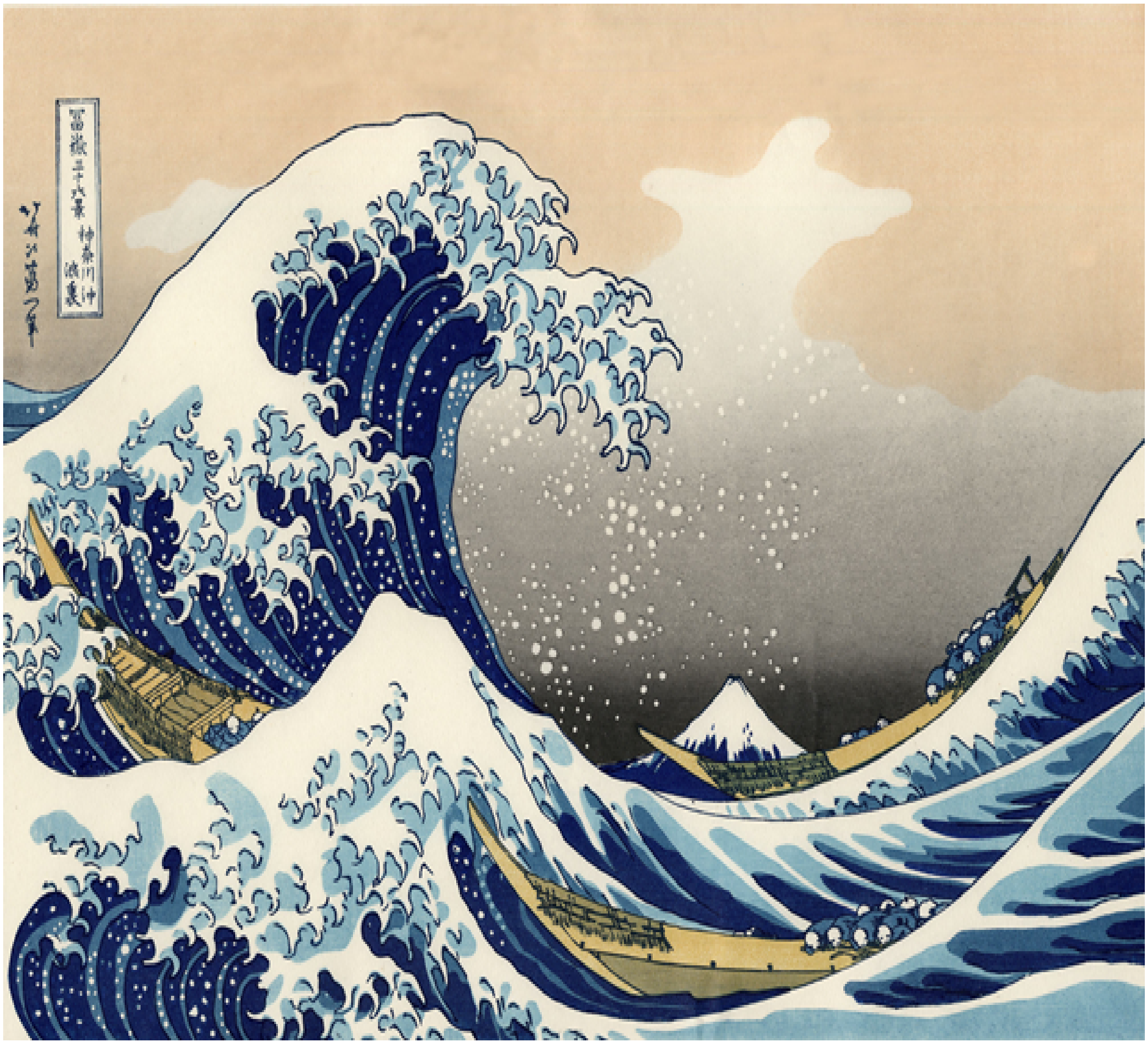
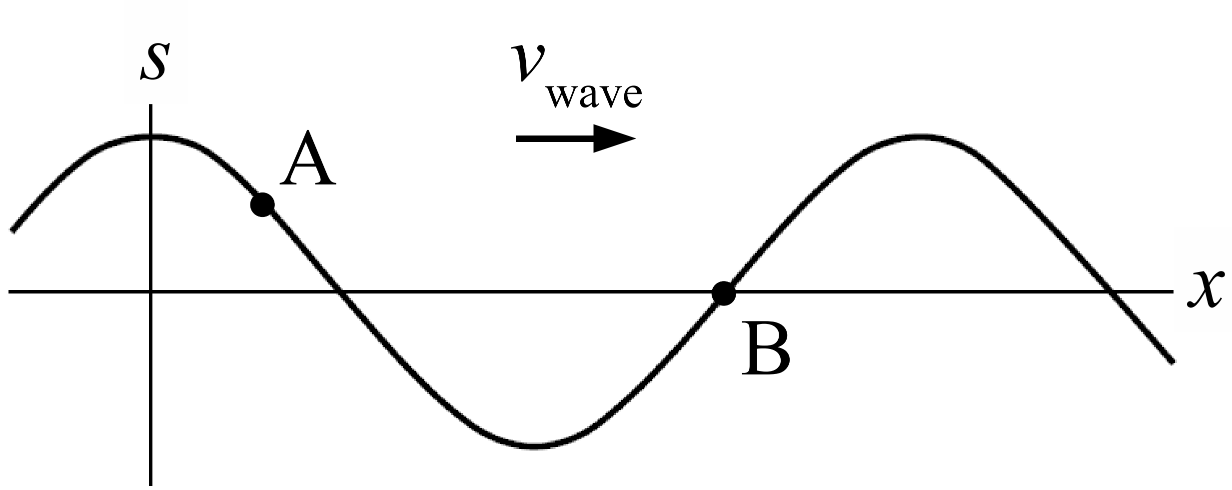
Wave Motion



The figure below shows an instantaneous snapshot of a string on which a transverse wave is traveling to the right. In what direction (relative to the graph) is the string moving at point *A*?

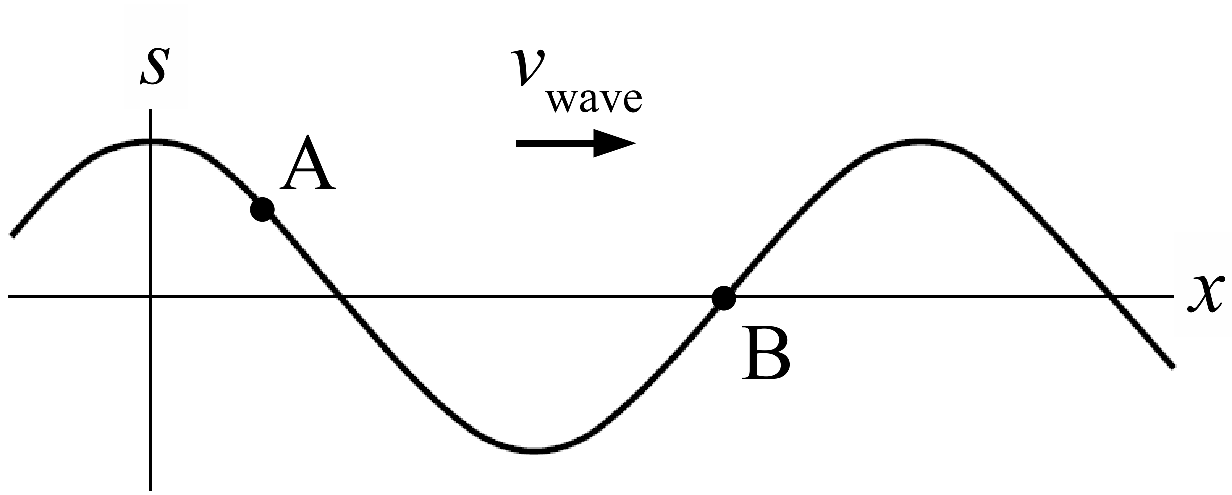


1. Left
2. Right
3. Up
4. Down
5. It is not moving
6. Need more information

ANS: **3**—The string is moving up.

Each point on the string in this transverse wave will either move up or down. Points on the string do not move to the right even though the wave does. In the picture it is clear that the wave crest just to the left of point A is moving to the right and will soon be at point A. That means, in a short time, point A will be higher than it currently is in the picture, so point A is moving up.

The figure below shows an instantaneous snapshot of a string on which a transverse wave is traveling to the right. In what direction (relative to the graph) is the string moving at point *B*?



1. Left
2. Right
3. Up
4. Down
5. It is not moving
6. Need more information

ANS: **4** The string is moving down.

The “trough” of the wave approaches point *B*, which will cause that point of the string to move down.

What can be said about the speed of a particle in a uniform medium through which a wave travels and the speed of the wave?

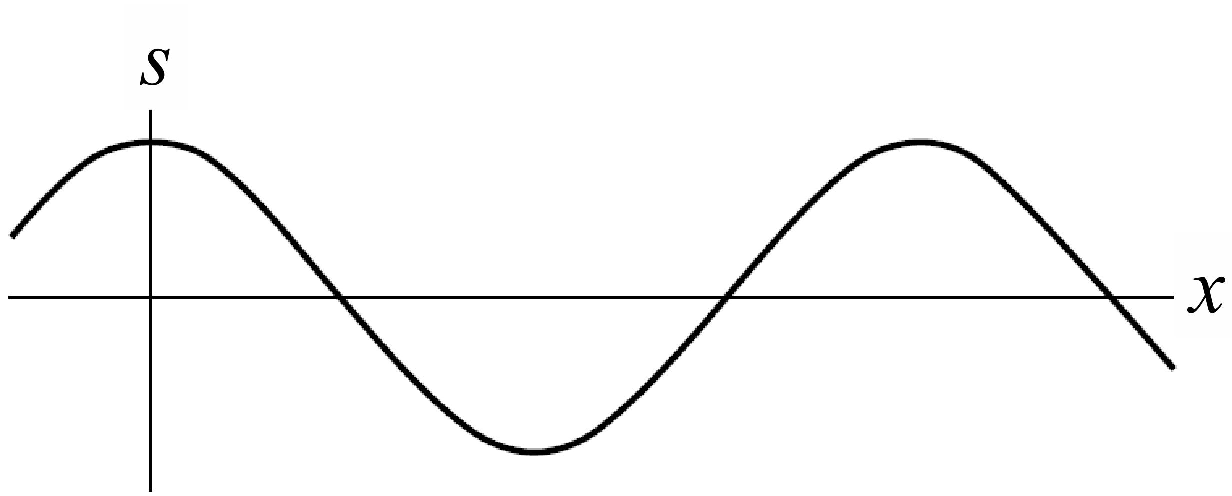
1. The motion of the wave and a particle in the medium are always perpendicular.
2. The speed of the wave varies but the speed of the particle does not.
3. The speed of the particle varies but the speed of the wave does not.
4. Both speeds are constant.

ANS: **3**—The speed of the particle varies, but the speed of the wave does not.

The speed of a wave is a property of the medium it travels through. It is the speed at which the disturbance moves through the medium. As long as the medium is uniform, the speed will not change.

However, each particle in the medium will not move with a constant speed as the wave travels through. For example, if the wave is harmonic, each point in the medium will undergo simple harmonic motion about its equilibrium position, whether it is transverse or longitudinal. In this case the speed of each point will definitely not be constant.

The graph shows the displacement, s, of a slinky as a function of position, x, along the slinky. The wave is

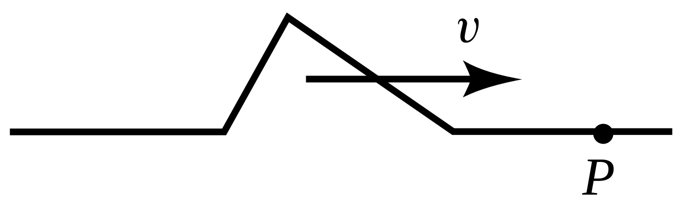


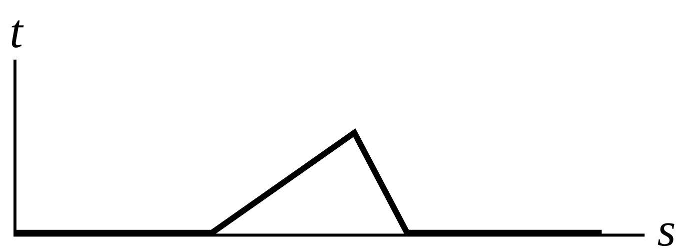
1. a transverse wave.
2. a longitudinal wave.
3. either of the above.
4. none of the above.

ANS: **3**—The wave can be either transverse or longitudinal.

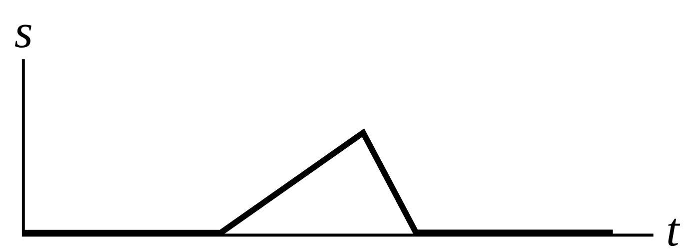
A “slinky” is a specific type of spring. Springs can support transverse waves (displacements perpendicular to the direction of the wave motion) and longitudinal wave (displacements parallel and anti-parallel to the direction of the wave motion). This graph simply shows displacement from equilibrium as a function of position along the length of the slinky. It does not indicate the direction of the displacement from equilibrium.

A wave pulse is moving, as illustrated, with uniform speed v along a rope. Which of the graphs $1-4$ below correctly shows the relation between the displacement s at point P and time t?

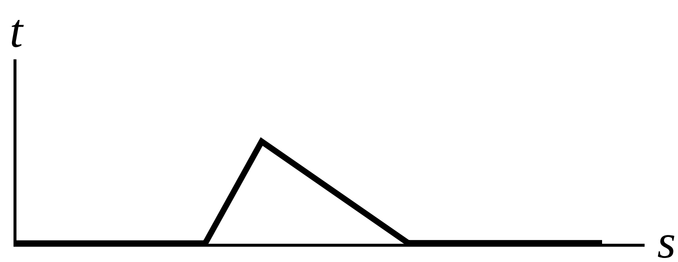




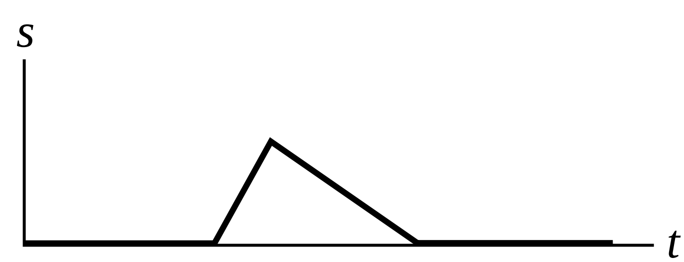
1



2



3



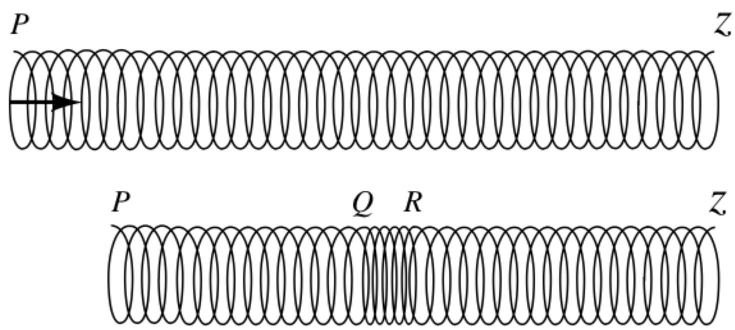
4

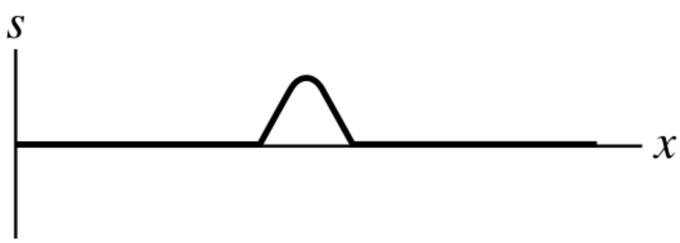
ANS: Choice **2** is correct.

Answers 1 and 3 cannot possibly be right, because they portray time as a function of displacement of the point.

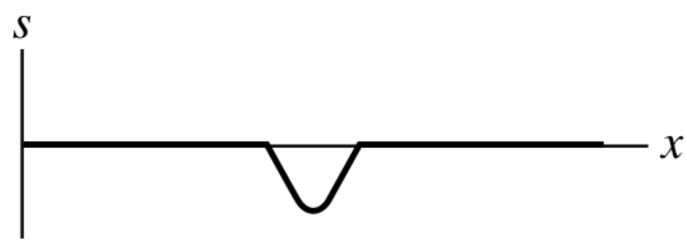
As the wave pulse approaches point *P*, that point will rise (positive displacement) slowly, then return to its equilibrium position at a much faster rate. This is what is portrayed in graph 2. In graph 4, on the other hand, the wave grows rapidly at first, then returns slowly to its equilibrium position.

A wave is sent along a long spring by moving the left end rapidly to the right and keeping it there. The figure shows the wave pulse at QR — part RS of the long spring is as yet undisturbed. Which of the graphs 1 – 5 correctly shows the relation between displacement *s* and position *x*? (Displacements to the right are positive.)

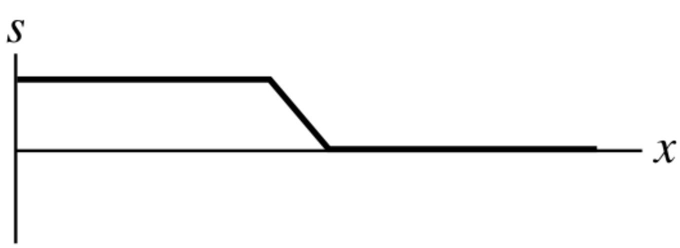




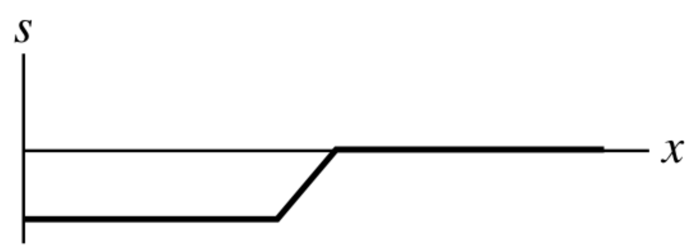
1



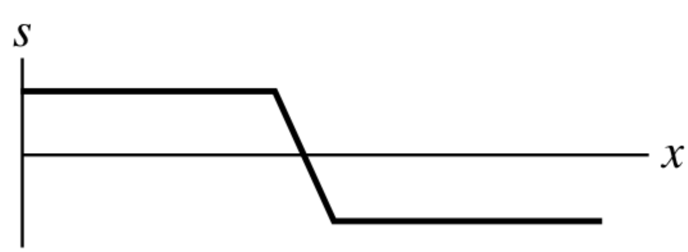
2



3



4



5

ANS: Choice **3** is correct.

The spacing of all points between *P* and *Q* is the same as before. The only difference is that every point on the spring between *P* and *Q* has moved the same distance to the right (positive displacement). Points between *Q* and *R* will have been displaced slightly to the right—more near *Q*, and less near *R*. No part of the spring between *R* and *S* has been influenced by the wave yet, so there will be no displacement for points between *R* and *S*.

A slinky is suspended from its upper end only and allowed to hang stretched out toward the floor. What happens to the bottom when the top is suddenly released?

1. It moves upward toward the top
2. It immediately falls downward
3. It remains in place until the top joins it
4. Something else

Warmup Question

You’ve probably seen “The Wave” at done at sporting events and such, where people stand up and sit down in sequence to produce a traveling pulse. In what sense is The Wave a wave in the physics sense? In what sense does it not qualify as a wave? (Yes, it has both aspects, so please address them both!) (See `https://youtu.be/H0K2dvB-7WY` for a video of the wave in action.)

ANS: It is a wave in the sense that it is the disturbance in the medium (the displacement of the people from their chairs), and not the medium itself (people) that is moving through the stadium. It is also like a wave in the sense that displacements in the medium are small compared to the distance over which the wave travels.

It is not a wave in the sense that there is no physical connection between the adjacent “molecules” that make up the wave. No person is required to stand up just because her neighbors have. (The people are psychologically coupled, but not physically coupled.) Also, this wave does not transmit energy. The oscillation energy comes from the people themselves standing up—it is not carried along the crowd.

Warmup Question

For The Wave just discussed, estimate the typical speed at which it propagates in m/s, explaining your logic.

ANS: From the video, I estimate that the wave has traveled around 100 feet in around 4 s, so the wave speed is around 25 ft/s, or around 8 m/s.

Warmup Question

Which of the following is not a classification of waves mentioned in the notes?

1. Longitudinal
2. Latitudinal
3. Transverse
4. all of the above were mentioned
5. None of the above were mentioned

ANS: **2**—We did not discuss “latitudinal” waves.