

PISA Science Literacy Items and Scoring Guides

The *Science Literacy Items and Scoring Guides* document contains 10 science assessment units and 31 items associated with these units. These released items from the PISA 2000 and PISA 2006 assessments are distinct from the secure items, which are kept confidential so that they may be used in subsequent cycles to monitor trends.

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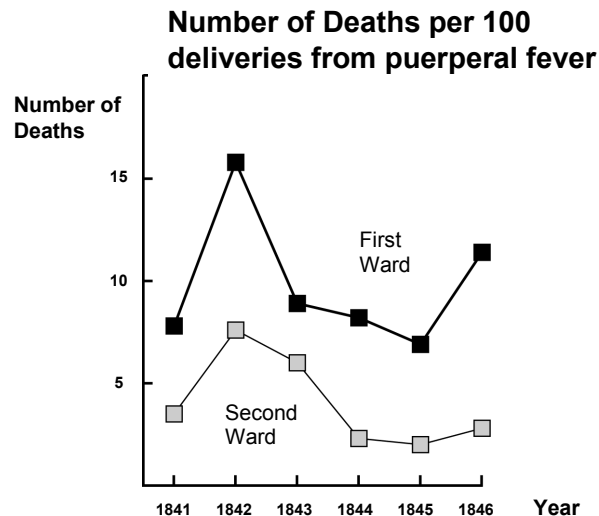
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SEMMELWEIS' DIARY

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.'

These lines from the diary of Ignaz Semmelweis (1818-1865) illustrate the devastating effects of puerperal fever, a contagious disease that killed many women after childbirth. Semmelweis collected data about the number of deaths from puerperal fever in both the First and the Second Wards (see diagram).



Diagram

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! 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: SEMMELWEIS' DIARY

S195Q02- 01 02 03 04 11 12 13 21 99

Question intent: Critically evaluating scientific evidence/data

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

.....

.....

.....

.....

.....

SCORING:

Fully Correct

Answers which refer to the difference between the numbers of deaths (per 100 deliveries) in both wards.

Partially Correct

Answers which refer to the fact that earthquakes don't occur frequently.

Answers which refer to the fact that earthquakes also influence people outside the wards.

Answers which refer to the thought that when earthquakes occur, men don't get puerperal fever.

Incorrect

Answers which state (only) that earthquakes cannot cause the fever.

Answers which state (only) that the fever must have another cause (right or wrong).

Answers that are combinations of the two incorrect answers above.

**Percentage of students
answering correctly in
PISA 2000:**

OECD average: 25%
U.S.: 23%

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 on 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 in 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' DIARY

S195Q04

Question intent: Recognizing questions

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

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 dissections 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.

SCORING:

Correct

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

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2000:**

OECD average: 64%
U.S.: 68%

Question 3: SEMMELWEIS' DIARY

S195Q05- 01 02 11 12 13 14 15 99

Question intent: Apply scientific knowledge in situation presented

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.

.....

.....

SCORING:***Correct***

Answers which refer to *killing* of *bacteria*.

Answers which refer to *killing* of microorganisms, germs or viruses.

Answers which refer to the *removal* (not killing) of bacteria.

Answers which refer to the *removal* (not killing) of microorganisms, germs, or viruses or to the sterilization of the sheets.

Incorrect

Answers which refer to killing of disease.

Other responses.

**Percentage of students
answering correctly in
PISA 2000:**

OECD average: 68%
U.S.: 64%

Question 4: SEMMELWEIS' DIARY

S195Q06

Question intent: Apply scientific knowledge to situation presented

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.

SCORING:

Correct

Answer B. Bacteria become resistant to antibiotics.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2000:**

OECD average: 60%
U.S.: 60%

OZONE

OZONE TEXT

Read the following section of an article about the ozone layer.

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 ten 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 ultra-violet rays from the Sun. In the last decades the amount of ozone has decreased. In 1974 it was hypothesised 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 to the use of CFCs.

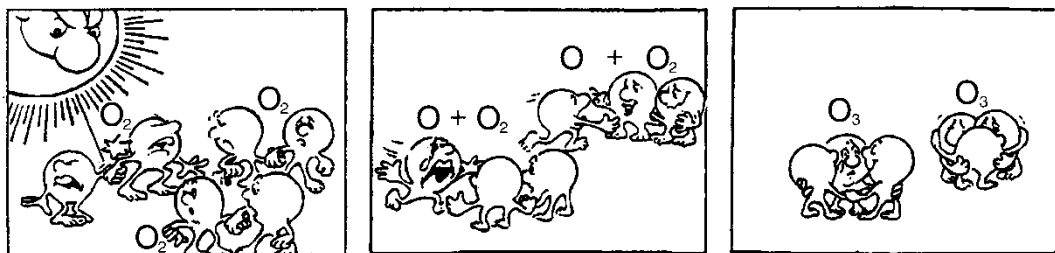
Source: Connect, UNESCO International Science, Technology & Environmental Education Newsletter, section from an article entitled "The Chemistry of Atmospheric policy", Vol., XXII No. 2, 19978 (spelling adapted).

Question 1: OZONE

S253Q01- 01 11 12 13 21 22 23 31 99

Question intent: Communicating to others valid conclusions from evidence/data

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.



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_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.

.....

.....

.....

SCORING:

Fully Correct

Gives an answer in which the following three aspects are mentioned:

1. An oxygen molecule or some oxygen molecules (each consisting of two oxygen atoms) are split into oxygen atoms (picture 1).
2. The splitting (of oxygen molecules) takes place under the influence of sunlight (picture 1).
3. The oxygen atoms combine with other oxygen molecules to form ozone molecules (pictures 2 and 3).

Partially Correct

Answers which correctly mention only:

- First and second aspects only correct.
- First and third aspects only correct.
- Second and third aspects only correct.
- First aspect only correct.
- Second aspect only correct.
- Third aspect only correct.

Incorrect

None of the three aspects correct.

**Percentage of students
answering correctly in
PISA 2000:**

OECD average: 28%
U.S.: 20%

Question 2: OZONE

S253Q02

Question intent: Critically evaluating scientific evidence/data

Ozone is also formed during thunderstorms. It causes the typical smell after such a storm. In lines 9–13 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.

SCORING***Correct***

Answer B. Bad. It is formed in the troposphere.

Incorrect

Other responses

**Percentage of students
answering correctly in
PISA 2000:**

OECD average: 35%
U.S.: 32%

Question 3: OZONE

S253Q05- 0 1 9

Question intent: Applying scientific knowledge to the presented situation

Lines 14 and 15 state: "Without this beneficial ozone layer, humans would be more susceptible to certain diseases due to the increased incidence of ultra-violet rays from the Sun."

Name one of these specific diseases.

.....

SCORING:

Correct

Answers which refer to skin cancer.

Incorrect

Answers which refer to other specific types of cancer.

Answers which only refer to cancer in general.

**Percentage of students
answering correctly in
PISA 2000:**

OECD average: 55%
U.S.: 57%

Question 4: OZONE

S270Q03

Question intent: Recognizing questions

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 shown in the table below.

Can the questions listed below be answered by scientific research?

Circle either Yes or No for each.

Question:	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

SCORING***Correct***

Answers which indicate No and Yes, in that order.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2000:**

OECD average: 57%
U.S.: 62%

GREENHOUSE

Read the texts and answer the questions that follow.

THE GREENHOUSE EFFECT: FACT OR FICTION?

Living things need energy to survive. The energy that sustains life on the Earth comes from the Sun, which radiates energy into space because it is so hot. A tiny proportion of this energy reaches the Earth.

The Earth's atmosphere acts like a protective blanket over the surface of our planet, preventing the variations in temperature that would exist in an airless world.

Most of the radiated energy coming from the Sun passes through the Earth's atmosphere. The Earth absorbs some of this energy, and some is reflected back from the Earth's surface. Part of this reflected energy is absorbed by the atmosphere.

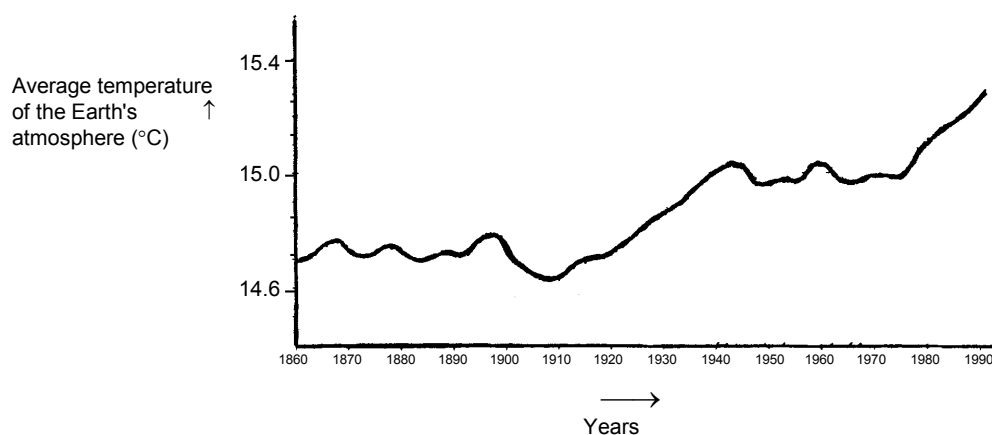
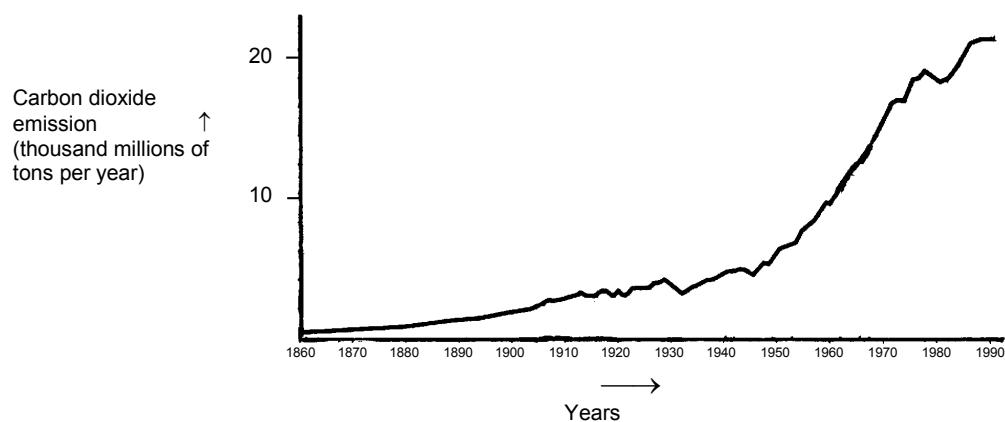
As a result of this the average temperature above the Earth's surface is higher than it would be if there was no atmosphere. The Earth's atmosphere has the same effect as a greenhouse, hence the term *greenhouse effect*.

The greenhouse effect is said to have become more pronounced during the twentieth century.

It is a fact that the average temperature of the Earth's atmosphere has increased. In newspapers and periodicals the increased carbon dioxide emission is often stated as the main source of the temperature rise in the twentieth century.

A student named André becomes interested in the possible relationship between the average temperature of the Earth's atmosphere and the carbon dioxide emission on the Earth.

In a library he comes across the following two graphs.



André concludes from these two graphs that it is certain that the increase in the average temperature of the Earth's atmosphere is due to the increase in the carbon dioxide emission.

Question 1: GREENHOUSE

S114Q03- 01 02 11 12 99

Question intent: Using scientific evidence

What is it about the graphs that supports André's conclusion?

.....

.....

SCORING:

Correct

Answers that refer to the increase of both (average) temperature and carbon dioxide emission.

Incorrect

Answers that refer to the increase of either the (average) temperature or the carbon dioxide emission.

Answers that refer to temperature and carbon dioxide emission without being clear about the nature of the relationship.

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 54%
U.S.: 54%

Question 2: GREENHOUSE

S114Q04- 01 02 03 11 12 13 14 15 21 99

Question intent: Using scientific evidence

Another student, Jeanne, disagrees with André's conclusion. She compares the two graphs and says that some parts of the graphs do not support his conclusion.

Give an example of a part of the graphs that does not support André's conclusion. Explain your answer.

.....

.....

.....

SCORING:***Fully Correct***

Answers that refer to one particular part of the graphs in which the curves are not both descending or both climbing and gives the corresponding explanation, such as:

- In 1900–1910 (about) CO₂ was increasing, whilst the temperature was going down.
- In 1980–1983 carbon dioxide went down and the temperature rose.
- The temperature in the 1800's is much the same but the first graph keeps climbing.
- Between 1950 and 1980 the temperature didn't increase but the CO₂ did.
- From 1940 until 1975 the temperature stays about the same but the carbon dioxide emission shows a sharp rise.
- In 1940 the temperature is a lot higher than in 1920 and they have similar carbon dioxide emissions.

Partially Correct

Answers that mention a correct period, without any explanation.

Answers that mention only one particular year (not a period of time), with an acceptable explanation.

Answers that give an example that doesn't support André's conclusion but makes a mistake in mentioning the period. *[Note: There should be evidence of this mistake – e.g. an area clearly illustrating a correct answer is marked on the graph and then a mistake made in transferring this information to the text.]*

Answers that refer to differences between the two curves, without mentioning a specific period.

Science Literacy

Answers that refer to an irregularity in one of the graphs.

Answers that indicate difference in the graphs, but explanation are poor.

Incorrect

Answers that refer to an irregularity in a curve without referring specifically to the two graphs.

Answers that refer to a poorly defined period or year without any explanation.

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 34%
U.S.: 29%

Question 3: GREENHOUSE

S114Q05- 01 02 03 11 12 99

Question intent: Explaining phenomena scientifically

André persists in his conclusion that the average temperature rise of the Earth's atmosphere is caused by the increase in the carbon dioxide emission. But Jeanne thinks that his conclusion is premature. She says: "Before accepting this conclusion you must be sure that other factors that could influence the greenhouse effect are constant".

Name one of the factors that Jeanne means.

.....

.....

SCORING:***Correct***

Answers that give a factor referring to the energy/radiation coming from the Sun.

Answers that give a factor referring to a natural component or a potential pollutant.

Incorrect

Answers that refer to a cause that influences the carbon dioxide concentration.

Answers that refer to a non-specific factor.

Other incorrect factors or other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 19%

U.S.: 18%

GENETICALLY MODIFIED CROPS

GM CORN SHOULD BE BANNED

Wildlife conservation groups are demanding that a new genetically modified (GM) corn be banned.

This GM corn is designed to be unaffected by a powerful new herbicide that kills conventional corn plants. This new herbicide will kill most of the weeds that grow in cornfields.

The conservationists say that because these weeds are feed for small animals, especially insects, the use of the new herbicide with the GM corn will be bad for the environment. Supporters of the use of the GM corn say that a scientific study has shown that this will not happen.

Here are details of the scientific study mentioned in the above article:

- Corn was planted in 200 fields across the country.
- Each field was divided into two. The genetically modified (GM) corn treated with the powerful new herbicide was grown in one half, and the conventional corn treated with a conventional herbicide was grown in the other half.
- The number of insects found in the GM corn, treated with the new herbicide, was about the same as the number of insects in the conventional corn, treated with the conventional herbicide.

Question 1: GENETICALLY MODIFIED CROPS

S508Q02

Question intent: Identifying scientific issues

What factors were deliberately varied in the scientific study mentioned in the article? Circle "Yes" or "No" for each of the following factors.

Was this factor deliberately varied in the study?	Yes or No?
The number of insects in the environment	Yes / No
The types of herbicide used	Yes / No

SCORING:***Correct***

Both correct: No, Yes in that order.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 61%
U.S.: 58%

Question 2: GENETICALLY MODIFIED CROPS

S508Q03

Question intent: Identifying scientific issues

Corn was planted in 200 fields across the country. Why did the scientists use more than one site?

- A So that many farmers could try the new GM corn.
- B To see how much GM corn they could grow.
- C To cover as much land as possible with the GM crop.
- D To include various growth conditions for corn.

SCORING:

Correct

Answer D. To include various growth conditions for corn.

Incorrect

Other responses.

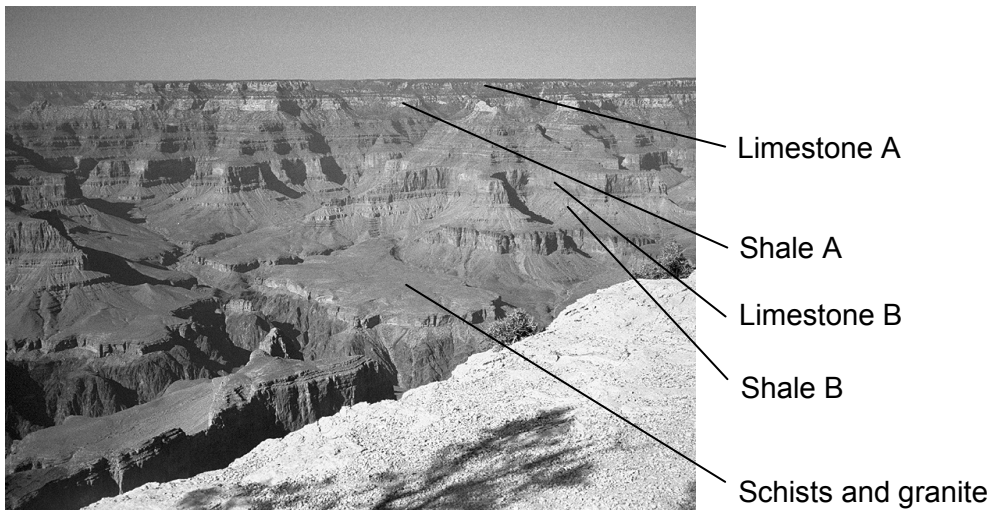
**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 74%
U.S.: 76%

THE GRAND CANYON

The Grand Canyon is located in a desert in the USA. It is a very large and deep canyon containing many layers of rock. Sometime in the past, movements in the Earth's crust lifted these layers up. The Grand Canyon is now 1.6 km deep in parts. The Colorado River runs through the bottom of the canyon.

See the picture below of the Grand Canyon taken from its south rim. Several different layers of rock can be seen in the walls of the canyon.



Question 1: THE GRAND CANYON

S426Q07

Question intent: Identifying scientific issues

About five million people visit the Grand Canyon national park every year. There is concern about the damage that is being caused to the park by so many visitors.

Can the following questions be answered by scientific investigation? Circle "Yes" or "No" for each question.

Can this question be answered by scientific investigation?	Yes or No?
How much erosion is caused by use of the walking tracks?	Yes / No
Is the park area as beautiful as it was 100 years ago?	Yes / No

SCORING:***Correct***

Yes, No in that order.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 61%
U.S.: 67%

Question 2: THE GRAND CANYON

S426Q03

Question intent: Explaining phenomena scientifically

The temperature in the Grand Canyon ranges from below 0 °C to over 40 °C. Although it is a desert area, cracks in the rocks sometimes contain water. How do these temperature changes and the water in rock cracks help to speed up the breakdown of rocks?

- A Freezing water dissolves warm rocks.
- B Water cements rocks together.
- C Ice smooths the surface of rocks.
- D Freezing water expands in the rock cracks.

SCORING:***Correct***

Answer D. Freezing water expands in the rock cracks.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 68%
U.S.: 72%

Question 3: THE GRAND CANYON

S426Q05

Question intent: Explaining phenomena scientifically

There are many fossils of marine animals, such as clams, fish and corals, in the Limestone A layer of the Grand Canyon. What happened millions of years ago that explains why such fossils are found there?

- A In ancient times, people brought seafood to the area from the ocean.
- B Oceans were once much rougher and sea life washed inland on giant waves.
- C An ocean covered this area at that time and then receded later.
- D Some sea animals once lived on land before migrating to the sea.

SCORING:***Correct***

Answer C. An ocean covered this area at that time and then receded later.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 76%

U.S.: 77%

ACID RAIN

Below is a photo of statues called Caryatids that were built on the Acropolis in Athens more than 2500 years ago. The statues are made of a type of rock called marble. Marble is composed of calcium carbonate.

In 1980, the original statues were transferred inside the museum of the Acropolis and were replaced by replicas. The original statues were being eaten away by acid rain.



Question 1: ACID RAIN

S485Q02 – 0 1 2 9

Question intent: Explaining phenomena scientifically

Normal rain is slightly acidic because it has absorbed some carbon dioxide from the air. Acid rain is more acidic than normal rain because it has absorbed gases like sulphur oxides and nitrogen oxides as well.

Where do these sulphur oxides and nitrogen oxides in the air come from?

.....

.....

SCORING:***Correct***

Answers that mention any one of: car exhausts, factory emissions, *burning* fossil fuels such as oil and coal, gases from volcanoes or other similar things.

Answers that include an incorrect as well as a correct source of the pollution.

Answers that refer to “pollution” but do not give a source of pollution that is a significant cause of acid rain.

Scoring Comment: Just mentioning “pollution” is sufficient for Full Credit.

Incorrect

Other responses, including responses that do not mention “pollution” *and* do not give a significant cause of acid rain.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 58%
U.S.: 54%

The effect of acid rain on marble can be modelled by placing chips of marble in vinegar overnight. Vinegar and acid rain have about the same acidity level. When a marble chip is placed in vinegar, bubbles of gas form. The mass of the dry marble chip can be found before and after the experiment.

Question 2: ACID RAIN

S485Q03

Question intent: Using scientific evidence

A marble chip has a mass of 2.0 grams before being immersed in vinegar overnight. The chip is removed and dried the next day. What will the mass of the dried marble chip be?

- A Less than 2.0 grams
- B Exactly 2.0 grams
- C Between 2.0 and 2.4 grams
- D More than 2.4 grams

SCORING:

Correct

Answer A. Less than 2.0 grams

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 67%
U.S.: 66%

Question 3: ACID RAIN

S485Q05 – 0 1 2 9

Question intent: Identifying scientific issues

Students who did this experiment also placed marble chips in pure (distilled) water overnight.

Explain why the students include this step in their experiment.

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.....

SCORING:***Fully Correct***

Answers such as:

- To show that the acid (vinegar) is necessary for the reaction.
- To make sure that rainwater must be acidic like acid rain to cause this reaction.
- To see whether there are other reasons for the holes in the marble chips.
- Because it shows that the marble chips don't just react with any fluid since water is neutral.

Partially Correct

Answers which compare with the test of vinegar and marble, but it is not made clear that this is being done to show that the acid (vinegar) is necessary for the reaction.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 36%
U.S.: 35%

PHYSICAL EXERCISE

Regular but moderate physical exercise is good for our health.



Question 1: PHYSICAL EXERCISE

S493Q01

Question intent: Explaining phenomena scientifically

What are the advantages of regular physical exercise? Circle “Yes” or “No” for each statement.

Is this an advantage of regular physical exercise?	Yes or No?
Physical exercise helps prevent heart and circulation illnesses.	Yes / No
Physical exercise leads to a healthy diet.	Yes / No
Physical exercise helps to avoid becoming overweight.	Yes / No

SCORING:***Correct***

All three correct: Yes, No, Yes in that order.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 53%
U.S.: 41%

Question 2: PHYSICAL EXERCISE

S493Q03

Question intent: Explaining phenomena scientifically

What happens when muscles are exercised? Circle “Yes” or “No” for each statement.

Does this happen when muscles are exercised?	Yes or No?
Muscles get an increased flow of blood.	Yes / No
Fats are formed in the muscles.	Yes / No

SCORING:***Correct***

Both correct: Yes, No in that order.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 82%
U.S.: 76%

Question 3: PHYSICAL EXERCISE

S493Q05 – 01 11 12 99

Question intent: Explaining phenomena scientifically

Why do you have to breathe more heavily when you're doing physical exercise than when your body is resting?

.....

.....

.....

SCORING:

Correct

To remove *increased* levels of carbon dioxide **and** to supply *more* oxygen to your body. *[Do not accept "air" instead of "carbon dioxide" or "oxygen".]*

To remove *increased* levels of carbon dioxide from your body **or** to supply *more* oxygen to your body, but not both. *[Do not accept "air" instead of "carbon dioxide" or "oxygen".]*

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 45%
U.S.: 41%

SUNSCREENS

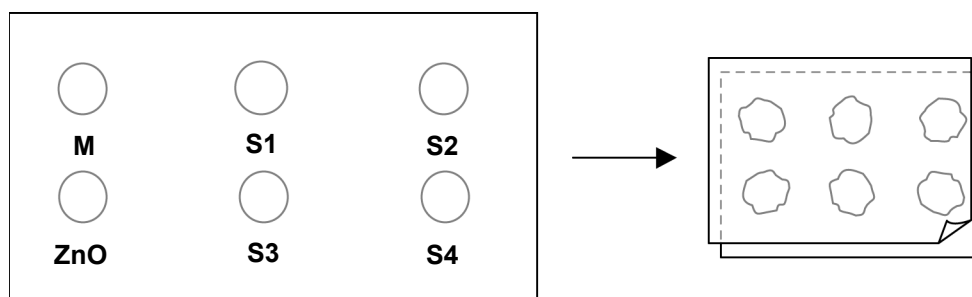
Mimi and Dean wondered which sunscreen product provides the best protection for their skin. Sunscreen products have a *Sun Protection Factor (SPF)* that shows how well each product absorbs the ultraviolet radiation component of sunlight. A high SPF sunscreen protects skin for longer than a low SPF sunscreen.

Mimi thought of a way to compare some different sunscreen products. She and Dean collected the following:

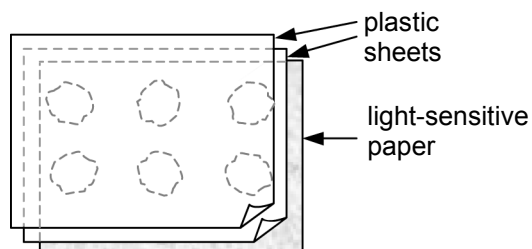
- two sheets of clear plastic that do not absorb sunlight;
- one sheet of light-sensitive paper;
- mineral oil (M) and a cream containing zinc oxide (ZnO); and
- four different sunscreens that they called S1, S2, S3, and S4.

Mimi and Dean included mineral oil because it lets most of the sunlight through, and zinc oxide because it almost completely blocks sunlight.

Dean placed a drop of each substance inside a circle marked on one sheet of plastic, and then put the second plastic sheet over the top. He placed a large book on top of both sheets and pressed down.



Mimi then put the plastic sheets on top of the sheet of light-sensitive paper. Light-sensitive paper changes from dark gray to white (or very light gray), depending on how long it is exposed to sunlight. Finally, Dean placed the sheets in a sunny place.



Question 1: SUNSCREENS

S447Q02

Question intent: Identifying scientific issues

Which one of these statements is a scientific description of the role of the mineral oil and the zinc oxide in comparing the effectiveness of the sunscreens?

- A Mineral oil and zinc oxide are both factors being tested.
- B Mineral oil is a factor being tested and zinc oxide is a reference substance.
- C Mineral oil is a reference substance and zinc oxide is a factor being tested.
- D Mineral oil and zinc oxide are both reference substances.

SCORING:

Correct

Answer D. Mineral oil and zinc oxide are both reference substances.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 40%
U.S.: 36%

Question 2: SUNSCREENS

S447Q03

Question intent: Identifying scientific issues

Which one of these questions were Mimi and Dean trying to answer?

- A How does the protection for each sunscreen compare with the others?
- B How do sunscreens protect your skin from ultraviolet radiation?
- C Is there any sunscreen that gives less protection than mineral oil?
- D Is there any sunscreen that gives more protection than zinc oxide?

SCORING:

Correct

Answer A. How does the protection for each sunscreen compare with the others?

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 58%
U.S.: 62%

Question 3: SUNSCREENS

S447Q04

Question intent: Identifying scientific issues

Why was the second sheet of plastic pressed down?

- A To stop the drops from drying out.
- B To spread the drops out as far as possible.
- C To keep the drops inside the marked circles.
- D To make the drops the same thickness.

SCORING:

Correct

Answer D. To make the drops the same thickness.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 43%
U.S.: 37%

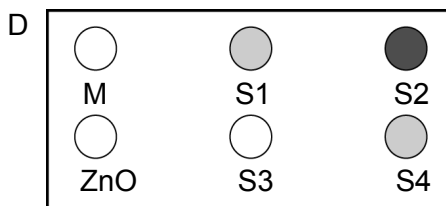
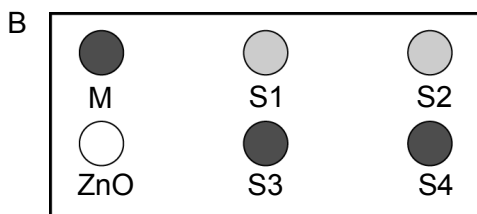
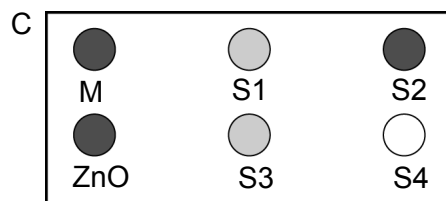
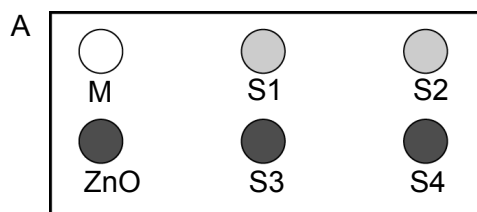
Question 4: SUNSCREENS

S447Q05 – 0 1 2 9

Question intent: Using scientific evidence

The light-sensitive paper is a dark gray and fades to a lighter gray when it is exposed to some sunlight, and to white when exposed to a lot of sunlight.

Which one of these diagrams shows a pattern that might occur? Explain why you chose it.



Answer:

Explanation:

.....

.....

SCORING:

Fully Correct

Answer A. With explanation that the ZnO spot has stayed dark gray (because it blocks sunlight) **and** the M spot has gone white (because mineral oil absorbs very little sunlight).

*[It is **not** necessary (though it is sufficient) to include the further explanations that are shown in parentheses.]*

Partially Correct

Answer A. Gives a correct explanation for either the ZnO spot **or** the M spot, but **not** both.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 27%
U.S.: 27%

MARY MONTAGU

Read the following newspaper article and answer the questions that follow.

THE HISTORY OF VACCINATION

Mary Montagu was a beautiful woman. She survived an attack of smallpox in 1715 but she was left covered with scars. While living in Turkey in 1717, she observed a method called inoculation that was commonly used there. This treatment involved scratching a weak type of smallpox virus into the skin of healthy young people who then became sick, but in most cases only with a mild form of the disease.

Mary Montagu was so convinced of the safety of these inoculations that she allowed her son and daughter to be inoculated.

In 1796, Edward Jenner used inoculations of a related disease, cowpox, to produce antibodies against smallpox. Compared with the inoculation of smallpox, this treatment had less side effects and the treated person could not infect others. The treatment became known as vaccination.

Question 1: MARY MONTAGU

S477Q02

Question intent: Explaining phenomena scientifically

What kinds of diseases can people be vaccinated against?

- A Inherited diseases like haemophilia.
- B Diseases that are caused by viruses, like polio.
- C Diseases from the malfunctioning of the body, like diabetes.
- D Any sort of disease that has no cure.

SCORING:

Correct

Answer B. Diseases that are caused by viruses, like polio.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 75%
U.S.: 73%

Question 2: MARY MONTAGU

S477Q03

Question intent: Explaining phenomena scientifically

If animals or humans become sick with an infectious bacterial disease and then recover, the type of bacteria that caused the disease does not usually make them sick again.

What is the reason for this?

- A The body has killed all bacteria that may cause the same kind of disease.
- B The body has made antibodies that kill this type of bacteria before they multiply.
- C The red blood cells kill all bacteria that may cause the same kind of disease.
- D The red blood cells capture and get rid of this type of bacteria from the body.

SCORING:

Correct

Answer B. The body has made antibodies that kill this type of bacteria before they multiply.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 75%
U.S.: 70%

Question 3: MARY MONTAGU

S477Q04 – 0 1 9

Question intent: Explaining phenomena scientifically

Give one reason why it is recommended that young children and old people, in particular, should be vaccinated against influenza (flu).

.....

.....

.....

SCORING:***Correct***

Answers referring to young and/or old people having weaker immune systems than other people, or similar.

The reason(s) given must refer to young or old people *in particular*—not to everyone in general. Also, the response must indicate, directly or indirectly, that these people have weaker immune systems than other people—not just that they are generally “weaker”.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 62%
U.S.: 51%

CLOTHES

Read the text and answer the questions that follow.

CLOTHES TEXT

A team of British scientists is developing “intelligent” clothes that will give disabled children the power of “speech”. Children wearing waistcoats made of a unique electrotexile, linked to a speech synthesiser, will be able to make themselves understood simply by tapping on the touch-sensitive material.

The material is made up of normal cloth and an ingenious mesh of carbon-impregnated fibers that can conduct electricity. When pressure is applied to the fabric, the pattern of signals that passes through the conducting fibers is altered and a computer chip can work out where the cloth has been touched. It then can trigger whatever electronic device is attached to it, which could be no bigger than two boxes of matches.

“The smart bit is in how we weave the fabric and how we send signals through it – and we can weave it into existing fabric designs so you cannot see it’s in there,” says one of the scientists.

Without being damaged, the material can be washed, wrapped around objects or crunched up. The scientist also claims it can be mass-produced cheaply.

Source: Steve Farrer, ‘Interactive fabric promises a material gift of the garb’, *The Australian*, 10 August 1998.

Question 1: CLOTHES

S213Q01

Question intent: Identifying scientific issues

Can these claims made in the article be tested through scientific investigation in the laboratory?

Circle either “Yes” or “No” for each.

The material can be	Can the claim be tested through scientific investigation in the laboratory?
washed without being damaged.	Yes / No
wrapped around objects without being damaged.	Yes / No
scrunched up without being damaged.	Yes / No
mass-produced cheaply.	Yes / No

SCORING:***Correct***

Yes, Yes, Yes, No, in that order.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 48%
U.S.: 50%

Question 2: CLOTHES

S213Q02

Question intent: Explaining phenomena scientifically

Which piece of laboratory equipment would be among the equipment you would need to check that the fabric is conducting electricity?

- A Voltmeter
- B Light box
- C Micrometer
- D Sound meter

SCORING:

Correct

Answer A. Voltmeter.

Incorrect

Other responses.

**Percentage of students
answering correctly in
PISA 2006:**

OECD average: 79%
U.S.: 69%