The seismogram below shows P-wave and S-wave arrival times at a seismic station following an earthquake.

<table>
<thead>
<tr>
<th>Arrival of P-waves</th>
<th>Arrival of S-waves</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 minutes</td>
<td>6 minutes</td>
</tr>
<tr>
<td></td>
<td>12 minutes</td>
</tr>
</tbody>
</table>

The distance from this seismic station to the epicenter of the earthquake is approximately

(1) 1,600 km          \[\rightarrow\] (3) 4,400 km
(2) 3,200 km          (4) 5,600 km
Base your answers to questions 43 through 46 on the diagram and map below. The diagram shows three seismograms of the same earthquake recorded at three different seismic stations, X, Y, and Z. The distances from each seismic station to the earthquake epicenter have been drawn on the map. A coordinate system has been placed on the map to describe locations. The map scale has not been included.

43 Approximate how far away from station Y is the epicenter?
(1) 1,300 km (2) 2,600 km
(3) 3,900 km (4) 5,200 km

44 The S-waves from this earthquake that travel toward Earth’s center will
(1) be deflected by Earth’s magnetic field
(2) be totally reflected off the crust-mantle interface
(3) be absorbed by the liquid outer core
(4) reach the other side of Earth faster than those that travel around Earth in the crust

45 Seismic station Z is 1,700 kilometers from the epicenter. Approximately how long did it take the P-wave to travel to station Z?
(1) 1 min 50 sec (2) 2 min 50 sec
(3) 3 min 30 sec (4) 6 min 30 sec

46 On the map, which location is closest to the epicenter of the earthquake?
(1) E–5 (2) G–1
(3) H–3 (4) H–8
Base your answers to questions 42 and 43 on the map below. Seismic stations are located at the four cities shown on the map. Letter X represents the epicenter of an earthquake determined from seismic waves recorded at all four cities.

42 At which city is there a difference of approximately 3 minutes and 20 seconds between the arrival times of the $P$-waves and the $S$-waves?

(1) New Orleans  
(2) Louisville  
(3) Pittsburgh  
(4) New York City

43 Which map correctly shows how the location of the epicenter was determined?

(1)  
(2)  
(3)  
(4)
Base your answers to questions 36 through 38 on the data table below, which gives information collected at seismic stations A, B, C, and D for the same earthquake. Some of the data has been deliberately omitted.

<table>
<thead>
<tr>
<th>Seismic Station</th>
<th>P-Wave Arrival Time</th>
<th>S-Wave Arrival Time</th>
<th>Difference in Arrival Times</th>
<th>Distance to Epicenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>08:48:20</td>
<td>No S-waves arrived</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>08:42:00</td>
<td></td>
<td>00:04:40</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>08:39:20</td>
<td></td>
<td>00:02:40</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>08:45:40</td>
<td></td>
<td></td>
<td>6,200 km</td>
</tr>
</tbody>
</table>

Key for Reading Time on the Table

36 What is the most probable reason for the absence of S-waves at station A?
(1) S-waves cannot travel through liquids.
(2) S-waves were not generated at the epicenter.
(3) Station A was located on solid bedrock.
(4) Station A was located too close to the epicenter.

37 What is the approximate distance from station C to the earthquake epicenter?
(1) 3,200 km  (3) 1,600 km
(2) 2,400 km  (4) 1,000 km

38 How long did it take the P-wave to travel from the epicenter of the earthquake to seismic station D?
(1) 00:46:20  (3) 00:17:20
(2) 00:39:20  (4) 00:09:40
The diagram below is a seismogram of the famous San Francisco earthquake of 1906, recorded at a seismic station located 6,400 kilometers from San Francisco.

Which time scale best represents the arrival-time difference between P-waves and S-waves at this station?

1. [Diagram showing time scale with P-wave arrival at 0 and S-wave arrival at 4 minutes]
2. [Diagram showing time scale with P-wave arrival at 0 and S-wave arrival at 5 minutes]
3. [Diagram showing an arrow pointing from P-wave to S-wave arrival, with both at 3 minutes]
4. [Diagram showing time scale with P-wave arrival at 0 and S-wave arrival at 10 minutes]
Base your answers on the map below, which shows the depths of selected earthquakes along the crustal plate boundary near the west coast of South America. Letters A, B, C, and D are epicenter locations along a west-to-east line at the surface. The relative depth of each earthquake is indicated.

<table>
<thead>
<tr>
<th>Key</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthquake</td>
<td>Average depth</td>
</tr>
<tr>
<td>* Shallow</td>
<td>50 km</td>
</tr>
<tr>
<td>□ Intermediate</td>
<td>250 km</td>
</tr>
<tr>
<td>△ Deep</td>
<td>500 km</td>
</tr>
</tbody>
</table>

Which graph best shows the depth of earthquakes beneath epicenters A, B, C, and D?

- (1) 
- (2) 
- (3) 
- (4) 

The earthquake beneath epicenter D occurred in which part of Earth's interior?

- (1) crust 
- (2) rigid mantle 
- (3) asthenosphere 
- (4) stiffer mantle
Model A best represents the motion of earthquake waves called

1. \( P \)-waves (compressional waves) that travel faster than \( S \)-waves (shear waves) shown in model \( B \)
2. \( P \)-waves (compressional waves) that travel slower than \( S \)-waves (shear waves) shown in model \( B \)
3. \( S \)-waves (shear waves) that travel faster than \( P \)-waves (compressional waves) shown in model \( B \)
4. \( S \)-waves (shear waves) that travel slower than \( P \)-waves (compressional waves) shown in model \( B \)

The difference in seismic station arrival times of the two waves represented by the models helps scientists determine the

1. amount of damage caused by an earthquake
2. intensity of an earthquake
3. distance to the epicenter of an earthquake
4. time of occurrence of the next earthquake
The arrows shown in the asthenosphere represent the inferred slow circulation of the plastic mantle by a process called convection.

The temperature of rock at location A is approximately 2,600°C.
28 The hottest crustal temperature measurements would most likely be found at location

(1) A  
(2) B

(3) C  
(4) D

29 Which table best shows the relative densities of the crustal bedrock at locations A, B, C, and D?

(1) Relative Densities of Crust

<table>
<thead>
<tr>
<th>More Dense</th>
<th>Less Dense</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B</td>
<td>C, D</td>
</tr>
</tbody>
</table>

(2) Relative Densities of Crust

<table>
<thead>
<tr>
<th>More Dense</th>
<th>Less Dense</th>
</tr>
</thead>
<tbody>
<tr>
<td>B, C</td>
<td>A, D</td>
</tr>
</tbody>
</table>

(3) Relative Densities of Crust

<table>
<thead>
<tr>
<th>More Dense</th>
<th>Less Dense</th>
</tr>
</thead>
<tbody>
<tr>
<td>C, D</td>
<td>A, B</td>
</tr>
</tbody>
</table>

(4) Relative Densities of Crust

<table>
<thead>
<tr>
<th>More Dense</th>
<th>Less Dense</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, D</td>
<td>B, C</td>
</tr>
</tbody>
</table>