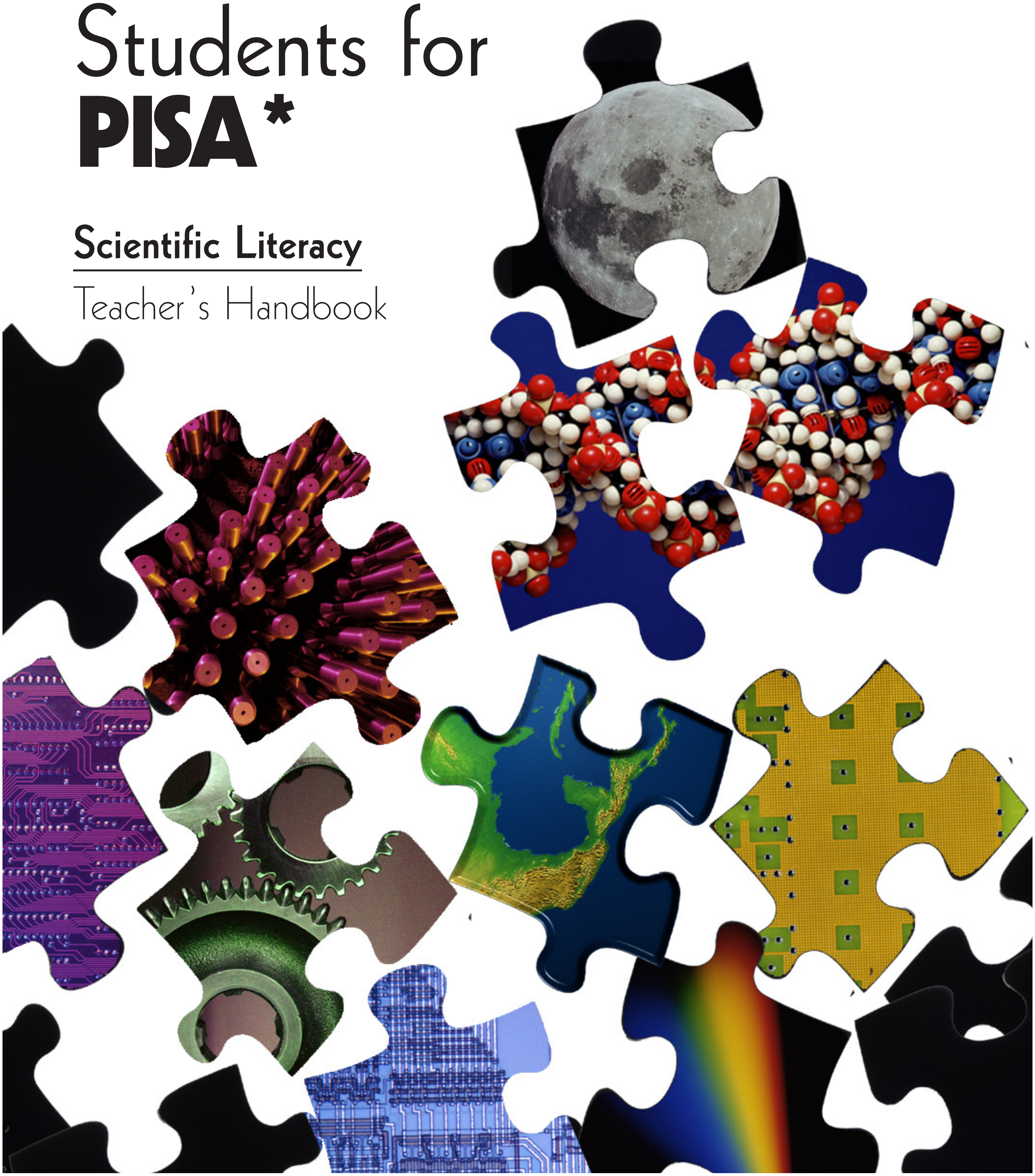
Preparing Students for PISA*

Scientific Literacy

Teacher's Handbook



*Programme for International Student Assessment

Prince Edward Island
CANADA

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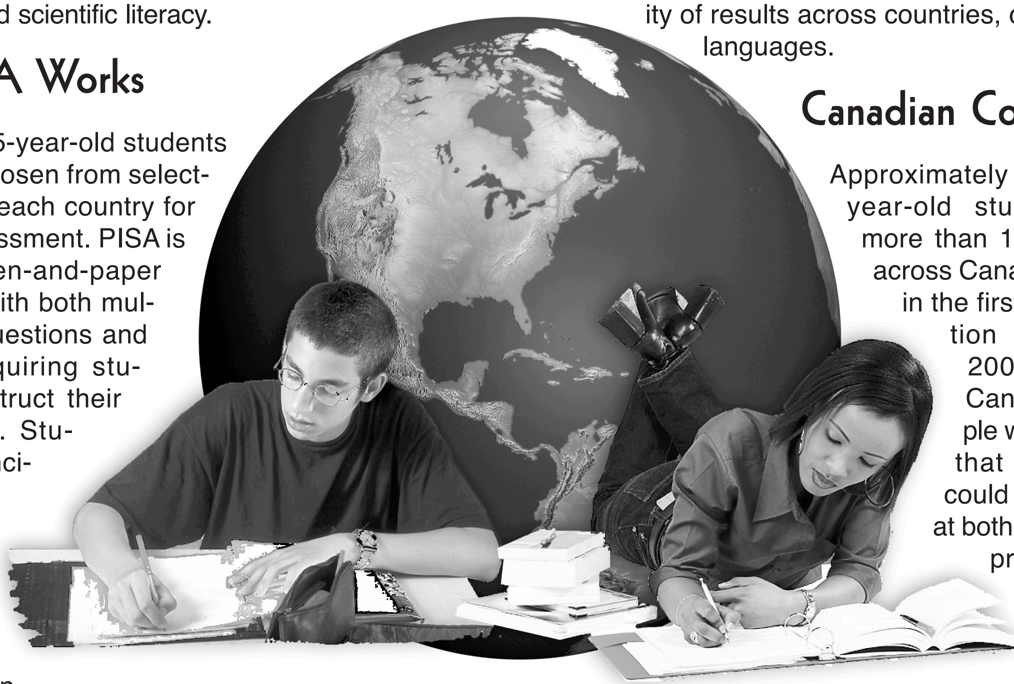
Introduction

PISA — Programme for International Student Assessment

PISA is a collaborative effort on the part of the member countries of the OECD (Organisation for Economic Co-operation and Development) to measure how well 15-year-olds are prepared to meet the challenges of today's knowledge societies. Over 40 countries, including Canada, and more than a quarter of a million students participate in this international assessment that occurs every three years. PISA assesses three domains: reading literacy, mathematical literacy, and scientific literacy.

How PISA Works

A sample of 15-year-old students is randomly chosen from selected schools in each country for the PISA assessment. PISA is a two-hour pen-and-paper assessment with both multiple-choice questions and questions requiring students to construct their own answers. Students and principals also complete a questionnaire. Each assessment examines one domain in depth, and the other two domains provide a summary profile of skills. Reading literacy was examined in depth in 2000, mathematical literacy will be examined in depth in 2003, and scientific literacy will be examined in depth in 2006.



Significance of PISA

The internationally comparable evidence on student performance can assist jurisdictions to bring about improvements in schooling to better prepare young people to enter a society of rapid change and global interdependence. As well, it can provide directions for policy development, for curricular and instructional efforts, and for student learning. Coupled with appropriate incentives, it can motivate students to learn better, teachers to teach better, and schools to be more effective. PISA represents an unprecedented effort to achieve comparability of results across countries, cultures, and languages.

Canadian Context

Approximately 30 000 15-year-old students from more than 1000 schools across Canada took part in the first administration of PISA in 2000. A large Canadian sample was drawn so that information could be provided at both national and provincial levels. Canadian students performed well in the global context, ranking second in reading, sixth in mathematics, and fifth in science. The performance of the students in the Atlantic provinces was above the international average, but well below the Canadian average.

Preparing Atlantic Canadian Students for PISA

In preparation for the next PISA assessment, two documents have been prepared, one for teachers and another for students. In this document for teachers, there are two examples for whole-class discussion and two sample tasks with answers and scoring criteria. In the companion document for students, the sample tasks are also provided but without answers and scoring criteria. These two documents are published to enable students, with the help of their teachers, to attain a clear understanding of the assessment and how it is scored and to help ensure more confident and successful participation. There is also a pamphlet for parents to raise awareness of the purpose, methodology, and significance of PISA.

Information for Teachers

Sample tasks for teachers and students are provided in this package. Suggested examples for the whole-class to discuss are Example1 History of Immunization and Example 2 Australian Road Research Board. It is recommended that teachers will discuss these questions and their scoring criteria with the students. Teachers can decide how best to use the other sample tasks, Semmelweis and Ozone.

Suggestions for Teaching

- Engage your students in each task in the document as a whole-class discussion or by asking students to attempt a task and then discussing it afterward with them.
- Scoring criteria used by the PISA markers to score the actual assessment are provided. Examine the criteria and review the acceptable answers with your students.
- Use the tasks when planning a unit of work on a specific topic in the curriculum. Try to incorporate the tasks into your instructional and assessment plans.
- Remind students that partial marks are given for partially correct answers and encourage them to take the assessment seriously and strive for excellence.

Scientific Literacy

"The capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity."

PISA believes that every individual should be able to think scientifically about the evidence they encounter in their real-life challenges. The PISA assessment, therefore, tests students' performance in applying scientific literacy in real-life situations. Students should be able to use scientific processes, scientific concepts, and scientific situations to answer questions and make decisions about the natural world. The student is required to use knowledge that would be gained from the science curriculum and apply it in a novel situation.

Scientific Concepts

PISA assesses students' understanding of certain phenomena of the natural world and the changes made to it through human activity. The concepts are familiar ones relating to physics, chemistry, biology, and earth science. Students must apply their knowledge to real-life scientific problems. Concepts will be sampled from themes found throughout the science curriculum at the intermediate and high school levels. These themes include

- structure and properties of matter
- chemical and physical changes
- forces and movement
- human biology
- biodiversity
- ecosystems
- geological change
- atmospheric change
- energy transformations
- form and function
- physiological change
- genetic control
- Earth and its place in the universe

Scientific Situations

PISA ASSESSES scientific situations by assessing students ability to apply science to a real-world phenomenon that happens in everyday life rather than from the practice of science in a school classroom, laboratory, or the work of professional scientists

The main content of the assessment of scientific applications is selected from three areas:

Science in life and heath	Science in Earth and environment	Science in technology
Health, disease, and nutrition; maintenance and sustainable use of species; interdependence of physical and biological systems	Pollution; production and loss of soil; weather and climate	Biotechnology; use of material and waste disposal; use of energy transportation

Scientific Processes

The scientific processes for PISA assessments are as follows:

Process 1 - Recognizing scientifically investigative questions.

Given	Response Required
An account of an investigation or procedure in which data were collected or comparisons were made	Select or produce the question or idea that was being (or could have been) tested
A description of a situation in which questions could be investigated scientifically	Formulate a question that could be investigated scientifically
Several questions/ideas arising from or relevant to the situation presented	Select the one(s) that can be answered/tested by scientific investigation

Process 2 - Identifying evidence needed in a scientific investigation.

Given	Response Required
An idea or hypotheses put forward in the question or reading passage that is to be tested.	Select or produce information about what is needed to test the idea or to make a prediction based on it. The information may be about • what things should be compared • what variables should be changed or controlled • what additional information is needed • what action should be taken so that relevant data can be collected

Example 1: History of Immunization

(Source: www.pisa.oecd.org)

The first two processes are assessed in this example. Students are asked to read the text, which includes an extract about the history of immunization.

> As early as the 11th century, Chinese doctors were manipulating the immune system. By blowing pulverized scabs from a smallpox victim into their patients' nostrils, they could often induce a mild case of the disease that prevented a more severe onslaught later on. In the 1700s, people rubbed their skins with dried scabs to protect themselves from the disease. These primitive practices were introduced into England and the American colonies. In 1771 and 1772, during a smallpox epidemic, a Boston doctor named Zabdiel Boylston scratched the skin on his six-year-old son and 285 other people and rubbed pus from smallpox scabs into the wounds. All but six of his patients survived.

Question 1: What idea might Zabdiel Boylston have been testing?

This item requires a constructed response, which is scored as 2, 1, or 0 according to the amount of relevant detail given in the answer. (A score of 2 would be given to an idea along the lines of "breaking the skin and applying pus directly into the blood stream will increase the chances of developing immunity against smallpox.") This item assesses Process 1.

Question 2: Give two other pieces of information that you would need to decide how successful Boylston's approach was.

This item is also scored as 2, 1, or 0 according to whether one or both pieces of information are mentioned (the rate of survival without Boylston's treatment and whether his patients were exposed to smallpox apart from within the treatment). This item assesses Process 2.

Process 3 - Drawing or evaluating conclusions.

Given	Response Required
Data (test results, observations) from which conclusions can be drawn	Produce conclusion that fits the data.
Data (test results, observations) and conclusions drawn from them	Select the conclusion that fits the data and give an explanation.
Data (test results, observations) and a conclusion drawn from it	Produce reasons for the given data supporting or not supporting the conclusion or suggest the extent to which confidence can be placed in it.

Process 4 - Communicating valid conclusions

Given	Response Required
A situation in which (different) conclusions can be drawn or that requires information to be brought together to support a conclusion or recommendation and a specified audience	Produce an argument that is expressed clearly for the given audience and that is supported by relevant evidence/data found in the stimulus material.

Process 5 - Demonstrating understanding of scientific concepts

Given	Response Required
A situation in which a prediction, explanation, or information is requested	Produce or select a prediction or explanation or additional information based on the understanding of a scientific concept or on information not given in the question or stimulus material.

Example 2: Australian Road Research Board

(Source: www.pisa.oecd.org)

The following four questions are part of a task for which the reading passage is about Peter Cairney, who works for the Australian Road Research Board.

> ... Another way that Peter gathers information is by the use of a TV camera on a 13-metre pole to film the traffic on a narrow road. The pictures tell the researchers such things as how fast the traffic is going, how far apart the cars travel, and what part of the road the traffic uses. Then after a time lane lines are painted on the road. The researchers can then use the TV camera to see whether the traffic is now different. Does the traffic now go faster or slower? Are the cars closer together or further apart than before? Do the motorists drive closer to the edge of the road or closer to the centre now that the lines are there? When Peter knows these things he can give advice about whether or not to paint lines on narrow roads

Question 1: If Peter wants to be sure that he is giving good advice, he might collect some other information as well as filming the narrow road. Which of these things would help him to be more sure about his advice concerning the effect of painting lines on narrow roads?

a) Doing the same on other narrow roads	Yes/No
b) Doing the same on wide roads	Yes/No
c) Checking the accident rates before and after painting the lines	Yes/No
d) Checking the number of cars using the road before and after painting the lines	Yes/No

- **Score 2** if response is: a) yes b) no c) yes d) no
- **Score 1** if response is: a) yes b) no c) no d) no
- **Score 0** for any other combination.

Question 1 assesses Process 2.

Question 2: Suppose that on one stretch of narrow road Peter finds that after the lane lines are painted the traffic changes as in this table

Speed	Traffic moves more quickly
Position	Traffic keeps nearer edges of road
Distance apart	No change

On the basis of these results it was decided that lane lines should be painted on all narrow roads.

Do you think this was the best decision? Agree Disagree

Give your reasons for agreeing or disagreeing.

____

____

No credit is given for agreeing or disagreeing but for the reason that is consistent with either and the given information. (For example: agree because there is less chance of collisions if the traffic is keeping near the edges of the road even if it is moving faster; if it is moving faster there is less incentive to overtake. Or, disagree because if the traffic is moving faster and keeping the same distance apart this may mean that they don't have enough room to stop in an emergency.)

Question 3: Drivers are advised to leave more space between their vehicles and the one in front when they are travelling more quickly than when they are travelling more slowly because faster cars take longer to stop.

Explain why a faster car takes longer to stop than a slower one.

____

____

Question 3 assesses Process 5.

It requires a constructed response, marked 2, 1, or 0 according to whether one or both of these significant points are mentioned:

- greater momentum of a vehicle when it is moving more quickly and the consequent need for more force to stop it
- at a higher speed a vehicle will move further in the same time, whilst slowing down than a slower vehicle.

Question 4: Watching his TV, Peter sees one car (A) travelling at 45 km/h being overtaken by another car (B) travelling at 60 km/h. How fast does car B appear to be travelling to someone in car A?

a) 0 km/h b) 15 km/h c) 45 km/h d) 60 km/h e) 105 km/h

The correct answer is b), which is given one mark.

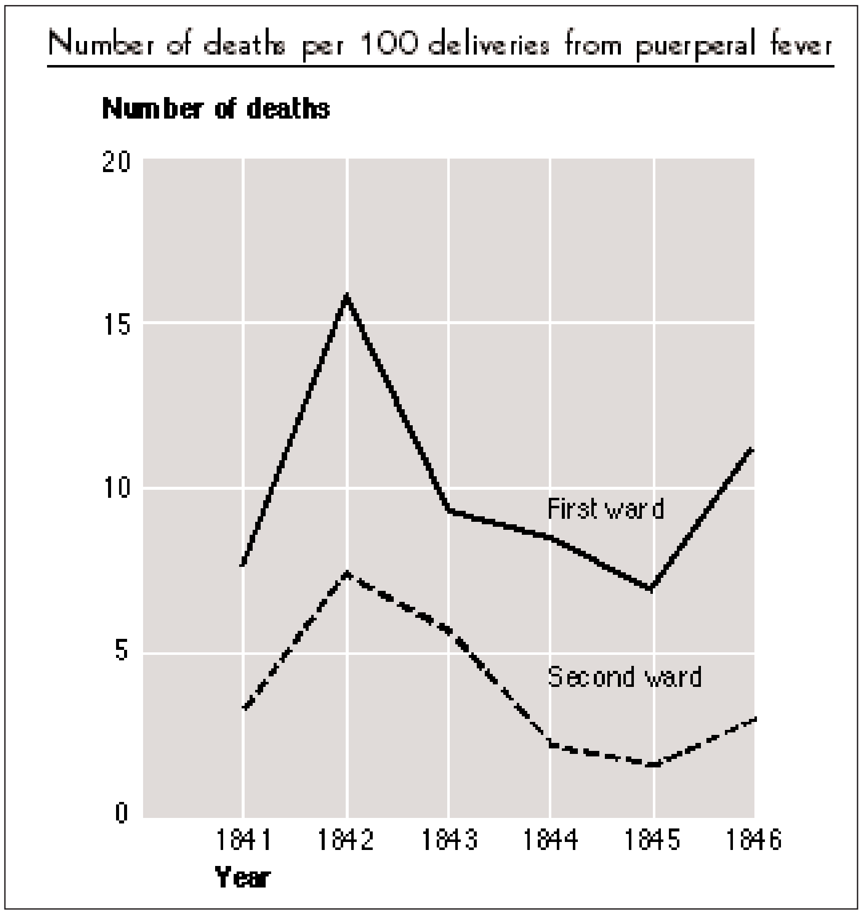
Question 4 assesses Process 5.

Task 1
SEMMELWEIS

The following four questions are part of a task for which the reading passages are taken from the diary of Ignaz Semmelweis, who attempted to find the cause of puerperal fever.

Semmelweis diary text 1

July 1846. Next week I will take up a position as Herr Doktor at the First Ward of the maternity clinic of the Vienna General Hospital. I was frightened when I heard about the percentage of patients who die in this clinic. This month not less than 36 of the 208 mothers died there, all from puerperal fever. Giving birth to a child is as dangerous as first-degree pneumonia.



Physicians, among them Semmelweis, were completely in the dark about the cause of puerperal fever. Semmelweis diary again:

December 1846. Why do so many women die from this fever after giving birth without any problems? For centuries science has told us that it is an invisible epidemic that kills mothers. Causes may be changes in the air or some extraterrestrial influence or a movement of the earth itself, an earthquake.

Nowadays, not many people would consider extraterrestrial influence or an earthquake as possible causes of fever. We now know it has to do with hygienic conditions. But in the time Semmelweis lived, many people, even scientists, did! However, Semmelweis knew that it was unlikely that fever could be caused by extraterrestrial influence or an earthquake. He pointed at the data he collected (see diagram) and used this to try to persuade his colleagues.

Question 1: Suppose you were Semmelweis. Give a reason (based on the data Semmelweis collected) why puerperal fever is unlikely to be caused by earthquakes.

Process: Critically evaluating scientific evidence/data
Concept: Science in life and health (human biology)
Situation: Historical

■ **Score 2(1):**
Answers that refer to the difference between the number of deaths (per 100 deliveries) in both wards. For example:

- The fact that the first ward had a high rate of women dying compared to women in the second ward, obviously shows that it had nothing to do with earthquakes.
- Not as many people died in ward 2 so an earthquake couldn't have occurred without causing the same number of deaths in each ward.
- Because the second ward isn't as high, maybe it had something to do with ward 1.
- It is unlikely that earthquakes cause the fever since death rates are so different for the two wards.

■ **Score 1(1):**
Answers that refer to the fact that earthquakes don't occur frequently. For example:

- It would be unlikely to be caused by earthquakes because earthquakes wouldn't happen all the time.

■ **Score 1(2):**
Answers that refer to the fact that earthquakes also influence people outside the wards. For example:

- If there were an earthquake, women from outside the hospital would have got puerperal fever as well.
- If an earthquake were the reason, the whole world would get puerperal fever each time an earthquake occurs (not only ward 1 and 2).

■ **Score 1(3):**
Answers that refer to the thought that when earthquakes occur, men don't get puerperal fever. For example:

- If a man were in the hospital and an earthquake came, he wouldn't get puerperal fever, so earthquakes cannot be the cause.
- Because girls get it and not men.

■ **Score0(1):**
Answers that state (only) that the fever must have another cause (right or wrong). For example:

- An earthquake cannot influence a person or make him sick.
- A little shaking cannot be dangerous.

■ **Score 0(2):**
Answers that state (only) that the fever must have another cause (right or wrong). For example:

- Earthquakes do not let out poison gases. They are caused by the plates of the Earth folding and faulting into each other.
- Because they have nothing to do with each other and it's just superstition.
- An earthquake doesn't have any influence on pregnancy. The reason was that the doctors were not specialised enough.

■ **Score 0(3):**

Answers that are combinations of scores 0(1) and 0(2). For example:

- Puerperal fever is unlikely to be caused by earthquakes as many women die after giving birth without any problem. Science has told us that it is an invisible epidemic that kills mothers.
- The death is caused by bacteria and the earthquakes cannot influence them.

■ **Score 0(4):**

Other incorrect answers. For example:

- I think it was a big earthquake that shook a lot.
- In 1843 the deaths decreased in Ward 1 and less so in Ward 2.
- Because there weren't any earthquakes in the ward and they still got it. [Note: the assumption that there were no earthquakes at that time is not correct.]

Semmelweis diary text 2

Part of the research in the hospital was dissection. The body of a deceased person was cut open to find a cause of death. Semmelweis recorded that the students working the First Ward usually took part in dissections on women who died the previous day, before they examined women who had just given birth. They did not pay much attention to cleaning themselves after the dissections. Some were even proud of the fact that you could tell by their smell that they had been working the mortuary, as this showed how industrious they were!

One of Semmelweis friends died after having cut himself during such a dissection. Dissection of his body showed he had the same symptoms as mothers who died from puerperal fever. This gave Semmelweis a new idea.

Question 2: Semmelweis' new idea had to do with the high percentage of women dying in the maternity wards and the students' behaviour.

What was this idea?

A Having students clean themselves after dissections should lead to a decrease of puerperal fever.
B Students should not take part in dissection because they may cut themselves.
C Students smell because they do not clean themselves after a dissection.
D Students want to show that they are industrious, which makes them careless when they examine the women.

Process: Recognising questions
Concept: Science in life and health (human biology)
Situation: Historical

■ **Score 1:**

Answer A — having students clean themselves after dissections should lead to a decrease of puerperal fever.

■ **Score 0:**

Other answers.

Question 3: Semmelweis succeeded in his attempts to reduce the number of deaths due to puerperal fever. But puerperal fever even today remains a disease that is difficult to eliminate. Fevers that are difficult to cure are still a problem in hospitals. Many routine measures serve to control this problem. Among those measures are washing sheets at high temperatures. Explain why high temperature (while washing sheets) helps to reduce the risk that patients will contract a fever.

Process: Apply scientific knowledge in situation presented
Concept: Science in life and health (human biology)
Situation: Historical

■ **Score 1(2):**
Answers that refer to killing of micro-organisms, germs, or viruses. For example
- Because high heat kills small organisms which cause disease.
- It's too hot for germs to live.

■ **Score 1(3):**
Answers that refer to the removal (not killing) of bacteria: For example:
- The bacteria will be gone.
- The number of bacteria will decrease.
- You wash the bacteria away at high temperatures.

■ **Score 1(4):**
Answers that refer to the removal (not killing) of micro-organisms, germs, or viruses. For example:
- Because you wont have the germ on your body.

■ **Score1(5):**
Answers that refer to the sterilization of the sheets. For example:
- The sheets will be sterilized.

■ **Score0(1):**
Answers that refer to killing of disease. For example:
- Because the hot water temperature kills any disease on the sheets.
- The high temperature kills most of the fever on the sheets, leaving less chance of contamination.

■ **Score 0(2):**
Other incorrect answers. For example:
- So they dont get sick from the cold.
- Well when you wash something it washes away the germs.

Question 4: Many diseases may be cured by using antibiotics. However, the success of some antibiotics against puerperal fever has diminished in recent years.

What is the reason for this?

A Once produced, antibiotics gradually lose their activity.
B Bacteria become resistant to antibiotics.
C These antibiotics only help against puerperal fever, but not against other diseases.
D The need for these antibiotics has been reduced because public health conditions have improved considerably in recent years.

Process: Apply scientific knowledge to situation presented
Concept: Science in life and health (biodiversity)
Situation: Historical

■ **Score 1:**
Answer B — bacteria become resistant to antibiotics

■ **Score 0:**
Other answers

Task 2
OZONE

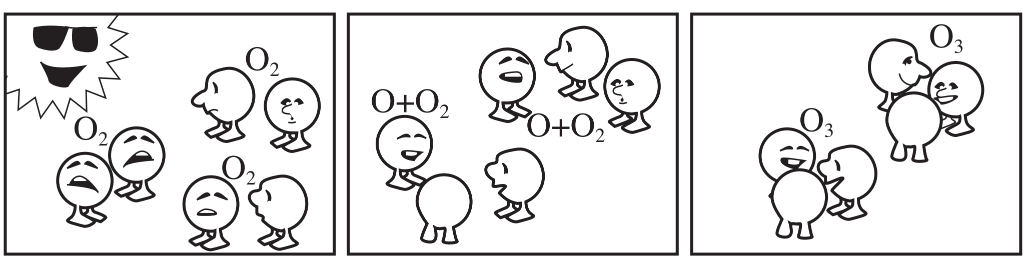
Read the following section of an article about the ozone layer. (Source: Sample Tasks from PISA 2000 Assessment)

The atmosphere is an ocean of air and a precious natural resource for sustaining life on the Earth. Unfortunately, human activities based on national/personal interests are causing harm to this common resource, notably by depleting the fragile ozone layer, which acts as a protective shield for life on the Earth.

Ozone molecules consist of three oxygen atoms, as opposed to oxygen molecules, which consist of two oxygen atoms. Ozone molecules are exceedingly rare: fewer than 10 in every million molecules of air. However, for nearly a billion years, their presence in the atmosphere has played a vital role in safeguarding life on Earth. Depending on where it is located, ozone can either protect or harm life on Earth. The ozone in the troposphere (up to 10 kilometres above the Earth's surface) is "bad" ozone, which can damage lung tissues and plants. But about 90 percent of ozone found in the stratosphere (between 10 and 40 kilometres above the Earth's surface) is "good" ozone, which plays a beneficial role by absorbing dangerous ultraviolet (UV-B) radiation from the Sun.

Without this beneficial ozone layer, humans would be more susceptible to certain diseases due to the increased incidence of ultraviolet rays from the Sun. In the last decades the amount of ozone has decreased. In 1974 it was hypothesized that chlorofluorocarbons (CFCs) could be a cause for this. Until 1987, scientific assessment of the cause-effect relationship was not convincing enough to implicate CFCs. However, in September 1987, diplomats from around the world met in Montreal (Canada) and agreed to set sharp limits on the use of CFCs.

Question 1: In the text above nothing is mentioned about the way ozone is formed in the atmosphere. In fact each day some ozone is formed and some other ozone disappears. The way ozone is formed is illustrated in the following comic strip.



Source: deilig er den Himme, Temahefte 1, Institute for Physics, University of Osla, August 1997.

Suppose you have an uncle who tries to understand the meaning of this strip. However, he did not get any science education at school, and he doesn't understand what the author of the strip is explaining. He knows that there are no little fellows in the atmosphere, but he wonders what those little fellows in the strip stand for, what those strange notations O, O_2, and O_3 mean, and which processes the strip represents. He asks you to explain the strip. Assume that your uncle knows:

- that O is the symbol for oxygen;
- what atoms and molecules are.

Write an explanation of the comic strip for your uncle. In your explanation, use the words atoms and molecules in the way they are used in lines 5 and 6.

Process: Communicating to others valid conclusions from evidence/data
Concept: Science in Earth and environment (chemical and physical changes)
Situation: Global

■ Score 3(1):

Answers that mention the following three aspects:

- First aspect: an oxygen molecule or some oxygen molecules (each consisting of two oxygen atoms) are split into oxygen atoms (picture 1).
- Second aspect: the splitting (of oxygen molecules) takes place under the influence of sunlight (picture 1).
- Third aspect: the oxygen atoms combine with other oxygen molecules to form ozone molecules (pictures 2 and 3).

Remarks on each of the three aspects

First aspect:

- The splitting should be described using the correct words (see lines 5 and 6) for O (atom or atoms) and O_2 (molecule or molecules).
- If O and/or O_2 have been described only as particles or small parts no credit should be given for this aspect.

Second aspect:

- The sun's influence should be related to the splitting of O_2 (an oxygen molecule or oxygen molecules).
- If the sun's influence is related to the forming of an ozone molecule from an oxygen atom and an oxygen molecule (picture 2 and 3) no credit should be given for this second aspect.
- Note: Aspects 1 and 2 may typically be given in the one sentence.

Third aspect:

- Credit (1 point) should be given for this aspect if the answer contains any description of an O combining with an O_2 . If the formation of O_3 is described as the combining of (three, separate) O atoms, credit should not be given for this third aspect.
- If O_3 is not described as a molecule or molecules but for example as "a group of atoms," this can be tolerated for the third aspect.

■ Score 3(1):

- When the sun shines on the O_2 molecule the two atoms separate. The two O atoms look for other O_2 molecules to join with. When the O_1 and O_2 join they form O_3, which is ozone.
- The strip illustrates the formation of ozone. If an oxygen molecule is affected by the sun, it breaks into two separate atoms. These separate atoms, O, float around looking for a molecule to link up to; they link up to existing O_2 molecules and form an O_3 molecule, as three atoms are now joined together; O_3 forms ozone.
- The little guys are O, or oxygen atoms. When two are joined they make O_2 or oxygen molecules. The sun causes these to decompose into oxygen again. The O_2 atoms then bond with O_2 molecules creating O_3, which is ozone. [Note: this answer can be regarded as correct. There is only one slip of the pen (O_2 atoms after having mentioned oxygen atoms previously).]

■ Score 2(1):
Answers that correctly mention only the first and second aspects. For example:
- The sun decomposes the oxygen molecules into single atoms. The atoms fuse into groups. The atoms form groups of three atoms together.

■ Score 2(2):
Answers that correctly mention only the first and third aspects. For example:
- Each of the little fellows stands for one atom of oxygen. O is one oxygen, O_2 is an oxygen molecule, and O_3 is a group of atoms all joined together. The processes shown are one pair of oxygen atoms (O_2) getting split and then each joining with two other pairs forming two groups of 3 (O_3).
- The little fellows are oxygen atoms. O_2 means one oxygen molecule (like a pair of little fellows holding hands), and O_3 means three oxygen atoms. The two oxygen atoms of one pair break apart and one joins each of the other pairs, and out of the three pairs, two sets of three oxygen molecules (O_3) are formed.

■ Score 2(3):
Answers that correctly mention only the second and third aspect. For example:
- The oxygen is broken up by the sun's radiation. It splits in half. The two sides go and join other oxygen particles forming ozone.
- Most of the time in pure oxygen (O_2) environments oxygen comes in pairs of two so there are three pairs of two. One pair is getting too hot and they fly apart going into another pair making O_3 instead of O_2. [Note: Although one pair is getting too hot is not a very good description for the sun's influence, credit should be given for the second aspect; the third aspect can also be regarded as correct.]

■ Score 1(1):
Answers that correctly mention only the first aspect. For example:
- Oxygen molecules are breaking down. They form O atoms. And sometimes there are ozone molecules. The ozone layer remains the same because new molecules are formed and others die.

■ Score 1(2):
Answers that correctly mention only the second aspect. For example:
- O represents an oxygen molecule, O_2 = oxygen, O_3 = ozone. Sometimes both oxygen molecules, joining each other, are separated by the sun. The single molecules join another pair and form ozone (O_3).

■ Score 1(3):
Answers that correctly mention only the third aspect. For example:
- The O (oxygen) molecules are forced to bond with O_2 (2 x oxygen molecules) to form O_3 (3 x oxygen molecules), by the heat of the sun. *[Note: the underlined part of the answer shows the third aspect. No credit can be given for the second aspect, because the sun is not involved in the formation of ozone from 0 + 0_2 but only in breaking down bonds in 0_2.]*

■ Score 0(1):
Answers that do not correctly mention any of the three aspects. For example:
- The sun (ultraviolet rays) burns the ozone layer and at the same time is destroying it as well. Those little men are the ozone layers and they run away from the sun because it is so hot. [Note: no point can be awarded, not even for mentioning something about the sun's influence.]
- The sun is burning the ozone in the first box. In the second box they are running away with tears in their eyes and in the third box they are cuddling each other with tears in their eyes.
- Well Uncle Herb it's simple. O is one oxygen particle, the numbers next to O increase the amounts of particles in the group.

Question 2: Ozone is also formed during thunderstorms. It causes the typical smell after such a storm. In lines 10–12 the author of the text distinguishes between "bad ozone" and "good ozone." In terms of the article, is the ozone that is formed during thunderstorms bad ozone or good ozone? Choose the answer and the explanation that is supported by the text.

	Bad ozone or good ozone?	Explanation
A	Bad	It is formed during bad weather
B	Bad	It is formed in the troposphere.
C	Good	It is formed in the stratosphere.
D	Good	It smells good.

Process: Critically evaluating scientific evidence/data
Concept: Science in Earth and environment (Earth/space)
Situation: Global

■ Score 1:
Answer B — bad. It is formed in the troposphere.

■ Score 0:
Other answers.

Question 3: Line 14 and 15 : Without this beneficial ozone layer, humans would be more susceptible to certain diseases due to the increased incidence of ultraviolet rays from the Sun.

Name one of these specific diseases.

Process: Applying scientific knowledge in situation presented
Concept: Science in life and health (physiological change)
Situation: Global

■ Score 1:
Answers that refer to skin cancer. For example:
- Skin cancer
- Melonoma

■ Score 0:
Answers that refer to other specific types of cancer. For example:
- Lung cancer

OR

Answers that only refer to cancer. For example:
- Cancer OR
- Other incorrect answers

Question 4: At the end of the text an international meeting in Montreal is mentioned. At that meeting lots of questions in relation to the possible depletion of the ozone layer were discussed. Two of those questions are given in the table below:

Which of the questions below can be answered by scientific research?

Questions:	**Answerable by scientific research?**
Should the scientific uncertainties about the influence of CFCs on the ozone layer be a reason for governments to take no action?	Yes/No
What would the concentration of CFCs be in the atmosphere in the year 2002 if the release of CFCs into the atmosphere takes place at the same rate as it does now?	Yes/No

Process: Recognizing questions
Concept: Science in Earth and environment (Earth/space)
Situation: Global

■ Score 1:
Answers which No and Yes, in that order.

■ Score 0:
Other responses.