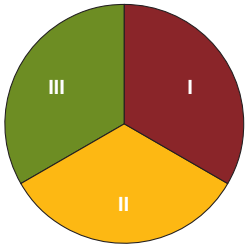
General Science: Content Essays (0433)

Test at a Glance

Test Name	General Science: Content Essays
Test Code	0433
Time	1 hour
Number of Questions	3 essay questions, one each in physical science, life science, and earth/space science
Format	Multipart questions requiring extended written responses in English



Content Categories	Approximate Number of Questions	Approximate Percentage of Examination
I. Fundamental Concepts in Physical Science	1	33.3%
II. Fundamental Concepts in Life Science	1	33.3%
III. Fundamental Concepts in Earth and Space Science	1	33.3%

About this test

The General Science: Content Essays test measures the knowledge and competencies necessary for a beginning teacher of secondary school general science. The test assesses the beginning teacher's ability to use and analyze critical concepts in science and to integrate knowledge from science, technology, and society. These questions cover topics that examinees will have studied in freshman college-level courses in chemistry, physics, the life sciences, and earth sciences.

Each of the three equally weighted questions focus on one of the content areas of physical science, life science, or earth and space science. (For a description of these content areas, see Tests 0431 and 0432.) Each question is framed within a specific scientific skill or context: concepts, models, systems, and patterns; data analysis, experimental design, and investigations; or science, technology, and society. Thus, a question might involve the content area of life science and be framed within the perspective of models or systems or how that issue is related to problems in science, technology, and society.

- Data analysis, experimental design, and investigation questions evaluate examinees' ability to design experiments that test simple hypotheses, analyze and interpret data, suggest demonstrations that illustrate concepts, and propose investigations within a specific content area.
- Concepts, models, and systems questions evaluate examinees' ability to use scientific knowledge to formulate major concepts, to understand model use and limitations and to communicate the process by which scientists create and use models, and to understand the interacting components of a functional system. Patterns content addresses examinees' ability to recognize and relate patterns in the physical world in terms of connections, trends, cycles, and irregular changes over space and time. The emphasis is on the underlying causes and mechanisms of the observed patterns.
- Science, technology, and society questions evaluate examinees' ability to discuss the impact of science and technology on society and to demonstrate an understanding of the scientific concepts and principles involved.

A beginning teacher of general science needs to have a knowledge of scientific principles, facts, methodology, and philosophy. The teacher candidate also needs to have in-depth knowledge of scientific concepts and an ability to integrate basic knowledge from all the sciences. To communicate an accurate understanding of various science fields to secondary-school students, teachers need to understand the subject matter from a more advanced viewpoint than that actually presented to the students. Accordingly, some questions of a more advanced nature are included.

Sample Test Questions

This section presents sample questions and constructed-response samples along with the standards used in scoring the essay. When you read these sample responses, keep in mind that they will be less polished than if they had been developed at home, edited, and carefully presented. The examinee does not know what questions will be asked and must decide, on the spot, how to respond. Readers take these circumstances into account when scoring the responses.

Readers will assign scores based on the following scoring guide.

Scoring Guide

5

- Demonstrates a superior understanding of the science concepts required by the question
  - gives clear, accurate, and well-reasoned explanations
  - uses accurate scientific terminology throughout
  - when required, provides accurate and well-chosen supporting evidence (e.g., physical laws, definitions, examples)
  - any diagrams, tables, and graphs presented are complete, clear, accurate, and well organized

4

- Demonstrates a strong understanding of the science concepts required by the question
  - gives clear, accurate, and logical explanations
  - uses accurate scientific terminology
  - when required, provides accurate and well-chosen supporting evidence (e.g., physical laws, definitions, examples)
  - any diagrams, tables, and graphs presented are complete, clear, accurate, and well organized

3

- Demonstrates an adequate understanding of the science concepts required by the question
  - gives generally clear, accurate, and logical explanations
  - uses some accurate scientific terminology
  - when required, provides accurate and relevant supporting evidence (e.g., physical laws, definitions, examples)
  - any diagrams, tables, and graphs presented are sufficiently complete and accurate

2

- Demonstrates a limited understanding of the science concepts required by the question, as evidenced by one or more of the following characteristics:
  - may give insufficiently accurate and/or poorly developed explanations
  - may lack accurate scientific terminology
  - when required, may give very limited supporting evidence (e.g., physical laws, definitions, examples)
  - any diagrams, tables, and graphs presented may be incomplete and/or inaccurate

1

- Demonstrates very little understanding of the science concepts required by the question, as evidenced by one or more of the following characteristics:
  - may give inaccurate, illogical, incoherent, or seriously incomplete explanations
  - may fail to use accurate scientific terminology
  - may give little or no supporting evidence (e.g., physical laws, definitions, examples)
  - any diagrams, tables, and graphs presented may be seriously inaccurate, confusing, or incomplete

0

- Completely inaccurate or inappropriate, blank, or off topic

Sample Question 1

"Climate is the prevailing weather in a particular region, whereas weather is the description of atmospheric variables such as temperature, cloudiness, precipitation, and radiation. The climate of a region depends on its latitude, or distance from the equator. A city that is close to the equator has a warmer climate than a city farther north. Regions that are at about the same latitude have similar climates."

The excerpt above is from a local newspaper article on climate. Discuss the ideas found in the article in terms of what is correct and what is misleading or incorrect, using appropriate examples in your discussion.

Sample Response That Received a Score of 5:

While the article does discuss one important factor dictating the climate of a region, it gives no mention of other highly relevant factors to be considered. The climate of a region does depend upon latitude to a certain extent. Areas near the equator receive more direct sunlight year round. Regions to the north or south of the equator receive a more variable and less direct amount of sunlight through the year due to the tilt of the earth's axis. Thus during summertime in the Northern Hemisphere, the Earth's axis is oriented so that the North Pole is closer to the Sun than the South Pole is. Hence the northern region is enjoying warmer temperatures than Southern Hemisphere areas. Temperature is more constant year round in the equator regions. Thus latitude does play a critical role in climate.

However, the article leaves out other essential elements of climate. In particular, the regional geography of an area plays a critical role. The presence of mountains, lakes, and oceans have a tremendous impact on climate. Why are the winters in Buffalo, NY, so much colder and snowier than the winters in Idaho, which is at the same latitude (roughly)? Why does it always rain in Seattle? Important elements in climate are air and water. As air travels over mountains, it expands and cools. These changes cause water in the air to condense and fall in the form of rain. After the air reaches the other side of the mountains, it has lost much of the water content it once had.

The presence of a cool or warm ocean current together with prevailing winds also influences the weather, and hence the climate, on nearby continental masses. Another factor to consider in climate is the elevation of the area. The air is much thinner at higher elevations. This is an important factor to consider when comparing the climates of Denver, Colorado, which has an elevation of one mile, and Los Angeles, which is at sea level. Considerations of jet streams and global air patterns also must be taken into account.

Sample Response That Received a Score of 3:

The description of climate is correct in that it mentions that it relates to a particular region and to its latitude. Regions near the equator receive more direct sunlight than regions further from the equator. But the article left out factors such as the proximity to oceans or mountains which also affects climate. Temperatures are lower in the mountains. For example, it is cooler in the Andes mountains near the equator while it is much warmer in the Amazon rain forest. The description of weather is accurate except it is missing some features such as hurricanes, tornados and similar severe weather events.

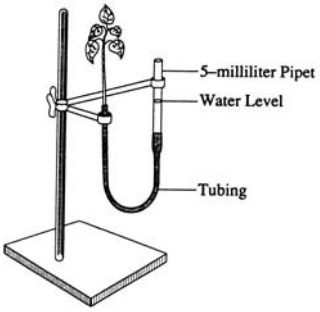
Sample Response That Received a Score of 1:

The article's idea of climate is inaccurate in that climate is better described as the weather conditions of a particular region. "Prevailing" misleads one to believe that conditions can, and frequently do, change. Climate is the usual temperature and precipitation of an area, not just a day-to-day occurrence.

The weather description is reasonable in that such factors of temperature, cloudiness and precipitation are important. Such factors as daily winds and pressure should also have been included. A better article could be worded as follows:

Climate is the common weather conditions of temperature, annual rainfall, days of sunshine and cloudy days for a geographic region. This region is defined as the distance above, or below the equator called the latitude. As the equator receives the most direct sunlight annually, it is a warmer region. Moving away in either direction results in a cooler climate. Weather is a day-to-day report of these climatic conditions.

Sample Question 2



The potometer shown above is used to estimate transpiration rate in plants.

A. Define the process of transpiration.

B. Identify three variables that would affect transpiration rate. Describe how the potometer can be used to test these variables.

C. Discuss how and why a change in each variable is expected to affect the transpiration rate.

Sample Response That Received a Score of 5:

Transpiration is defined as the evaporative loss of water vapor by any part of a plant but mostly through the stomata found in leaves and other parts of the plant above the soil. Water and minerals from the soil enter the root hairs and cross the root endodermis into the sap of the xylem vessels. The transpiration of water through the stomata and the capillary action of water in the xylem causes the water with its dissolved minerals to flow up the plant to the veins that branch out in each leaf.

Those factors that increase evaporation have the greatest effect on transpiration rate. Three variables that are most likely to affect transpiration rate are temperature, humidity, and wind or air flow. Plant shoots can be placed in potometers and the effects of temperature, humidity, and wind can be analyzed. Because the plant shoot is sealed in one end of a piece of tubing and the other end of the tubing is attached to a pipet partially filled with water, one can examine the change in water level under different conditions and relate that change to an increase or decrease in transpiration rate. To set up the experiment, it is important to have at least 12 shoots from the same species of plant. These shoots should be about the same size and all have as close to the same leaf surface area as possible (so that one does not have to normalize change in water level with respect to surface area). The shoots are to be divided into four groups, with three shoots per group. Group I is the control, maintained at room temperature. Group II should be set up near a heater to increase the temperature. Group III shoots should be sealed in clear plastic bags to increase humidity. Group IV shoots should be placed in front of a fan to increase air flow. All shoots should be maintained in one room and exposed to the same amount of light. The water level in each potometer will be recorded at the start of the treatments and at several time intervals such as 30, 60, and 90 minutes (more time points are better in case it is difficult to detect a change shortly after the start of the experiment). The change in water level for each group of shoots should be averaged at each time point.

In comparison to the control, it is expected that the water level will drop for the shoots set up near the heater (Group II). An increase in temperature means that more water molecules will have sufficient energy to evaporate from the surface of the leaf than when at room temperature (Group I). Thus more water should be pulled up through the bottom of the shoot and the water level in the pipet should drop. There should be little or no drop in water level for the shoots sealed in plastic bags (Group III). The bags will keep the evaporating water vapor in the bag with the shoots. This will decrease the water vapor concentration gradient between the surface of the leaf and the surrounding air in the bags, making it less likely for water to evaporate from the shoots. With less evaporation, there is a decreased pull on the water in the shoots so less water will be pulled into the shoots from the pipet. The shoots placed in front of the fan (Group IV) should also exhibit an increase in transpiration in comparison to the control. The flow of air over the surface of a leaf allows water vapor escaping the surface of the leaf to come in contact with air of lower moisture content than air that is stationary over the leaf, as in the control group. This will increase the concentration gradient of water vapor between the shoot and the air and water will evaporate more rapidly. This will cause greater transpiration, demonstrated by a drop in the water level in the pipet as the water is pulled up through the shoots.

Sample Response That Received a Score of 3:

Transpiration concerns the loss of water from a plant by evaporation. Water enters the roots of the plant and travels up the stem to the leaves where it evaporates from their surface.

Three variables that might affect transpiration rate are temperature, humidity, and wind. Temperature is important because evaporation increases at higher temperatures, humidity is important because there is less evaporation when it is humid outside, and wind is important because evaporation increases when wind blows over a surface.

You can test these variables with a potometer. Place one plant in a warm part of the room, mist the leaves of another plant, and blow a fan on a third plant. Make sure all plants receive the same amount of light. Then see how the water level changes in the pipet part of the potometer. It should drop with a plant kept in a warm part of the room or by a fan and it should stay the same or increase for the misted plant.

Sample Response That Received a Score of 1:

Transpiration means how much water is used by a plant. Plants need water so that they do not become droopy and dry up. They need lots of water when it is hot outside so it is important to keep the soil of plants moist if they are in pots outside in the summer. They also need water to make sugar to feed themselves so if they are making lots of sugar this will effect the rate of transpiration. Moisture in the air will also effect the rate of transpiration. Lots of moisture is usually because there has been a lot of rain so more water is available to a plant. This means that the plant will increase its rate of transpiration because it senses that it can make more sugar. A final thing that can effect transpiration is the size of a plant. Testing different sized plants in a potometer when they are in the sun or in the shade or in the rain will allow you to watch transpiration occur because the amount of water in the pipet will change.

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