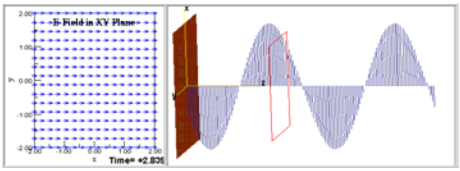
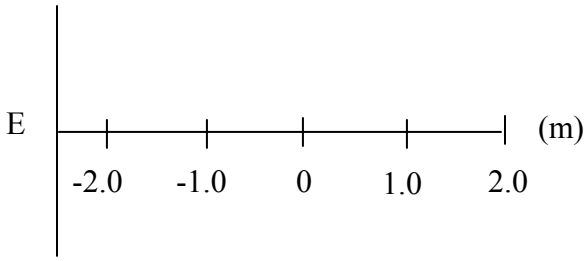
Worksheet for Exploration 32.1: Representation of Plane Waves



Move the slider and observe the animation on the left-hand panel of your screen. The animation shows the electric field in a region of space. The arrows show the field-vector representation of the electric field. The amplitude of the field is represented by the brightness of the arrows. The slider allows you to move along the z axis. Notice that the electric field is always uniform in the xy plane but varies along the z axis **(position is given in meters and time in given in nanoseconds)**. Restart.

a. Construct a graph that represents the electric field along the z axis at t = 0 ns.



Now view a representation of the electric field. Click-drag inside the animation on the right to view the electric-field representation from different points of view. This representation should closely match the graph you drew for part (a). Click on *play* to see a traveling wave. The representation on the right is often used to show a field like that on the left. Remember that the representation on the right is actually a graph of amplitude along the direction of propagation (z axis).

b. Keeping that in mind and looking at the graph on the right, rank the amplitude of the field at t = 0 ns for the following locations, from smallest to largest.

Location	x coordinate	y coordinate	z coordinate
I	1	0	-1.5
II	1	1	-1.5
III	0	0	-1.5
IV	0	1	-1.0
V	1	1	-0.5

Ranking =_____

Justify your ranking.

i. Consider the following statements made by two students.

Student One - “The field at Location II is zero because the graph on the right does not show a field along the y-axis.”

Student Two - “The field at Location II is not zero and is equal to the field at Location I because the window on the left shows that the field is uniform along the xy plane.”

Which student is correct? How would you explain to the other student why his/her statement is incorrect?

c. Now, push “play” to see the traveling wave. At position z = -0.5 m, rank the amplitude of the field at the following times (approximately), from smallest to largest.

Time (ns)	x coordinate	y coordinate	z coordinate
t = 0	1	1	-0.5
t = 1.7	1	1	-0.5
t = 3.3	1	1	-0.5
t = 5.0	1	1	-0.5
t = 6.7	1	1	-0.5

Ranking =_____

Justify your ranking.

d. What is the wavelength (distance between peaks) of the wave?

e. What is the frequency of the wave (the period T = 1/f is the time it takes for the wave to repeat itself at a given location)?

f. What is the speed of the wave?