PROGRAMME FOR INTERNATIONAL SCHOOL ASSESSMENT (PISA)

Making Test items

Day :2

Session: 6

Programme for International Student Assessment

Developing Questions For PISA -2021

Scientific Literacy—The structure of the assessment

Item response formats

- Students are presented with units that require them to construct a response to a stimulus and a series of questions (or “items”)
- Context is represented in each unit by the stimulus material, which is typically a brief written passage or text accompanying a table, chart , graph, photograph or diagram.

Each unit contains several questions or items

Scientific Literacy—The structure of the assessment

Item response formats

- While students need to possess a certain level of reading competency in order to understand and answer the science items, the stimulus material uses language that is as clear, simple and brief as possible while still conveying the appropriate meaning

Scientific Literacy—The structure of the assessment

Item response formats

- More importantly, the items require students to use one or more of the scientific competencies as well as knowledge of science and/or knowledge about science

Distribution of items

Three types of items are used to assess the competencies and scientific knowledge identified in the framework:

* **Simple multiple-choice items**

– items calling for selection of a single response from four options

– selection of a “hot spot”, an answer that is a selectable element within a graphic or text

Distribution of items

Three types of items are used to assess the competencies and scientific knowledge identified in the framework:

***complex multiple-choice items**

– items calling for responses to a series of related "Yes/No" questions that are treated for scoring as a single item

– selection of more than one response from a list

Distribution of items

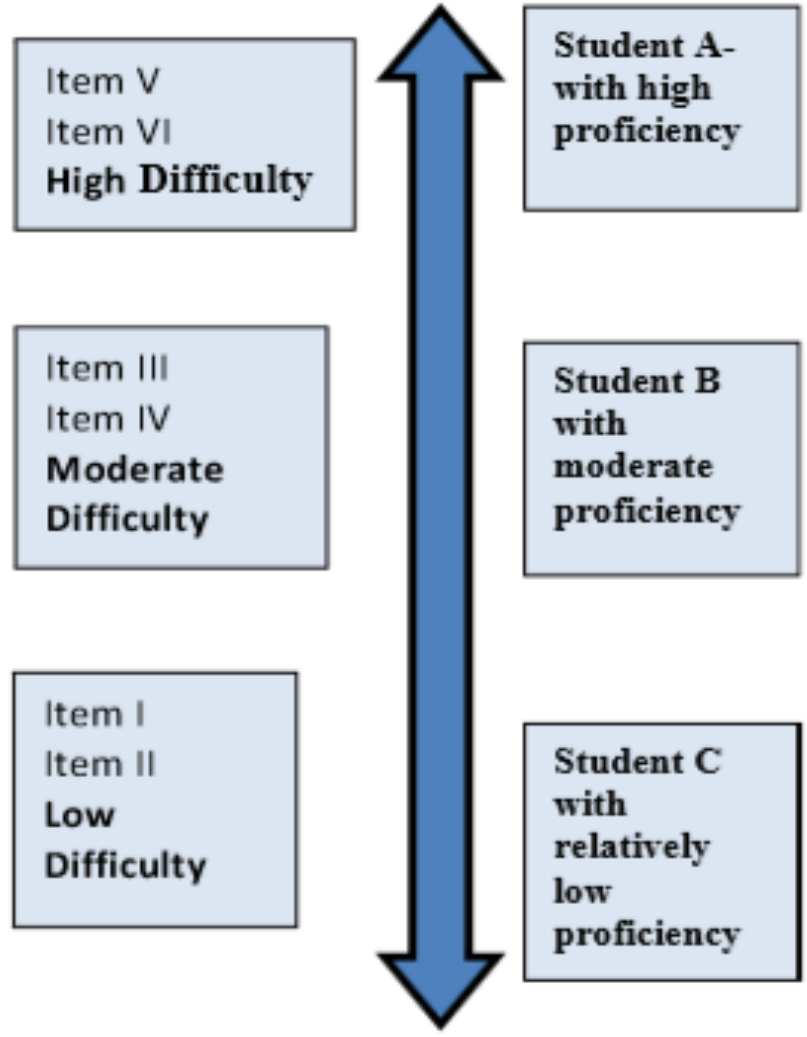
*__Constructed-response items- (Open and Closed)__

items calling for written or drawn responses

Constructed- response items in scientific literacy typically call for a written response ranging from a phrase to a short paragraph
(e.g. two to four sentences of explanation).
A small number of constructed-response items call for drawing (e.g. a graph or diagram).

Besides binary choice questions are also asked.

Scaling the Scientific Literacy tasks
&
Scientific Literacy Scale



It is expected that student A will be able to complete items I to V successfully, and probably item VI as well.

It is expected that student B will be able to complete items I, II and III successfully, will have a lower probability of completing item IV and is unlikely to complete items V and VI successfully.

.

It is expected that student C will be unable to complete items II to VI successfully, and will also have a low probability of completing item I successfully

Let us look at all the reasons why PISA assessments turn out to be difficult for most Indian students.

The mentality that questions can only be from the textbook or minor variants of textbook questions

READING, READING, READING!

Our average student has very poor reading abilities and usually prefers to guess what the question must be by glancing through it.

Process of answering questions – pattern matching versus problem solving

The strategy that students use to solve questions in typical Indian exams is very different from what is needed for tests like PISA

Being put off by the unfamiliar and not proceeding further

Many students freeze at the first sign of the unfamiliar and decide that they have not ‘learnt this question type’ and cannot solve it.

Genuinely low understanding of processes or concepts and even comprehension skills

Actual learning levels and understanding of concepts is low

Anatomy of PISA Style Science Questions

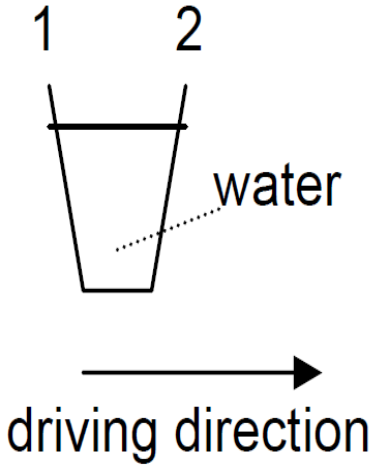
SCIENCE PASSAGE 1: BUSES

A bus is driving along a straight stretch of road. The bus driver, named Ray, has a cup of water resting on the dashboard:
Suddenly Ray has to slam on the brakes.

Question -1

What is most likely to happen to the water in the cup?

A :The water will stay horizontal.
B :The water will spill over side 1.
C :The water will spill over side 2.
D :The water will spill but you cannot tell if it will spill at side 1 or side 2.



BUSES SCORING 1

QUESTION INTENT:

Context: Science & technology

Situation: Personal

Process: Demonstrating knowledge and understanding

Theme: Forces and movement

Level: Medium

Question Format : MCQ type

Full credit C. The water will spill over side 2.

No credit Other responses & Missing.

Question 2: BUSES

Ray's bus is, like most buses, powered by a petrol engine. These buses contribute to environmental pollution.

Some cities have trolley buses: they are powered by an electric engine.

The voltage needed for such an electric engine is provided by overhead lines (like electric trains).

The electricity is supplied by a power station using fossil fuels.

Supporters for the use of trolley buses in a city say that these buses don't contribute to environmental pollution.

Are these supporters right? Explain your answer.

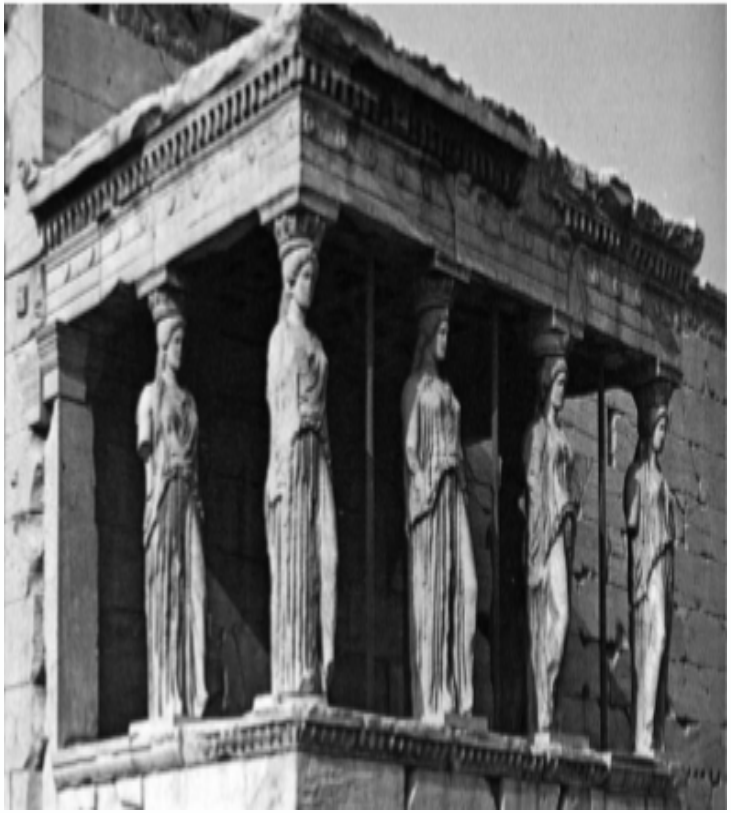
.....

The process being assessed is demonstrating knowledge and understanding.
Full credit: Gives an answer in which it is stated that the power station also contributes to environmental pollution, such as:
*No, because the power station causes environmental pollution as well.
* Yes, but this is only true for the city itself; the power station however causes environmental pollution.
No credit: No or yes without a correct explanation and missing.

QUESTION INTENT:
Context: Science & technology
Situation: Personal
Process: Demonstrating knowledge and understanding
Theme: Forces and movement
Level: Medium
Question format: Open constructed response

SCIENCE PASSAGE 2: ACID RAIN

This is a photo of statues called Caryatids that were built on the Acropolis in Athens more than 2500 years ago. The statues are made up 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

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 sulfur oxides and nitrogen oxides as well. Where do these sulphur oxides and nitrogen oxides in the air come from?

Examples of correct answers (full credit only): Gives any one of car exhausts, factory emissions, burning fossil fuels, or similar, or just refers to pollution.

Examples of incorrect answers: Responses that do not mention ‘pollution’ and do not give a significant cause of acid rain.

Context: Environment
Situation: Global Process: Explaining phenomena scientifically;
Physical systems
Level: High
Question format: Short constructed response

Question 2: Acid Rain

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. 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

Full credit A. Less than 2.0 grams

No credit Other responses & Missing.

Context: Environment
Situation: Personal Process: Using scientific evidence;Physical systems
Level:Medium
Question format: Multiple choice

Question 3: Acid Rain

Students who did this experiment also placed marble chips in pure (distilled) water overnight.
Explain why the students include this step in their experiment.

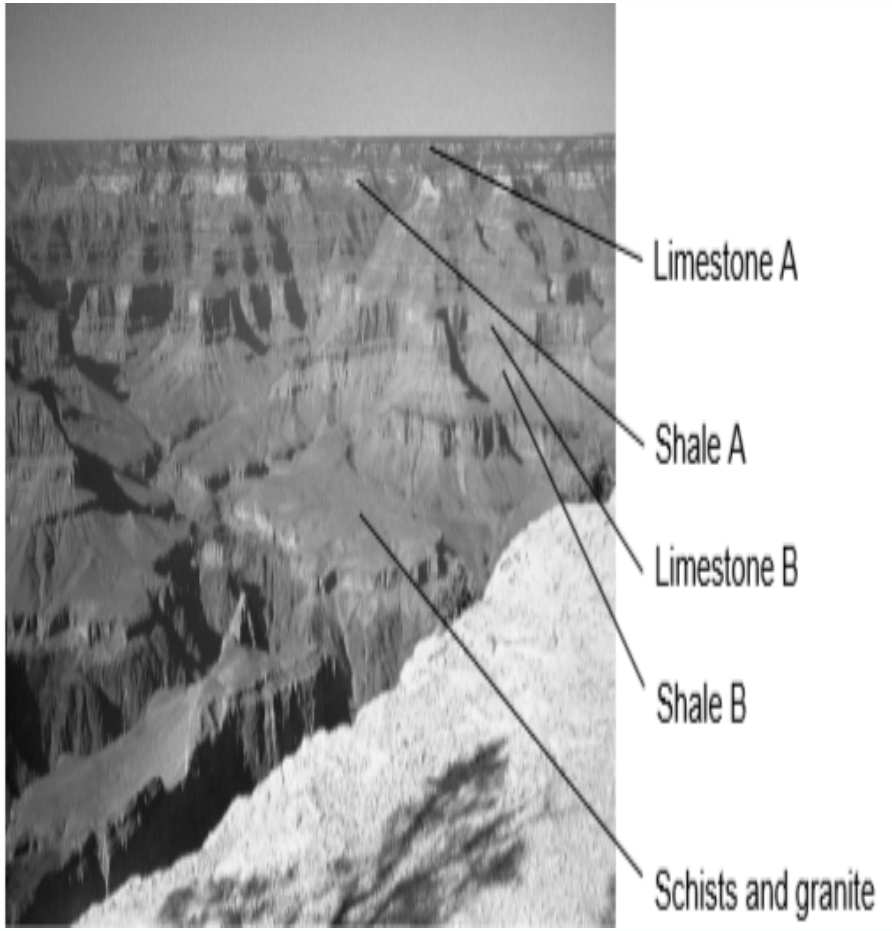
Examples of correct answers (full credit only): Response explains that the students used water to show that acid (vinegar) is necessary for the reaction.

Examples of incorrect answers: Refers to a comparison with the vinegar and marble test, without clarifying that vinegar is necessary for the reaction; other insufficient, vague, or irrelevant responses.

Context: Environment
Situation: Personal
Process: Identifying scientific issues; Scientific enquiry
Level: Medium
Question format: Open constructed response

SCIENCE PASSAGE 3: 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

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/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

Full credit Yes Yes No
No credit Other responses & Missing.

Context: Environment
Situation: Social

Process: Identifying scientific issues; Scientific enquiry
Earth and space systems

Level: Medium
Question format: Complex multiple choice

Question 2: The Grand Canyon

The temperature in the Grand Canyon ranges from below 0 ^{o}C to over 40 ^{o}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 smoothes the surface of rocks.
D Freezing water expands in the rock cracks.

Full credit

D. Freezing water expands in the rock cracks.

No credit Other responses & Missing.

Context: Environment
Situation: Social
Process: Explaining phenomena scientifically;
Earth and space systems
Level : High
Question format: Multiple choice

Question 3: The Grand Canyon

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.

Full credit

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

No credit Other responses & Missing.

Context; Environment
Situation: Global
Process: Explaining phenomena scientifically;Earth and space systems

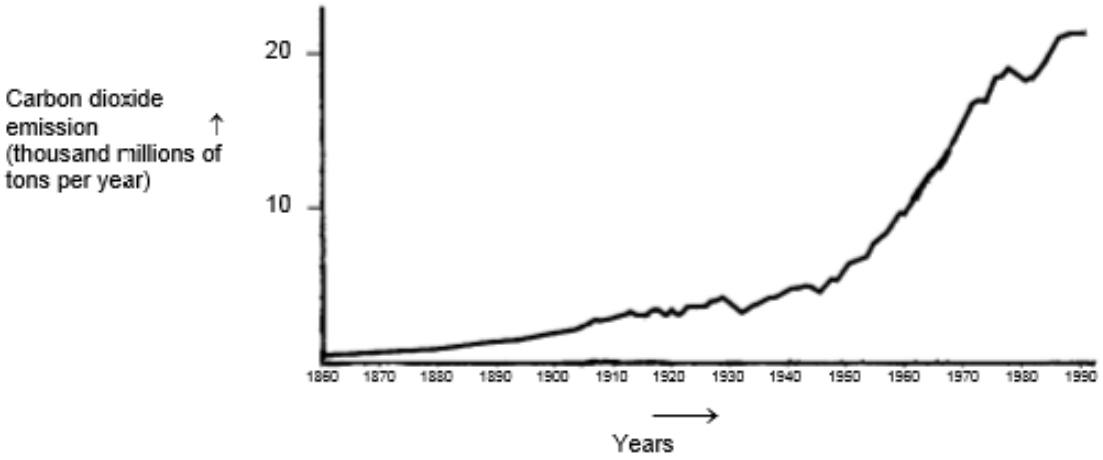
Level: High
Question format: Multiple choice

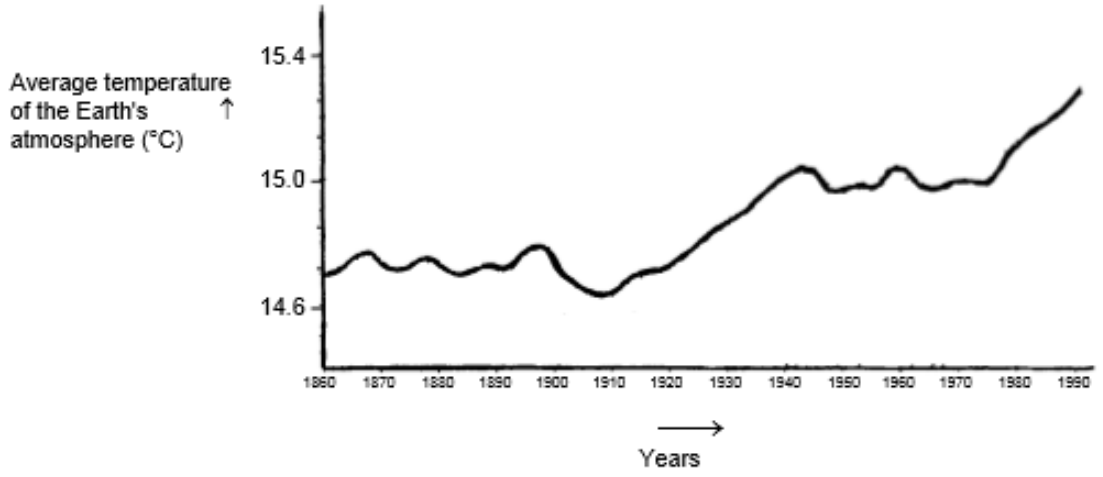
SCIENCE PASSAGE 4: THE GREENHOUSE EFFECT: FACT OR FICTION?

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.

SCIENCE PASSAGE 4: THE GREENHOUSE EFFECT: FACT OR FICTION?

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.


Carbon dioxide emission ↑ (thousand millions of tons per year)
20
10
1860 1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990
Years


Average temperature of the Earth's atmosphere (°C) ↑
15.4
15.0
14.6
1860 1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990
Years

SCIENCE PASSAGE 4: THE GREENHOUSE EFFECT: FACT OR FICTION?

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.

SCIENCE PASSAGE 4: THE GREENHOUSE EFFECT: FACT OR FICTION?

Question 1: GREENHOUSE
Question intent: Using scientific evidence
What is it about the graphs that supports André's conclusion?

……

SCIENCE PASSAGE 4: THE GREENHOUSE EFFECT: FACT OR FICTION?

Question 1

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.

Context: Environment
Situation: Global

Process: Using scientific evidence

Level : High
Question format: Open constructed type

SCIENCE PASSAGE 4: THE GREENHOUSE EFFECT: FACT OR FICTION?

Question 2: GREENHOUSE
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.

.....

SCIENCE PASSAGE 4: THE GREENHOUSE EFFECT: FACT OR FICTION?

Question 2

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) CO_2 was increasing, whilst the temperature was going down.

In 1980–1983 carbon dioxide went down and the temperature rose.

SCIENCE PASSAGE 4: THE GREENHOUSE EFFECT: FACT OR FICTION?

Question 2

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 CO_2 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.

Question 2

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.

Question 2

Partially Correct

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.

Question 2

Partially Correct

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

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

Question 2

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.

Context: Environment
Situation: Global
Process: Using scientific evidence
Level : High
Question format: Open constructed type

SCIENCE PASSAGE 4: THE GREENHOUSE EFFECT: FACT OR FICTION?

Question 3:

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.

.....

Question 3:

Question intent: Explaining phenomena scientifically

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.

Question 3:

Question intent: Explaining phenomena scientifically

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.

Context: Environment
Situation: Global
Process: Explaining phenomena scientifically
Level : High
Question format: Open constructed type

SCIENCE PASSAGE 5: PHYSICAL EXERCISE

Regular but moderate physical exercise is good for our health.

SCIENCE PASSAGE 5: PHYSICAL EXERCISE

Question 1: PHYSICAL EXERCISE

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

SCIENCE PASSAGE 5: PHYSICAL EXERCISE

Question 1: PHYSICAL EXERCISE
Question intent: Explaining phenomena scientifically

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

Incorrect
Other responses.

Context: Health
Situation: Social/Personal
Process: Explaining phenomena scientifically
Level : Medium
Question format: Complex MCQ

SCIENCE PASSAGE 5: PHYSICAL EXERCISE

Question 2: PHYSICAL EXERCISE

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 /No
Muscles get an increased flow of blood.	Yes/ No
Fats are formed in the muscles.	Yes/ No

SCIENCE PASSAGE 5: PHYSICAL EXERCISE

Question 2: PHYSICAL EXERCISE

SCORING:

Correct Both correct: Yes, No in that order.

Incorrect Other responses.

Context: Health
Situation: Social/Personal
Process: Explaining phenomena scientifically
Level : High
Question format: Complex MCQ

Question 3: PHYSICAL EXERCISE
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?

.....

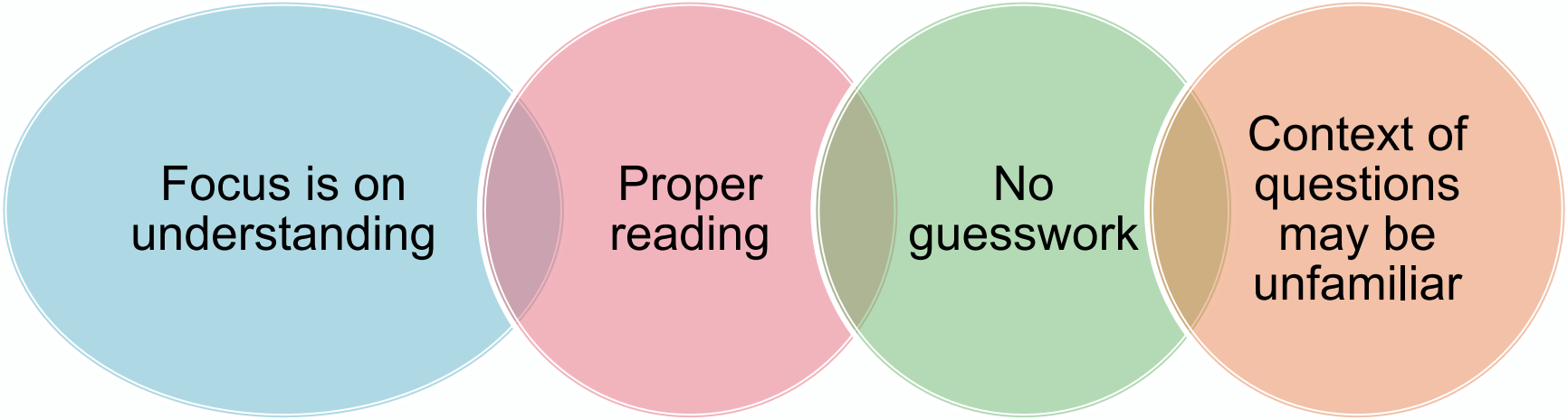
Question 3: PHYSICAL EXERCISE

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.

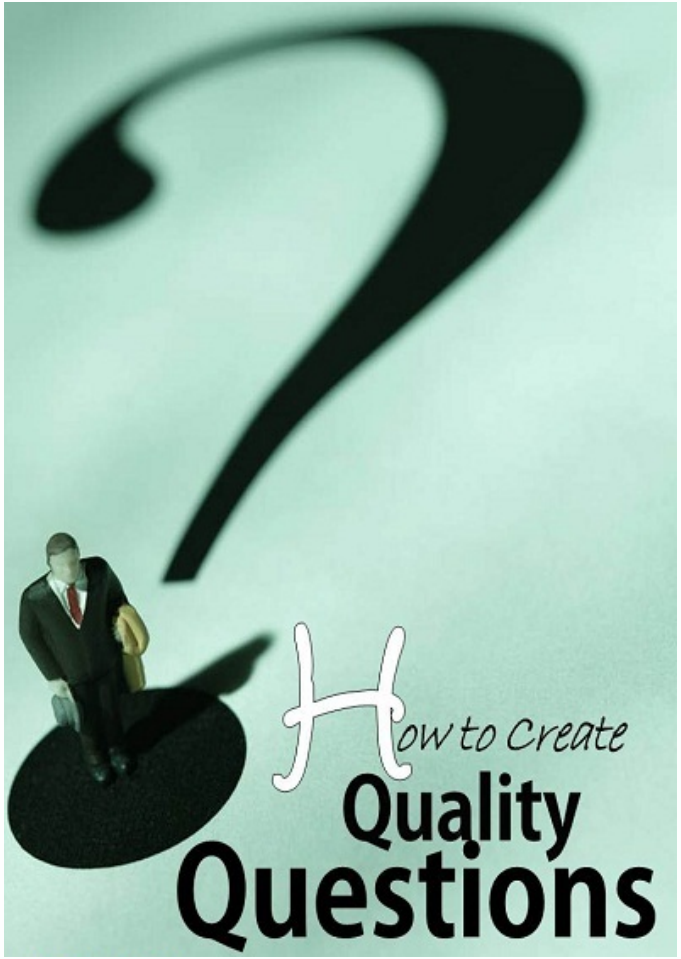
Context: Health
Situation: Social/Personal
Process: Explaining phenomena scientifically
Level : High
Question format: Closed construct type

Thus PISA test is different



Let's discuss

Let us see



Developing PISA Science Questions

Step -1

Identification of Concept/Topic on which Questions are to be framed

Developing PISA Science Questions

Step - 2

List the major and minor concept/ideas connected to the topic

Developing PISA Science Questions

Step -3

write related stanza in clear, understandable and unambiguous language

Developing PISA Science Questions

Step - 4

Support written brief with relevant pictures ,data , graph etc

Developing PISA Science Questions

Step - 5

Shortlist the possible concept /ideas that can be tested in the light of PISA Scientific Literacy Competencies

Developing PISA Science Questions

Step - 6

Now frame questions considering PISA Scientific Literacy Competencies

Developing PISA Science Questions

Step - 7

Analyse each Question as follows

Context/Area
Situation
Process
Level
Item response format

Developing PISA Science Questions

Step - 8

Write probable answer/answers

For MCQ:
One correct option and 3 incorrect options
For Open constructed questions: all possible answers

Developing PISA Science Questions

Please avoid using common errors committed / misconceptions prevailing in students

Q.1 SMOG:The word smog is derived from smoke and fog. It is an airborne pollution It is caused by small particles of material which become concentrated in the air for a variety of reasons. Commonly, smog is caused by an inversion, in which cool air presses down on a column of warm air, forcing the air to remain stationary.

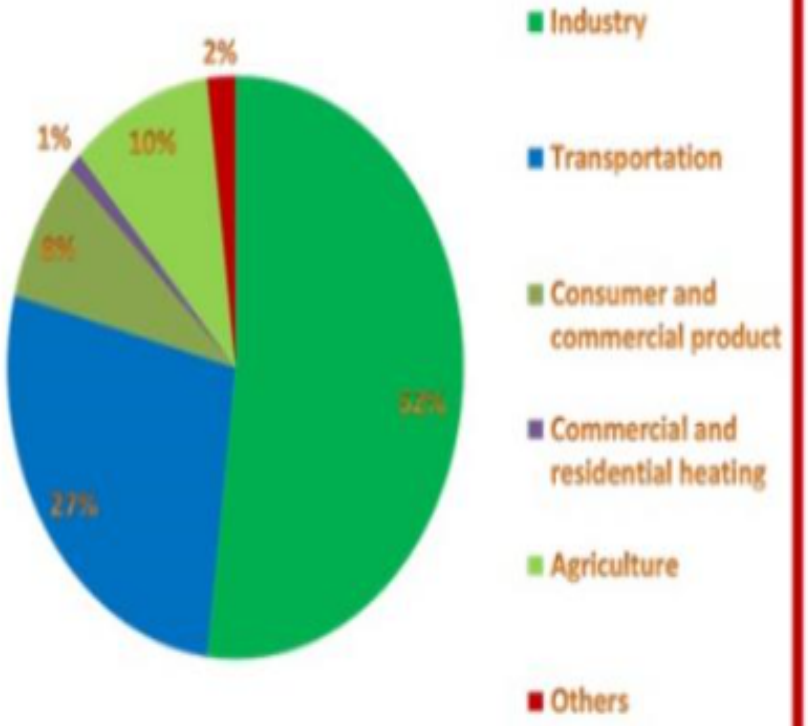
There are two types of smog:classical and photochemical smog.

Classical smog occurs in cool humid climate. It is a mixture of smoke, fog and sulphur dioxide. It is also called reducing smog.

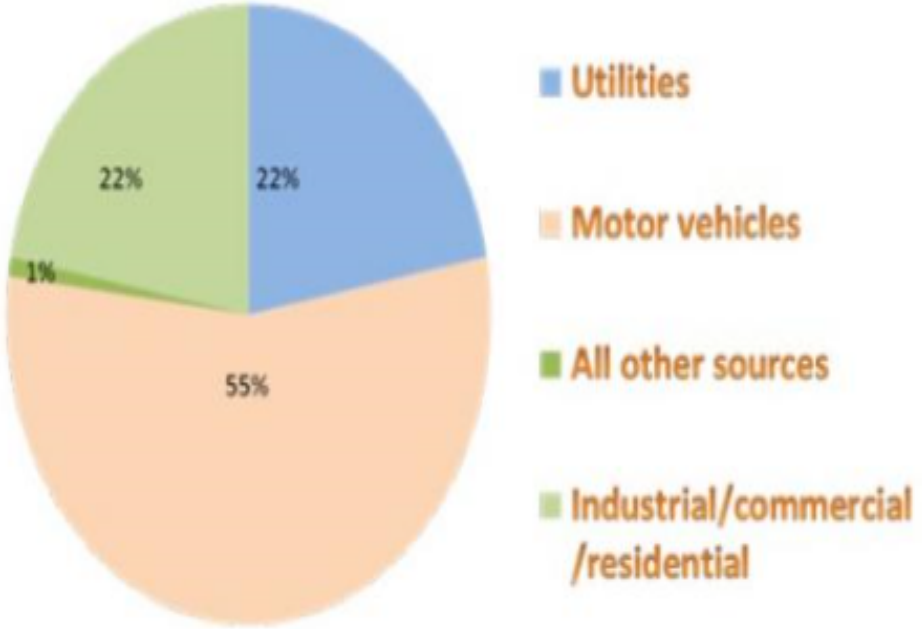
Photochemical smog occurs in warm and dry sunny climate. It is formed due to chemical reaction between sunlight and pollutants like hydrocarbons and nitrogen dioxide. It has high concentration of oxidizing agents and therefore ,it is also called as oxidizing smog.

Health effects of smog include breathing problems, cough, eye, nose and throat irritation, heart diseases, reduced resistance to colds and pneumonia.
Environmental effects involve damage to plants and trees. Additionally, Smog reduces visibility considerably leads to traffic chaos.

Contribution of various sources in smog formation



Sources of nitrogen oxides



Q.1.1 SMOG is caused due to:

A. Emissions from vehicles
B. From incinerators
C. Oil paints
D. All of the above

Context: Environment
Situation: Global
Process: Explaining phenomena scientifically
Level : Medium
Question format: MCQ

Scoring

Full credit D. All of the above

No credit Other responses & Missing.

Q.1.2 Which of the following is the major photochemical smog?

A. Peroxyl acetyl nitrate
B. Sulphur dioxide
C. Hydrogen peroxide
D. Chlorofluorocarbon

Context: Environment
Situation: Global
Process: Explaining phenomena scientifically
Level : High
Question format: MCQ

Scoring

Full credit D. Chlorofluorocarbon

No credit Other responses & Missing.

Q.1.3 Photochemical smog is misnomer as it does not contain any smoke or fog. Why is it so called ?

.....

.....

Context: Environment
Situation: Global
Process: Explaining phenomena scientifically
Level : Medium
Question format: Close construct type

Scoring

Full credit Ans It takes place in presence of sunlight

No credit Other responses & Missing.

Q.1.4 Classical smog is also known as London smog and photochemical smog is also known as Los Angeles smog. In this context circle ‘Agree’ or ‘Disagree’ for each of the followings facts:

a.Photochemical smog is formed during summer season. Agree/Disagree
b. Classical smog is oxidizing in nature. Agree/Disagree
c. Classical smog is formed due to reaction of sulfur dioxide gas and water. Agree/Disagree

Context: Environment
Situation: Global
Process: Explaining phenomena scientifically
Level : High
Question format: Complex MCQ

Scoring

Full credit Ans a.agree
b.disagree
c.agree

No credit Other responses & Missing.

Q.1.5 Give any two methods to control smog formation.

.....

.....

Context: Environment
Situation: Global
Process: Explaining phenomena scientifically
Level : Medium
Question format: Open construct type

Scoring

Full credit Ans Any two methods as
Use of renewable energy in place of coal in power plants
Reducing and managing vehicular and industrial emissions
Increasing energy efficiency and conserving energy
Use of environmentally friendly consumer products
Tight emissionsregulations on vehicles and factories are one such step
Use of hybrid or electrical vehicle
Use of bicycle
Car/Bus pooling
Government agencies must monitor air quality through testing, citing companies which violate the law and issuing warnings when smog levels are dangerous. etc

No credit Other responses & Missing.

Q.2 Dengue is a mosquito-borne viral infection causing a severe flu-like illness and, sometimes causing a potentially lethal complication called severe dengue. The incidence of dengue has increased 30-fold over the last 50 years.

The full life cycle of dengue fever virus involves the role of mosquito as a transmitter (or vector) and humans as the main victim and source of infection. The female *Aedes aegypti* mosquito is the main vector that transmits the dengue virus (DEN). The viruses are passed on to humans through the bites of an infective female *Aedes* mosquito, which mainly acquires the virus while feeding on the blood of an infected person.

Symptoms of dengue fever closely resembles with chikungunya, and Zika fever.

Symptoms, which usually begin four to six days after infection and last for up to 10 days, may include Sudden high fever,Severe headaches,Severe joint and muscle pain,Skin rashes, bleeding from body opening /orifice etc.

Q.2.1 Incubation period is the time elapsed between exposure to a pathogenic organism (a chemical, or radiation) and when symptoms and signs are first apparent. What happens during this period?

……

……

Context: Health
Situation: Global
Process: Explaining phenomena scientifically
Level : High
Question format: Closed construct type

Scoring

Full credit
In a typical infectious disease, incubation period signifies the period taken by the multiplying organism to reach a threshold, necessary to produce symptoms in the host.
No credit Other responses & Missing.

Q.2.2 In the context of dengue fever circle ‘Agree’ or ‘Disagree’ for each of the following facts:

Mosquitos are the source of infection for dengue fever	Agree/ disagree
Dengue fever effects blood platelets count of the infected person	**Agree/ disagree**
Sudden high fever, joint pain and skin rashes are not always an indicator of dengue fever.	**Agree/ disagree**

Context: Health
Situation: Global
Process: Explaining phenomena scientifically
Level : Medium
Question format: Complex MCQ

Full credit Disagree,
agree,
agree in this order

No credit Other responses & Missing.

Q.2.3 Dengue fever usually remains associated with Nasal/oral/vaginal bleeding.
Give probable cause of that .

Context: Health
Situation: Global
Process: Explaining phenomena scientifically
Level : High
Question format: Closed construct type

Full credit : Dengue virus, the main cause of dengue fever induces bone marrow suppression. Since bone marrow is the manufacturing centre of blood cells its suppression causes deficiency of blood cells leading to low platelets count. Low platelets count is responsible for gum bleeding and bleeding from body orifices /openings(internal and external) as Nasal opening /Ear opening/vaginal etc.

No credit: Other responses & Missing.

Let us Start