



California Subject Examinations for Teachers®

TEST GUIDE

SCIENCE SUBTEST II: EARTH AND SPACE SCIENCES

Sample Questions and Responses and Scoring Information

Copyright © 2017 Pearson Education, Inc. or its affiliate(s). All rights reserved.
Evaluation Systems, Pearson, P.O. Box 226, Amherst, MA 01004

California Subject Examinations for Teachers, CSET, and the CSET logo are trademarks of the
Commission on Teacher Credentialing and Pearson Education, Inc. or its affiliate(s).

Pearson and its logo are trademarks, in the U.S. and/or other countries, of Pearson Education, Inc. or its affiliate(s).

CS-TG-QR219X-01

Sample Test Questions for CSET: Science Subtest II: Earth and Space Sciences

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 II: Earth and Space Sciences. 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.

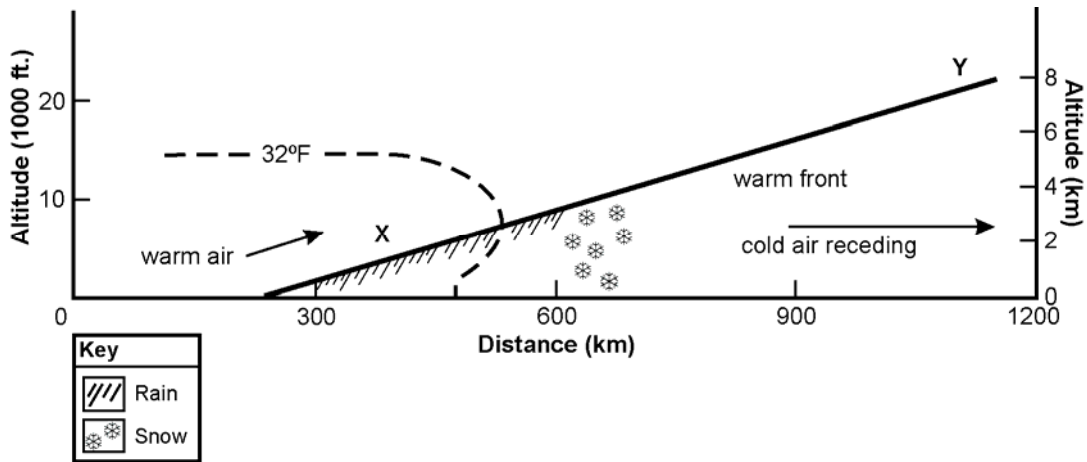
Scientific calculators **will be provided** for the examinees taking Science Subtest I: General Science, as well as the specialty subtests of Life Sciences, Chemistry, Earth and Space Sciences, and Physics. Refer to the California Educator Credentialing Examinations website for a list of the calculator 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. The observed speed at which stars in the Milky Way rotate around the galactic center is less than the speed of rotation that is predicted based on the mass of the stars and gases in the Milky Way. The accepted scientific explanation for this difference in observed versus predicted speed is the:
 - A. presence of supermassive black holes in different regions of the Milky Way.
 - B. existence of large amounts of unseen dark matter throughout the Milky Way.
 - C. effects of satellite galaxies that perturb the motion of stars in the Milky Way.
 - D. concentration of high-density star clusters in the spiral arms of the Milky Way.
2. Which of the following statements 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.

3. Scientists believe that 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 electromagnetic field.
4. The Basin and Range geologic province of the western United States is an area of linear mountain ranges and intervening valleys that encompasses the region between eastern California and central Utah. Normal faults parallel most of the mountain ranges and deep sediments fill the valleys. Which of the following components of plate tectonics theory best accounts for these geologic features of the Basin and Range?
- A. Subduction of an oceanic plate beneath the active margin of North America caused downwarping of a broad area of continental crust.
 - B. The North American Plate overrode an area of hot-spot volcanism that caused rifting and thinning of continental crust.
 - C. Extensional forces produced by the shearing of North America's western plate margin have thinned and fractured the crust.
 - D. The North American Plate collided with and accreted island arcs and marine sediments, causing folding and uplift of the region's crust.

5. 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.
6. The soils of some areas of the westernmost 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
7. 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 which of the following?
- 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
8. Water that evaporates from bodies of water and Earth's surface enters the atmosphere in its gas phase as water vapor. Which of the following atmospheric processes is most likely to cause water vapor to move back into the liquid phase during the water cycle?
- A. convection of a warm air mass
 - B. rising atmospheric temperature
 - C. compression of a cool air mass
 - D. increasing atmospheric pressure

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



The diagram 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. 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 statements 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.
11. The overall decrease in groundwater storage in California's Central Valley since the late 1990s has occurred even during years with historically good surface-water deliveries. Other than groundwater pumping, which of the following factors is primarily responsible for the change in groundwater storage in this regional aquifer over this time period?
- A. Normal surface-water inflows have been diverted to reservoirs.
 - B. Hotter summers have reduced the infiltration of mountain precipitation.
 - C. Compaction of aquifer sediments has decreased storage capacity.
 - D. Less frequent, but heavier, rainfall events have reduced aquifer recharge.
12. Which of the following natural hazards is most directly associated with the geology of the Mammoth Lakes region of California's Sierra Nevada mountains?
- A. pyroclastic flows from rhyolitic eruptions
 - B. seismicity along blind thrust faults
 - C. liquefaction of unconsolidated sediments
 - D. emission of toxic volcanic gases

13. In some areas of California, agricultural practices have significantly increased soil salinity, reducing yields and, in some cases, making soils unusable for growing plants. Which of the following statements best describes the primary cause of this problem?
- A. Pesticides applied to crops build up when sodium- and chloride-containing chemical residues adhere to soil colloids.
 - B. Plowing of fields several times a year mixes naturally occurring sodium and chloride ions from marine aerosols into soils.
 - C. Planting of single-variety crops over large areas removes usable nutrients from the soil while concentrating the remaining salts.
 - D. Irrigation of crops concentrates salts in the soil as the water evaporates and the salts precipitate out of solution.
14. 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.
15. A climate scientist is helping a paleoecologist reconstruct the changes to the biosphere that occurred in the northeastern United States during the early Holocene. Which of the following types of paleoclimate data would provide the paleoecologist with the most useful information for this project?
- A. dendrochronological data from regional old-growth forests
 - B. potassium-argon dating of igneous rock samples
 - C. radiolarian and diatom fossils collected from bay and estuary clays
 - D. palynological data retrieved from lake-bottom sediment cores

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.

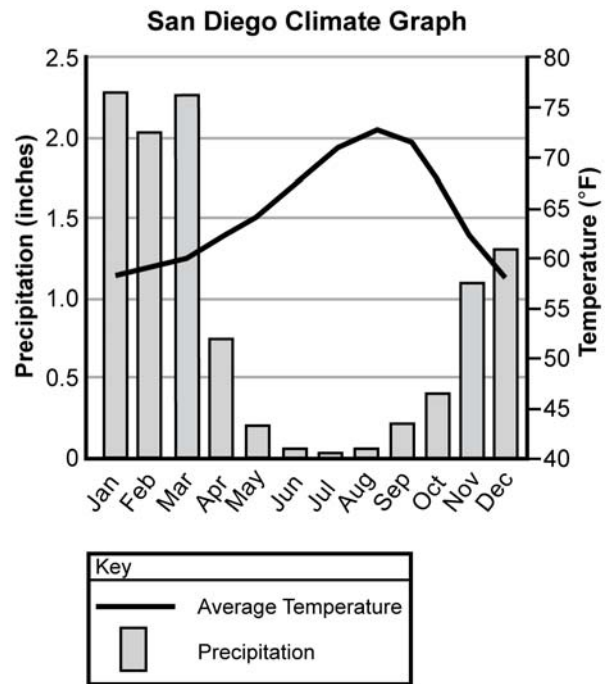
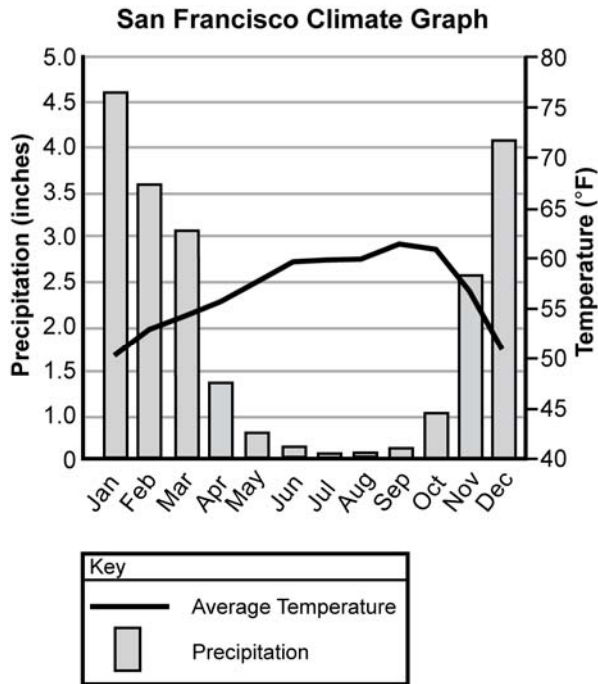
16. Complete the exercise that follows.

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. Use the graphs below to complete the exercise that follows.



California experiences a distinct rainy season and dry season, as shown in the climate graphs.

Using your knowledge of Earth systems and climate:

- explain how seasonal changes in the interaction between Earth's atmospheric and oceanic systems lead to pronounced dry and wet seasons in California;
- discuss how these patterns of rainfall affect the management of California's water resources; and
- describe how technology is helping scientists track precipitation levels and better understand precipitation patterns.

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 II: Earth and Space Sciences

- Correct Response: B.** (SMR Code: 1.1d) The existence of dark matter throughout the Milky Way galaxy accounts for the slower than predicted speed of rotation of stars around the galactic center. Dark matter is a type of matter that does not emit or interact with electromagnetic radiation but contains mass and is theorized to be spread throughout the universe. By adding unseen mass and extending the radius of rotation well beyond the visible edge of the galaxy, dark matter reduces the rotational speed of galaxies from the rotational speeds calculated based on visible matter alone.
- Correct Response: D.** (SMR Code: 1.1e) 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.
- Correct Response: A.** (SMR Code: 1.2b) 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.
- Correct Response: C.** (SMR Code: 1.3a) Linear mountain ranges suggest the movement of a plate boundary. Normal faults occur where two sections of rock are pulled apart, as through tension. Extensional forces, which are associated with the stretching of the crust, are common at normal faults. Some characteristic extensional structures are sediment-filled valleys and linear mountain ranges.
- Correct Response: A.** (SMR Code: 1.3d) 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.
- Correct Response: B.** (SMR Code: 2.1a) 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.
- Correct Response: D.** (SMR Code: 2.2d) 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.
- Correct Response: A.** (SMR Code: 2.3d) Condensation of water from vapor to its liquid phase occurs when water vapor-laden air reaches its saturation point. Warm air is able to hold more water vapor than cooler air, and since warm air is less dense than cooler air, it tends to rise through the process of convection. As a warm air mass rises, it cools and reaches the point at which it is fully saturated with water vapor. Any further cooling results in the condensation of water vapor to the liquid phase.

9. **Correct Response: A.** (SMR Code: 2.4c) 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: D.** (SMR Code: 2.4e) 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.
11. **Correct Response: C.** (SMR Code: 3.1a) Aquifers are made up of water-saturated permeable rocks as well as rock fractures and unconsolidated materials with pore spaces, such as sand and gravel. When aquifers are depleted of water for an extended period of time, the sediments shift and compact. This compaction eliminates the pore spaces in the sediments where the water was once stored. When water does penetrate the aquifer, the water cannot be retained because the pore spaces no longer exist.
12. **Correct Response: D.** (SMR Code: 3.2a) The Mammoth Lakes region experiences high CO₂ emissions caused by magma moving into a subsurface reservoir in the shallow crust. The highest concentration of CO₂ is on the flanks of Mammoth Mountain, a dormant volcano. In the Mammoth Lakes region, the CO₂ rises diffusely from the soil surface rather than flowing from distinct vents and displaces air in the pore spaces of soil. In addition to killing vegetation through its permeating the soil, high concentrations of CO₂ can cause loss of consciousness or death in animals.
13. **Correct Response: D.** (SMR Code: 3.3a) Almost all water contains some dissolved salts. When a region has a shallow water table or relatively impermeable surface soil, additional irrigation water cannot percolate into deeper soils. Therefore, the dissolved salts from the irrigation water remain near the surface. As water evaporates, it draws the salts upward through the soil by capillary action and leaves behind the salt precipitates in the root zone of plants. As this process repeats over time, the salts accumulate and become concentrated enough to inhibit the retention of water in plant roots.
14. **Correct Response: C.** (SMR Code: 3.3b) 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.
15. **Correct Response: D.** (SMR Code: 3.4b) In order to examine a biosphere on an ecological scale, a wide range of life must be examined together with as many environmental factors as possible. Palynology comprises the examination of a wide subset of biological and abiotic matter through the study of microscopic dust particles, such as pollen, spores, chitinozoans, and particulate organic matter. Since each species grows in a certain type of habitat and species can be identified by distinctly shaped pollen grains or spores, analyzing the pollen grains and spores contained in specific sediment layers allows for inferences to be made as to the characteristics of the climate and biosphere during the time period under study.

Examples of Strong Responses to Sample Constructed-Response Questions for CSET: Science Subtest II: Earth and Space Sciences

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.

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.

Technology is helping scientists track precipitation levels and patterns via mapping precipitation in real time (for example, using Doppler radar), and maintaining measurement stations along typical storm tracks. These precipitation level monitoring stations provide records on storm dates, and precipitation levels, and can be time correlated and compared geographically. Use of these data are highly influential when developing things like General Circulation Models that help scientists predict both storm behavior and serve as models for testing hypotheses on how climate change may affect precipitation patterns across the world.

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 meta-morphosed 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 II: Earth and Space Sciences

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 II: Earth and Space Sciences 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 17).

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 II: Earth and Space Sciences

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

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 II: Earth and Space Sciences

Scores will be assigned to each response to the constructed-response questions on CSET: Science Subtest II: Earth and Space Sciences 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>