Unit 15 · Geology

ANSWER KEY · FOR TEACHERS

Full marks 46

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. lithosphere → **f.** the stiff crust and topmost mantle, broken into plates
2. asthenosphere → **g.** the soft, slowly creeping layer the plates ride on
3. subduction → **d.** the sinking of an oceanic plate under another plate
4. thrust → **c.** a low-angle fault along which a sheet of rock is pushed over the rock in front
5. lahar → **b.** a mudflow of volcanic ash and water
6. epicenter → **e.** the point on the surface directly above the focus

K · 3

Each carries 0.5 mark.

2 Label the diagram

1. crater
2. main vent
3. side vent
4. magma chamber

K · 2

Each carries 0.5 mark.

3 Multiple choice

i. **c.** lithosphere — K · 1

The lithosphere, the stiff crust and topmost mantle, about 100 km thick, is broken into plates, which slide on the soft asthenosphere below.

ii. **d.** recumbent — K · 1

A recumbent fold (Latin *recumbere*, to lie down) has been pushed over so far that its axial plane is almost horizontal. In an overturned fold, one limb is past upright, but the fold doesn't yet lie flat.

iii. **b.** a dormant volcano — U · 1

A volcano that hasn't erupted for a long time but could erupt again is dormant. Fuji is also a composite volcano, not a shield volcano.

iv. **b.** epicenter — K · 1

The focus, or hypocenter, is where the rock slips underground; the epicenter is the point on the surface straight above it.

4 Very short answers

a. MARKING SCHEME — K · 1

✓ Transform.

b. MARKING SCHEME — K · 1

✓ The Tethys Sea.

c. MARKING SCHEME — U · 1

✓ S waves.

d. MARKING SCHEME — K · 1

✓ The Modified Mercalli scale.

5 Short answers

a. MARKING SCHEME — U · 2

✓ The rocks were laid down on the floor of the Tethys Sea, with the shells of sea animals in them.

✓ When India hit Asia, the layers were folded and pushed up thousands of meters.

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b. MARKING SCHEME U · 2

- ✓ Continent meets continent; neither sinks, so no wet ocean plate melts the mantle (and there are no ridges or hot spots).
- ✓ The stuck fault slips from time to time, causing earthquakes.

c. MARKING SCHEME U · 2

- ✓ Most deaths come from buildings collapsing.
- ✓ The code (firm foundation, tied walls, steel, light roof) keeps buildings standing.

d. MARKING SCHEME U · 2

- ✓ Magma is under the surface, lava has come out on it.
- ✓ Any one more: magma holds much dissolved gas, lava has lost much of it; magma cools slowly, lava quickly.

6 Long answers

a. ANSWER U · 4

a. **Divergent**: plates move apart; magma rises into the gap and makes new crust, forming mid-ocean ridges and rift valleys. Example: the Mid-Atlantic Ridge, which rises above the sea in Iceland.

b. **Convergent**: plates move towards each other. Where sea floor meets a continent, it sinks under it (subduction), making a trench and a line of volcanoes, as in the Andes. Where two continents meet, the crust crumples into fold mountains, as in the Himalaya.

c. **Transform**: plates slide past each other, causing earthquakes but making no new crust. Example: the San Andreas Fault in California.

MARKING SCHEME

- ✓ Divergent: plates move apart, new crust made; Mid-Atlantic Ridge.
- ✓ Convergent where sea floor sinks: trench and volcanoes; Andes.
- ✓ Convergent where continents collide: fold mountains; Himalaya.
- ✓ Transform: plates slide past, earthquakes, no crust made; San Andreas Fault.

b. ANSWER U · 4

An earthquake is a sudden shaking of the ground caused by waves of energy released when rock breaks or slips below the surface. By the elastic rebound theory: the rock on either side of a fault is held by friction while the plates keep moving, so it bends and stores energy, like a bent stick, over many years. When the force becomes greater than the friction, the fault slips suddenly, and the rock on both sides springs back to an unbent shape. The stored energy is released as seismic waves, which spread out from the focus and shake the ground.

MARKING SCHEME

- ✓ Definition: sudden shaking from waves released when rock slips.
- ✓ The rock along a fault is stuck by friction while the plates move.
- ✓ It bends and stores energy over many years.
- ✓ When the force beats friction, the fault slips and the rock springs back, releasing waves.

c. ANSWER A · 4

a. Build houses according to the National Building Code, with ties, bands and steel to hold them together.

b. Retrofit old buildings, especially schools and hospitals.

c. Don't build on steep, loose slopes or soft filled ground; keep open spaces in towns.

d. Fix heavy furniture to the walls, keep an emergency bag, and practice earthquake drills; mark Earthquake Safety Day on 2 Magh.

e. During shaking, Drop, Cover and Hold On indoors; outdoors, move to an open place away from buildings, poles and slopes.

MARKING SCHEME

- ✓ Build to the National Building Code.
- ✓ Retrofit old buildings, especially schools and hospitals.
- ✓ Any one of: plan land use; fix furniture; emergency bag; drills.
- ✓ Drop, Cover and Hold On during the shaking.

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7 Numerical problems

a. ANSWER A · 2

1,800 km = 1,800 × 100,000 cm = 180,000,000 cm.

$$v = \frac{180{,}000{,}000 \text{ cm}}{40{,}000{,}000 \text{ yr}} = 4.5 \text{ cm/yr}$$

4.5 cm a year, about the speed of India today.

MARKING SCHEME

✓ 1,800 km = 180,000,000 cm.
✓ 180,000,000 ÷ 40,000,000 = 4.5 cm a year.

b. ANSWER A · 3

a. Shortening = 50 − 35 = **15 km**, and $\frac{15}{50} \times 100\% = \mathbf{30\%}$.

b. 15 km = 1,500,000 cm, so

$$t = \frac{1{,}500{,}000 \text{ cm}}{1.5 \text{ cm/yr}} = 1{,}000{,}000 \text{ years}$$

One million years.

MARKING SCHEME

✓ Shortening 15 km.
✓ 30%.
✓ 1,500,000 cm ÷ 1.5 cm/yr = 1,000,000 years.

c. ANSWER A · 2

d = 7.0 − 5.0 = 2.

a. $10^2 =$ **100 times** higher.

b. $10^{1.5 \times 2} = 10^3 =$ **1,000 times** as much energy.

MARKING SCHEME

✓ $10^2 = 100$ times higher waves.
✓ $10^3 = 1{,}000$ times the energy.

d. ANSWER A · 3

$$\frac{d}{3.5} - \frac{d}{6} = 20 \quad \Rightarrow \quad d \times \frac{6 - 3.5}{21} = 20 \quad \Rightarrow \quad d = \frac{20 \times 21}{2.5} = 168 \text{ km}$$

168 km.

MARKING SCHEME

✓ d/3.5 − d/6 = 20.
✓ d × 2.5/21 = 20.
✓ d = 168 km.

8 Think

ANSWER HA · 3

No. The Himalaya began to rise about 50 million years ago, when India hit Asia, and they are still rising, because India still pushes north, so they stay high even as they wear down. The Aravalli hills are far older, more than a billion years old: once the push stopped, they were worn down for hundreds of millions of years into low hills. High mountains are young mountains.

MARKING SCHEME

✓ No: the Himalaya are young, rising since about 50 million years ago.
✓ They are still being pushed up faster than they wear down.
✓ The Aravalli are much older, worn low since their push stopped.

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9 Activity: Rocks and minerals of the Himalayan region (Practical 28)

(not marked)

WHAT STUDENTS SHOULD FIND

Terai: loose boulders, gravel, sand, silt, clay; sand and gravel, groundwater. Chure: mudstone, siltstone, sandstone, conglomerate; sand, gravel, building stone. Lesser Himalaya: shale, sandstone, slate, phyllite, schist, quartzite, limestone, dolomite; limestone for cement (Chobhar, Udayapur), slate (Bandipur), magnesite (Kharidhunga), iron and marble (Phulchoki, Godawari). Higher Himalaya: gneiss, marble, granite; aquamarine and tourmaline (Taplejung, Sankhuwasabha). Tethys Himalaya: fossil-rich limestone, shale, sandstone; ammonite fossils (Kali Gandaki), gas seeps (Muktinath). Each belt formed in a different way and at a different depth: young sediment from the worn-down mountains in the south, rock buried deep and changed by heat and pressure in the middle, sea-floor rock lifted with its fossils in the north.

See it at Science Playground

Exhibits and plants at the center, Bhaktapur, that go with this unit. Book a class visit at science-playground.com/booking.

- **Stone & Mineral Collection** (exhibit): Read each specimen's texture, coarse, layered or crystalline: geologists use such clues to tell how and where a rock formed.
- **World Map Jigsaw** (exhibit): Compare the coasts of South America and Africa on the map: they look as if they would fit, Wegener's first clue that the continents, riding on their plates, have moved apart.
- **3D Map of Nepal** (exhibit): See the land climb from about 60 to 8,849 meters within about 200 km: the Himalaya, folded up as the Indian plate pushes north.
- **The Rock That Floats** (exhibit): Look for the holes left by gas bubbles: frothy lava thrown out by a volcano cooled so fast that its gas was trapped inside.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	11	18	14	3	**46**

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