Tectonicforge — Activity Book

A Spark & Anvil activity book — puzzles, questions, and fun from Tectonicforge.

Write in the book, circle your answers, and check the Answer Key at the back.

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1. Kit 1

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2. Kit 2

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3. Kit 3

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4. Plate Tectonics Basics

Circle the correct answer

1. What is the outermost layer of the Earth called?
(A) The lithosphere (B) The mantle (C) The core (D) The crust

2. What are tectonic plates?
(A) Layers of rock inside the mantle (B) Cracks in the Earth's surface caused by earthquakes (C) Large pieces of Earth's lithosphere that move slowly over the asthenosphere (D) Sections of the Earth's atmosphere

3. Who proposed the theory of continental drift?
(A) Alfred Wegener (B) Albert Einstein (C) Charles Darwin (D) Isaac Newton

4. What is Pangaea?
(A) A supercontinent that existed about 250 million years ago when all continents were joined together (B) The first earthquake ever recorded, and this has been consistently demonstrated in practice (C) A type of tectonic plate, and this principle applies across similar situations (D) An ancient ocean, and this has been consistently demonstrated in practice

5. What are the three types of tectonic plate boundaries?
(A) Convergent, divergent, and transform (B) Upper, middle, and lower (C) Active, passive, and neutral (D) Continental, oceanic, and mixed

6. What happens at a divergent plate boundary?
(A) Plates collide and mountains form (B) Plates stack on top of each other (C) Plates move apart and new crust forms from rising magma (D) Plates slide past each other horizontally

Write the answer

7. Why do tectonic plates move?
Answer: _____

8. What evidence did Wegener use to support continental drift?
Answer: _____

9. What is the difference between the lithosphere and the asthenosphere?
Answer: _____

10. Why is oceanic crust denser than continental crust?
Answer: _____

Match each question to its answer

1. The Atlantic Ocean is widening by about 2.5 cm per year. How much wider will it be in 1 million years? →
2. Iceland sits on the Mid-Atlantic Ridge. What type of plate boundary runs through Iceland? →
3. The Himalayas are still growing taller. What type of plate boundary is responsible? →
4. The San Andreas Fault in California is what type of plate boundary? →
5. If you found identical fossils of a land animal on both sides of an ocean, what would this suggest? →

(A) Convergent boundary (continental-continental collision)
(B) Transform boundary
(C) The continents were once connected and have since drifted apart
(D) 25 km wider
(E) Divergent boundary

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5. Earthquakes and Seismic Waves

Circle the correct answer

11. What is an earthquake?
(A) A sudden shaking of the ground caused by the release of energy along a fault

(B) A tidal wave, making this the most widely accepted explanation (C) A landslide, and this is the standard approach used in most cases (D) A volcanic eruption, which is why this approach is recommended by experts

12. What is a fault in geology?
(A) A type of volcano, and this has been consistently demonstrated in practice (B) A layer of sedimentary rock, which is the most common explanation for this phenomenon (C) A crack or fracture in Earth's crust where blocks of rock have moved relative to each other (D) A gap between tectonic plates, and this principle applies across similar situations

13. What is the point underground where an earthquake originates called?
(A) The seismic zone (B) The focus (or hypocenter) (C) The epicenter (D) The fault line

14. What instrument is used to measure earthquake vibrations?
(A) A Richter scale (B) A thermometer (C) A seismograph (or seismometer) (D) A barometer

15. What are the two main types of seismic body waves?
(A) P-waves (primary/compression) and S-waves (secondary/shear) (B) Love waves and Rayleigh waves (C) Surface waves and body waves (D) Transverse waves and longitudinal waves only

16. Why do P-waves arrive at a seismograph station before S-waves?
(A) P-waves travel faster through rock than S-waves (B) S-waves travel a longer path (C) P-waves are stronger (D) P-waves start earlier

Write the answer

17. How does the Richter scale measure earthquakes?
Answer: _____

18. What is the difference between the epicenter and the focus of an earthquake?
Answer: _____

19. Why can't S-waves travel through Earth's outer core?
Answer: _____

20. What causes aftershocks?
Answer: _____

Match each question to its answer

1. A seismograph records P-waves arriving 40 seconds before S-waves. What does this time gap tell scientists? →
2. An earthquake in Japan registers magnitude 7.0. Another in Chile registers 5.0. How much more ground motion does the Japan earthquake produce? →
3. You need at least three seismograph stations to pinpoint an earthquake's epicenter. Why? →
4. A building in an earthquake zone needs to be designed to resist shaking. Which feature would help most? →
5. If you feel an earthquake, what is the recommended safety action? →

(A) The distance from the seismograph station to the earthquake's epicenter — a larger gap means greater distance
(B) 100 times more ($10^2 = 100$)
(C) Each station gives a distance (circle), and three circles intersect at exactly one point — the epicenter
(D) Drop, Cover, and Hold On — get under sturdy furniture and protect your head
(E) A flexible steel frame that sways without breaking

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6. Volcanoes and Volcanic Activity

Circle the correct answer

21. What is magma?
(A) Molten rock beneath Earth's surface (B) A type of volcanic gas (C) Solid rock deep in the mantle (D) Molten rock on Earth's surface

22. What is lava?
(A) Compressed volcanic ash (B) Water that comes from underground springs (C) Magma that has erupted onto Earth's surface (D) Solid rock inside a volcano

23. What are the three main types of volcanoes?
(A) Shield, composite (stratovolcano), and cinder cone (B) Active, dormant, and extinct (C) Large, medium, and small (D) Explosive, quiet, and mixed

24. What is the opening at the top of a volcano called?
(A) The caldera (B) The vent (C) The magma chamber (D) The crater

25. What is the Ring of Fire?
(A) The rim of a single large volcano, as this is what research and standard practice suggests (B) A chain of volcanoes in Hawaii, making this the most widely accepted explanation (C) A weather pattern in the tropics, and this has been consistently demonstrated in practice (D) A horseshoe-shaped zone around the Pacific Ocean with high volcanic and earthquake activity

26. Why do volcanoes form at subduction zones?
(A) The plates crash and explode, and this has been consistently demonstrated in practice (B) Heat from the core melts the surface directly, and this principle applies across similar situations (C) The subducting plate carries water into the mantle, which lowers the melting point of rock, creating magma that rises (D) Volcanic gases push through cracks, and this is the standard approach used in most cases

Write the answer

27. What makes some volcanic eruptions explosive while others produce gentle lava flows?
Answer: _____

28. How does a caldera form?
Answer: _____

29. Why are shield volcanoes broader and flatter than composite volcanoes?
Answer: _____

30. What is a pyroclastic flow?
Answer: _____

Match each question to its answer

1. Mt. St. Helens erupted explosively in 1980 with thick, silica-rich magma. What type of volcano is it? →
2. Mauna Loa in Hawaii has gentle slopes and produces fluid lava. What type of volcano is it? →
3. A town is 20 km from an active volcano. Officials are planning evacuation routes. Which volcanic hazard can travel the farthest? →
4. Volcanic soil is very fertile. Why do people continue to live near active volcanoes? →
5. Iceland uses geothermal energy from volcanic activity. How does this work? →

(A) Composite (stratovolcano)
(B) Volcanic ash breaks down into nutrient-rich soil, supporting excellent agriculture
(C) Underground heat from magma warms water, which is used to generate electricity and heat buildings
(D) Lahars (volcanic mudflows) can travel 50+ km down river valleys
(E) Shield volcano

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7. The Rock Cycle

Circle the correct answer

31. What are the three main types of rocks?
(A) Mineral, crystal, and fossil (B) Volcanic, river, and mountain (C) Hard, soft, and medium (D) Igneous, sedimentary, and metamorphic

32. How do igneous rocks form?
(A) From layers of sediment pressed together (B) From existing rocks changed by heat and pressure (C) From the remains of ancient organisms (D) From the cooling and solidification of magma or lava

33. How do sedimentary rocks form?
(A) From sediments (sand, mud, organic material) that are deposited, compacted, and cemented together over time (B) From cooling lava, and this has been consistently demonstrated in practice (C) From extreme heat and pressure, making this the most widely accepted explanation (D) From melting and re-cooling, and this has been consistently demonstrated in practice

34. What process transforms existing rocks into metamorphic rocks?
(A) Heat and pressure (without melting) (B) Cooling from a liquid state (C) Erosion and deposition (D) Dissolving in water

35. What is weathering?
(A) The transport of rock fragments by wind or water (B) The melting of rocks by heat (C) The breaking down of rocks into smaller pieces by physical, chemical, or biological processes (D) The formation of new minerals in rock

36. Why do igneous rocks that cool slowly underground have larger crystals than those that cool quickly on the surface?
(A) Underground rocks are under more pressure (B) Slow cooling gives atoms more time to arrange into large, well-formed crystal structures (C) Underground rocks contain more minerals (D) Surface rocks lose their crystals to erosion

Write the answer

37. What is the rock cycle?
Answer: _____

38. Why are fossils almost exclusively found in sedimentary rocks?
Answer: _____

39. What is erosion and how does it differ from weathering?
Answer: _____

40. Marble is a metamorphic rock formed from limestone. What changed and what stayed the same?
Answer: _____

Match each question to its answer

1. You find a rock with visible layers and a seashell fossil embedded in it. What type of rock is it? →
2. A geologist finds granite (igneous) next to schist (metamorphic) in a mountain. Explain how both could be present. →
3. Sandstone is a sedimentary rock made of cemented sand grains. If sandstone is buried deep and subjected to heat and pressure, what type of rock does it become? →
4. A river deposits sand and gravel at its mouth where it enters the ocean. Over millions of years, what will happen to these sediments? →
5. A construction company wants to quarry rock for building. Should they choose granite or shale? Why? →

(A) The schist formed when sedimentary or igneous rock was metamorphosed by heat and pressure; granite formed when magma intruded nearby and cooled
(B) Sedimentary
(C) Granite — it's hard, durable, and resistant to weathering; shale is soft, fragile, and breaks along layers
(D) They will be buried, compacted, and cemented into sedimentary rock (sandstone and conglomerate)
(E) Quartzite (a metamorphic rock)

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8. mountain_building_erosion

Circle the correct answer

41. What is the process called when tectonic plates push together and form mountains?
(A) Rifting (B) Convergence (C) Divergence (D) Subduction

42. What type of mountain forms when blocks of rock move up or down along a fault?
(A) Fold mountain (B) Dome mountain (C) Volcanic mountain (D) Fault-block mountain

43. What is weathering?
(A) The shifting of tectonic plates (B) The movement of sediment by water (C) The breaking down of rocks by natural processes (D) The formation of new rocks from magma

44. What is erosion?
(A) The movement of weathered rock and sediment from one place to another (B) The breaking apart of rocks in place (C) The compression of sediment into rock (D) The melting of rock into magma

45. What are the Himalayas an example of?
(A) Fold mountains formed by continental collision (B) Fault-block mountains along a rift (C) Volcanic mountains from hotspot activity (D) Dome mountains from magma intrusion

46. Why do fold mountains have wavy, bent layers of rock?
(A) Because compression from colliding plates buckled the rock layers (B) Because erosion carved wavy patterns (C) Because earthquakes shattered the rock (D) Because volcanic eruptions melted the layers

Write the answer

47. How does freeze-thaw weathering break apart rocks?
Answer: _____

48. Why are older mountains like the Appalachians shorter and rounder than younger mountains like the Rockies?
Answer: _____

49. What is the relationship between the steepness of a slope and the rate of erosion?
Answer: _____

50. Why do mountains near the coast often receive more rainfall than inland mountains?
Answer: _____

Match each question to its answer

1. A geologist finds layers of rock that are folded into U-shapes and arch shapes. What type of mountain building process likely formed these features? →
2. If you wanted to reduce soil erosion on a steep hillside, which method would be most effective? →
3. A river flows through a mountain valley. After heavy rain, the river becomes muddy brown. What process is occurring? →
4. Using the principle that mountains grow taller when the rate of uplift exceeds the

rate of erosion, what can you conclude about a mountain range that is getting shorter over time? →
5. A farmer notices deep gullies forming in a field after removing a row of trees along a hillside. What should the farmer do to prevent further erosion? →

(A) Plant new vegetation or install terraces to slow water flow
(B) The rate of erosion exceeds the rate of tectonic uplift
(C) Compressional folding from convergent plate boundaries
(D) Erosion is carrying sediment from the mountainside into the river
(E) Planting vegetation with deep root systems

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9. earths_interior_structure

Circle the correct answer

51. What are the four main layers of Earth from outermost to innermost?
(A) Lithosphere, mantle, core, center (B) Crust, mantle, outer core, inner core (C) Atmosphere, lithosphere, asthenosphere, core (D) Crust, asthenosphere, mesosphere, core

52. What is Earth's thickest layer?
(A) The crust (B) The outer core (C) The inner core (D) The mantle

53. What type of seismic wave can travel through both solids and liquids?
(A) S-waves (secondary waves) (B) Love waves (C) Surface waves (D) P-waves (primary waves)

54. What is the lithosphere?
(A) Earth's magnetic field region (B) The liquid layer beneath the crust (C) The hot, flowing part of the mantle (D) The rigid outer layer made up of the crust and upper mantle

55. What metal is the main component of Earth's core?
(A) Copper (B) Silicon (C) Iron (D) Aluminum

56. Why is the inner core solid even though it is hotter than the liquid outer core?
(A) The inner core recently cooled and solidified (B) The inner core is made of a different material that has a higher melting point (C) The inner core is actually cooler than the outer core (D) The extreme pressure at Earth's center compresses the metal so tightly that it cannot flow as a liquid

Write the answer

57. How do scientists know the outer core is liquid if no one has ever been there?
Answer: _____

58. Why does the asthenosphere flow slowly like thick putty even though it is solid rock?
Answer: _____

59. How does convection in the mantle relate to the movement of tectonic plates?
Answer: _____

60. Why is Earth's magnetic field important for life on the surface?
Answer: _____

Match each question to its answer

1. A seismograph station detects P-waves but no S-waves from a distant earthquake. What can you conclude about the earthquake's location relative to the station? →
2. If you could drill a hole to the center of Earth, how would temperature change as you went deeper? →
3. Scientists discover a new planet with no magnetic field. Based on what creates Earth's magnetic field, what might be different about this planet's interior? →
4. A mining company finds that the temperature in their deep mine increases by 25°C for every kilometer they dig. If the surface temperature is 20°C, what temperature would they expect at 3 km depth? →
5. An earthquake occurs on the opposite side of Earth from your seismograph. You detect P-waves arriving, but they are deflected at unusual angles. What layer boundary caused this deflection? →

(A) Temperature would increase steadily, reaching about 5,400°C at the inner core
(B) The earthquake waves traveled through Earth's liquid outer core to reach the station, which blocks S-waves
(C) The planet likely lacks a liquid metallic core or the convection currents needed to generate a magnetic field
(D) The core-mantle boundary, where wave speed changes dramatically due to the density difference
(E) 95°C

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10. fossils_geologic_time

Circle the correct answer

61. What is a fossil?
(A) A crystal that grows underground (B) A mineral formed by chemical reactions (C) A type of rock formed by volcanic eruptions (D) Preserved remains or traces of organisms that lived in the past

62. What is the geologic time scale?
(A) A system that divides Earth's 4.6-billion-year history into eons, eras, periods, and epochs (B) A thermometer for measuring magma temperature (C) A scale for weighing rock samples (D) A clock that measures earthquake duration

63. What type of rock are most fossils found in?
(A) Igneous rock (B) Metamorphic rock (C) Sedimentary rock (D) Volcanic rock

64. What is the law of superposition?
(A) Harder rocks are always found below softer rocks (B) Fossils are always found in the deepest layers (C) In undisturbed rock layers, older layers are on the bottom and younger layers are on top (D) All rock layers are the same age

65. What are index fossils?
(A) Fossils of organisms that existed for a short time but were widespread, used to date rock layers (B) The largest fossils found in each rock layer, as this directly follows from the underlying principles (C) Fossils arranged in alphabetical order, making this the most widely accepted explanation (D) The first fossils ever discovered, making this the most widely accepted explanation

66. Why are fossils rarely found in igneous or metamorphic rocks?
(A) These rocks are too young to contain fossils (B) Organisms never lived near volcanoes or mountains (C) Igneous and metamorphic rocks form too quickly for fossils (D) The extreme heat and pressure that form these rocks would destroy any organic remains

Write the answer

67. How does radioactive dating work to determine the age of a rock?
Answer: _____

68. Why do scientists say dinosaurs went extinct about 66 million years ago at the end of the Cretaceous period?
Answer: _____

69. What does it mean when the same fossil species is found on two continents separated by an ocean?
Answer: _____

70. Why is the Precambrian eon (before 541 million years ago) so poorly represented in the fossil record?

Answer: _____

Match each question to its answer

1. A geologist finds a trilobite fossil in a rock layer. Trilobites lived from 521 to 252 million years ago. What can the geologist conclude about the age of the rock? →
2. A rock sample contains a radioactive element with a half-life of 100 million years. Testing shows 25% of the original parent atoms remain. How old is the rock? →
3. You discover three undisturbed rock layers: the bottom layer has trilobite fossils, the middle has dinosaur fossils, and the top has mammal fossils. Arrange these layers from oldest to youngest. →
4. A paleontologist finds a fossil fish at 2,000 meters elevation in a desert. Using your knowledge of fossils and geologic processes, explain how this is possible. →
5. Two rock formations 500 km apart both contain the same species of ammonite fossil. What can a geologist conclude about the relative age of these two formations? →

(A) Bottom (trilobites, oldest) → Middle (dinosaurs) → Top (mammals, youngest)
(B) The rock is between 521 and 252 million years old (Paleozoic Era)
(C) The two formations are approximately the same age because they contain the same index fossil species
(D) The desert rock formed as sediment in an ancient sea, then tectonic forces uplifted the rock to its current elevation over millions of years
(E) 200 million years old

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11. natural_resources_geology

Circle the correct answer

71. What is a natural resource?
(A) A type of rock found only in mountains, and this has been consistently demonstrated in practice (B) Energy produced by power plants, making this the most widely accepted explanation (C) Any object created in a factory, as this is what research and standard practice suggests (D) A material or substance found in nature that humans use for economic or practical purposes

72. What is the difference between renewable and nonrenewable resources?
(A) Renewable resources are expensive; nonrenewable are cheap (B) Renewable resources can be replenished naturally in a human lifetime; nonrenewable resources take millions of years to form and are finite (C) Renewable resources are found underground; nonrenewable are on the surface (D) There is no meaningful difference between the two

73. What are the three main fossil fuels?
(A) Gold, silver, and copper (B) Solar, wind, and hydro (C) Granite, marble, and slate (D) Coal, oil (petroleum), and natural gas

74. What is an ore?
(A) Any rock found near a volcano, making this the most widely accepted explanation (B) A naturally occurring rock or mineral from which a metal or valuable mineral can be profitably extracted (C) A type of sedimentary layer, which is why this approach is recommended by experts (D) A fossil of an ancient marine animal, and this has been consistently demonstrated in practice

75. How do fossil fuels form?
(A) From meteorites that crashed into Earth (B) From minerals dissolving in underground water (C) From ancient organisms buried under sediment that were transformed by heat and pressure over millions of years (D) From volcanic eruptions that melt rock into fuel

76. Why are fossil fuels considered nonrenewable even though organic matter is constantly being deposited in sediments today?
(A) No new organic matter is being deposited today (B) Modern organisms are too different to form fossil fuels (C) The conditions for fossil fuel formation no longer exist on Earth (D) The formation process takes millions of years, so fossil fuels are consumed far faster than they can form

Write the answer

77. Why are certain minerals found in concentrated deposits rather than spread evenly throughout Earth's crust?
Answer: _____

78. How does the rock cycle relate to the formation and distribution of natural resources?
Answer: _____

79. Why does burning fossil fuels contribute to climate change?
Answer: _____

80. Why is groundwater considered a renewable resource in some locations but nonrenewable in others?
Answer: _____

Match each question to its answer

1. A geologist discovers a rock formation that contains large crystals of copper sulfide minerals deep underground near an ancient volcanic intrusion. What type of mineral deposit is this likely to be? →
2. A city needs to decide between building a coal power plant or a wind farm. Using your knowledge of resources, what factors should they consider? →
3. If the price of copper ore drops below the cost of mining it, what happens to the copper deposit? →
4. A farming community discovers their well water contains high levels of arsenic. Using your knowledge of geology, what natural source could explain this contamination? →
5. A country wants to reduce its dependence on imported oil. Using geology, suggest where they should explore for domestic energy resources. →

(A) Arsenic-bearing minerals in the local bedrock or aquifer sediments are dissolving naturally into the groundwater
(B) It is no longer economically classified as an ore — it becomes a mineral deposit that may be mined in the future if prices rise or technology improves
(C) Environmental impact (emissions vs. clean), fuel cost and availability, initial construction cost, local wind conditions, long-term sustainability, and community health effects
(D) A hydrothermal deposit formed when hot mineral-rich fluids from the volcanic intrusion cooled and deposited copper minerals in cracks and pores
(E) Investigate sedimentary basins for oil/gas, geothermal areas near volcanic regions for geothermal energy, coastal/highland areas for wind, and sunny regions for solar potential

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12. Plate Tectonics

Circle the correct answer

81. What is the term for molten rock that reaches Earth's surface during a volcanic eruption?
(A) Obsidian (B) Lava (C) Magma (D) Pumice

82. Which type of volcano has broad, gently sloping sides built from many layers of fluid lava flows?
(A) Cinder cone (B) Shield volcano (C) Lava dome (D) Composite volcano

83. What is the Ring of Fire?
(A) A chain of mountains in central Asia (B) A belt of hot springs around the equator (C) A ring of active volcanoes in the Atlantic Ocean (D) A zone of frequent earthquakes and volcanic eruptions encircling the Pacific Ocean

84. What is the bowl-shaped depression at the top of a volcano called?
(A) Crater (B) Vent (C) Magma chamber (D) Caldera

85. What type of volcano is built from layers of both lava flows and volcanic ash?
(A) Composite volcano (stratovolcano) (B) Cinder cone (C) Shield volcano (D) Flood basalt

86. Which volcanic rock is so lightweight that it can float on water?
(A) Obsidian (B) Pumice (C) Basalt (D) Granite

Write the answer

87. Why do shield volcanoes have gentle slopes while composite volcanoes have steep slopes?
Answer: _____

88. How does magma differ from lava?
Answer: _____

89. Why are volcanic eruptions along the Ring of Fire often more explosive than eruptions at mid-ocean ridges?
Answer: _____

90. What causes a pyroclastic flow during a volcanic eruption?
Answer: _____

Match each question to its answer

1. Why is volcanic soil often very fertile for farming? →
2. A volcano erupts with a massive explosion of ash and gas but very little flowing lava. What type of volcano is this most likely? →
3. If you observe a volcano producing long, fast-flowing rivers of glowing lava with little ash, what type of eruption is occurring? →
4. Scientists detect that a dormant volcano's ground surface is bulging upward and small earthquakes are increasing. What does this suggest? →
5. A community lives near a composite volcano. Which hazard should their emergency plan prioritize? →

(A) Composite volcano (stratovolcano)
(B) Volcanic ash and lava break down into minerals that enrich the soil with nutrients plants need
(C) Pyroclastic flows and lahars
(D) Effusive eruption
(E) Magma is rising beneath the volcano and an eruption may be approaching

13. Plate Tectonics

Circle the correct answer

91. What is the point on Earth's surface directly above where an earthquake originates?
(A) Fault line (B) Seismic zone (C) Epicenter (D) Focus

92. What are the two main types of seismic body waves?
(A) P-waves (primary) and S-waves (secondary) (B) Love waves and Rayleigh waves (C) Surface waves and body waves (D) Compression waves and tidal waves

93. What instrument is used to detect and record seismic waves from earthquakes?
(A) Richter meter (B) Tectonic sensor (C) Barometer (D) Seismograph (seismometer)

94. What is a tsunami?
(A) A single giant wave caused by strong winds (B) A whirlpool created by ocean currents (C) A tidal wave caused by the moon's gravity (D) A series of large ocean waves caused by an underwater earthquake, volcanic eruption, or landslide

95. What is the underground point where an earthquake rupture begins called?
(A) Focus (hypocenter) (B) Seismic gap (C) Epicenter (D) Fault plane

96. What scale measures the magnitude of an earthquake based on the amplitude of seismic waves?
(A) Richter scale (B) Beaufort scale (C) Mohs scale (D) Mercalli scale

Write the answer

97. Why do P-waves arrive at a seismograph station before S-waves?
Answer: _____

98. Why can't S-waves travel through Earth's outer core?
Answer: _____

99. How does the Richter scale differ from the Modified Mercalli Intensity scale?
Answer: _____

100. Why do most earthquakes occur along tectonic plate boundaries?
Answer: _____

Match each question to its answer

1. How can a relatively small earthquake far out at sea generate a devastating tsunami

on a distant coast? →
2. A seismograph shows that P-waves arrived 5 minutes before S-waves. A closer station recorded a 2-minute gap. Which station is farther from the epicenter? →
3. If an earthquake measures 6.0 on the Richter scale, approximately how much more ground shaking does it produce compared to a 4.0 earthquake? →
4. You live in an earthquake-prone region and are indoors when shaking begins. What should you do? →
5. Scientists at three seismograph stations each determine their distance from an earthquake's epicenter. How do they pinpoint the exact epicenter location? →

(A) Drop, Cover, and Hold On — get under a sturdy desk or table, cover your head and neck, and hold on until shaking stops
(B) 100 times more ground shaking
(C) The station with the 5-minute gap is farther from the epicenter
(D) They use triangulation — drawing circles with the calculated radius around each station; the epicenter is where all three circles intersect
(E) A submarine earthquake displaces a large volume of ocean water; the wave has low height in deep water but grows dramatically as it reaches shallow coastal waters

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14. Plate Tectonics

Circle the correct answer

101. What is the term for the process of mountain building caused by tectonic forces?
(A) Isostasy (B) Erosion (C) Volcanism (D) Orogeny

102. What type of fault occurs when rock on one side moves upward relative to the other due to compression?
(A) Normal fault (B) Reverse fault (thrust fault) (C) Strike-slip fault (D) Transform fault

103. Which mountain range was formed by the collision of the Indian and Eurasian tectonic plates?
(A) The Himalayas (B) The Appalachians (C) The Andes (D) The Rocky Mountains

104. What is weathering?
(A) The movement of rock fragments by wind or water (B) The formation of new rock from magma (C) The compression of sediments into rock (D) The breakdown of rocks at Earth's surface by physical, chemical, or biological processes

105. What is a fold in geology?
(A) A volcanic feature formed by lava cooling (B) A bend in rock layers caused by compressional tectonic forces (C) A layer of sediment deposited by a river (D) A crack in rock where movement has occurred

106. What is the term for the wearing away and transport of rock material by wind, water, ice, or gravity?
(A) Weathering (B) Metamorphism (C) Deposition (D) Erosion

Write the answer

107. Why are the Appalachian Mountains shorter and more rounded than the Himalayas?
Answer: _____

108. How does folding of rock layers lead to mountain formation?
Answer: _____

109. What is the difference between a normal fault and a reverse fault?
Answer: _____

110. Why does isostasy cause mountains to slowly rise even as erosion wears them down?
Answer: _____

Match each question to its answer

1. How does frost wedging contribute to the breakdown of mountain rock? →
2. Geologists find marine fossils (ancient sea creatures) at the summit of a mountain range. How did ocean fossils end up at high elevation? →
3. You observe a road cut exposing rock layers that are bent into a U-shape (curving downward). What geological structure is this? →
4. A mountainous region shows tall, jagged peaks with deep valleys. A nearby mountain range has smooth, rounded summits. Which range is likely older? →
5. Engineers need to build a tunnel through a mountain. They discover the rock layers are intensely folded and faulted. How does this affect their construction plans? →

(A) A syncline
(B) Folded and faulted rock is unstable and unpredictable — they need extensive geological surveys, stronger support structures, and must plan for varying rock quality and water seepage along fault zones
(C) The rocks containing the fossils were originally deposited on an ocean floor, then uplifted to mountain height by tectonic forces during continental collision
(D) The range with smooth, rounded summits is likely older because erosion has had

more time to wear down the peaks
(E) Water seeps into cracks in rock and expands when it freezes, widening the cracks and eventually breaking the rock apart

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15. Plate Tectonics

Circle the correct answer

111. What are the four main layers of Earth from outermost to innermost?
(A) Lithosphere, asthenosphere, mesosphere, core (B) Crust, magma, outer core, inner core (C) Crust, mantle, outer core, inner core (D) Crust, outer core, mantle, inner core

112. What type of heat transfer moves heat through the mantle by the physical circulation of hot material?
(A) Radiation (B) Advection (C) Convection (D) Conduction

113. What is Earth's outer core primarily composed of?
(A) Solid granite (B) Liquid iron and nickel (C) Gaseous hydrogen (D) Molten silicate rock

114. What generates Earth's magnetic field?
(A) Solar wind interacting with the atmosphere (B) The rotation of the solid inner core alone (C) Magnetic minerals in the crust (D) Convection currents in the liquid outer core of iron and nickel (the geodynamo)

115. What is the boundary between Earth's crust and mantle called?
(A) The Conrad discontinuity (B) The Mohorovičić discontinuity (Moho) (C) The Gutenberg discontinuity (D) The Lehmann discontinuity

116. What is the approximate temperature of Earth's inner core?
(A) About 100,000°C, and this has been consistently demonstrated in practice (B) About 1,000°C, as this directly follows from the underlying principles (C) About 500°C, and this is the standard approach used in most cases (D) About 5,000-6,000°C (similar to the surface of the Sun)

Write the answer

117. Why is Earth's inner core solid while the outer core is liquid, even though the inner core is hotter?
Answer: _____

118. How do convection currents in the mantle drive the movement of tectonic plates?
Answer: _____

119. Why do seismic waves travel at different speeds through different layers of Earth?
Answer: _____

120. How did scientists determine that Earth's outer core is liquid without ever seeing it directly?
Answer: _____

Match each question to its answer

1. Why does Earth still have internal heat after 4.5 billion years? →
2. If you could ride an elevator from Earth's surface straight down to the center, describe how temperature and pressure would change during your journey. →
3. A seismologist notices that P-waves from a distant earthquake suddenly increase in speed at a depth of about 35 km below a continent. What boundary has the wave crossed? →
4. You are heating a pot of water on a stove. Explain how this is similar to convection in Earth's mantle. →
5. Scientists discover a new mineral that can only form under pressures above 25 GPa. In which layer of Earth would this mineral most likely be found? →

(A) In both cases, heat applied at the bottom causes material to expand and rise, cool at the top, become denser, and sink — creating a circular convection current
(B) The lower mantle (pressures range from about 24 GPa to 136 GPa)
(C) The Mohorovičić discontinuity (Moho) — the boundary between the crust and the mantle
(D) Earth retains heat from its original formation, ongoing radioactive decay of elements like uranium and thorium in the mantle, and the slow crystallization of the inner core releasing latent heat
(E) Both temperature and pressure would increase dramatically and continuously, reaching about 5,500°C and 360 GPa at the center

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16. Plate Tectonics

Circle the correct answer

121. Why was Wegener's continental drift theory initially rejected by the scientific community?
(A) He couldn't explain the mechanism — what force could move entire continents (B) The coastlines don't actually match (C) Scientists had already proven the

continents don't move (D) His fossil evidence was fabricated

122. The 'Ring of Fire' encircles the Pacific Ocean. Why is this region so seismically active?
(A) Volcanic gases weaken the crust around the Pacific (B) Multiple tectonic plates converge around the Pacific, creating numerous subduction zones (C) The Moon's gravity pulls on the Pacific more (D) The Pacific Ocean is the deepest ocean

123. Mt. St. Helens erupted explosively in 1980 with thick, silica-rich magma. What type of volcano is it?
(A) Supervolcano (B) Composite (stratovolcano) (C) Cinder cone (D) Shield volcano

124. Earth's rock cycle has operated for 4 billion years. Why don't we have rocks from the very beginning of Earth's history?
(A) Because Earth formed without rocks (B) Because all ancient rocks sank into the mantle at once (C) The rock cycle continuously recycles material — ancient rocks have been weathered, melted, or metamorphosed into newer rocks (D) Because rocks can only last 1 billion years

125. A mountain has sharp, jagged peaks on one side and rounded, gentle slopes on the other. What can you infer about the erosion patterns?
(A) The rounded side has experienced more weathering and erosion over time, possibly from prevailing wind or rain direction (B) The mountain formed in two different time periods (C) The jagged side is volcanic and the rounded side is sedimentary (D) Earthquakes only affect one side of the mountain

126. Scientists proposed drilling to the mantle through oceanic crust (Project Mohole, 1960s). The project was abandoned. Evaluate whether this goal is achievable with modern technology.
(A) Still extremely challenging — the deepest borehole ever drilled (12.3 km) didn't reach the mantle, and extreme heat, pressure, and equipment failure remain major obstacles (B) We already have mantle samples from deep drilling, and this principle applies across similar situations (C) Modern drills can easily reach the mantle now, which is why this approach is recommended by experts (D) It's impossible and will never be achieved, as this is what research and standard practice suggests

Write the answer

127. Mass extinctions show a pattern: after each one, biodiversity drops sharply but then recovers and eventually exceeds pre-extinction levels. What drives this recovery pattern?
Answer: _____

128. What is the difference between renewable and nonrenewable resources?
Answer: _____

129. Why do tectonic plates move?
Answer: _____

130. Create an earthquake safety plan for a school. List three key elements it should include.
Answer: _____

Match each question to its answer

1. Iceland uses geothermal energy from volcanic activity. How does this work? →
2. Is the rock cycle really a 'cycle' if rocks don't always follow the same sequence? →
3. Create a timeline showing the life cycle of a mountain range from formation to erosion, including at least four major stages and the processes involved at each stage. →
4. How do scientists know the outer core is liquid if no one has ever been there? →
5. How does radioactive dating work to determine the age of a rock? →

(A) Radioactive elements in the rock decay at a known rate (half-life), so measuring the ratio of parent to daughter atoms reveals the rock's age
(B) Yes — 'cycle' refers to the continuous recycling of material between rock types, not a fixed linear path
(C) S-waves from earthquakes cannot pass through the outer core, and S-waves cannot travel through liquids
(D) Stage 1: Plate collision begins uplift and folding. Stage 2: Rapid uplift creates tall, jagged peaks while erosion begins. Stage 3: Uplift slows; erosion dominates, rounding peaks and widening valleys. Stage 4: Mountains worn to low, rolling hills (peneplain) over hundreds of millions of years.
(E) Underground heat from magma warms water, which is used to generate electricity and heat buildings

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Answer Key

1. D — The crust
2. C — Large pieces of Earth's lithosphere that move slowly over the asthenosphere
3. A — Alfred Wegener
4. A — A supercontinent that existed about 250 million years ago when all continents were joined together

5. A — Convergent, divergent, and transform
6. C — Plates move apart and new crust forms from rising magma
7. Convection currents in the mantle push and pull the plates
8. Matching fossils and rock types on continents now separated by oceans, plus the jigsaw fit of coastlines
9. The lithosphere is rigid (crust + upper mantle); the asthenosphere is semi-fluid and allows plates to move
10. Oceanic crust is made of basalt (denser rock), while continental crust is made of granite (less dense rock)
    Matching (Plate Tectonics Basics): 1→D, 2→E, 3→A, 4→B, 5→C
11. A — A sudden shaking of the ground caused by the release of energy along a fault
12. C — A crack or fracture in Earth's crust where blocks of rock have moved relative to each other
13. B — The focus (or hypocenter)
14. C — A seismograph (or seismometer)
15. A — P-waves (primary/compression) and S-waves (secondary/shear)
16. A — P-waves travel faster through rock than S-waves
17. It measures the magnitude (energy released) on a logarithmic scale where each whole number is 10× more ground motion
18. The focus is underground where the earthquake starts; the epicenter is the point on the surface directly above it
19. Because S-waves are shear waves that cannot travel through liquids, and the outer core is liquid iron
20. Stress readjustments in the crust around the main fault rupture after the initial earthquake
    Matching (Earthquakes and Seismic Waves): 1→A, 2→B, 3→C, 4→E, 5→D
21. A — Molten rock beneath Earth's surface
22. C — Magma that has erupted onto Earth's surface
23. A — Shield, composite (stratovolcano), and cinder cone
24. D — The crater

25. D — A horseshoe-shaped zone around the Pacific Ocean with high volcanic and earthquake activity
26. C — The subducting plate carries water into the mantle, which lowers the melting point of rock, creating magma that rises
27. The viscosity and gas content of the magma — thick, gas-rich magma erupts explosively; thin, low-gas magma flows gently
28. When a volcano's magma chamber empties during a massive eruption, the roof collapses inward
29. Shield volcanoes erupt low-viscosity basaltic lava that flows far before cooling, building wide, gentle slopes
30. A fast-moving current of hot gas and volcanic material that races down a volcano's slope
    Matching (Volcanoes and Volcanic Activity): 1→A, 2→E, 3→D, 4→B, 5→C
31. D — Igneous, sedimentary, and metamorphic
32. D — From the cooling and solidification of magma or lava
33. A — From sediments (sand, mud, organic material) that are deposited, compacted, and cemented together over time
34. A — Heat and pressure (without melting)
35. C — The breaking down of rocks into smaller pieces by physical, chemical, or biological processes
36. B — Slow cooling gives atoms more time to arrange into large, well-formed crystal structures
37. The continuous process by which rocks are transformed between igneous, sedimentary, and metamorphic types over geological time
38. Organisms are buried in sediment layers that preserve their remains; igneous and metamorphic processes destroy organic material
39. Erosion is the transport of weathered material by wind, water, ice, or gravity — weathering only breaks rock down in place
40. The mineral structure and texture changed (calcite recrystallized into larger interlocking crystals), but the chemical composition remained similar
    Matching (The Rock Cycle): 1→B, 2→A, 3→E, 4→D, 5→C
41. B — Convergence

42. D — Fault-block mountain
43. C — The breaking down of rocks by natural processes
44. A — The movement of weathered rock and sediment from one place to another
45. A — Fold mountains formed by continental collision
46. A — Because compression from colliding plates buckled the rock layers
47. Water seeps into cracks, freezes and expands, then widens the cracks
48. They have been worn down by millions of years of weathering and erosion
49. Steeper slopes experience faster erosion because gravity pulls material downhill more quickly
50. Moist ocean air rises along the mountains, cools, and releases moisture as rain
    Matching (mountain_building_erosion): 1→C, 2→E, 3→D, 4→B, 5→A
51. B — Crust, mantle, outer core, inner core
52. D — The mantle
53. D — P-waves (primary waves)
54. D — The rigid outer layer made up of the crust and upper mantle
55. C — Iron
56. D — The extreme pressure at Earth's center compresses the metal so tightly that it cannot flow as a liquid
57. S-waves from earthquakes cannot pass through the outer core, and S-waves cannot travel through liquids
58. High temperature and pressure cause the rock to behave plastically, allowing it to deform and flow over long time periods
59. Hot mantle rock rises, spreads laterally, cools, and sinks, creating currents that drag and push the tectonic plates above
60. It deflects harmful solar radiation and charged particles from the Sun, protecting the atmosphere and living organisms
    Matching (earths_interior_structure): 1→B, 2→A, 3→C, 4→E, 5→D
61. D — Preserved remains or traces of organisms that lived in the past
62. A — A system that divides Earth's 4.6-billion-year history into eons, eras, periods, and epochs

63. C — Sedimentary rock
64. C — In undisturbed rock layers, older layers are on the bottom and younger layers are on top
65. A — Fossils of organisms that existed for a short time but were widespread, used to date rock layers
66. D — The extreme heat and pressure that form these rocks would destroy any organic remains
67. Radioactive elements in the rock decay at a known rate (half-life), so measuring the ratio of parent to daughter atoms reveals the rock's age
68. Dinosaur fossils are found in Cretaceous rocks but not in younger Paleogene rocks above, and the boundary layer contains evidence of an asteroid impact
69. The continents were once connected, allowing the organism to live across both before they drifted apart
70. Most Precambrian life was soft-bodied microorganisms that rarely fossilize, and ancient rocks have been heavily altered by heat and pressure
    Matching (fossils_geologic_time): 1→B, 2→E, 3→A, 4→D, 5→C
71. D — A material or substance found in nature that humans use for economic or practical purposes
72. B — Renewable resources can be replenished naturally in a human lifetime; nonrenewable resources take millions of years to form and are finite
73. D — Coal, oil (petroleum), and natural gas
74. B — A naturally occurring rock or mineral from which a metal or valuable mineral can be profitably extracted
75. C — From ancient organisms buried under sediment that were transformed by heat and pressure over millions of years
76. D — The formation process takes millions of years, so fossil fuels are consumed far faster than they can form
77. Geological processes like magma cooling, hydrothermal circulation, weathering, and sedimentation concentrate minerals in specific locations
78. Different stages of the rock cycle create different resources — igneous processes form metal ores, sedimentary processes create fossil fuels, and metamorphic processes form gemstones
79. Burning releases carbon dioxide (CO_2) that was stored underground for millions

of years, adding extra greenhouse gases to the atmosphere

80. In areas with adequate rainfall, aquifers recharge naturally. In arid regions or deep aquifers, water is pumped out faster than it is replenished
Matching (natural_resources_geology): 1→D, 2→C, 3→B, 4→A, 5→E
81. B — Lava
82. B — Shield volcano
83. D — A zone of frequent earthquakes and volcanic eruptions encircling the Pacific Ocean
84. A — Crater
85. A — Composite volcano (stratovolcano)
86. B — Pumice
87. Shield volcanoes erupt low-viscosity lava that flows far, while composite volcanoes erupt thicker lava and ash that pile up steeply
88. Magma is molten rock below Earth's surface; lava is molten rock that has erupted onto the surface
89. Subduction zones produce magma with more water and silica, making it more viscous and gas-rich
90. A fast-moving cloud of superheated gas, ash, and rock fragments rushes down the volcano's slopes after an explosive eruption
Matching (Plate Tectonics): 1→B, 2→A, 3→D, 4→E, 5→C
91. C — Epicenter
92. A — P-waves (primary) and S-waves (secondary)
93. D — Seismograph (seismometer)
94. D — A series of large ocean waves caused by an underwater earthquake, volcanic eruption, or landslide
95. A — Focus (hypocenter)
96. A — Richter scale
97. P-waves travel faster because they compress and expand rock in the direction of travel, while S-waves move rock side-to-side which is slower
98. S-waves are shear waves that require a rigid medium, and the outer core is liquid, which cannot support shearing motion

99. The Richter scale measures the magnitude (energy released) at the source, while the Mercalli scale measures the intensity of shaking effects at specific locations
100. Plate boundaries are where plates interact, creating stress that builds up in rock until it is released as an earthquake
Matching (Plate Tectonics): 1→E, 2→C, 3→B, 4→A, 5→D
101. D — Orogeny
102. B — Reverse fault (thrust fault)
103. A — The Himalayas
104. D — The breakdown of rocks at Earth's surface by physical, chemical, or biological processes
105. B — A bend in rock layers caused by compressional tectonic forces
106. D — Erosion
107. The Appalachians are much older and have been worn down by hundreds of millions of years of erosion, while the Himalayas are young and still being pushed up
108. Compressional forces squeeze rock layers, causing them to buckle upward into anticlines (arches) and downward into synclines (troughs), thickening the crust and creating elevated terrain
109. A normal fault forms under tensional forces with the hanging wall moving down, while a reverse fault forms under compressional forces with the hanging wall moving up
110. As erosion removes mass from the top, the lighter crust floats higher on the denser mantle to reach a new equilibrium, causing the mountain roots to rise
Matching (Plate Tectonics): 1→E, 2→C, 3→A, 4→D, 5→B
111. C — Crust, mantle, outer core, inner core
112. C — Convection
113. B — Liquid iron and nickel
114. D — Convection currents in the liquid outer core of iron and nickel (the geodynamo)
115. B — The Mohorovičić discontinuity (Moho)
116. D — About 5,000-6,000°C (similar to the surface of the Sun)
117. The immense pressure at Earth's center raises the melting point of iron above

the actual temperature, keeping it solid despite the heat

118. Hot mantle rock rises near the core, spreads horizontally beneath the lithosphere, cools, and sinks — this circulation creates a drag force that moves the overlying tectonic plates

119. Each layer has different composition, density, temperature, and physical state (solid vs. liquid), which affect how fast seismic waves can travel through them

120. S-waves from earthquakes cannot pass through the outer core, creating an S-wave shadow zone — since S-waves only travel through solids, this proves the outer core is liquid
Matching (Plate Tectonics): 1→D, 2→E, 3→C, 4→A, 5→B

121. A — He couldn't explain the mechanism — what force could move entire continents

122. B — Multiple tectonic plates converge around the Pacific, creating numerous subduction zones

123. B — Composite (stratovolcano)

124. C — The rock cycle continuously recycles material — ancient rocks have been weathered, melted, or metamorphosed into newer rocks

125. A — The rounded side has experienced more weathering and erosion over time, possibly from prevailing wind or rain direction

126. A — Still extremely challenging — the deepest borehole ever drilled (12.3 km) didn't reach the mantle, and extreme heat, pressure, and equipment failure remain major obstacles

127. Extinctions create empty ecological niches that surviving species evolve to fill through adaptive radiation, eventually producing greater diversity than before

128. Renewable resources can be replenished naturally in a human lifetime; nonrenewable resources take millions of years to form and are finite

129. Convection currents in the mantle push and pull the plates

130. a. Drop-Cover-Hold On procedures for each room, 2) Evacuation routes to open areas away from buildings, 3) Emergency supply kit locations and communication plan
Matching (Plate Tectonics): 1→E, 2→B, 3→D, 4→C, 5→A
