page 12 (Appendix B) for a list of participation status codes].**

Balancing inclusiveness and student well-being

We want all students to have the opportunity to be represented in this assessment. However, we do not want students with special needs to be overly pressured to participate in the assessment if they would be adversely affected or if appropriate accommodations cannot be made for them.

2.1.4 Identify students with very limited science ability for exemption

- Meet with the school principal and other school staff to review the description of level 1 performance from Appendix D (page 14) and sample items from Appendix E (pages 24-39). Discuss student ability relative to this description.
- For those students on the list with very limited science ability, the school can designate them as below level 1 and exempt them from writing the assessment.
- **Record a "D" in the participation status column of the *List of Selected Students* and on the front cover of the *Response Booklet* assigned to the student [see page 12 (Appendix B)].**
- In the report of results, these students will be classified as being below level 1 in science achievement.

2.1.5 Inform participating students, their families, and school staff

We encourage you to announce the school's participation in this pan-Canadian project and discuss its importance with all teachers and students.

- At least two weeks before the assessment date, inform participating students about the assessment.
- Distribute copies of the *Information for Parents and Students* brochure.
- One week before the date set for the assessment session, inform students of its time and location. Students will need a pencil, an eraser, a ruler, a protractor, and a calculator.

Doing their best

Since student motivation can have a strong influence on performance levels, it is important that students be encouraged to do their best. This can ensure that results will be a true indication of how well all students can perform in science.

2.1.6 Arrange for a suitable time and location

The assessment must be administered between April 1 and April 30, 2004 (unless specified otherwise by your jurisdictional coordinator). Please find a quiet area with sufficient desk or table space where students will have time to complete the assessment without interruption (2½ hours). If possible, schedule the administration of the assessment for the morning in order to obtain the best student performance. If students from your school have been selected to participate in both 13- and 16-year-old samples, please attempt to schedule their assessments for the same time and date.

2.1.7 Check materials

Please confirm that the following materials were included in your package:

- *School Packing List*
- *List of Selected Students* — one per age group sampled
- *Teacher Questionnaire* — one for each science teacher of the participating students
- *School Questionnaire* — one per school
- *Assessment Booklet* — one for each participating student
- *Response Booklet* — one for each participating student
- *Scoring Overlay* for *Section A*
- *School Coordinator's Report*

Student ID Numbers

A specific student identification number has been assigned to each student selected.

Ensure that all numbered student booklets included in the package correspond to the student ID numbers assigned to your students as recorded on the *List of Selected Students.*

If a discrepancy exists, contact the jurisdictional coordinator as soon as possible.

Photocopying and Security

You may photocopy booklets only if there is a shortage and you cannot obtain copies from the jurisdictional coordinator in time for the assessment.

Please keep *Assessment Booklets* secure prior to the administration. **All** copies of the *Response Booklets* and of the *Assessment Booklets*, including any photocopies, must be returned at the completion of the assessment.

2.1.8 Distribute questionnaires to the principal and teachers

- Ask the school principal to complete the *School Questionnaire*.
- Ask selected students to identify their current science teacher(s).
- Each questionnaire has an ID number on its cover. Assign a teacher questionnaire ID number to each of the identified teachers and keep a record.
- Distribute the *Teacher Questionnaire* to all teachers currently teaching science to any of the students selected to participate in this assessment. Inform them that you will collect the completed questionnaires following the assessment session.
- **Do not forward any teachers' names to us. Destroy any lists containing teachers' names after the assessment**.

Confidentiality

Linking teacher responses to student achievement provides important information to policy makers. The use of teacher names is only for the purpose of linking a *Student Questionnaire* ID to a *Teacher Questionnaire* ID. All references to teachers' names are to be destroyed by the school to ensure confidentiality.

2.2 Administration of the Assessment

2.2.1 Check materials needed

- Script (page 11, Appendix A)
- *List of Selected Students* — one per age group sampled
- For each participating student, individual copies of
  - *Response Booklet* with student ID number on the cover
  - *Assessment Booklet*
- *Scoring Overlay* for *Section A*
- List of *Teacher Questionnaire* booklet numbers
- Spare pencils, erasers, rulers, protractors, and calculators (to be supplied by the school)

2.2.2 Carry out introductory procedures

- Prior to arrival of the students, write the names of all science teachers and their corresponding questionnaire ID numbers as assigned by you on the board or on a chart.
- Begin reading the *Script for the Administration of the Assessment* on page 11 (Appendix A) to the students.
- Distribute the *Response Booklets*. **Make sure that each student receives the booklet with his/her student ID number.**
- Ask students to code the front cover of their response booklet with
  - their participation status (students present are participation status code **B**)
  - their age
  - their sex
  - the teacher questionnaire ID number(s) of **all** teachers currently teaching them science (listed on the board or chart). **Students not currently studying science should leave this blank.**
- Inform students that they will have 2½ hours to complete the assigned written exercise.
- Ask students to begin *Section A* of the assessment.
- For students exempted or absent from the assessment, code their age, sex, participation status, and teacher questionnaire ID on the front cover of all *Assessment Booklets* assigned to them. This will enable the verification of the *List of Selected Students* against the *Assessment Booklets* [see list of participation status codes, page 12 (Appendix B)].
- Ensure that students have completely filled out the cover page of the *Response Booklet*.

2.2.3 Administer the Assessment

Answers to the 12 questions in *Section A* must be scored before the students go on to either *Section B* or *Section C*. The scoring can be done quickly with the overlay answer key provided. Score the short answer questions 6 and 8 using the criteria for correct responses given on the *Scoring Overlay* for *Section A*.

Record the student score for questions 6 and 8 by filling in **one** circle beside each question number on page 1 of the *Response Booklet* as indicated below:

- C — student recorded an acceptable answer
- E — student recorded an unacceptable answer
- N — student left the answer space blank

Place the square boxes of the overlay directly over the corresponding square boxes on page 1 of the *Response Booklet*. Count the number of blackened circles that appear in the 10 circles inscribed on the overlay for the multiple-choice questions, plus the number of acceptable responses for questions 6 and 8.

If a student fills in more than one circle for a particular question, that question must not be counted as correct. If a student fills in two circles and puts an "x" through one, consider the one without the "x" as the intended response.

Determine whether each student will proceed to *Section B* or *Section C* of the *Assessment Booklet* as indicated below:

***Section A* Score**	***Assessment Booklet***
0 – 7	*Section B*, page 6
8 – 12	*Section C*, page 24

Circle either 1 or 2 at the bottom of page 1 of the *Response Booklet* to indicate where the student should continue the assessment.

Students should answer the *Student Questionnaire* after they have completed their assigned section (either *B* or *C*) in the *Response Booklet.*

- Check to ensure that all students have coded the front cover of the *Response Booklet* as instructed.
- At the end of this session, collect and secure all assessment materials.
- Complete the *List of Selected Students* by recording the following for each student (including those students exempted or absent from the assessment):
  - their sex
  - their participation status code [see list of participation status codes, page 12 (Appendix B)].
  - the questionnaire ID number assigned to each of their current science teachers. **If they are not currently studying science, leave this blank.**

2.3 Following Administration of the Assessment

- If students have completed the assessment using Braille or large-print forms, transfer students' work from these versions to the assigned *Response Booklets.*
- Collect completed *School Questionnaire* and *Teacher Questionnaires* distributed prior to the assessment.
- Secure all assessment booklets and questionnaires until shipping.

2.3.1 Hold a make-up session (if necessary)

- Calculate the percentage of students who participated in the regular assessment session.
- Count the number of code **B**s, **A**s, and **D**s that you recorded on the *List of Selected Students* for the assessment session (ignore all other codes for this calculation).
- Calculate the participation rate using the formula $\frac{(B+D)}{(A+B+D)} \times 100$.

If the participation rate for the assessment is less than 85%, a make-up session must be conducted before May 10, 2004.

If make-up sessions are necessary (as indicated by the calculations above), schedule an assessment session to include as many of the absent students as possible. If a student completes the assessment during the make-up session, change the participation status code for that student from "**A**" to "**C**" on the *List of Selected Students*.

Ensure that "**C**" is coded on the front cover of the assigned student *Response Booklets*.

2.3.2 Complete *School Coordinator's Report*

- Complete the *School Coordinator's Report* included with the assessment materials.

2.3.3 Return materials

- Complete the *School Packing List* to indicate the numbers of each of the items being returned to the jurisdictional coordinator.
- Package the following:
  - *School Packing List*
  - *School Coordinator's Report*
  - Completed *List of Selected Students*
  - Completed *School Questionnaire*
  - All *Teacher Questionnaires* in ascending numerical order
  - All completed *Response Booklets* in ascending numerical order
  - All unused *Response Booklets* and any photocopies
  - All *Assessment Booklets*
  - *Scoring Overlay* for *Section A*

- Return the package to the jurisdictional coordinator as soon as possible after the administration of the assessment and no later than **May 17, 2004**. Please use the return address label and waybill provided by the jurisdictional coordinator.
- If you have any questions, please consult the Frequently Asked Questions in Appendix F (pages 40-42), or contact your jurisdictional coordinator.

Appendix A

Script for the Administration of the Assessment

Good morning/afternoon. You have been chosen to take part in an important national project to discover what Canadian students know about science. With this information, people in education can plan better courses and produce better teaching materials. Students who are thirteen and sixteen from all the provinces and territories of Canada are doing the same test that you will be doing today.

It is important that you give your best effort, so that the best possible information is gathered from this project. The results from each of your tests will be added together with the results of all the other students who are writing these tests to produce a picture of the achievement of (*province/territory*) students and of Canadian students.

The assessment consists of both multiple-choice and short-answer questions. You may find some parts of the test very easy, and other parts difficult. There may be some questions on things you haven't studied yet. Please do your best to answer as many questions as you can, and see if you can use what you know to figure out the answers to the questions you find difficult.

Since this is a test, I can only answer questions about the directions or the questionnaire, but not about science.

First, you will complete 12 questions in *Section A* of your *Assessment Booklet*. I must mark these questions before you go on to the second section of the science test. Please sit quietly as it will take only a short period of time to complete the scoring. Once I have marked the first 12 questions, I will tell you where to start working (*Section B* or *Section C*) in the *Assessment Booklet*. When you have finished the test, **you may then begin answering the questionnaire**.

Are there any questions?

Please start working in your *Assessment Booklet* at page 1. Be sure to mark all of your answers in the space provided in the *Response Booklet*.

You will have 2½ hours to complete the assessment and to answer the questionnaire.

Appendix B

Participation Status Codes

A - Absent (and not previously categorized as codes **D** to **L**)

B - Participated during scheduled session

C - Participated during make-up session

D - Exempted: school designates student's science ability at below level 1

E - Excluded because interpreter not available (for a student who does not understand English or French well enough to attempt the assessment)

F - Excluded for emotional reasons

G - Excluded for physical reasons

H - Excluded because appropriate modifications could not be made (to accommodate the student's special needs — see page 4)

I – Excluded because of wrong birth date (student's birth date is not between September 1, 1986, and August 31, 1987, **OR** between September 1, 1989, and August 31, 1990)

J - No longer enrolled in this school

K - Student refusal: did not participate (school staff is unable to persuade the student to participate)

L - Parent refusal: did not participate (parent of the student demands that the student not participate)

Tracking the participation status of **all** selected students allows fair sampling from each province and territory. After participation rates have been calculated, **any lists containing student names are destroyed.**

In some circumstances, the assessment may trigger emotional or physical reactions that a principal may consider harmful for particular students. Participation Status Codes F and G can be used to exclude such students.

Appendix C

List of Selected Students

(SAMPLE)

School Number: XS123456 **SAIP School Number:** 11001011
School Name: I.M. Learning High School **Age:** 16

Student Name	**Sex F/M**	**Student ID Number**	***Participation Status**	***Teacher Questionnaire* ID Number(s)**
Adams, R.	M	11313000	B	11211000
Anderson, D.	M	11313001	B	
Bourassa, D.	M	11313002	B	11211001
Brown, J.	F	11313003	B	11211002
Chiasson, F.	M	11313004	A	11211003
Genge, D.	F	11313005	B	11211002,11211003
Gillap, D.	F	11313006	B	11211003
Hall, J.	M	11313007	B	11211002,11211003
Kanerva, E.	F	11313008	D	11211003
Kassen, W.	F	11313009	D	
Lizaire, F.	M	11313010	B	11211004
Ouellet, H.	F	11313011	B	11211002
Pietschmann, F.	F	11313012	A	11211004
Sherwood, P.	M	11313013	B	11211002
Williams, T.	F	11313014	B	11211003

***Ensure that the participation status, sex, and teacher ID number(s) for each student are coded on the front cover of each booklet assigned to the student.**

A - Absent
B - Participated during scheduled session
C - Participated during make-up session
D - Exempted: school designates student's science ability at below level 1
E - Excluded because interpreter not available
F - Excluded for emotional reasons
G - Excluded for physical reasons
H - Excluded because appropriate modifications could not be made
I - Excluded because of wrong birth date
J - No longer enrolled in this school
K - Student refusal: did not participate
L - Parent refusal: did not participate

Calculate participation rate for each of the assessment sessions:

If $\frac{(B+D)}{(A+B+D)} \times 100 <$ **85% for session, a make-up session is required.**

All participation status codes are explained in Appendix B.

Appendix D

Framework and Criteria for the Assessment

Science Assessment Conceptual Framework

Questions included in the assessment address student understanding in the following areas:

Knowledge and concepts of science

- Matter has structure, and there are interactions among its components.
- Life forms interact within environments in ways that reflect their uniqueness, diversity, genetic continuity, and changing nature.
- Basic gravitational and electromagnetic forces result in the conservation of mass, energy, momentum, and charge.
- Earth and the physical universe exhibit form, structure, and processes of change.

Nature of science

Relationship of science to technology and societal issues

Questions on the assessment deal with conceptual knowledge and understanding, procedural knowledge and skills, and the ability to use science to solve problems.

Questions that assess conceptual knowledge and understanding ask students to

- outline, explain, or define concepts
- identify suitable examples of concepts
- suggest new ways of representing concepts

Questions that assess procedural knowledge and skills ask students to

- recognize when a particular procedure should be used
- suggest procedures to solve particular problems
- modify familiar procedures to solve new problems

Questions that assess the ability to use science to solve problems ask students to

- formulate problems
- apply a variety of strategies to solve problems
- produce solutions to problems
- assess given solutions to problems

Science Assessment Criteria

In consultation with all jurisdictions, the development team developed the following criteria. Questions were chosen that would give a broad representation of student understanding in all areas and at all levels.

Knowledge and concepts of science

A. Matter has structure, and there are interactions among its components. (Physical Sciences – Chemistry)

At level 1, the student can

1. describe physical properties of various objects and substances (solids, liquids, and gases)
2. predict the changes in the physical properties of substances that will result from given conditions
3. classify objects with respect to the substances they are made of

At level 2, the student can

1. describe qualitative changes in the properties of a substance when it is heated or cooled
2. investigate and describe physical properties of common substances
3. determine the total mass of a substance knowing the mass of its parts, or vice versa
4. classify substances using their physical properties
5. distinguish between the concepts of substance and object

At level 3, the student can

1. compare the composition of two samples using the results of chemical tests
2. classify materials according to their chemical and physical properties
3. identify and describe some changes to materials that are reversible and some that are not
4. explain changes of state using the particle model of matter
5. compare the total mass of materials before and after a physical or chemical change
6. distinguish between solvents and solutes
7. relate the role of oxygen to the process of rusting or burning
8. describe the relationship between the mass, volume, and density of solids, liquids, and gases
9. classify substances as acids, bases, or salts, based on their characteristics, name, or formula
10. describe the structure of matter in terms of particles

At level 4, the student can

1. qualitatively describe a chemical reaction or phase change
2. relate the charge on an ion to a gain or loss of electrons
3. describe the relative acidity of solutions in terms of whole numbers on the pH scale
4. describe chemical changes in terms of atomic theory
5. use a periodic table to predict the number of an atom's outermost electrons
6. compare neutrons and protons in terms of their mass and charge
7. distinguish isotopes of a given element in terms of its number of neutrons
8. explain trends on the periodic table of elements

At level 5, the student can

1. write and balance chemical equations to predict the reactions of selected elements or compounds
2. determine the electron configuration of any element
3. illustrate and explain the formation of ionic, covalent, and metallic bonds
4. relate the properties of a substance to its structural model
5. explain how different factors affect a chemical system, using the concept of equilibrium
6. choose appropriate chemical indicators to determine the relative acidity of solutions

B. Life forms interact within environments in ways that reflect their uniqueness, diversity, genetic continuity, and changing nature. (Life Sciences – Biology)

At level 1, the student can

1. distinguish between animals and plants by their external features and behaviour patterns
2. identify predator/prey relationships between organisms living in the same environment
3. identify variations within and between animal or plant populations
4. describe features of environments that support the health and growth of life forms
5. describe biotic and abiotic factors in an ecosystem
6. use the Canada Food Guide to classify food according to the four major food groups
7. describe actions and decisions that support a healthy lifestyle

At level 2, the student can

1. classify life forms according to major structural characteristics
2. distinguish between innate and learned behaviours
3. state that for offspring to resemble their parents, there must be a reliable way to transfer information from one generation to the next
4. describe nutritional and other requirements for maintaining a healthy body
5. identify the roles of producers, consumers, and decomposers in an ecosystem
6. describe both the diversity and the interactions of producers, consumers, and decomposers in an ecosystem
7. describe the life cycles of a representative of mammals, birds, reptiles, fish, amphibians, insects, and flowering plants
8. compare the external features and behavioural patterns of animals that help them thrive in different environments
9. compare the structural features of plants that enable them to thrive in different kinds of places

At level 3, the student can

1. describe microscopic life forms from original observations
2. identify characteristics of living things
3. explain why certain life forms are not readily classified as plants or animals
4. illustrate and explain that the cell is a living system that exhibits all the characteristics of life
5. illustrate and explain the differences between unicellular and multicellular life forms
6. explain how a variety of animal and plant structures provide a basis for adaptation to specific environments
7. illustrate the dependency of life forms, including the human species, on interconnected global food webs
8. describe the processes of growth and repair at the cellular and tissue levels
9. explain how the unique properties of water allow cells to carry on essential life activities
10. identify and describe the function of important biochemical compounds, such as carbohydrates, proteins, lipids, and nucleic acids
11. evaluate the adequacy of a person's daily dietary intake using the Canada Food Guide
12. describe and distinguish between the concepts of habitat, biome, and niche
13. classify organisms according to their role in a food chain
14. describe the impact of external factors on an ecosystem

At level 4, the student can

1. distinguish between sexual and asexual reproduction in representative organisms
2. relate the increase of variations within a species to the likelihood that some members will survive under changed environmental conditions
3. relate a cell's structure to its function in an organism
4. relate structural organization, interdependence, and specialization to the functions of cells, tissues, and organs
5. compare the structures of DNA and RNA

6. describe the role of enzymes in cellular metabolism
7. assess biological consequences of eating disorders, overnutrition, and undernutrition
8. illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking carbon, nitrogen, and oxygen
9. explain how different plant and animal systems, including the vascular and nervous systems, help maintain homeostasis
10. describe natural mechanisms and interventions that prevent imbalances within the body

At level 5, the student can

1. compare sexual and asexual reproduction in terms of their advantages and disadvantages
2. describe kinship within and between species in terms of DNA sequences or structural similarities
3. describe factors that may lead to mutations in a cell's genetic information
4. identify proteins as resulting from cell activities
5. predict the effects of changes in temperature and acidity on the function of complex molecules in a cell
6. criticize or defend the use of supplements as sources of nutrients for humans
7. evaluate nutritional claims in advertising
8. analyze interactions within and between populations
9. explain qualitative and quantitative changes in the function of human body systems that lead to loss of homeostasis
10. explain that when gene mutations occur in sex cells, these mutations can be passed on to offspring

C. Basic gravitational and electromagnetic forces result in the conservation of mass, energy, momentum, and charge. (Physical Sciences – Physics)

At level 1, the student can

1. describe the movement of objects
2. identify examples where the sun warms the land, air, and water
3. identify examples of different forms of energy

At level 2, the student can

1. identify various types of forces used to move or maintain the position of an object
2. describe how forces affect the motion and shape of objects
3. describe the transfer and conversion of energy
4. describe different types of electromagnetic radiation, including infrared, ultraviolet, X-rays, microwaves, and radio waves
5. describe quantitatively the relationship among displacement, time, and velocity
6. illustrate propagation and reflection of light
7. describe the laws of reflection of visible light and their applications in everyday life
8. compare transmission of heat by conduction, convection, and radiation

At level 3, the student can

1. identify properties of static electrical charges
2. determine current intensity, voltage, and resistance in simple circuits
3. predict the position of an image in a plane mirror
4. apply the laws of reflection
5. describe how various surfaces absorb radiant heat
6. define the weight of an object as a gravitational force
7. predict changes in gravitational force on objects that move from the surface of the Earth to other locations in space

At level 4, the student can

1. describe the characteristics of longitudinal and transversal waves
2. describe the responses of different kinds of materials to electrical forces
3. describe the flow of charge in an electrical circuit
4. analyze graphically and mathematically the relationship among displacement, velocity, and time
5. determine the per cent efficiency of energy transformations
6. apply quantitively the law of conservation of momentum to one- and two-dimensional collisions and explosions
7. describe how sound and electromagnetic radiation, as forms of energy, are produced and transmitted
8. apply the laws of reflection and the laws of refraction to predict wave behaviour
9. sketch and analyze ray diagrams to determine characteristics of reflected images

At level 5, the student can

1. apply quantitatively the law of conservation of mass and energy, using Einstein's mass-energy equivalence
2. describe the properties of electromagnetic waves
3. explain diffraction and polarization and their applications
4. predict the direction, magnitude, and extent of various electrical fields
5. compare gravitational, electrical, and nuclear forces
6. analyze accelerated motion in two dimensions graphically and algebraically
7. apply the laws of conservation of momentum and energy to analysis of motion in two dimensions
8. calculate gravitational forces between bodies in space
9. calculate the altitude of geosynchronous satellites

D. Earth and the physical universe exhibit form, structure, and processes of change. (Earth and Space Sciences)

At level 1, the student can

1. describe the apparent motion of the Sun or Moon with respect to the Earth
2. describe changes that occur in seasonal cycles
3. distinguish sizes and shapes of rocks, from boulders to grains of sand and smaller

At level 2, the student can

1. describe constancy and change in the patterns of stars
2. describe the movement of Earth around the Sun, and the Moon around Earth
3. state that stars are like the Sun, some being smaller and some larger, but so far away that they look like points of light
4. identify evidence for the presence of air and its movements
5. describe how the tilt of Earth's axis relative to the plane of Earth's orbit results in seasonal changes
6. identify the components of soil
7. describe how the rotation of Earth on its axis every 24 hours produces the night-and-day cycle

At level 3, the student can

1. describe the relative motions (orbits) of bodies in the solar system, including planets, moons, comets, meteors, planetary rings, and artificial satellites
2. compare stars according to their size, temperature, age, and composition
3. identify factors influencing the composition, texture, and fertility of the soil and its resistance to erosion
4. explain how the ability to recover and extract substances from minerals depends on their accessibility, concentration, and mineral form
5. describe processes by which rock is formed
6. explain how the interpretation of sedimentary rock provides evidence of the history of climates, land forms, and life forms
7. describe the processes of soil formation
8. compare planetary sizes, composition, and surface features
9. compare the distances from Earth to the Moon, Sun, and other stars
10. cite evidence on which our knowledge of the planets and their moons is based
11. compare abrupt changes in Earth's surface and climate (caused by earthquakes, volcanic eruptions, and meteorite impacts) to slower changes (caused by glacial action and uplift of mountains)
12. relate the cycling of water to its role in determining climatic patterns
13. interpret evidence that Earth's surface is shaped by waves, wind, water, and ice

At level 4, the student can

1. describe the transfer of heat energy between the hydrosphere and the atmosphere
2. describe natural cycles of materials through global biochemical and geochemical systems
3. relates earthquakes, volcanic activity, and emergence of mountains to plate tectonic theory
4. explain the effects of gravitational forces on the rotation and revolution of Earth
5. classify rocks according to the processes by which they are formed

At level 5, the student can

1. analyze data and techniques used for establishing geological time scales
2. provide evidence for the theory of plate tectonics
3. analyze evidence for plate tectonics theory

Nature of science

Science involves an understanding of the nature of scientific knowledge and processes by which that knowledge develops. (Science, Technology, Society, and the Environment)

At level 1, the student can

1. state that observation and experimentation are ways to learn about things
2. describe teamwork as a component often found in science activities
3. apply the rules that need to be taken for the well-being of living things that are studied
4. predict reproducibility of results
5. explain how instruments such as thermometers, magnifiers, rulers, or balances enhance observation
6. make accurate observations to provide a basis to test and compare ideas
7. follow safety procedures when doing science activities

At level 2, the student can

1. outline many different scientific processes, including observing, collecting specimens, organizing data, and doing experiments
2. use the results of scientific investigations to determine the cause of large differences in results
3. provide different explanations (inferences) for the same set of observations
4. make careful and accurate observations and communicate them clearly

5. establish the link between the need to keep significant conditions of an investigation the same (controlled) and achieving meaningful results
6. provide an example that scientific knowledge is based on an accumulated body of evidence rather than on the claims of a single person

At level 3, the student can

1. identify the type of locations in which specific scientific work is carried out
2. give examples of scientific knowledge that was modified as new information was discovered
3. recognize the importance of acquiring the consent of human subjects when they are part of an investigation
4. outline the general steps that scientists follow involving the collection of relevant evidence, the use of logical reasoning, and the application of imagination in devising hypotheses and explanations to make sense of the collected evidence
5. distinguish between observations and inferences
6. give examples of scientific knowledge that is very old and yet is still applicable today
7. give examples of new ideas in science that result from unexpected findings
8. describe how science provides a way of learning about the world and testing ideas to help inform our decisions and actions
9. identify the variables in an experiment
10. describe different means that scientists can use to arrive at similar results
11. judge objectivity in scientific work in terms of appropriate safeguards in the way investigations are conducted and the way data are examined
12. give examples of similar scientific investigations that give different results and determine whether the differences are trivial or significant

At level 4, the student can

1. give examples of new areas of scientific study that involve a combination of earlier areas of study and new methods of study
2. list basic rules that scientists use to interpret the universe as a single system
3. outline how scientists control conditions in order to obtain data
4. give examples of major shifts that have occurred in scientific views
5. explain the role of hypotheses in science
6. explain that ongoing experimentation and evaluation of results lead to an increasingly better understanding of how things work in the world but do not lead to absolute truth
7. state that change and continuity are persistent features of science
8. show that investigations are conducted for different reasons, including to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories
9. outline science investigations that take into account basic beliefs about the value of evidence, logic, and good arguments
10. identify sources of bias in design and in data analysis when carrying out an investigation
11. criticize or defend the processes of testing, revising, discarding theories, and making predictions for the advancement of scientific knowledge
12. analyze the objectivity of methods and findings reported by any one group of scientists

At level 5, the student can

1. explain how alternative theories provide different interpretations of the same data
2. give examples of new ideas in science that are limited by the context in which they are conceived or that have been rejected by the scientific establishment
3. explain that a scientific theory can be evaluated on the basis of how well it describes and explains an array of things that are known, and how well it predicts that which is not yet known

4. illustrate where scientific knowledge in a given field has given rise to alternative theoretical structures (e.g., conceptual elements, models, proposed relationships, theoretical explanations), each of which can be used to explain and predict
5. propose alternative means, which are practical and ethical, to observe as wide a range of natural occurrences as possible
6. explain how science is one of the ways of acquiring knowledge
7. identify criteria by which scientific ideas are evaluated

Relationship of science to technology and societal issues

Science involves an understanding of relationships among science, technology, and society.

At level 1, the student can

1. identify tools that make some tasks easier
2. list some tasks that could not be done without certain tools
3. identify tools and processes that people have invented which affect all aspects of life
4. describe materials that can or cannot be used over again
5. list fuels such as wood, oil, coal, natural gas, or electricity that can be used to cook food and warm houses
6. identify vaccinations and other scientific treatments as technologies that protect people from getting certain diseases
7. identify some of the conditions needed for healthy plants and animals
8. describe effects of pests and spoilage on food crops

At level 2, the student can

1. describe the science knowledge associated with a technology
2. name a technology that has influenced or currently influences the course of science
3. give examples of technological processes that slow down or stop the spoilage of food
4. give examples of machines that are powered by wind or moving water
5. give an example of a technology that has made it possible to repair or replace body parts
6. use technology to observe things that are too small or too far away to be seen without it
7. illustrate changes in properties that result from the processing or combining of naturally occurring materials such as wood, clay, cotton, and animal skins
8. identify the scientific knowledge behind a technology that has influenced decision making
9. relate the normal ranges for body temperature, heart rate, and blood composition to ways of telling when people and animals are well
10. propose ways to protect food supplies from pests
11. compare building materials with respect to their cost, availability, durability, or ease of handling

At level 3, the student can

1. describe a technology essential for obtaining data from outer space and other remote locations
2. identify examples where technology can be used to manufacture chemical substances that are normally produced by the body
3. name professions that use scientific knowledge and technology to solve practical problems
4. describe ways to conserve energy in order to slow down the depletion of energy resources and/or to save money
5. give examples of the characteristics of plants and animals that people control by selective breeding
6. choose materials for a job from their properties and from how they interact with other materials
7. give an example where improving sanitation to prevent disease has contributed to saving human life
8. describe a constraint, such as gravity or properties of the materials to be used, that must be considered in a design
9. give an example of the use of a technology that was not intended in its original design

10. describe a situation where a society has influenced what aspects of technology were developed and how these were used
11. show a relationship between the purposes, amounts, and kinds of energy resources used and the parts of the world that use them
12. describe how a technology can change values and social behaviour
13. compare energy sources in terms of their cost and pollution
14. criticize or defend the use of chemicals for controlling the damage to crops caused by rodents, weeds, and insects
15. compare the efficiency of modern technology at home, on farms, or in factories with technology used in the past

At level 4, the student can

1. list modern technologies that reduce manufacturing costs, produce more uniform products, and create new synthetic materials that can help reduce the depletion of some natural resources
2. identify and label materials with respect to their ease of recycling
3. outline a technological problem that has created a demand for new scientific knowledge
4. describe inoculations as the use of weakened germs (or parts of them) to stimulate the body's immune system to fight subsequent invasions by actual germs of that type
5. give examples of scientific research that have identified new materials and new uses of known materials
6. describe the effects that different ways of obtaining, transforming, and distributing energy have in terms of environmental consequences
7. describe a situation where science or technology has affected our view of what the world is like
8. explain why some plant and animal species are not suitable for human consumption
9. describe a situation where discarded products have contributed to the problem of waste disposal
10. explain political, economic, and technical problems associated with waste management in terms of quantity, safety, degradability, and cost
11. relate our knowledge of genetics to new fields of health care
12. criticize or defend genetic manipulation of farm plants and animals to produce new characteristics
13. give examples of trade-offs an individual must consider when addressing scientific issues of a personal or societal nature

At level 5, the student can

1. identify risk-benefit factors used to minimize the likelihood of unwanted side effects of a new technology
2. identify factors affecting the global environment, such as national policies and practices relating to energy use, waste disposal, ecological management, manufacturing, and population
3. describe a situation where world views have influenced science and technology
4. outline steps associated with manufacturing, and their sequence, such as designing a product, obtaining and preparing raw materials, processing the materials mechanically or chemically, assembling, testing, inspecting, and packaging
5. give an example of the impact that the human species has had on another species
6. identify the political, economic, technological, and social factors associated with the development of a scientific idea
7. list areas of science or technology that have resulted in competition for ideas, resources, power, and status
8. identify controversial social and ethical issues of a biotechnology that has contributed to health improvement
9. debate social trade-offs that pit personal benefit and the rights of the individual against social good and the rights of society
10. evaluate factors of cost, safety, appearance, and environmental impact involved in solving problems
11. describe what will happen if the solution fails when solving problems

Distribution of Questions within the SAIP Science III Assessment Framework

Learning Areas		Level 1	Level 2	Level 3	Level 4	Level 5	Total
Knowledge	Biology	4	4	4	4	4	20
	Chemistry	4	4	4	4	4	20
	Earth	3	4	4	4	4	19
	Physics	4	4	4	4	4	20
Nature of Science		5	5	5	5	5	25
Science, Technology, Society		5	5	5	5	5	25
Total		25	26	26	26	26	129

Appendix E

Sample Items

This appendix contains 30 sample items similar to those used for the assessment of science concepts. They represent one item per area for each of the five levels of achievement. The SAIP Science III Assessment (2004) of science concepts will not have the same proportion of items in each area as is represented here. Each sample item contains three distinct parts:

- The first part contains the question itself and is made up of the stem (which sets the context), the question (in bold), and either the choice of answers for the multiple-choice questions or appropriate space for the short-answer items.
- The second part is the solution. For the multiple-choice questions, the letter corresponding to the correct answer is given. One or more exemplars are given for short-answer items.
- The third part refers to the specific criterion being tested. The SAIP Science criteria are found in Appendix D of this document.

The coding used to identify the criteria should be interpreted as follows:

The letters refer to the specific area being tested.

- CC "Matter has structure, and there are interactions among its components."
- CB "Life forms interact within environments in ways that reflect their uniqueness, diversity, genetic continuity, and changing nature."
- CP "Basic gravitational and electromagnetic forces result in the conservation of mass, energy, momentum, and charge."
- CE "Earth and the physical universe exhibit form, structure, and processes of change."
- NS "Science involves an understanding of the nature of scientific knowledge and processes by which that knowledge develops."
- ST "Science involves an understanding of relationships among science, technology, and society."
- SS "Science inquiry skills are used to answer questions and solve problems about the world around us. These skills facilitate the application of scientific knowledge to a variety of scientific, technological, and societal issues."

The first number refers to the level from which the criterion was taken.

The last two numbers refer to the number of the criterion in the specific level.

Sample Question

The specialists who arrive at the site of a train accident smell a very strong odour of ammonia near one of the cars. Despite the odour, they do not find any liquids nearby.

What happened to the liquid ammonia that was in the car?

A. It disappeared.
B. It remained liquid.
C. It changed into a gas.
D. It changed into a solid.

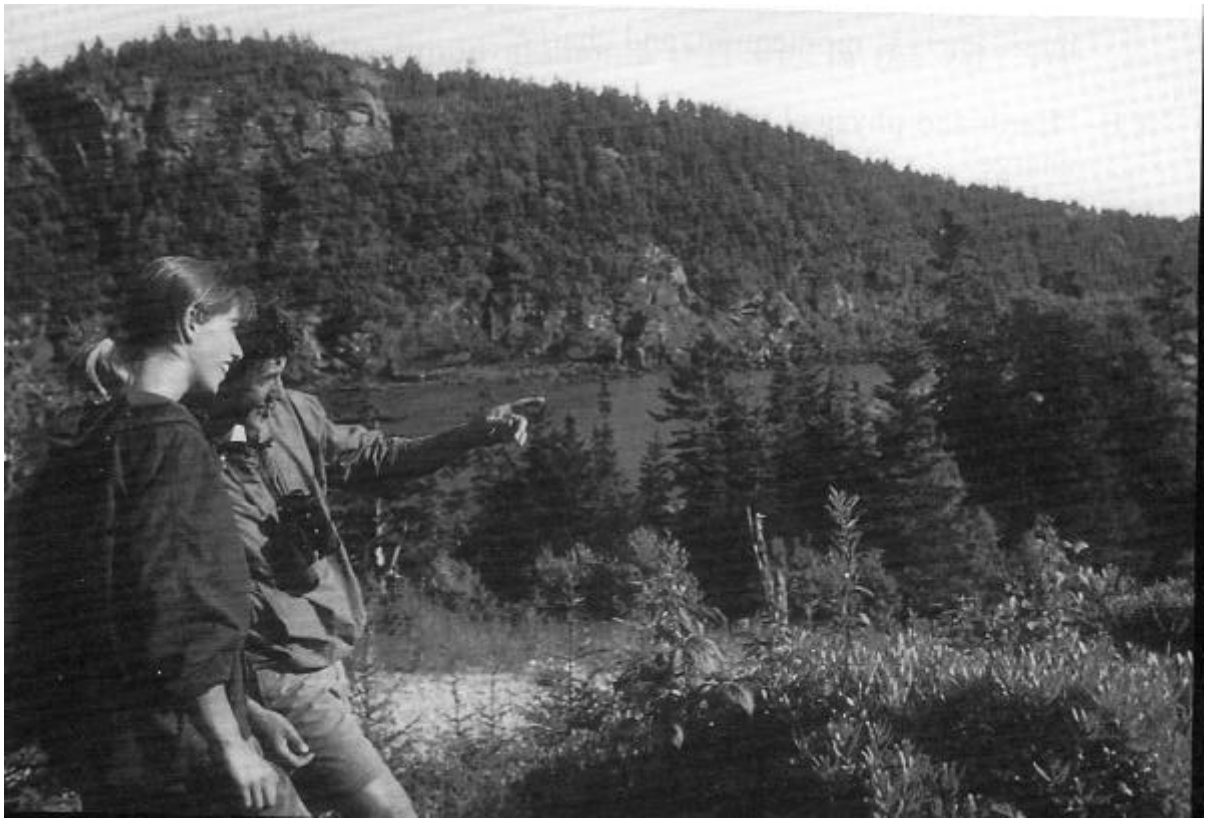
Solution: C

CC-2-01 Describe qualitative changes in the properties of a substance when it is heated or cooled.

The code CC-2-01 is interpreted as follows:
CC refers to the criteria section “matter has structure, and there are interactions among its components.”
2 refers to level 2 in this section.
01 refers to the first criterion of this level in this section.

Sylvie and Raymond

Sylvie and Raymond go hiking in the forest.



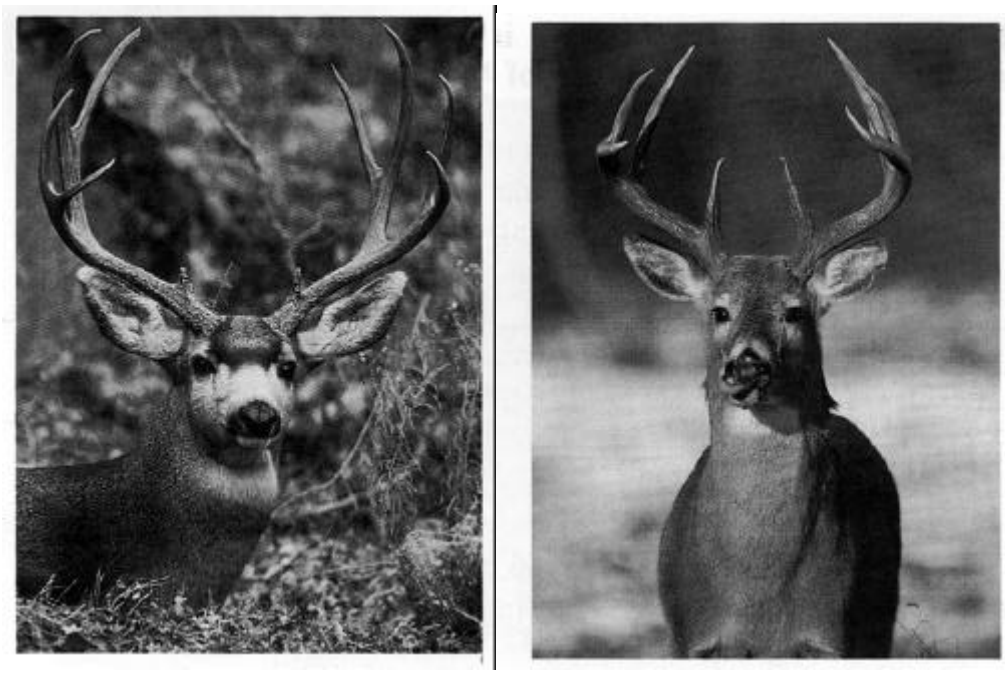
1. Early in the morning, the temperature is quite cool. Raymond warms his hands by rubbing them together.

How would you classify the heat generated this way?

A. It is a type of force.
B. It is a form of energy.
C. It is a form of matter.
D. It is a type of movement.

Solution: B
CP-1-03 Identify examples of different forms of energy.

2. During their hike, Sylvie takes pictures of two adult male deer.



What are two differences between the antlers?

1._____
2._____

Solution: *The number of points on each set of antlers, the width of each set of antlers, the height of each set of antlers, the shape of each set of antlers.*
CB-1-03 Identify variations within and between animal or plant populations.

3. Returning home at night, Sylvie and Raymond locate a constellation of stars.

What changes do they observe in the shape and position of the constellation over the course of the night?

A. The shape remains constant but its position appears to move.
B. Both the shape and position remain constant.
C. The shape appears to expand and its position appears to move.
D. The shape appears to expand but its position remains constant.

Solution: A
CE-2-01 Describe constancy and change in patterns of stars.

4. As they get closer to their city home, Sylvie and Raymond cannot see the constellation they had observed earlier because of the city lights and smog.

A chemical component that accounts for the brownish colour typical of smog is nitrogen dioxide, $NO_{2(g)}$. This compound is in equilibrium with $N_2O_{4(g)}$, as expressed by the following equation:

$2\ NO_{2(g)} \Leftrightarrow N_2O_{4(g)}$ + energy

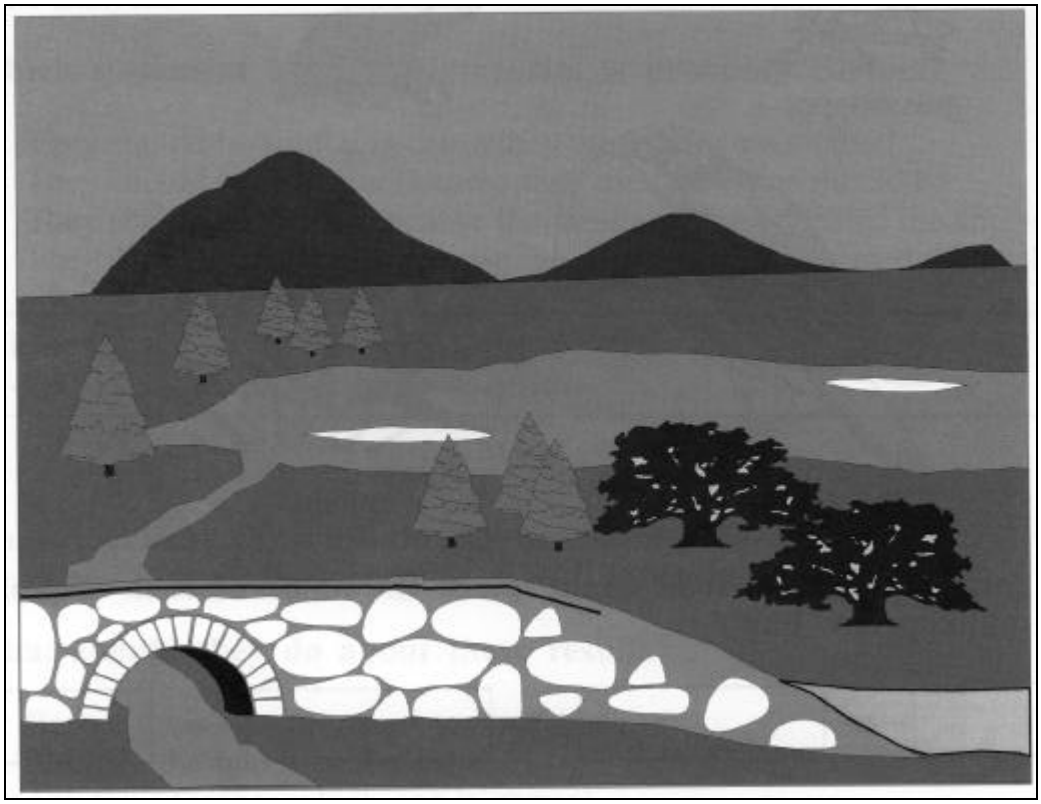
Which factor would cause $N_2O_{4(g)}$ to decompose and form $NO_{2(g)}$?

A. A constant atmospheric pressure
B. An increase in the air temperature
C. A decrease in the concentration of available $N_2O_{4(g)}$
D. An increase in the concentration of available $NO_{2(g)}$

Solution: B
CC-5-05 Explain how different factors affect a chemical system, using the concept of equilibrium.

McLaren's Pond

Martin and Patrick visit McLaren's Pond with their classmates during a field trip.



5. Patrick notices that boulders, clay, sand, and pebbles are present near the pond.

Which of these materials is composed of the smallest particles?

A. Boulders
B. Clay
C. Pebbles
D. Sand

Solution: B
CE-1-03 Distinguish sizes and shapes of rocks, from boulders to grains of sand and smaller.

6. Martin identifies the following plants and animals in and around McLaren's Pond.

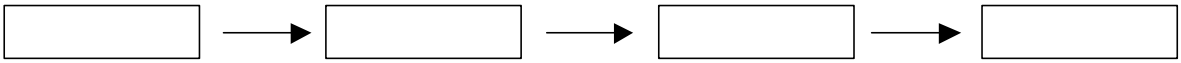

grasshopper


frog


falcon


plants

To form the correct food chain, place the name of each organism in the appropriate box.



Solution:

CB-2-06 Describe both the diversity and the interactions of producers, consumers, and decomposers in an ecosystem.

7. Patrick sees a soft drink can in the woods near the pond.

What is one physical property of a soft drink can?

Solution: *Its colour, its density, its hardness, etc.*
CC-1-01 Describe physical properties of various substances (solids, liquids, and gases).

8. In the winter, salt is used on the road near McLaren's Pond to prevent it from icing. Two other students, Roger and Julie, determine the salt content of a sample of pond water. They immediately repeat the analysis. Two other students also carry out the same analysis.

Which statement about their results is probably correct?

A. The results should be similar because the students used the same method.
B. The results should be different because students used the same method.
C. The results should be similar because the same students repeated the analysis.
D. The results should be different because the same students repeated the analysis.

Solution: A
NS-1-04 Predict reproducibility of results.

9. Martin and Patrick find that the temperature of a water sample is 10^{o}C, while Roger and Julie get a temperature of 16^{o}C for the same sample.

What should they do about these results?

A. Repeat their measurements several times.
B. Average the two sets of results.
C. Ask their teacher which one is correct.
D. Assume that they used a different method.

Solution: A
NS-2-02 Use the results of scientific investigations to determine the cause of large differences in results.

10. Martin's sunglasses are polarized.

What is the major advantage of using polarized lenses in sunglasses?

A. They filter red light.
B. They protect the eyes from ultraviolet rays.
C. They increase intensity of light rays.
D. They reduce glare coming from reflected light.

Solution: D
CP-5-03 Explain diffraction and polarization and their applications.

11. **Since light can be polarized, what type of waves are light waves?**

A. Longitudinal
B. Magnetic
C. Mechanical
D. Transversal

Solution: D
CP-4-01 Describe the characteristics of longitudinal and transversal waves.

12. During lunch break, Martin notices that some of his lunch has spoiled.

What are two ways to slow down the spoiling of food?

First way:

Second way:

Solution: *Refrigeration or freezing, heating, drying, etc.*
ST-2-03 Give examples of technological processes that slow down or stop the spoilage of food.

13. The teacher explains to the students that nutrients are important for staying healthy.

Which statement about nutrients best explains the teacher's comments?

A. Nutrients are needed for the repair and growth of the human body.
B. Nutrients are responsible for high cholesterol levels in the body.
C. Nutrients make food taste better.
D. Not all nutrients are needed by the body.

Solution: A
CB-3-10 Identify and describe the function of important biochemical compounds, such as carbohydrates, proteins, lipids, and nucleic acids.

14. After lunch break, the students continue experimenting. Three rock samples from the bottom of the pond are analyzed. Bits of the samples are placed in identical containers and mixed with 5 ml of an acid. The first and third samples bubble during their reaction with the acid. The second sample breaks down but does not bubble.

What can you conclude about the composition of the three rock samples? Justify your answer.

Solution: *The second sample is different from the first and third. The first and third have similar reactions to the acid and need to be tested further to determine if they are samples of the same rock.*
CC-3-01 Compare the composition of two samples using the results of chemical tests.

15. Martin and Patrick study the aquatic organisms found in McLaren's Pond. Some of the organisms are too small to be seen with the unaided eye.

What tool or device should they use to help them see these organisms?

Solution: *Magnifying glass, microscope.*
ST-1-01 Identify tools that make some tasks easier.

16. Some of the organisms they observe reproduce sexually, while others reproduce asexually.

What is one advantage of each method of reproduction?

Sexual:

Asexual:

Solution
Sexual: Ensures genetic variety, provides means of adapting to a changing environment.
Asexual: Ensures genetic integrity; no mate required.

CB-5-01 Compare sexual and asexual reproduction in terms of their advantages and disadvantages.

17. Certain species in and around McLaren's Pond can survive changes in environmental conditions, while others cannot.

Which factor allows a species to survive changes in environmental conditions?

A. A good night vision
B. A balanced diet
C. A short reproduction period
D. A lot of variety within the species

Solution: D
CB-4-02 Relate the increase of variations within a species to the likelihood that some members will survive under changed environmental conditions.

18. On the way back to school, a truck whose licence plate is “BXF 373” follows the school bus.

What would the bus driver see when viewing this licence plate in his rear-view mirror?

A. 373 BXF
B. ꓭXꓤ ƐΓƐ
C. ꓤXꓭ ƐΓƐ
D. ƐΓƐ ꓤXꓭ

Solution: D
CP-3-04 Apply laws of reflection.

19. The bus covers a distance of 30 km between McLaren’s Pond and the school in 30 minutes.

What is the average speed of the bus between McLaren’s Pond and the school?

_____km/h

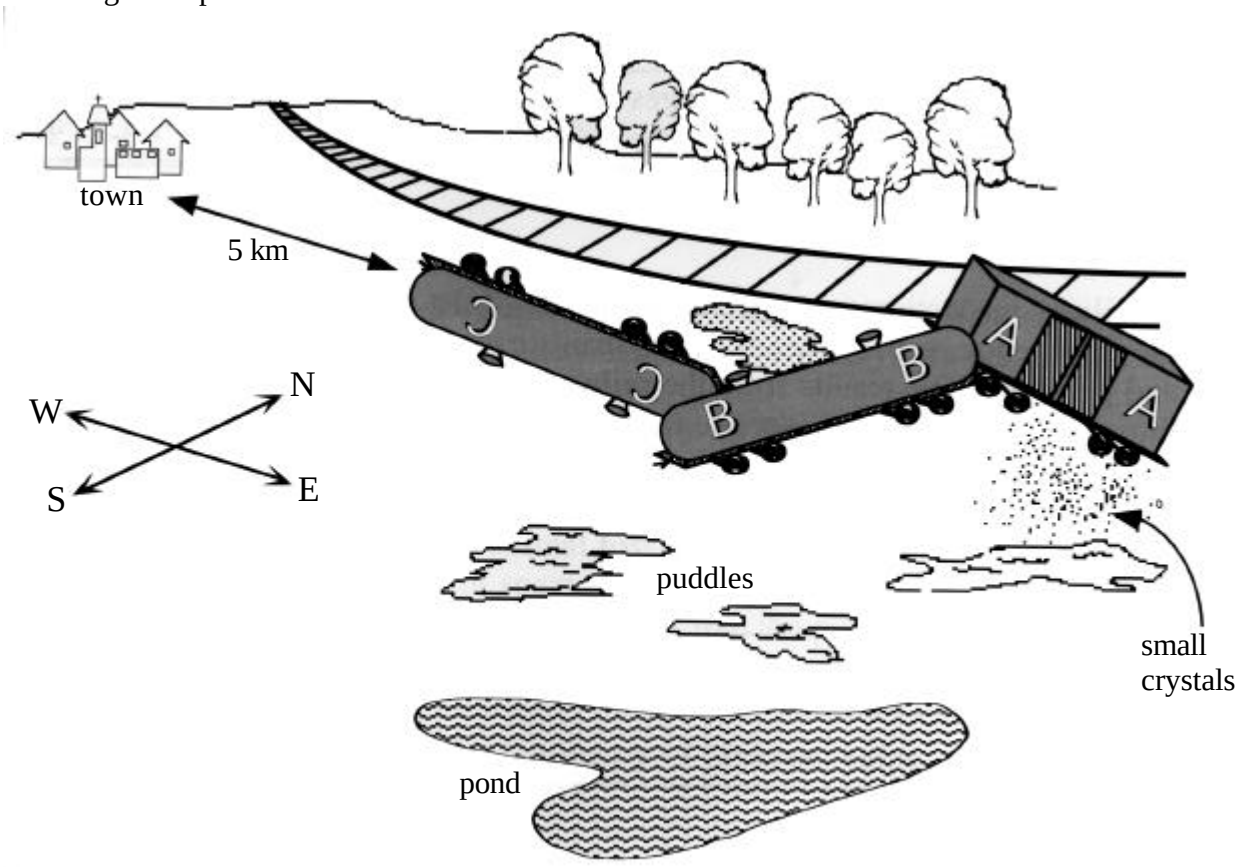
Solution: *60 km/h*
CP-2-05 Describe quantitatively the relationship among displacement, time, and velocity.

Derailment

Spring thaw and torrential rain brought about a slight landslide that caused a train to derail. Three train cars containing dangerous goods were damaged. An emergency team arrived at the site of the accident in less than two hours. They recorded the following information:

- Air temperature: 25°C
- Wind speed and direction: 5 km/h from the east
- Weather forecast: sunny, warm, and windy

This diagram represents the accident site:



The train contained the following substances:
Car A: sodium hydroxide (crystals that can cause skin burns)
Car B: Protocil (a liquid weed-killer)
Car C: ammonia (a liquid, under pressure and at low temperatures; evaporates quickly in warm air; can cause eye, nose, and throat irritations)

20. The specialists who arrive at the site of the accident smell a very strong odour near car C. Despite the odour, they do not find any spill nearby.

What happened to the liquid ammonia?

A. It remained in car C.
B. It remained a liquid.
C. It changed into a gas.
D. It changed into a solid.

Solution: C
CC-2-01 Describe qualitative changes in properties of a substance when it is heated or cooled.

21. A railway inspection team arrives at the site of the accident a short time after the emergency response team. Both teams carry out temperature, soil, water, and pH tests. The results from the railway inspection team are different from those of the emergency response team.

Give two reasons that might explain the differences between their results.

First reason:

Second reason:

Solution: *Their equipment is different: more or less accurate. One of the teams, or both, is biased. One of the teams misread their instruments.*
NS-3-11 Judge objectivity in scientific work in terms of appropriate safeguards in the way investigations are conducted and the way data are examined.

22. The emergency response team members collect a soil sample because they are concerned about the organisms living in the soil near the derailment site. Igneous rocks containing large crystals are found in the soil sample.

How were these rocks formed?

A. From cooled magma
B. By bioaccumulation over the years
C. By heat and pressure within Earth
D. From sediments deposited by glaciers in successive layers

Solution: A
CE-3-05 Describe processes by which rock is formed.

23. While working on the soil sample, one inspector mentions to the others that he has just read a scientific article that describes the theory of plate tectonics.

Which is *not* evidence for the theory of plate tectonics?

A. The presence of deep ocean trenches
B. The discovery of marine animal fossils in the mountains
C. The presence of different species on different continents
D. The way continents can fit together like the parts of a puzzle

Solution: C
CE-5-03 Analyze evidence for plate tectonics theory.

24. When such an accident takes place, it is important for the emergency response team to be able to communicate the test results and nature of the accident to its superiors, the media, and the public.

What is one technology that the team can use to communicate efficiently and quickly?

Solution: *Cellular phones, CB radio, computer modem, fax.*
ST-3-01 Describe a technology essential for obtaining data from outer space and other remote locations.

Environment

Chantal lives on a farm and is interested in several environmental issues.

25. Chantal's parents put a 200 L metal barrel beside their house to collect rainwater from the roof. Chantal notices that after several months, the outside of the rain barrel changes colour from blue to brown.

What does this colour change indicate?

A. The water is evaporating.
B. A phase change has occurred.
C. The pH of the water is neutral.
D. A chemical change has occurred.

Solution: D
CC-4-01 Qualitatively describe a chemical reaction or phase change.

26. A community near where Chantal lives provides each house with different recycling containers. These pictures represent four examples of materials that can be recycled.

Cardboard

Plastic

Metal

Toxic Waste

Of the materials shown, which is the easiest and which is the hardest material to recycle?

The easiest:

The hardest:

Solution: *The easiest - metal. The hardest - toxic waste.*
ST-4-02 Identify and label materials with respect to their ease of recycling.

27. The current in the power line near Chantal's house produces electric and magnetic fields. Some scientists claim that exposing children to strong magnetic fields may increase the risk of getting leukemia.

What is a scientific way to verify this claim?

A. Ask people if they have cancer.
B. Raise money for a research project.
C. Start a nation-wide campaign to alert people to the danger.
D. Perform studies to determine how magnetic fields affect living cells.

Solution: D
NS-5-06 Explain how science is one of the ways of acquiring knowledge.

28. There are several ways to produce electricity for power lines. Since the tides in the Bay of Fundy are the highest in the world, tidal power is an energy source that could be used by New Brunswick and Nova Scotia to produce electrical energy.

What is the principal cause of tides?

A. The gravitational force of the Moon
B. Volcanic activity in the oceans
C. The presence of tectonic plates
D. Earth's rotation

Solution: A
CE-4-04 Explain the effects of gravitational forces on the rotation and revolution of Earth.

29. On a rainy day, Chantal reads a science magazine. There is an article that outlines how sand is used in the manufacture of a glass product according to the following steps:

1. Test the glass product.
2. Design the glass product.
3. Inspect the glass product.
4. Get the raw materials.
5. Mechanically or chemically process the raw materials.

In order to make the glass product, in which sequence should these steps be performed?

A. 2, 4, 5, 1, 3
B. 3, 1, 4, 5, 2
C. 4, 5, 1, 2, 3
D. 5, 3, 2, 1, 4

Solution: A
ST-5-04 Outline steps associated with manufacturing, and their sequence, such as designing a product, obtaining and preparing raw materials, processing the materials mechanically or chemically, assembling, testing, inspecting, and packaging.

30. Chantal also reads an article about radiation in drinking water. In Ontario, many organizations publish guidelines for safe levels of radiation in drinking water.

Organization	**Safe Level (Bq/L)**
Canadian Government	40 000
Ontario Government	7 000
Committee of Ontario environmental scientists	100

What is the best conclusion that can be made about the information in the data table?

A. Each organization does science differently.
B. The organizations share their research data.
C. Each organization has a different view of risks posed by radiation.
D. The organizations are studying a different problem.

Solution: C
NS-4-12 Analyze the objectivity of methods and findings reported by any one group of scientists.

Appendix F

Frequently Asked Questions

Is this science assessment valid and authentic for our students?

Students' performance on this assessment will represent a snapshot of their ability in science. Although different provinces and territories have different science curricula, all have approved the conceptual framework and criteria of this assessment as well as the descriptive scale that will be used in scoring. Moreover, the various components of this science assessment have been reviewed by provincial and territorial education personnel and have been field-tested throughout the country to verify their suitability.

Why do 13-year-old and 16-year-old students write the same assessment?

Administering the same assessment to 13- and 16-year-old students allows educators to gauge the development that takes place between these two age cohorts: the results show the effect of three additional years of schooling and maturity and, in addition, demonstrate the full range of achievement for each age group. It is expected that most 13-year-olds will achieve at least level 2 on the performance scale and that most 16-year-olds will achieve at least level 3.

How do our students and the school benefit from participating in the assessment?

Jurisdictional results will help educators and other decision makers in planning initiatives to enhance teaching and learning for all students. Participating students and schools do not, however, receive individual results. Nonetheless, the assessment, designed by a pan-Canadian consortium of teachers and consultants, is itself a valid learning activity, and students stand to benefit from the experience.

Can students find out how well they did in this assessment? Can our school find out how well our students did in the assessment?

Principles of anonymity and confidentiality do not allow individual results to be shared with students. Lists linking student names with *Response Booklet* numbers remain in the province or territory where the student resides; they are not sent to the marking centre. Once all assessment materials have been scored, it will be impossible to report individual results.

For the same reason, schools cannot find out their students' individual results. Sampling is conducted to provide a jurisdictional picture of students' achievement levels, but the size of the sample is not sufficient to accurately represent the achievement levels of students in a particular school or school district.

What if the sample for our school does not represent the range of science ability evident in our school?

The sample is not intended to represent the range of science ability in a particular school or school district. It is intended to provide a jurisdictional picture of students' achievement in science. It is quite possible that a given sample from a school may have a disproportionate number of low-level or high-level students. However, such disproportion balances out when results are compiled from the many schools that contribute to the jurisdictional profile of science achievement.

What if students with poor science skills are chosen as part of the sample?

It is anticipated that most 13- and 16-year-old students will experience some success on this assessment by demonstrating at least level 1 or level 2 achievement. **We suggest that you encourage as many as possible of the students selected in your school to write the assessment.** Nonetheless, certain students may have such limited science skills that they would experience great frustration in even attempting to complete the assessment. For these few students, school personnel can pre-determine that they are below level 1 and can exempt them from the assessment. During data analysis, they will be treated as if they had written the assessment and had been assessed below level 1.

Why not have an intact science class write this assessment instead of pulling out students from several classes?

The goal of the assessment is to provide a snapshot of the full range of student ability. Sampling theory suggests that this is best achieved by sampling from the pool of all age-appropriate students, not by using intact classes that might have some homogeneous grouping. We realize this may cause a disruption to school schedules similar to that experienced when students from a school team are absent from class for a tournament. We know your involvement as school coordinator requires time and effort in this regard, and we appreciate your contribution to this project.

Are individual results and questionnaire answers kept confidential?

Yes. Any links that identify student, teacher, or school responses are destroyed after all provincial or territorial data have been collected and before any data are forwarded for analysis at the pan-Canadian level.

What can be done to encourage students to do their best?

Individual students are motivated in different ways, some responding better to extrinsic motivational factors and rewards and some to intrinsic factors. You probably know what is best in your situation. In the past, teachers have reported doing the following:

- giving public recognition of students' participation through announcements at school; awarding certificates of appreciation from school principals or directors of education
- appealing to students' pride in representing their province or territory so as to benefit science education across the country
- providing a breakfast before the assessment or offering a celebration with snacks or a pizza party afterward

Are there suggestions for organizing and running the administration of the assessment?

This handbook contains directions for administering the assessment. Two commonly used ways of distributing the materials to ensure each student has the correct booklet(s) are

1. The *List of Selected Students* has booklet numbers corresponding to each student's name. Place a nametag along with a corresponding booklet at each workspace. When students enter the room, ask them to find the workspace labelled with their name and to await further instructions.

2. After all students have arrived, ask them to be seated at any workspace. From the *List of Selected Students*, read out the name of each student and ask them to come and receive the booklet assigned to them. Have them return to their workspace to await further instruction.

A script (Appendix A) has been prepared to help you introduce the assessment and guide the students.

Is there a time limit for the assessment?

The assessment session is two and a half hours in length. For most students, this should provide ample time to complete the assessment and the *Student Questionnaire.* However, some students may require extra time. We suggest allowing an extra 30 minutes for these students.

Can students take breaks during the assessment?

We invite you to make the appropriate arrangement in your circumstances so as to ensure an orderly administration. The session is long, and students may require washroom or relaxation/stretching breaks. You should decide on the number of breaks (if any) and whether students should leave individually, in groups, or all together for these breaks.

How can I help students prepare for the assessment?

Prior to the assessment, you might provide copies of sample questions from this *Handbook for Schools* and encourage them to work together or individually responding to the questions. This might prepare them for what to expect when writing the assessment.

During the assessment, you may answer student questions to clarify wording on the test or questionnaire items, but you may not provide any help in remembering, understanding, or applying science concepts and problem-solving strategies.