

TRANSVERSE WAVES: GRAPHS OF PARTICLE MOTION (GRADE 10) [NCS]*

Free High School Science Texts Project

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1 Graphs of Particle Motion

In Chapter , we saw that when a pulse moves through a medium, there are two different motions: the motion of the particles of the medium and the motion of the pulse. These two motions are at right angles to each other when the pulse is transverse. Since a transverse wave is a series of transverse pulses, the particle in the medium and the wave move in exactly the same way as for the pulse.

When a transverse wave moves horizontally through the medium, the particles in the medium **only** move up and down. We can see this in the figure below, which shows the motion of a single particle as a transverse wave moves through the medium.

Image not finished

Figure 1

TIP: A particle in the medium **only** moves up and down when a transverse wave moves horizontally through the medium.

As in , we can draw a graph of the particles' position as a function of time. For the wave shown in the above figure, we can draw the graph shown below.

Image not finished

Figure 2

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The graph of the particle's velocity as a function of time is obtained by taking the gradient of the position vs. time graph. The graph of velocity vs. time for the position vs. time graph above, is shown in the graph below.

Image not finished

Figure 3

The graph of the particle's acceleration as a function of time is obtained by taking the gradient of the velocity vs. time graph. The graph of acceleration vs. time for the position vs. time graph shown above, is shown below.

Image not finished

Figure 4

As for motion in one dimension, these graphs can be used to describe the motion of the particle in the medium. This is illustrated in the worked examples below.

Exercise 1: Graphs of particle motion 1

(Solution on p. 4.)

The following graph shows the position of a particle of a wave as a function of time.

Image not finished

Figure 5

1. Draw the corresponding velocity vs. time graph for the particle.
2. Draw the corresponding acceleration vs. time graph for the particle.

1.1 Mathematical Description of Waves

If you look carefully at the pictures of waves you will notice that they look very much like *sine* or *cosine* functions. This is correct. Waves can be described by trigonometric functions that are functions of time or of position. Depending on which case we are dealing with the function will be a function of t or x . For example, a function of position would be:

$$y(x) = A \sin\left(360^\circ \frac{x}{\lambda} + \phi\right) \quad (1)$$

where A is the amplitude, λ the wavelength and ϕ is a *phase shift*. The phase shift accounts for the fact that the wave at $x = 0$ does not start at the equilibrium position. A function of time would be:

$$y(t) = A \sin \left(360^\circ \frac{t}{T} + \phi \right) \quad (2)$$

where T is the period of the wave. Descriptions of the wave incorporate the amplitude, wavelength, frequency or period and a phase shift.

1.2 Graphs of Particle Motion

1. The following velocity vs. time graph for a particle in a wave is given.

Image not finished

Figure 6

- a. Draw the corresponding position vs. time graph for the particle.
- b. Draw the corresponding acceleration vs. time graph for the particle.

Click here for the solution.¹

¹<http://www.fhsst.org.za/lrU>

Solutions to Exercises in this Module

Solution to Exercise (p. 2)

- Step 1. The y vs. t graph is given. The v_y vs. t and a_y vs. t graphs are required.
- Step 2. To find the velocity of the particle we need to find the gradient of the y vs. t graph at each time. At point A the gradient is a maximum and positive. At point B the gradient is zero. At point C the gradient is a maximum, but negative. At point D the gradient is zero. At point E the gradient is a maximum and positive again.

Image not finished

Figure 7

- Step 3. To find the acceleration of the particle we need to find the gradient of the v_y vs. t graph at each time. At point A the gradient is zero. At point B the gradient is negative and a maximum. At point C the gradient is zero. At point D the gradient is positive and a maximum. At point E the gradient is zero.

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Figure 8