1) The measure of the time between two peaks of a sine wave is called the
   A) period B) wavelength C) amplitude

Hint: look at the units of the axis.
2) Which of the following is true:
   A) T=1/f
   B) the period is the inverse of the frequency
   C) f= 1/T
   D) all of the above
3) In this slinky, the compressional wave is traveling in which direction?

- A) 
- B) 
- C) perpendicular to the page
4) In this slinky, the particle motion is in which direction?

- A)  
- B)  
- C) perpendicular to the page

Hint: imagine a particle of the slinky as a bead that is glued in place. Which direction would it move as the wave passes through?
1) The aftershock locations following a large earthquake show:

A) The length and depth of the fault that ruptured during the large earthquake
B) The depth and volume of the fault that ruptured during the large earthquake
C) The isoseismal map
D) The intensity of ground shaking
Based on this travel time curve, we would expect the S wave at a station that is 3200 km from the epicenter to arrive around what time?

A) 10 s  B) 30 min  C) 15 sec  D) 15 min  E) None of the above
2) Even if the origin time of the earthquake is unknown, the distance from a recording station to the earthquake hypocenter can be calculated by

- A) subtracting the P-wave arrival time from the Surface wave arrival time
- B) measuring the P wave amplitude and dividing by 100.
- C) measuring the S - P time and multiplying by 8 km/sec
- D) Multiplying the P wave time by the P-wave velocity of approximately 6 km/sec.
Quiz 7

• Typical P and S wave velocities in the crust are:
  • A) P is 5-8 km/s and S is 3.5-4.5 m/s
  • B) P is 3.5-4.5 m/s and S is 5-8 m/s
  • C) P is 3.5-4.5 km/s and S is 5-8 km/s
  • D) P is 5-8 km/s and S is 3.5-4.5 km/s
\[ \begin{align*}
\log(0.1) &= \log(10^{-1}) = -1 \\
\log(1) &= \log(10^{0}) = 0 \\
\log(10) &= \log(10^{1}) = 1 \\
\log(100) &= \log(10^{2}) = 2 \\
\log(100,000,000,000,000,000,000) &= \log(10^{17}) = ? 
\end{align*} \]

A) 4    B) 100    C) 17
What is the correct equation for the Richter Magnitude $M_L$

$A) M_L = \log_{10} (Amplitude)$

$A = \text{amplitude at 100km [measured in km]}$

$B) M_L = \log_{10} (Intensity)$

$I = \text{intensity at 100km [measured in acceleration]}$

$C) M_L = \log_{10} (A) + 3$

$A = \text{amplitude at 100km [measured in mm]}$

$D) M_L = \log_{10} (A) \cdot 3$

$A = \text{amplitude at 100km [measured in m]}$
What is the magnitude of Earthquake A

A) $M_L = -1$  B) $M_L = 4$  C) $M_L = 5$  D) $M_L = 7$
• If there are 30 M 3 earthquakes in a region in one year, then you can probably expect
• A) about 1 M8 earthquake in one year
• B) about 3 M 5 earthquakes in one year
• C) about 300 M 1 earthquakes in one year
• D) about 3 M 4 earthquakes in one year
\[ V = \sqrt{\frac{\mu}{\rho}} \]

\( \mu = \text{shear modulus} \)
\( \approx 20 \times 10^9 \text{ N/m}^2 \)

This is the velocity for

A) P waves - compressional waves - primary waves

B) S waves - shear waves - secondary waves
This earthquake ray is called
A) P
B) PKP
C) PKIKP
D) PcP
The slope of the travel-time curve gives the velocity of the waves.

Calculate the velocity of surface waves from the slope of their arrival times.

A

\[
\text{velocity} = \frac{\text{change in distance}}{\text{change in time}} = \frac{(9600 - 6400) \text{ km}}{(43 - 31) \text{ min}} = \frac{6400 \text{ km}}{1 \text{ min}} = \frac{6400 \text{ km}}{60 \text{ sec}} = 4.4 \text{ km/sec}
\]

B

\[
\text{velocity} = \frac{\text{distance}}{\text{time}} = \frac{6400 \text{ km}}{48000 \text{ min}} = \frac{60 \text{ min}}{1 \text{ min}} = \frac{8.0 \text{ km}}{60 \text{ sec}} = 0.133 \text{ km/sec}
\]

Figure 4: Long-period vertical-component travel-time curves. Black represents a pick density of 0.2 or greater. See text and Figure 7 for details.
The S-wave (shear wave) velocity from 2900 to 5100 km below the surface of the earth is
A) 3.5 km/s
B) 4.0 km/s
C) 6.0 km/s
D) 0 km/s
This is a A) Rayleigh wave - surface wave
B) S-wave - shear wave - secondary wave
C) P-wave - primary wave - compressional wave
• Which instrument will generate lower frequency sound?

A

B
Which earthquake will generate lower frequency energy?

A) The rather small Big Bear fault.

B) The rather large Hector Mine fault.
Which is the best magnitude to use to measure the size of the very largest earthquakes?

A  $M_L = \log(\text{Amplitude}) + 3$

measured on 1 sec waves 100 km from the EQ

(the Richter magnitude uses a seismometer that measures the equivalent of the “treble” on your stereo)

B  $M_s = \log(\text{Amplitude}) + 1.66 \log(\text{distance}) + 2.0$

measured on 20 sec surface waves more than 2000 km from the EQ

(the surface wave magnitude uses a seismometer that measures the equivalent of the “bass” on your stereo)

C  $M_W = \frac{2}{3} \log(M_0) - 10.7$

where $M_0$ is measured as the total energy radiated by all frequencies including the very lowest frequencies generated by the earthquake

(the moment magnitude uses a seismometer that measures all ranges of sounds from bass to treble on your stereo when you purchased the special amplifier so that you can REALLY hear that bass)
In our sliding block experiment the distance the block jump represents
A) the length of the fault
B) the amount of offset during an earthquake
C) the time between earthquakes
D) the frictional force on the fault
Quiz 11 - question 3

Seismic moment $M_0 = \mu SA$

\[ \mu = \text{shear modulus} \sim 3 \times 10^{10} \frac{N}{m^2} \]

\[ S = \text{slip on the fault } m \]

\[ A = \text{area of the fault} = \text{length } (m) \times \text{depth } (m) \]

Moment is a measure of the size of the earthquake and is specifically related to the amount of energy released. From the equation above we can tell

A) Moment (the size of an earthquake) is larger if the strength of the crust ($\mu$) is greater

B) Moment (the size of an earthquake) is larger if the offset ($S$) on the fault is larger

C) Moment (the size of an earthquake) is larger if the length of the fault is longer

D) Moment (the size of an earthquake) is larger if the depth that the fault ruptures is deeper

E) All of the above
seismic moment $M_0 = \mu SA$

$\mu = \text{shear modulus} \sim 3 \times 10^{10} \frac{N}{m^2}$

$S = \text{slip on the fault } m$

$A = \text{area of the fault} = \text{length } (m) \times \text{width } (m)$

$$M_w = \frac{2}{3 \log M_0} - 10.7$$

From these two equations we can see:

A) That if we can estimate
   - the **length** of a fault from a map,
   - the **depth** from the deepest small earthquake in the area,
   - the **slip** from a plot of slip versus fault length from past large earthquakes
   - => then we can calculate the **moment** and
   - => then we can estimate the **magnitude** of a future earthquake if that fault were to break.

B) That the shear modulus varies by a very large amount and the log of the moment can be estimated by looking at the exponent when it is written as a power of 10.

C) Both A) and B)
You can calculate that a fault that is 67 km long will produce an earthquake about $M_w=7.1$

A fault that is 12 km long will produce an earthquake about $M_w=6.2$

What size earthquake would you expect if the entire New Harmony fault ruptured at once?

A) $M_w=7.1$

B) $M_w=6.2$
Fault offset is approximately related to fault rupture length

If a geologist saw that a fault along the coast of Chile was 200 km long, what would she estimate the amount of slip in an earthquake to be if it ruptured all at once?

A) 2-3 m
B) 0.2-0.3 m
• This figure illustrates the part of the earthquake cycle when
• A) energy is released during an earthquake
• B) the fault ruptures
• C) energy is slowly built up as the crust deforms prior to an earthquake
How many earthquakes happened on this fault:
A) 0  B) 4  C) 9
Quiz 12  NO CALCULATORS:
seismic moment $M_0 = \mu SA$

\[ \mu = \text{shear modulus} \sim 3 \times 10^{10} \frac{N}{m^2} \]

\[ S = \text{slip on the fault} \, m \]

\[ A = \text{area of the fault} = \text{length} \,(m) \times \text{depth} \,(m) \]

An earthquake occurs with the following measurements:

offset = $3.33m$

fault length = $1000 \, km = 1000 \, km \cdot \frac{1000 \, m}{1 \, km} = 10^6 \, m$

fault ruptures the crust to depth = $10 \, km = 10 \, km \cdot \frac{1000 \, m}{1 \, km} = 10^4 \, m$

$M_0 = \mu SA$

\[ = 3 \times 10^{10} \frac{N}{m^2} \cdot 3.33 \, m \cdot 10^6 \, m \cdot 10^4 \, m \]

\[ = 10^{21} \, Nm \cdot \frac{10^7 \, \text{dyne} - cm}{NM} = 10^{28} \, \text{dyne} - cm \]

$M_w = 2 / 3 \log M_0 - 10.7$

What is the magnitude $M_w =$

A) 7  B) 7.5  C) 8  D) 8.5