



California
Subject
Examinations for
Teachers®

TEST GUIDE

SCIENCE SUBTEST III: EARTH AND PLANETARY SCIENCE

Sample Questions and Responses and Scoring Information

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Sample Test Questions for CSET: Science Subtest III: Earth and Planetary Science

Below is a set of multiple-choice questions and constructed-response questions that are similar to the questions you will see on CSET: Science Subtest III: Earth and Planetary Science. You are encouraged to respond to the questions without looking at the responses provided in the next section. Record your responses on a sheet of paper and compare them with the provided responses.

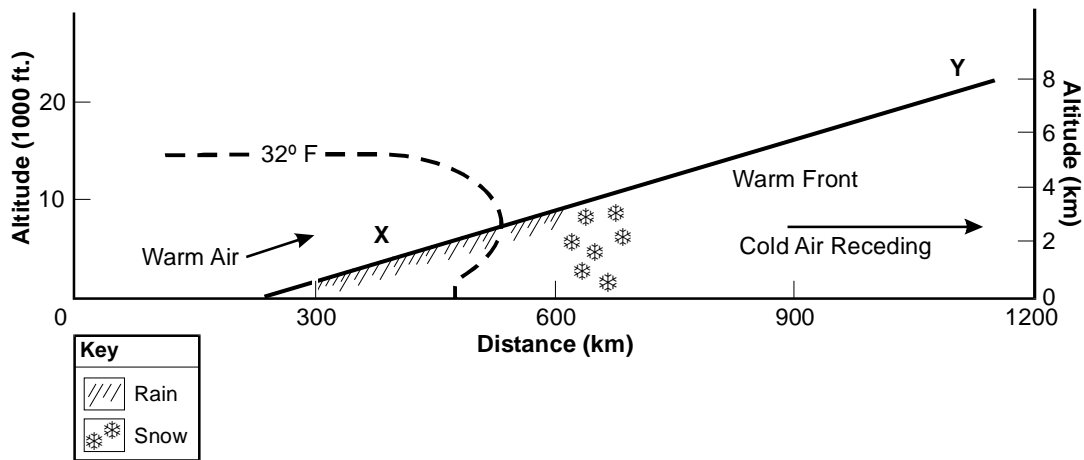
Scientific calculators **will be provided** for the examinees taking General Science Subtests I and II, as well as the specialty subtests of Biology/Life Science, Chemistry, Earth and Planetary Science, and Physics. Refer to the California Educator Credentialing Examinations website for a list of the calculator models that may be provided. Directions for the use of the calculator will not be provided at the test administration. You will not be allowed to use your own calculator for CSET: Science subtests.

1. Which of the following best describes the process of nuclear synthesis that created the known elements from hydrogen and helium?
 - A. Immediately following the Big Bang, intense heat and pressure produced all the existing elements through the fusion of lighter elements.
 - B. On the protoplanets, radioactive isotopes of primitive elements decayed into stable isotopes that compose the range of elements.
 - C. The formation of galaxies, stars, and planets produced environments in which the fission of primitive elements produced the elements.
 - D. Under the intense heat and pressure within stars, the heavier elements formed as the nuclei of two or more lighter elements combined and fused.
2. Scientists believe the solar system formed approximately 4.6 billion years ago. The best evidence for this theory is based on:
 - A. the decay of radioactive elements found in rocks from the moon, Earth, and meteorites.
 - B. the mass and rotational velocity of planetary objects.
 - C. the concentration of orbiting planetesimals within the asteroid belt and Kuiper belt.
 - D. the cyclical rate of change in the intensity of the sun's electro-magnetic field.

3. The temperature of Venus is believed to have changed significantly since its formation. Which of the following best explains why Venus developed such high atmospheric and surface temperatures?
- A. a rotational period that has increased since the planet's formation to 243 Earth days
 - B. a dense atmosphere that has developed an extremely high concentration of carbon dioxide over time
 - C. changes in shape of its elliptical orbit since its formation that brings it very close to the sun
 - D. a high level of volcanic activity that has transferred a tremendous amount of heat to the atmosphere over time
4. Which of the following tectonic events occurred during the Cenozoic era?
- A. The Himalaya Mountains were formed and Australia broke away from Antarctica.
 - B. Gondwanaland broke up and subduction along the western coast of North America began.
 - C. The Appalachian Mountains were formed and North America collided with Northern Europe.
 - D. The supercontinent Pangaea broke up and fault basins opened in eastern North America.
5. The rhyolitic character of some volcanic magmas makes them:
- A. more likely to produce explosive eruptions of ash.
 - B. less likely to produce pyroclastic lava flows.
 - C. more likely to produce non-explosive lava flows.
 - D. less likely to produce unpredictable eruptions.

6. The recent rise in sea level worldwide has been approximately 2–3 millimeters per year, and historical data suggest the rate of sea-level rise has been increasing over the last 75 years. Which of the following reasons is implicated as a significant factor in this recent increase in the rate of sea-level rise?
- A. increased worldwide precipitation
 - B. thermal expansion of ocean water
 - C. thinning of floating pack ice on the Arctic Ocean
 - D. decreased ocean evaporation
7. The cold ocean water that upwells off the western coasts of much of South America and southern Africa affects the climatic conditions in these regions. Which of the following best describes the effect that the temperature of the oceans in these regions has on the climatic conditions in these coastal areas?
- A. The cool ocean water increases condensation from wet subtropical air masses, enhancing coastal rainfall.
 - B. Overlying air, cooled by the cold water, produces atmospheric instability when mixed with the heated air from the land, creating regular thunderstorms.
 - C. The cool ocean water increases the strength of wind flow from land to sea during the day, causing increased local heating.
 - D. The coolness of the ocean water decreases evaporation from the water surface, reducing coastal rainfall.
8. A significant increase in the albedo of Earth would most likely result from an increase in the:
- A. average concentration of ozone in the stratosphere.
 - B. average cloud cover.
 - C. total surface area of lakes, rivers, and oceans.
 - D. total forest cover.

9. Use the diagram below to answer the question that follows.



The diagram above shows the passage of a warm front over receding cold air. Which of the following cloud types would typically be found at the points labeled X and Y?

- A. X—stratus
Y—cirrus
- B. X—cumulonimbus
Y—stratus
- C. X—cirrus
Y—cumulonimbus
- D. X—altostratus
Y—cumulus

10. An inversion in the atmosphere can lead to serious atmospheric pollution near the ground surface. Which of the following conditions typifies an atmospheric inversion?
- A. Warm air becomes trapped beneath a layer of cold air.
 - B. Low pressure aloft traps high pressure near the surface.
 - C. Cold air becomes trapped beneath a layer of immobile warm air.
 - D. A warm front forces warm air under cold air.
11. Quartz veins are frequently found throughout fractures in metamorphic and igneous rock formations. Typically, the quartz found in these veins:
- A. has an amorphous, loosely arranged crystal structure that allowed it to conform to the shape of the fractures.
 - B. formed at very high temperatures deep within the earth's crust at the same time the rock formed.
 - C. was deposited within the fractures by aqueous solution at lower temperatures after the rock was formed.
 - D. leached into the fractures from the surrounding rock while the rock was still semi-molten.
12. Research shows that limiting the clear-cutting of large tracts of forest can help reduce the greenhouse effect. Which of the following processes is most responsible for this?
- A. Healthy forests have slow rates of organic breakdown, decreasing the production of methane (CH₄).
 - B. Logging stimulates the activity of microorganisms in the forest litter, raising carbon dioxide production.
 - C. Forest ecosystems have high levels of photosynthesis, increasing the sequestration of carbon dioxide.
 - D. Clear-cutting increases the erosion of soils and underlying lithosphere, releasing stored carbon.
13. The soils of some areas of the western-most San Joaquin Valley have high levels of naturally occurring selenium, a trace mineral that can be toxic at high concentrations. Which of the following is the major source of the selenium found in these soils?
- A. dust that settles along the western side of the San Joaquin Valley
 - B. underlying bedrock strata derived from ocean sediments
 - C. river sediments washing down from the Coast Range
 - D. drought-tolerant plants that concentrate trace minerals

14. Death Valley, located in southeastern California, is an arid valley filled with deep sedimentary deposits and surrounded by rugged mountain ranges. The topography of this valley and mountain system is primarily a consequence of:
- A. the unequal erosion of different kinds of sedimentary rock layers that once covered the region.
 - B. the compression and uplift of the western United States due to thrust faulting.
 - C. the presence of synclinal folds that have produced a deep valley and the surrounding mountains.
 - D. the block faulting of surrounding mountains and the related down-drop of the valley.
15. A geologic map of the Point Reyes Peninsula in northern California shows a large area of granite immediately west of the San Andreas Fault. East of the fault is an unrelated area of banded chert, shale, and sandstone. Granite at the surface has never been found east of the San Andreas Fault in this part of northern California. Which of the following best explains the presence of the granite on Point Reyes Peninsula?
- A. Heavy rain has eroded the overlying sedimentary rock, exposing the granite that underlies much of northern California.
 - B. Granite from Point Reyes Peninsula is part of a displaced piece of continental crust that has gradually moved north along the San Andreas Fault.
 - C. Granite exists deep underground east and west of the fault, but it has been exposed on Point Reyes Peninsula due to thrust faulting along the San Andreas Fault.
 - D. The granite found on Point Reyes Peninsula is a remnant of the volcanic island arc that existed offshore until subduction of the oceanic plate carried it to the coast.

CONSTRUCTED-RESPONSE ASSIGNMENT DIRECTIONS

For each constructed-response assignment in this section, you are to prepare a written response.

Read each assignment carefully before you begin your response. Think about how you will organize your response. You may use the erasable notebooklet to make notes, write an outline, or otherwise prepare your response. **However, your final response must be either:**

- 1) typed into the on-screen response box,
- 2) written on a response sheet and scanned using the scanner provided at your workstation, or
- 3) provided using both the on-screen response box (for typed text) and a response sheet (for calculations or drawings) that you will scan using the scanner provided at your workstation.

Instructions for scanning your response sheet(s) are available by clicking the “Scanning Help” button at the top of the screen.

Your responses will be evaluated based on the following criteria.

PURPOSE: the extent to which the response addresses the constructed-response assignment's charge in relation to relevant CSET subject matter requirements

SUBJECT MATTER KNOWLEDGE: the application of accurate subject matter knowledge as described in the relevant CSET subject matter requirements

SUPPORT: the appropriateness and quality of the supporting evidence in relation to relevant CSET subject matter requirements

The assignments are intended to assess subject matter knowledge and skills, not writing ability. Your responses, however, must be communicated clearly enough to permit a valid judgment of your knowledge and skills. Your responses should be written for an audience of educators in the field.

Your responses should be your original work, written in your own words, and not copied or paraphrased from some other work. Please write legibly when using the response sheets. You may not use any reference materials during the testing session. Remember to review your work and make any changes you think will improve your responses.

Any time spent responding to an assignment, including scanning the response sheet(s), is part of your testing time. Monitor your time carefully. When your testing time expires, a pop-up message will appear on-screen indicating the conclusion of your test session. Only response sheets that are scanned before you end your test or before time has expired will be scored. Any response sheet that is not scanned before testing ends will NOT be scored.

16. Complete the exercise that follows.

During Earth's geologic history, the nature of geologic processes affecting Earth and the atmosphere have changed significantly. Volcanism is an example of an Earth system that has acted very differently over geologic history.

Using your knowledge of Earth's history and volcanism:

- explain changes in the nature of volcanism since the formation of Earth; and
- describe how the changes in volcanism have altered Earth's surface and atmosphere.

17. **Complete the exercise that follows.**

California experiences a distinct rainy season and dry season.

Using your knowledge of Earth systems and climate:

- explain the changes in atmospheric patterns that cause California to have pronounced dry and wet seasons; and
- suggest a strategy to involve the public in water conservation and give three examples through which the public can actively help conserve California's limited water resources either at home, on the farm, in industry, or within the community.

18. Complete the exercise that follows.

The geologic map for the western foothills of the central Sierra Nevada shows a north-south trending belt of metamorphosed marine sediments on either side of metamorphosed ancient volcanic rocks. In addition, there are exposures of ultramafic rocks near faults that parallel the trend of this group. This region is called the Foothills Metamorphic Belt and is believed to represent an accreted island-arc complex that was added on to the west coast of North America during the Jurassic period. It is a region that contains pyritic massive sulfide deposits rich in copper and gold.

Using your knowledge of California geology:

- explain the presence of an accreted island-arc complex in terms of California's tectonic history; and
- explain the environmental consequences of mining these deposits.

Annotated Responses to Sample Multiple-Choice Questions for CSET: Science Subtest III: Earth and Planetary Science

Earth's Place in the Universe

1. **Correct Response: D.** (SMR Code: 1.1) At the extremely high pressures and temperatures found inside stars, atomic nuclei fuse to form new elements. The fusion of hydrogen atoms first creates helium, which then fuses to form carbon and oxygen, which in turn may form silicon, iron, and eventually the very heaviest elements. Scientists postulate that all the known elements in the universe are generated in this manner from hydrogen fusion reactions.
2. **Correct Response: A.** (SMR Code: 1.2) Radioactive elements have precise, predictable rates of decay, which have enabled scientists to date the oldest rocks from the moon, Earth, and meteorites at about 4.6 billion years old. Since the planets and asteroids (a common source of meteorites) orbit in the same direction and lie in a similar orbital plane, scientists theorize that the objects in the solar system have a common origin and date to approximately 4.6 billion years ago.
3. **Correct Response: B.** (SMR Code: 1.3) Scientists believe that Venus's atmosphere was once a dense mixture of water vapor and carbon dioxide. The lighter water vapor rose to the top of the atmosphere and dissipated into space, a process that eventually produced the current atmosphere of 97% carbon dioxide. Carbon dioxide's capacity to transmit incoming sunlight while trapping outgoing heat—the "greenhouse effect"—is suspected to be the immediate cause of the high temperatures on Venus.

Planet Earth

4. **Correct Response: A.** (SMR Code: 2.1) Geologic evidence indicates that approximately 65 million years ago at the beginning of the Cenozoic era, the continental plate of India was drifting north toward Asia. By 45 million years ago, India had collided with Asia, creating the Himalayas in a tectonic event still active today. During the same era, Australia separated from Antarctica and drifted northeast to its present location.
5. **Correct Response: A.** (SMR Code: 2.1) Rhyolitic magmas contain at least 70% silica (SiO_2), a compound that causes magma to be significantly more viscous than ones composed mostly of basalt. Consequently, rhyolitic magmas can be difficult to extrude through volcanic vents and can sometimes plug the vent entirely. This characteristic increases the likelihood of a buildup of pressurized gases, resulting in explosive eruptions of ash.
6. **Correct Response: B.** (SMR Code: 2.2) The overall warming of Earth's atmosphere in recent years has warmed the surface and upper layers of the oceans. This warming produces a thermal expansion of ocean water, which increases its overall volume, raising the sea level relative to the shore.
7. **Correct Response: D.** (SMR Code: 2.3) The upwelling water along large areas of the coasts of western South America and southern Africa produces cold ocean surface temperatures. As surface air moves over this cool water, it is chilled to its dew point, producing fog and drizzle offshore and along the immediate coast. As this damp stable air mass moves inland, the fog evaporates. The relative dryness of this stable air mass combined with the presence of the subsidence inversion typical of these coastal desert regions prevents the air mass from rising to an altitude where cloud formation and precipitation could occur, making these regions among the driest on Earth.

Energy in the Earth System

8. **Correct Response: B.** (SMR Code: 3.1) Albedo is a measure of the reflectivity of a surface. In general, light-colored surfaces reflect far more radiation than do dark surfaces. Various natural materials and landscapes have widely differing levels of reflectivity due to differences in their color and surface texture. Snow and clouds, for example, have high albedos (reflecting between 30% and 95% of incident radiation), while forests, water bodies, and dark soils have low albedos (reflecting between 5% and 20% of incident radiation).
9. **Correct Response: A.** (SMR Code: 3.2) Clouds associated with a warm front moving over cold air are typically layered and widespread from expansional cooling, and they grow thicker and lower as one approaches the front. High cirrus clouds formed of wind-blown ice crystals would be expected at point Y, far in advance of the front. At point X, low heavy stratus clouds could be expected, causing light rain through the shallow, cold air underneath.
10. **Correct Response: C.** (SMR Code: 3.3) An atmospheric, or thermal, inversion results when warm stagnant air settles over cooler air. These conditions are likely when a slow-moving high-pressure system cools Earth's surface at night, drawing warm air into the atmosphere, or when a warm front slides above a cold air mass, creating a stable, still atmosphere. Pollution or fog trapped under the warm air intensifies the inversion by preventing sun-powered convection currents from forming.

Biogeochemical Cycles

11. **Correct Response: C.** (SMR Code: 4.1) Typically the formation of quartz veins begins as groundwater circulates near a pluton or magmatic intrusion. The circulating water dissolves silica and other minerals, creating a mineral-rich aqueous solution. The groundwater then moves away from the heat source by convection along fractures within the surrounding country rock. The temperature and pressure of this aqueous solution drop as it moves away from the heat source, causing the silicon and oxygen to come out of solution and precipitate as quartz (SiO_2) along the walls of the fractures.
12. **Correct Response: C.** (SMR Code: 4.2) Since carbon dioxide traps heat in the atmosphere, it is directly implicated in the warming associated with the greenhouse effect. The process of photosynthesis by plants takes carbon dioxide from the atmosphere and fixes the carbon in organic molecules in the plants. Leaving intact a significant mass of actively photosynthesizing plant life, such as large forests, could limit the amount of atmospheric carbon dioxide and control the greenhouse effect.

California Geology

13. **Correct Response: B.** (SMR Code: 5.2) The bedrock that forms the western edge of the San Joaquin Valley had its origins as part of the Pacific plate, which is being subducted under the North American plate. However, a narrow tongue of the Pacific plate, called the Coast Range thrust, overthrust the North American plate, resulting in sedimentary ocean strata overlying the continental rock. These ocean strata have the same trace elements as found in sea water: arsenic, boron, molybdenum, uranium, and selenium.
14. **Correct Response: D.** (SMR Code: 5.3) Death Valley belongs to a large system in Nevada and eastern California called the Basin and Range Province. Here Earth's crust has pulled apart, forming large-scale parallel fault regions and smaller-scale blocks of crust that alternate between uplifted mountains and down-faulted valleys or basins. Block-fault mountains often have steep sides along the fault, while the valleys can fill with sediments thousands of feet thick.

15. **Correct Response: B.** (SMR Code: 5.5) The Point Reyes Peninsula in northern California is a geologically isolated mix of igneous, sedimentary, and metamorphic rock lying immediately to the west of the San Andreas Fault. The United States Geological Survey reports that during the last 15–20 million years, there has been 350 miles of right-lateral displacement along the San Andreas Fault as the Pacific plate has slid north past the North American plate. The presence of granitic rocks at Point Reyes Peninsula, just across the San Andreas Fault from unrelated marine sediments on the eastern side, is a consequence of the ongoing northward movement of the Pacific plate relative to the North American plate.

Examples of Strong Responses to Sample Constructed-Response Questions for CSET: Science Subtest III: Earth and Planetary Science

Planet Earth

Question #16 (Score Point 3 Response)

It is believed that prehistoric Earth had so much more volcanic activity than we do now because the earth was much hotter then because it had been more recently formed. The crust would have been more fluid and the tectonic process very rapid. The volcanism was central to the cooling process as heat would not have radiated rapidly otherwise. Part of this process involved the expelling of materials into the atmosphere from within the interior of the earth.

Over time, as the earth cooled, volcanic activity calmed. As the earth cooled, large basalt flows occurred at points along rifts rather than continuous flows along the entire rift. Now, modern volcanoes are typically found at single points on rifts.

Materials expelled from prehistoric volcanoes included gases such as carbon dioxide and water vapor as well as molten rock. This is thought to account for the formation of the earth's atmosphere and oceans, through condensation. Similarly, the changes in the earth's surface can be seen in the rock formations created as the magma solidified in lava flows, and in volcanic mountain ranges. In addition to the basalt and massive sulfide deposits associated with them, volcanoes are often the site of concentrated minerals and heavy metals such as copper, lead, and zinc.

Energy in the Earth System

Question #17 (Score Point 3 Response)

California does have pronounced dry and wet seasons. This is mainly due to the seasonal motion of the Pacific high-pressure system that blocks moisture from the ocean in summer, diverting it northward. During the winter this high pressure system migrates southward, and then a low-pressure system named the Aleutian low strengthens and moves southward. This low-pressure system generates storms, which produce rain along the coastal areas, and snow in higher elevations inland, on the western side of the Sierra Nevada range.

Conservation of water in California is a major concern, because rainfall is seasonal, and the state is a major center of agriculture. The public needs to be well educated about this. Businesses as well as residences all must do their part in this conservation effort. The implementation of graduated water usage rates, where people pay higher rates for excessive water use, is one means by which public attention and awareness can be directed to this issue. People can also be encouraged to conserve by using water-saving showerheads, toilets, washing machines, and so on. Gardens can be watered with "grey" water. Larger conservation measures would include covering aqueducts and using drip irrigation.

If conservation techniques are made a part of the lifestyle of the citizens, there can be continued population and economic growth with the limited resources. Without the conservation, both public and corporate prosperity are threatened.

California Geology

Question #18 (Score Point 3 Response)

Explanation of the island-arc in terms of CA tectonic history:

West of North America, before the Jurassic period, a chain of volcanic islands was formed where one plate of ocean crust was subducted beneath another. During the Jurassic, the plate with the chain of islands slid toward the North American continent, its tectonic plate went under the continental plate, and the islands and some marine sediments near them were scraped off and deposited at the base of the future Sierra Nevada range (which may have been lifted by this same movement). So the Sierra Nevada foothills are composed of metamorphosed volcanic rocks flanked by metamorphosed marine sediments and traces of the ancient ocean crust.

Explanation of the environmental consequences of mining sulfide deposits:

There are several consequences that may be realized when mining sulfide deposits rich in copper and gold. One of these is that the rocks may dissolve in the water, causing pyrite to oxidize, creating sulfuric acid. This can change the pH of nearby soils and water and carry heavy metals into the environment. The chemicals used to process the ore may go into the environment too. Plants and animals will be endangered by these changes.

Scoring Information for CSET: Science Subtest III: Earth and Planetary Science

Responses to the multiple-choice questions are scored electronically. Scores are based on the number of questions answered correctly. There is no penalty for guessing.

There are three constructed-response questions in Subtest III: Earth and Planetary Science of CSET: Science. Each of these constructed-response questions is designed so that a response can be completed within a short amount of time—approximately 10–15 minutes. Responses to constructed-response questions are scored by qualified California educators using focused holistic scoring. Scorers will judge the overall effectiveness of your responses while focusing on the performance characteristics that have been identified as important for this subtest (see below). Each response will be assigned a score based on an approved scoring scale (see page 18).

Your performance on the subtest will be evaluated against a standard determined by the Commission on Teacher Credentialing based on professional judgments and recommendations of California educators.

Performance Characteristics for CSET: Science Subtest III: Earth and Planetary Science

The following performance characteristics will guide the scoring of responses to the constructed-response questions on CSET: Science Subtest III: Earth and Planetary Science.

PURPOSE	The extent to which the response addresses the constructed-response assignment's charge in relation to relevant CSET subject matter requirements.
SUBJECT MATTER KNOWLEDGE	The application of accurate subject matter knowledge as described in the relevant CSET subject matter requirements.
SUPPORT	The appropriateness and quality of the supporting evidence in relation to relevant CSET subject matter requirements.

Scoring Scale for CSET: Science Subtest III: Earth and Planetary Science

Scores will be assigned to each response to the constructed-response questions on CSET: Science Subtest III: Earth and Planetary Science according to the following scoring scale.

SCORE POINT	SCORE POINT DESCRIPTION
3	<p>The "3" response reflects a command of the relevant knowledge and skills as defined in the subject matter requirements for CSET: Science.</p> <ul style="list-style-type: none"> • The purpose of the assignment is fully achieved. • There is an accurate application of relevant subject matter knowledge. • There is appropriate and specific relevant supporting evidence.
2	<p>The "2" response reflects a general command of the relevant knowledge and skills as defined in the subject matter requirements for CSET: Science.</p> <ul style="list-style-type: none"> • The purpose of the assignment is largely achieved. • There is a largely accurate application of relevant subject matter knowledge. • There is acceptable relevant supporting evidence.
1	<p>The "1" response reflects a limited or no command of the relevant knowledge and skills as defined in subject matter requirements for CSET: Science.</p> <ul style="list-style-type: none"> • The purpose of the assignment is only partially or not achieved. • There is limited or no application of relevant subject matter knowledge. • There is little or no relevant supporting evidence.
U	<p>The "U" (Unscorable) is assigned to a response that is unrelated to the assignment, illegible, primarily in a language other than English, or does not contain a sufficient amount of original work to score.</p>
B	<p>The "B" (Blank) is assigned to a response that is blank.</p>