

SCIENCE ASSESSMENT FRAMEWORK AND CRITERIA

With Exemplars Drawn from Student Responses

WRITTEN ASSESSMENT FRAMEWORK

Questions dealing with science concepts assessed 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**
 - ◆ An understanding of the nature of scientific knowledge and the processes by which that knowledge develops.
- **relationship of science to technology and societal issues**
 - ◆ An understanding of the relationships among science, technology, and society.

Questions also dealt with conceptual knowledge and understanding, procedural knowledge and skills, and the ability to use science to solve problems.

Questions that assessed **conceptual knowledge and understanding** asked students to

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

Questions that assessed **procedural knowledge and skills** asked students to

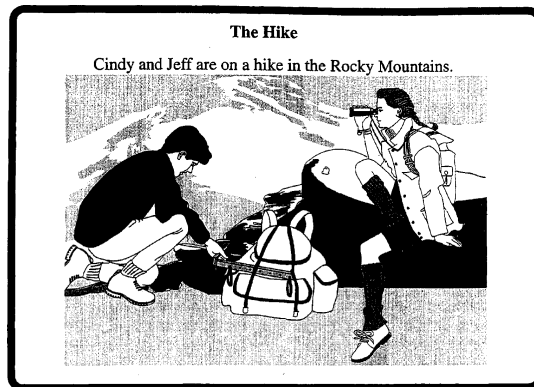
- recognize when a particular procedure should be used
- suggest procedures to solve particular problems
- modify familiar procedures to solve new problems

Questions that assessed the **ability to use science to solve problems** asked students to

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

At level one, the student can

- describe physical properties of objects
- distinguish living things from non-living things
- recognize that energy can appear in different forms
- recognize that objects in the universe undergo change
- demonstrate care and accuracy during scientific investigations
- identify various technologies important to society



Cindy and Jeff use a net to help them in their investigation of the pond.

Name another piece of equipment they could use in their investigation. Briefly tell how this equipment will help them.

Equipment: Magnifying glass.

How does it help? Allow them to see small details or distinguishing characteristics on certain organisms.

While on the trip, the students will be experiencing more hours of daylight than at any other time of the year.

During which month are they going?

- A. March
- * B. June
- C. September
- D. December

At level two, the student can

- classify substances according to their physical properties
- compare various plant and animal adaptations
- know that the amount of energy in the universe is conserved but that it can change form and be transferred
- know that the movement and the tilt of Earth affect cycles such as years, days, and seasons
- explain that there are different forms of scientific investigations and that their results may contradict each other
- identify technologies that influence science, and science knowledge that leads to new technologies

Sun Protection Factor (SPF)

Helen knows that overexposure to ultraviolet rays is harmful to the skin. She devises an experiment to compare the effectiveness of a lotion with a Sun Protection Factor (SPF) 15 to one with a SPF 30.

Helen's hypothesis: "The higher the SPF value, the better the protection."

She needs: – samples of SPF 15 and SPF 30 lotions from the same company
– 10 volunteers with similar complexion and skin colour

Why did Helen choose volunteers with the same skin type?

Answer: That would be her controlled
variable. Need same skin type to make experiment
true.

Canoe Trip

Three friends decide to celebrate the Canada Day holiday by taking a short canoe trip on a nearby lake.



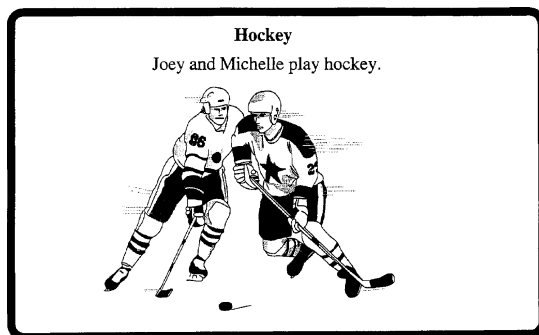
Alice describes the behaviour of the birds. Some behaviours were inherited and others were learned.

Which of the following describes a behaviour that the birds would have learned?

- A. Bringing food back to the nest to feed their young
- * B. Looking for their food near campsites
- C. Sleeping while perched on a branch
- D. Building nests with small twigs

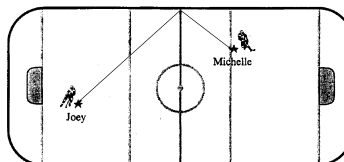
At level three, the student can

- use chemical properties to compare and classify substances
- know that some life forms are unicellular and others are multicellular, and that life forms are involved in the transfer of energy
- compare gravitational and electrical forces
- compare changes in Earth's surface and their causes
- analyse experiments and judge their validity
- identify areas where science knowledge and technologies address societal problems



Joey shoots the puck off the boards and it goes to Michelle.

Draw lines to show the path of the puck as it goes from Joey to the boards and then to Michelle.



Michelle knows that light reflected from the Moon's surface reaches Earth in about one second. She also knows that light from Alpha Centauri, the star nearest our solar system, takes about five years to reach Earth.

About how long does it take for light to travel from the Sun to Earth?

- A. 1 second
- * B. 8 minutes
- C. 5 years
- D. 10 years

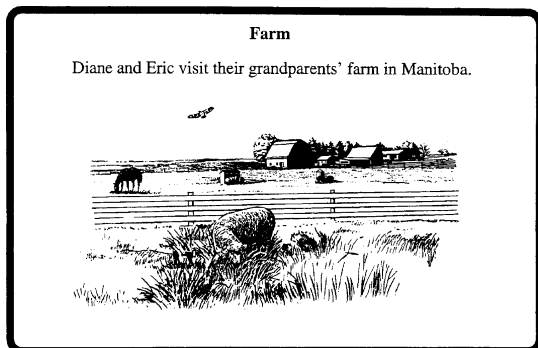
Amateur Astronomer

Michelle, an amateur astronomer, observes the night sky with her binoculars and her telescope.



At level four, the student can

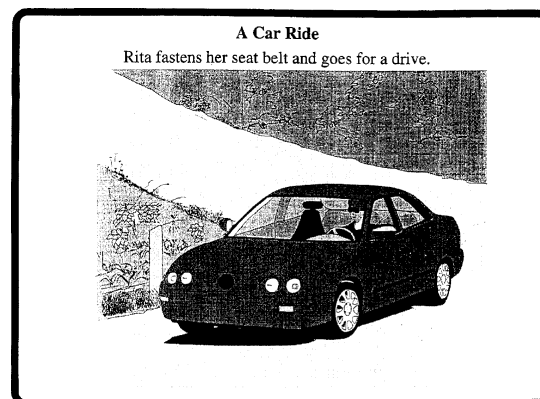
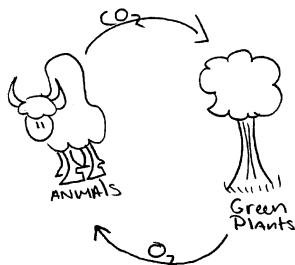
- describe and compare particles in terms of protons, neutrons, and electrons
- state the importance and role of DNA
- analyse uniform motion in one dimension
- use the theory of plate tectonics to explain various geological activities
- explain that scientific progress is the result of ongoing experimentation and evaluation
- describe a situation where science or technology has affected our view of what the world is like



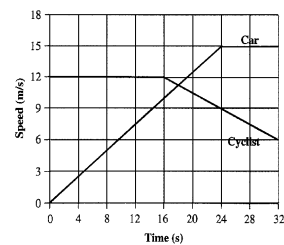
Oxygen, $O_{2(g)}$, is an important component of the air found in the soil. Like many other substances, oxygen is cycled in nature.

Describe the oxygen cycle in nature. Use a labelled diagram if you wish.

Answer: oxygen is used in respiration by animals. CO_2 a waste of respiration, is used by Green Plants in Photosynthesis. Photosynthesis also produces oxygen, which animals breathe completing the cycle.



As soon as Rita resumes driving, a cyclist passes her car. A speed versus time graph representing Rita's car and the cyclist follows:

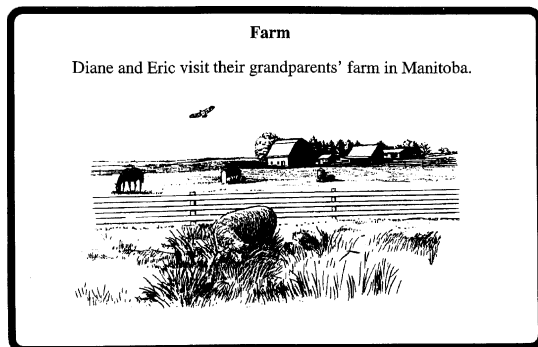


At 32 s, which one will be ahead of the other and by what distance?

- A. The car by 96 m
- B. The cyclist by 96 m
- C. The car by 36 m
- * D. The cyclist by 36 m

At level five, the student can

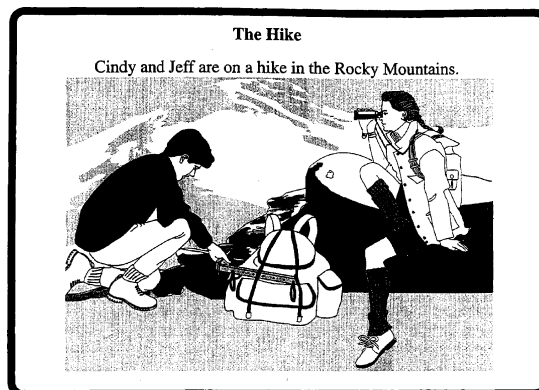
- relate properties of substances to their molecular structure
- know that various factors can mutate DNA and that some mutations may be passed on to offspring
- analyse uniform motion in two dimensions
- evaluate evidence for the theory of plate tectonics
- explain conditions used to evaluate scientific theories
- show the influence of world views on science and technology



Methane, $\text{CH}_4(g)$, is another fuel used in homes. Both methane and propane are gases at room temperature and pressure. Water, $\text{H}_2\text{O}(l)$, on the other hand, is a liquid at room temperature and pressure.

Under these conditions, why is water a liquid when methane and propane are both gases?

- A. Methane and propane have more hydrogen making them more gaseous.
- B. Methane and propane have large spaces between the molecules.
- * C. Water has more attractive forces between the molecules.
- D. Water molecules are smaller and will pack together more tightly.



Above the cliffs, they notice some Peregrine falcons. The falcons prey on swallows, and these in turn prey on mosquitoes.

What is one effect that human activity could have on these and other species in this area?

Answer: Reduce the number of mosquitoes, reducing the number of swallows, then falcons, and eventually, the bottom of the food chain is destroyed, all other lifeforms, including humans, are affected.

PRACTICAL TASKS ASSESSMENT FRAMEWORK

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.

Tasks that assessed science inquiry skills required students to

- identify questions that are, or should be, investigated
- carry out procedures
- select and use proper equipment and materials
- identify variables and controls in an experiment
- collect, organize, interpret, and communicate data
- design procedures

PRACTICAL TASKS ASSESSMENT CRITERIA BY LEVEL AND EXEMPLAR — A SUMMARY

At level one, the student can

- ask and identify relevant questions
- carry out identified procedures
- make relevant observations

At level two, the student can

- infer or predict possible answers to questions
- identify appropriate procedures and important variables
- organize and record observations and measurements accurately

At level three, the student can

- identify sources of error
- identify patterns, trends, and simple relationships
- extrapolate or interpolate

At level four, the student can

- formulate hypotheses and/or predictions to guide research
- organize and present data in concise and effective forms such as data charts, graphs, and mathematical and statistical treatments
- develop explanations by relating data to known information
- suggest alternatives or improvements to an experimental design

At level five, the student can

- design appropriate experiments
- evaluate the reliability and accuracy of data and explain its limitations
- evaluate the effects of sources of error
- identify factors that influence the acceptance or rejection of a body of evidence or a theory

The exemplar that follows includes the task assigned to participants, followed by the actual response of a student who successfully completed questions at all five levels.

CRATER CREATION

Context

Photographs taken of Earth, Moon, Mars and Mercury indicate that there are craters on the surfaces of these bodies that were created by collisions with meteors. In this task, you will simulate crater production by dropping a ball into sand.

Problem

What is the relationship between the height from which the ball is dropped and the width of the crater it creates in the sand?

You should have the following materials

- A tray with dry sand sitting inside a larger tray
- 1 metre stick
- 1 small plastic ruler
- 1 ball (20 g)
- safety goggles (**MUST be worn throughout this task**)

CRATER CREATION

- 6-1. Use the small plastic ruler to level the sand in the tray. (2cm)
- 6-2. Drop the ball from a height of 25 cm into the tray of sand.
- 6-3. Measure the width of the crater formed. If necessary, remove the ball from the sand.
- 6-4. Record this measurement on the chart provided.
- 6-5. Repeat steps 6-1 to 6-4 two more times.
- 6-6. Repeat steps 6-1 to 6-5, using heights of 50 cm and 75 cm.

Height (cm)	Crater Width (cm)		
	Trial 1	Trial 2	Trial 3
25	5	5	5
50	5.5	5.9	5.5
75	5.9	6.0	6

- 6-7. Based on your results what is the relationship between the height from which the ball is dropped and the width of the crater it creates?

Relationship: the higher the ball is dropped, the larger the crater it creates.

- 6-8. Identify a source of error in this experiment.

the height at which ball is dropped is not exact,
the measuring of the width of crater is only a approximation
(no definite lines.)

What effect does this source of error have on the accuracy of your results?

the accuracy of the experiment is very important to the outcome of the result & final conclusion. My measurements could have a very high % error and maybe what the ball actually does in real life is not what is observed in this experiment.

- 6-9. The same data as yours was collected on another planet. What is one assumption that you would have to make if the relationship you gave in question 6-7 is to remain valid?

the amount of gravity has a very important factor in this experiment. on another planet, very different measurements can be observed. A planet where gravity is greater than earth, the relationship with earth's is the same but the width of the crater created would be much larger given the same height the ball is dropped. A planet where there is very little gravity, a very different result would be observed.