Unit 25 · Recent Trends in Physics

HARDER PRACTICE QUESTIONS · ANSWER KEY

Full marks 31

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

10 times a step is the height of the waves on a seismograph. The energy goes up about 32 times a step: $E_1/E_2 = 10^{1.5 \times 2} =$ **1000 times**.

MARKING SCHEME

- ✓ The error: 10 times a step is the wave height, not the energy.
- ✓ $10^{1.5 \times 2}$.
- ✓ 1000 times.

2 Read the data

ANSWER A · 4

i. **X**: the nearer a station, the less time the slower S waves fall behind.

ii. $d = \dfrac{\Delta t}{1/4.0 - 1/7.0} = \Delta t \times 9.33$ km: X **60 km**, Y **120 km**, Z **210 km**.

iii. Draw a circle round each station on a map with its distance as the radius; the earthquake is where the three circles meet.

MARKING SCHEME

- ✓ X is nearest (smallest gap).
- ✓ d = Δt ÷ (1/4.0 − 1/7.0).
- ✓ 60, 120 and 210 km.
- ✓ Three circles meet at the epicenter.

3 Predict, then explain

MARKING SCHEME U · 3

- ✓ The order P, S, Love, Rayleigh.
- ✓ Explained by their speeds.
- ✓ P a sharp jolt; Rayleigh the rolling.

4 Show that

MARKING SCHEME A · 3

- ✓ Travel times d/v_S and d/v_P.
- ✓ Their difference is Δt.
- ✓ Rearranged to $d = \Delta t v_P v_S/(v_P - v_S)$.

5 Estimate it

ANSWER A · 3

$4 \times 10^{-18} \div 4000 =$ **10^{-21}** of the length. 800 km $\times\ 10^{-21} = 8 \times 10^5 \times 10^{-21} =$ **8×10^{-16} m**, smaller than a proton.

MARKING SCHEME

- ✓ Fraction about 10^{-21}.
- ✓ 8×10^{-16} m for 800 km.
- ✓ Smaller than a proton: why the waves are so hard to detect.

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6 Which explanation fits?

MARKING SCHEME U · 2

- ✓ B, a local disturbance.
- ✓ A real wave reaches both within 10 ms.

7 Correct the misconceptions

ANSWER U · 3

1. That point is the **focus** (hypocenter); the epicenter is the point on the surface straight above it.
2. Gravitational waves travel **at** the speed of light.
3. It was **predicted** in 1964 and **found in 2012 at CERN's Large Hadron Collider**.

MARKING SCHEME

- ✓ The underground point is the focus; the epicenter is above it.
- ✓ They travel at the speed of light.
- ✓ Predicted 1964, found 2012 at CERN.

8 Work backwards

ANSWER A · 3

$10^{1.5\,\Delta M} = 250$, so $1.5\,\Delta M = \log 250 = 2.40$ and $\Delta M = 1.6$: magnitude **6.6**. Waves: $10^{1.6} \approx$ **40 times** taller.

MARKING SCHEME

- ✓ $1.5\ \Delta M = \log 250$.
- ✓ Magnitude 6.6.
- ✓ About 40 times the wave height.

9 Compare

MARKING SCHEME U · 3

- ✓ Motions: rolling ellipses vs side to side.
- ✓ Love waves arrive first.
- ✓ Love waves need layered ground (soft over hard).

10 What if?

ANSWER HA · 2

They would record **S waves** as well as P waves: S waves pass through solids, so a solid core would let them through. That they are missing now is how we know the outer core is liquid.

MARKING SCHEME

- ✓ S waves would arrive on the far side.
- ✓ S waves pass only through solids; their absence shows a liquid core.

11 Make your own

ANSWER HA · 2

For example: "At a station, the S waves arrive 12 s after the P waves. Taking their speeds as 7.0 and 4.0 km/s, how far away is the earthquake?" $d = 12 \div (1/4.0 - 1/7.0) = 12 \times 9.33 = 112$ km. Any numbers that give 112 km are right.

MARKING SCHEME

- ✓ A sensible problem with two speeds and a gap.
- ✓ Solved correctly to 112 km.

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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.

- **3D Map of Nepal** (exhibit): Find Gorkha and the Kathmandu Valley on the raised map: in 2015 the Main Himalayan Thrust slipped beneath them, over about 150 km running east.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	0	14	13	4	**31**

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