Unit 15 · Geology

HARDER PRACTICE QUESTIONS · ANSWER KEY

Full marks 43

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

1 Spot the error

ANSWER U · 3

The gap between the waves is in **time**, not distance: both travel the same distance d, taking d/6 and d/3.5 seconds. So d/3.5 − d/6 = 12, d × 2.5/21 = 12, and d = 12 × 21 ÷ 2.5 = **100.8 km**, about 8.4 km for each second of gap.

MARKING SCHEME

- ✓ The mistake: subtracting speeds; the travel times must be subtracted.
- ✓ d/3.5 − d/6 = 12.
- ✓ d = 100.8 km.

2 How far, how long?

ANSWER A · 4

i. 2,000 km = 200,000,000 cm; t = 200,000,000 ÷ 4.5 ≈ **44 million years**.
ii. 5,000 km = 500,000,000 cm; t = 500,000,000 ÷ 2.5 = **200 million years**.
iii. India's: 4.5 ÷ 2.5 = **1.8 times** as fast.

MARKING SCHEME

- ✓ Distances changed to cm.
- ✓ About 44 million years.
- ✓ 200 million years.
- ✓ India's, 1.8 times as fast.

3 What if?

ANSWER HA · 3

a. There would be **no Himalaya**: the range was built by squeezing the layers between India and Asia after they collided.
b. The ammonite shells would still lie **on the sea floor**, or buried under it, not nearly 3,000 m up: they were lifted only by the collision.
c. There would be **no great earthquakes** from the Main Himalayan Thrust, since India wouldn't be sliding under the land and loading its stuck part.

MARKING SCHEME

- ✓ No Himalaya, since the collision built them.
- ✓ The fossils would still be on or under the sea floor.
- ✓ No great earthquakes from India's push.

4 Check the claim

ANSWER HA · 4

i. For example, Udayapur (6.9, 700+) and Gorkha (7.8, nearly 9,000), or Jajarkot and any other.
ii. **1934 and 2015**: Gorkha released less energy (7.8 against 8.0, about 2 times less, 10^(1.5 × 0.2)) yet killed about as many in Nepal; and Jajarkot, only 5.7, killed about 150 because it struck near midnight in houses of stone and mud.
iii. Any two: how buildings are built; the time of day; how shallow the focus is; distance from towns; soft ground; landslides.

MARKING SCHEME

- ✓ A supporting pair.
- ✓ A pair that doesn't follow the rule (1934 and 2015).
- ✓ Explained: the deaths aren't in step with the energy.
- ✓ Two other factors.

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking

5 Design a fair test

ANSWER A · 4

i. He changes whether the model has a band; he measures how long it stands (or how hard the shaking can be) before it falls.
ii. Any three: the same size, material and walls of the models; the same roof; the same shaking (how far and how fast); the same table.
iii. Build and test several of each, and average.
iv. The banded models standing longer, or through stronger shaking.

MARKING SCHEME

✓ Changes the band; measures how long it stands.
✓ Three things kept the same.
✓ Several models of each, averaged.
✓ Banded models standing longer.

6 Correct the misconceptions

ANSWER U · 3

1. The hot springs are **not volcanic**: water seeps deep along faults, is warmed by the hot rock below, and rises again.
2. Each step is about 32 times the energy: 4 steps is 10^(1.5 × 4) = **a million times**, not twice.
3. That point is the **focus** (hypocenter); the epicenter is the point on the surface directly above it.

MARKING SCHEME

✓ Hot springs: water heated deep along faults, no volcano.
✓ 4 steps is about a million times the energy.
✓ The point underground is the focus; the epicenter is above it.

7 Which explanation fits?

ANSWER HA · 3

Rojina's. Runny (silica-poor) lava flows far and fast, sometimes many kilometers, so it spreads into a broad, gently sloping mountain, and its bubbles escape, so it erupts quietly. Sticky (silica-rich) lava hardly flows, piles up near the vent with ash into a steep cone, and holds its gas until it bursts out explosively. The unit says nothing of runny lava being cooler.

MARKING SCHEME

✓ Rojina's explanation.
✓ Runny lava spreads far into a broad shape; sticky piles near the vent.
✓ Gas escapes from runny lava but is trapped in sticky lava, so it explodes.

8 Predict, then explain

ANSWER A · 3

P waves take 84 ÷ 6 = 14 s; S waves take 84 ÷ 3.5 = 24 s. **About 10 s** of warning (counting distance from the focus; less once the alert's own delay is counted).
A city 10 km away gets **less**, about 1.2 s, because the gap grows with distance: the faster P waves pull further ahead the farther they travel.

MARKING SCHEME

✓ 14 s and 24 s.
✓ About 10 s of warning.
✓ Less for a nearer city, since the gap grows with distance.

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking

9 Work backwards

ANSWER A · 4

i. 36 km is 75% of the original length: L = 36 ÷ 0.75 = **48 km**.

ii. Shortening = 48 − 36 = 12 km = 1,200,000 cm; speed = 1,200,000 ÷ 600,000 = **2 cm a year**.

MARKING SCHEME

✓ 36 km is 75% of the original.

✓ 48 km.

✓ 12 km = 1,200,000 cm.

✓ 2 cm a year.

10 Show that

ANSWER A · 3

For 1 s of gap: d/3.5 − d/6 = 1, so d × 2.5/21 = 1 and d = 21 ÷ 2.5 = **8.4 km**.

For 30 s: 30 × 8.4 = **252 km**.

MARKING SCHEME

✓ d/3.5 − d/6 = 1.

✓ d = 8.4 km.

✓ 252 km.

11 Estimate it

ANSWER A · 3

2015 − 1934 = 81 years; 2 cm × 81 = 162 cm, **about 1.6 m**.

A few meters of slip takes about a century or two to build up, so on any one stretch of the fault great earthquakes come **every century or two**, as the unit says.

MARKING SCHEME

✓ 81 years.

✓ About 1.6 m.

✓ Several meters needs a century or two of strain.

12 Make your own

ANSWER HA · 2

For example, magnitudes 7.5 and 5.5: d = 2, and 10^(1.5 × 2) = 10^3 = **1,000**. (Any pair 2 steps apart works.)

MARKING SCHEME

✓ A pair exactly 2 apart.

✓ 10^(1.5 × 2) = 1,000 shown.

13 Think

ANSWER HA · 4

i. **No.** The shallow part of the fault didn't slip in 2015 and still holds its strain, and India keeps loading the fault at 2 cm a year.

ii. 2 cm × 500 = 1,000 cm = **about 10 m**, enough for a very large earthquake.

iii. Build to the building code and retrofit schools and hospitals, since most deaths come from falling buildings; also plan land use and practice drills.

MARKING SCHEME

✓ No: the shallow part still holds its strain.

✓ India keeps loading the fault.

✓ About 10 m.

✓ Safe buildings (code, retrofitting).

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking

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	0	6	21	16	**43**