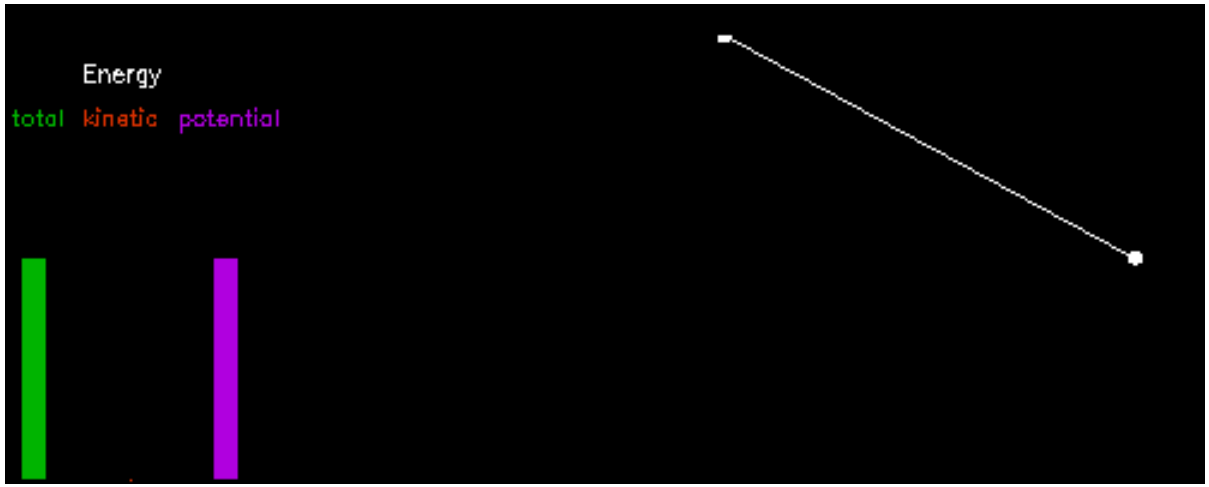
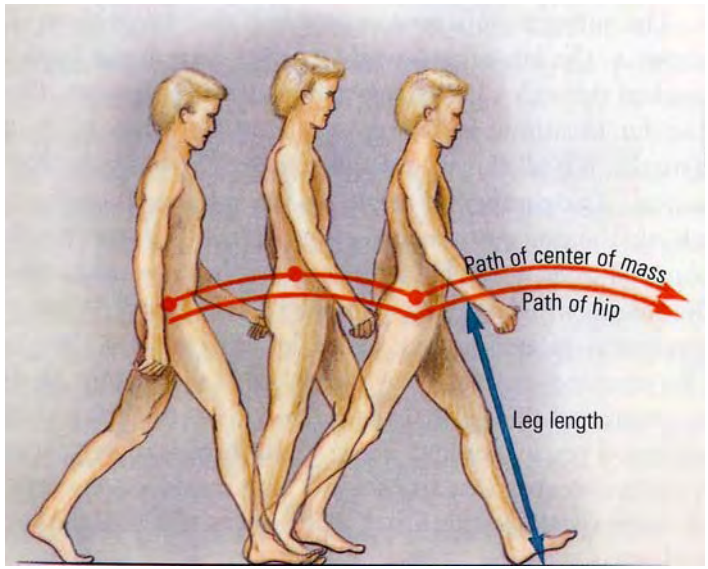
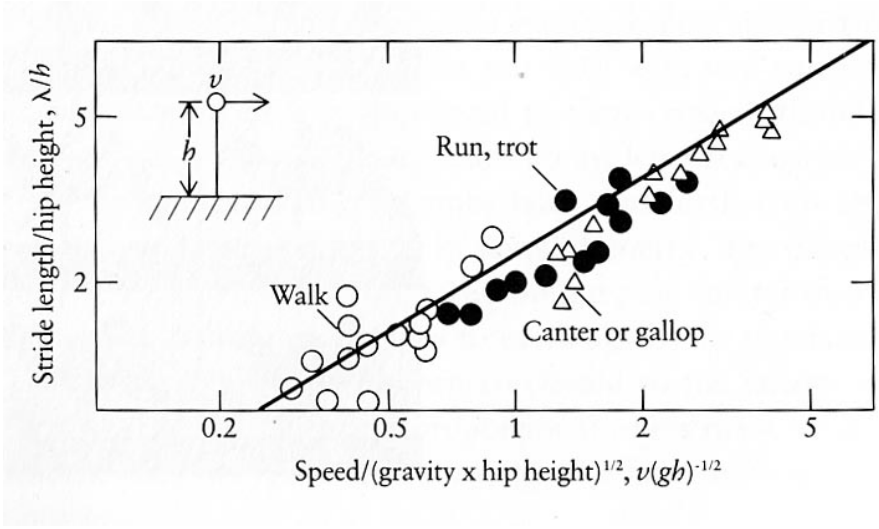
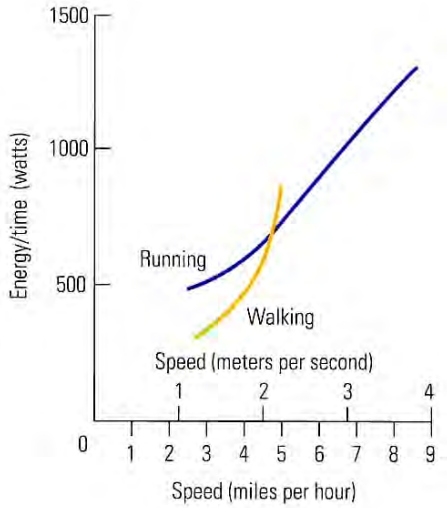
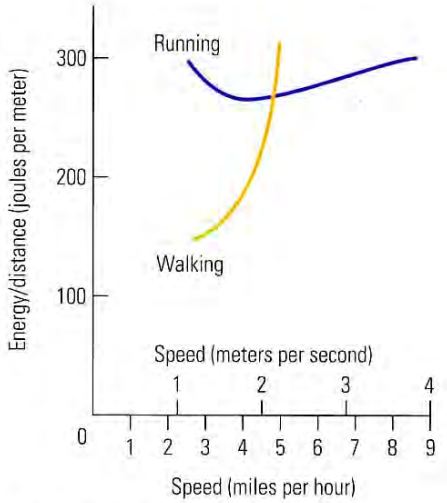
Vibrations & Waves


Energy
total
kinetic
potential



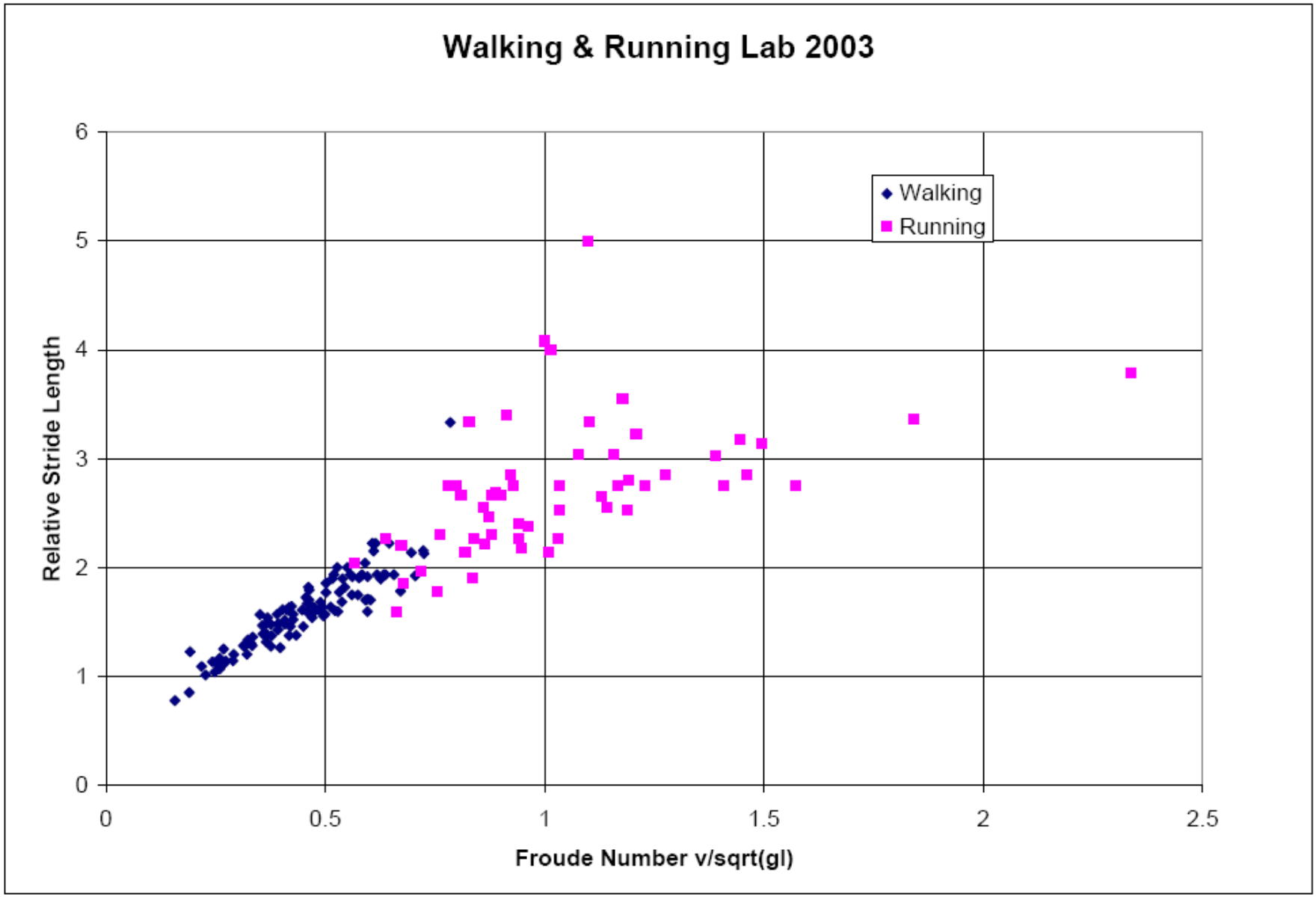


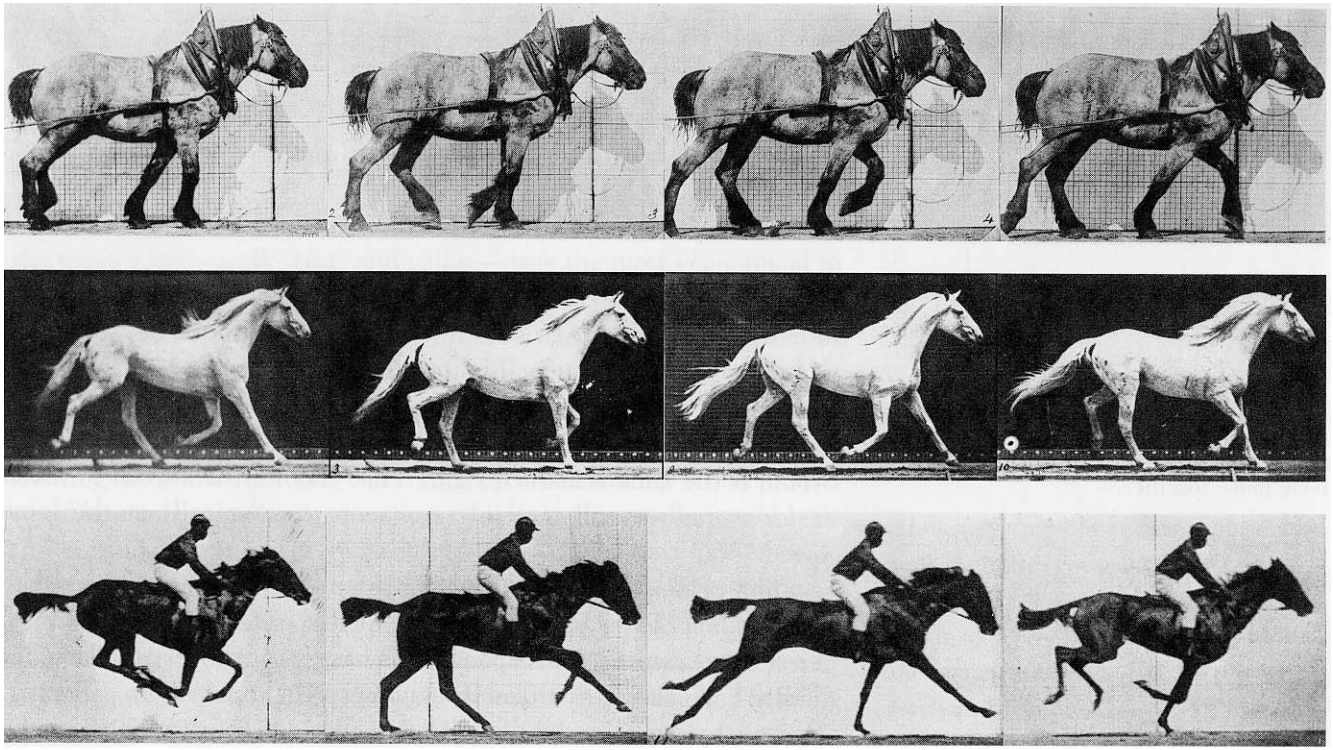




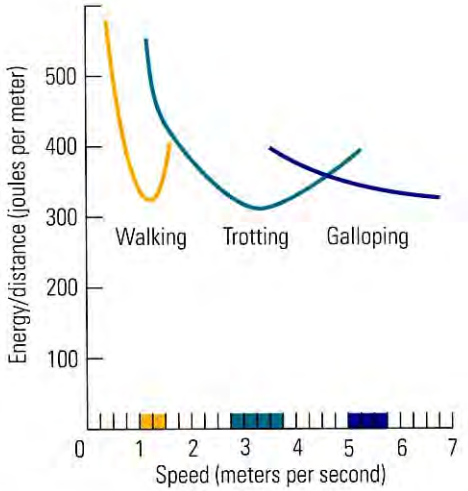
In plotting energy consumption against speed, whether we plot energy consumption per unit time or per unit distance, we find that walking uses less energy at speeds below about 2 meters per second and running uses less energy above that speed.

Exploring Biomechanics, R. McNeill Alexander


Walking & Running Lab 2003
Relative Stride Length
Froude Number v/sqrt(gl)
Walking
Running
0
1
2
3
4
5
6
0
0.5
1
1.5
2
2.5



Four stages of a stride of a walking horse *(top)*, a trotting horse *(middle)*, and a galloping horse *(bottom)*, photographed by Eadweard Muybridge. The walking horse moves its four feet in turn in the order left hind, left fore, right hind, right fore; the trotting horse moves diagonally opposite pairs of feet together; and the galloping horse sets down first one pair of feet, and then the other.

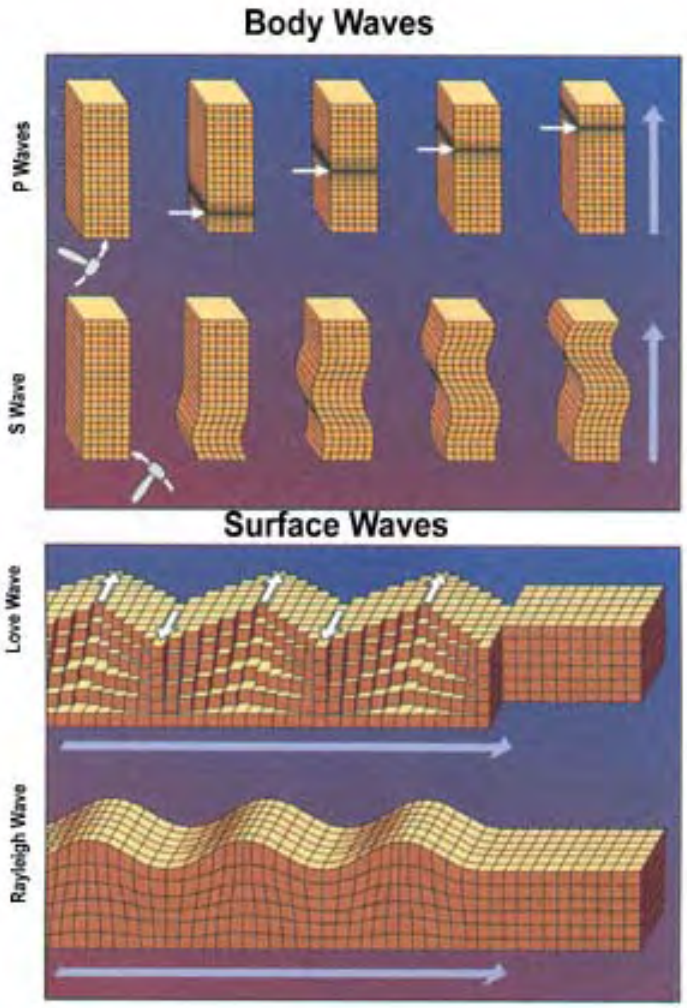


The energy used by ponies as they walked, trotted, or galloped at various speeds. The boxes at the bottom of the graph show the range of speeds at which the ponies used each gait when moving freely in their field.

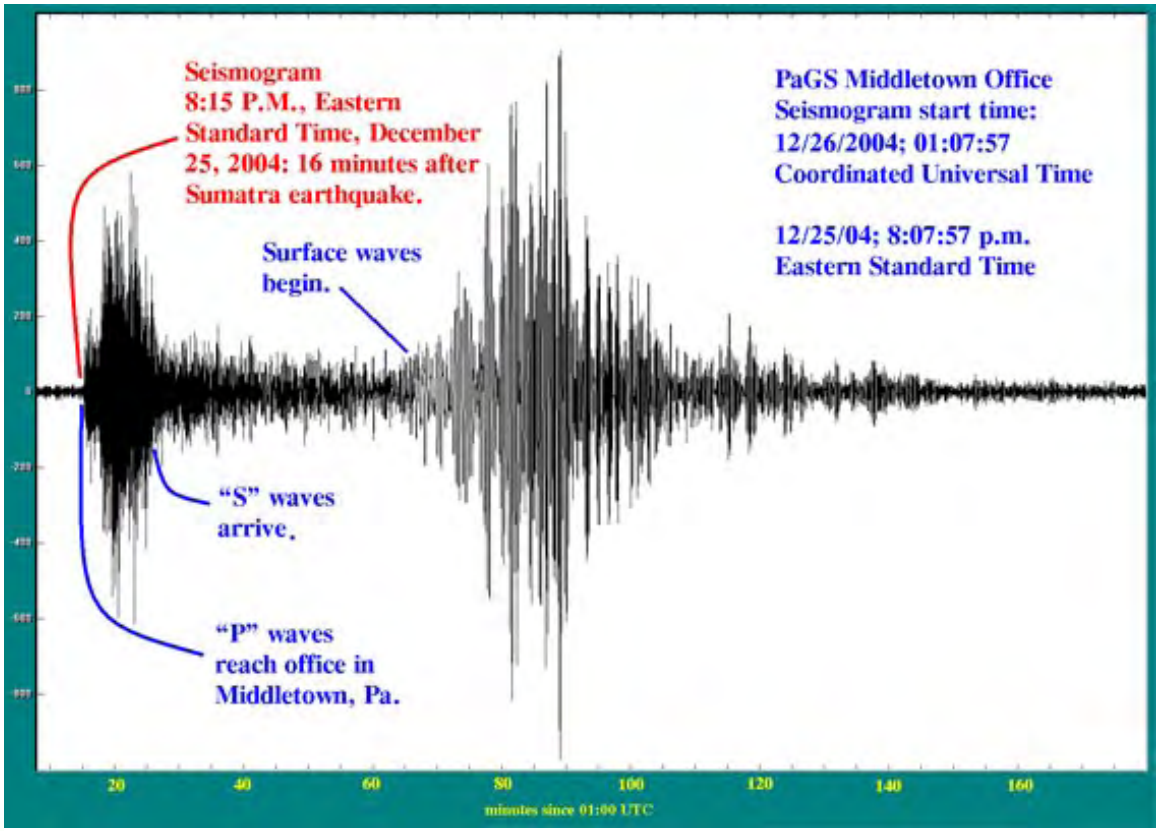
Quick Quiz 13.6 If the amplitude of a system moving in simple harmonic motion is doubled, which of the following quantities *doesn't* change?

(a) total energy
(b) maximum speed
(c) maximum acceleration
(d) period

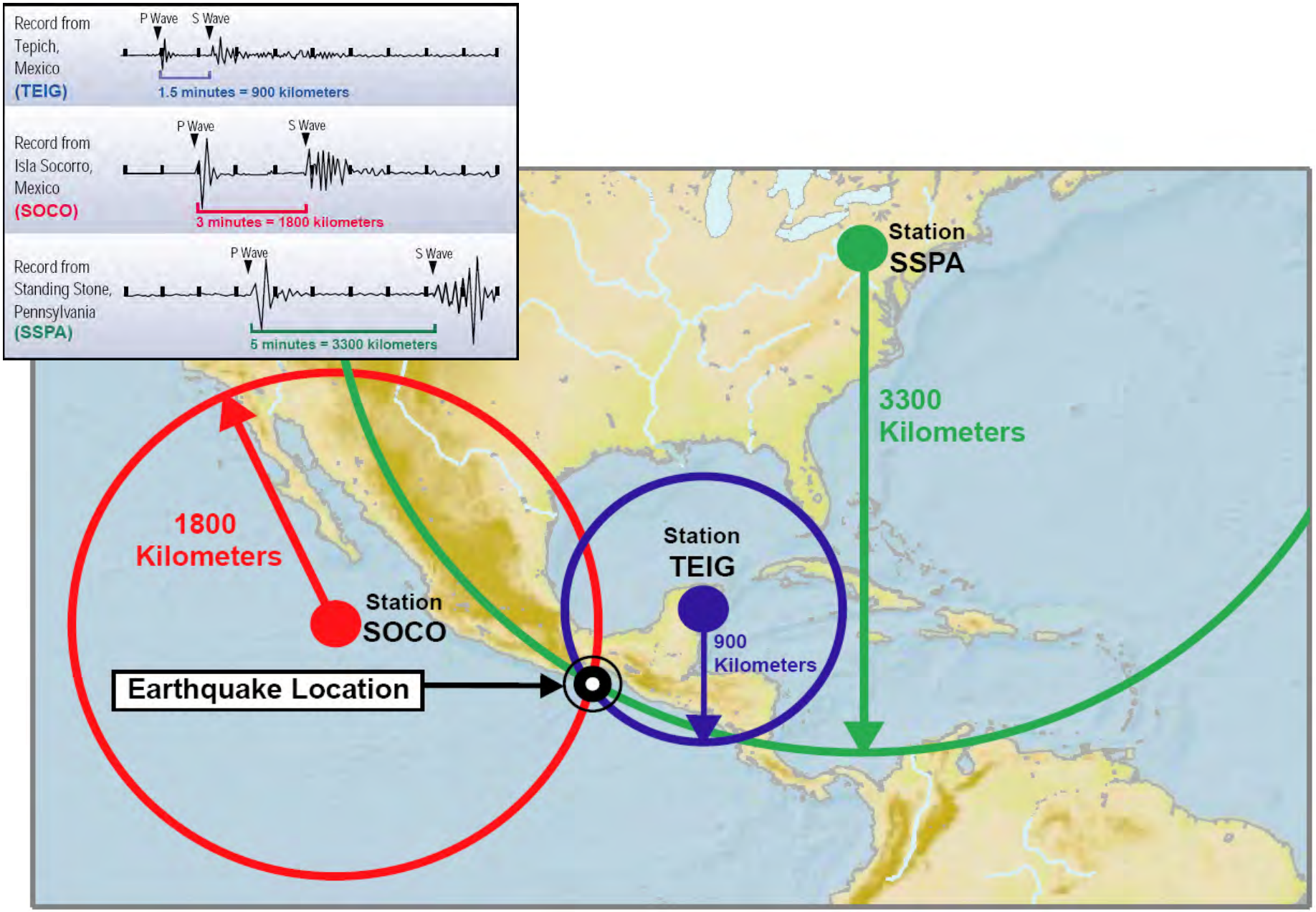
Tacoma Narros Bridge
November 7, 1940

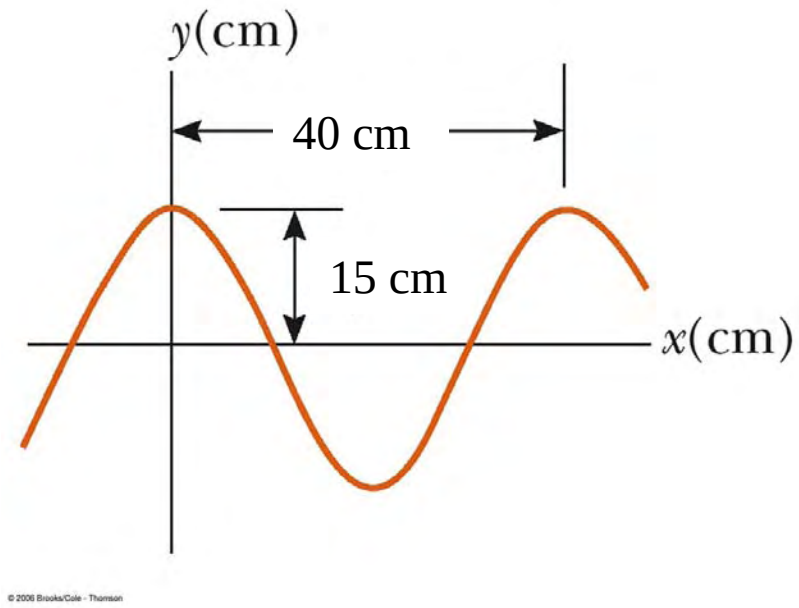


The image below is a seismogram of the Sumatra earthquake, which occurred at 7:58:53 p.m. Eastern Standard Time, December 25, 2004, or 7:58:53 a.m. local time, December 26, 2004 in Sumatra. The earthquake occurred beneath the Indian Ocean, just off the west coast of northern Sumatra. The seismogram was recorded on the Pennsylvania Geological Survey seismograph at Middletown, Pennsylvania, about 15,000 kilometers (9,000 miles) from the quake's epicenter. The seismograph at the Middletown office recorded the tremors over 2 hours and 30 minutes, starting at 8:15 p.m. on Christmas Day when compressional (P) waves arrived. Shear (S) waves followed soon after the “P” waves. Large surface waves began arriving about an hour later.

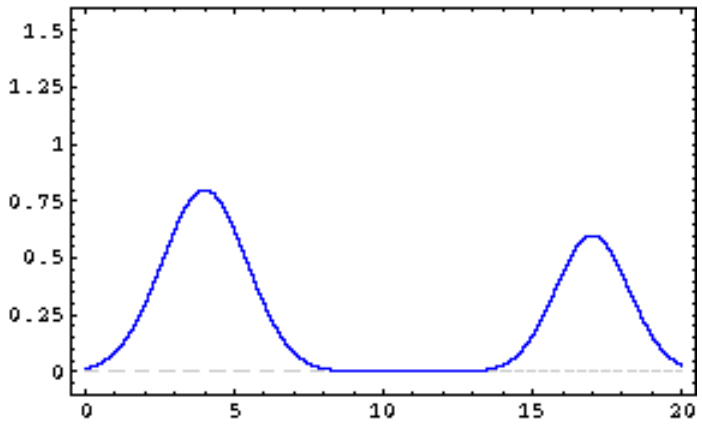


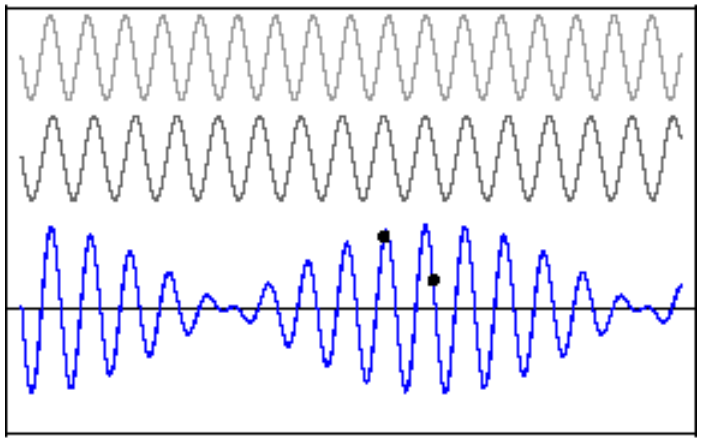
http://earthquake.usgs.gov/learning/
http://www.dcnr.state.pa.us/topogeo/hazards/sumatra.aspx


Record from Tepich, Mexico (TEIG)
P Wave
S Wave
1.5 minutes = 900 kilometers
Record from Isla Socorro, Mexico (SOCO)
P Wave
S Wave
3 minutes = 1800 kilometers
Record from Standing Stone, Pennsylvania (SSPA)
P Wave
S Wave
5 minutes = 3300 kilometers
Station SSPA
3300 Kilometers
1800 Kilometers
Station SOCO
Station TEIG
900 Kilometers
Earthquake Location



Example 13.8: A wave traveling in the positive x-direction is pictured. Find the amplitude, wavelength, speed, and period, if it has a frequency of 8 Hz.


1.5
1.25
1
0.75
0.5
0.25
0
0
5
10
15
20



PRESSURE WAVE from noise is canceled by destructive interference; the speaker creates a wave that is 180 degrees out of phase and of similar amplitude. Many frequencies are present in the noise.

HEADPHONE ear cup and ear seal attenuate high-frequency sound. Low-frequency noise penetrates, creating pressure waves inside the front cavity. A microphone senses the waves, and electronics direct a speaker to create inverse waves, negating the pressure change before it reaches the eardrum.