PH170 lab8

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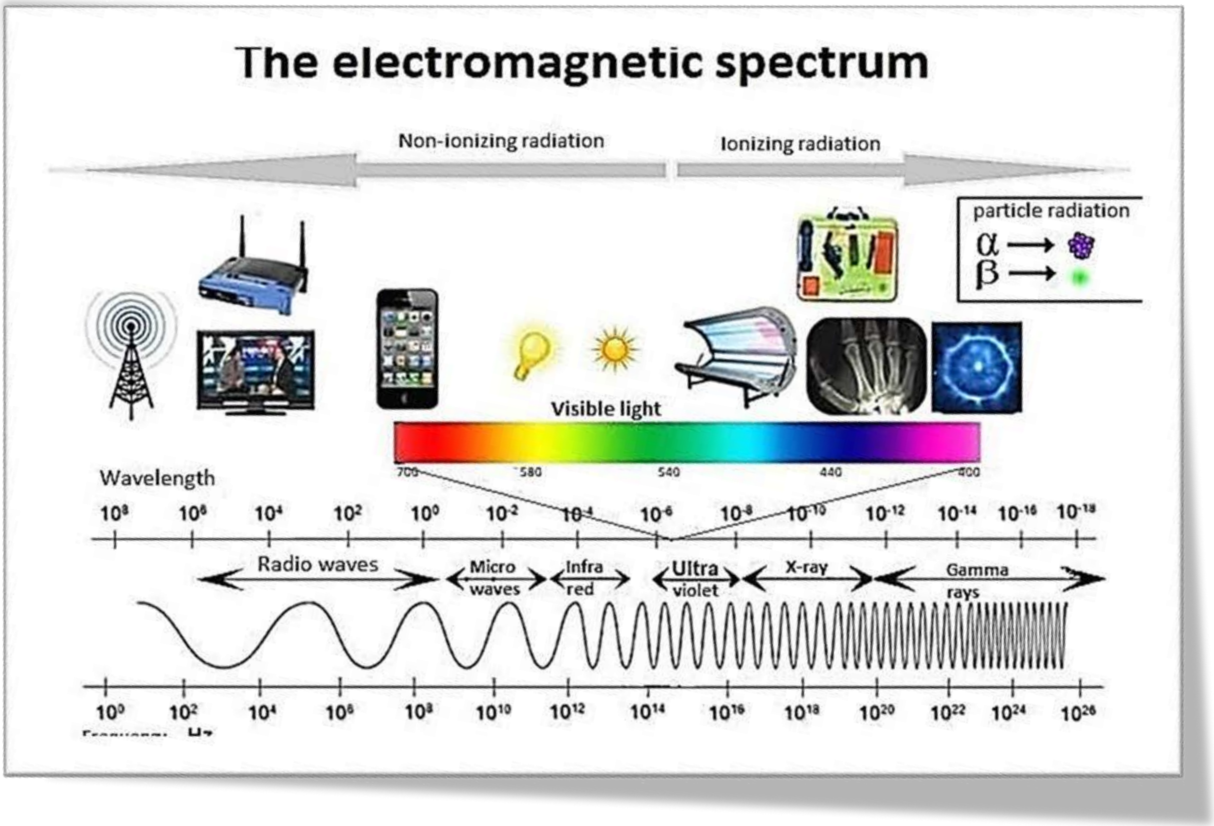
AIM:

• Understanding the relationships between accelerated motion for an electron and the field strength and direction. Wiggle the transmitter electron manually or have it oscillated automatically.
• When the radiation reaches the antenna to the right, what happens to the electron?
• How does the amplitude of oscillation of the receiving electron compare to the amplitude of the source electron?
• If you increase the frequency of oscillation, how does the amplitude of the source signal change?
• How does the amplitude of the radiation change as the signal travels to the right?
• How does the frequency of the electron in the receiving antenna
compare to the frequency of the electron in the source antenna (you can use a stopwatch to count the period)?

THEORY:

• Radio waves are a type of electromagnetic radiation with wavelengths in the electromagnetic spectrum longer than infrared light.
• Radio waves have frequencies as high as 300 gigahertz (GHz) to as low as 30 hertz (Hz). At 300 GHz, the corresponding wavelength is 1 mm (shorter than a grain of rice); at 30 Hz the corresponding wavelength is 10,000 km (longer than the radius of the Earth). Like all electromagnetic waves, radio waves in a vacuum travel at the speed of light, and in the Earth's atmosphere at a close, but slightly lower speed. Radio waves are generated by charged particles undergoing acceleration, such as time-varying electric currents.
• Naturally occurring radio waves are emitted by lightning and astronomical objects, and are part of the blackbody radiation emitted by all warm objects.
• Electric fields are created by differences in voltage: the higher the voltage, the stronger will be the resultant field. Magnetic fields are created when electric current flows: the greater the current, the stronger the magnetic field. An electric field will exist even when there is no current flowing. If current does flow, the strength of the magnetic field will vary with power consumption but the electric field strength will be constant.
• Electromagnetic fields are present everywhere in our environment but are invisible to the human eye. Electric fields are produced by the local build-up of electric charges in the atmosphere associated with thunderstorms. The earth's magnetic field causes a compass needle to orient in a North-South direction and is used by birds and fish for navigation.

• Besides natural sources the electromagnetic spectrum also includes fields generated by human-made sources: X-rays are employed to diagnose a broken limb after a sport accident. The electricity that comes out of every power socket has associated low frequency electromagnetic fields. And various kinds of higher frequency radio waves are used to transmit information – whether via TV antennas, radio stations or mobile phone base stations.

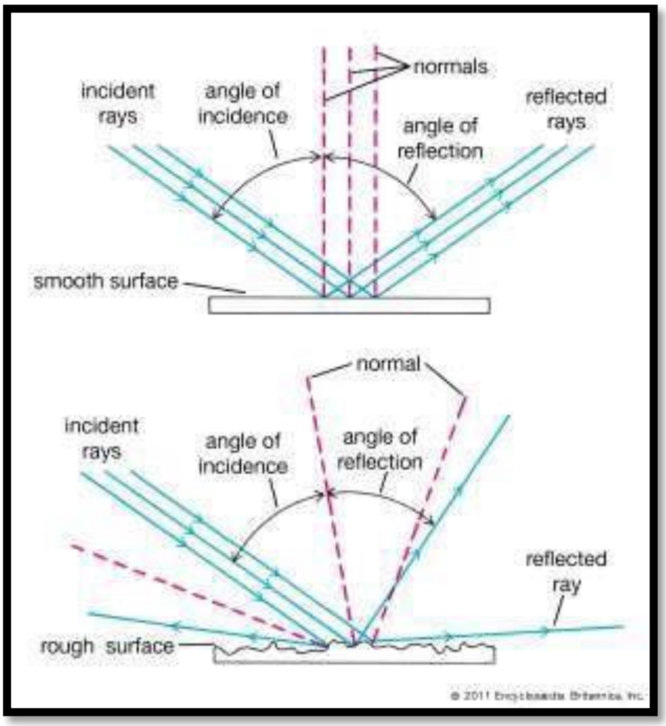


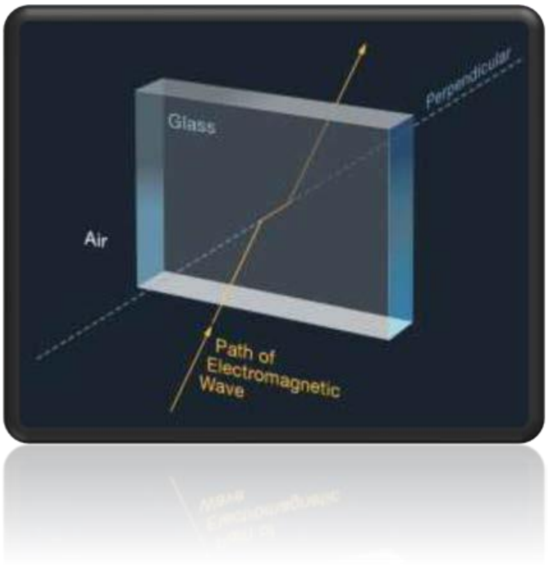
• **Snell's law** (also known as Snell–Descartes law and the law of refraction) is a formula used to describe the relationship between the angles of incidence and refraction, when referring to light or other waves passing through a boundary between two different isotropic media, such as water, glass, or air.

• In optics, the law is used in ray tracing to compute the angles of incidence or refraction, and in experimental optics to find the refractive index of a material. The law is also satisfied in metamaterials, which allow light to be bent "backward" at a negative angle of refraction with a negative refractive index.

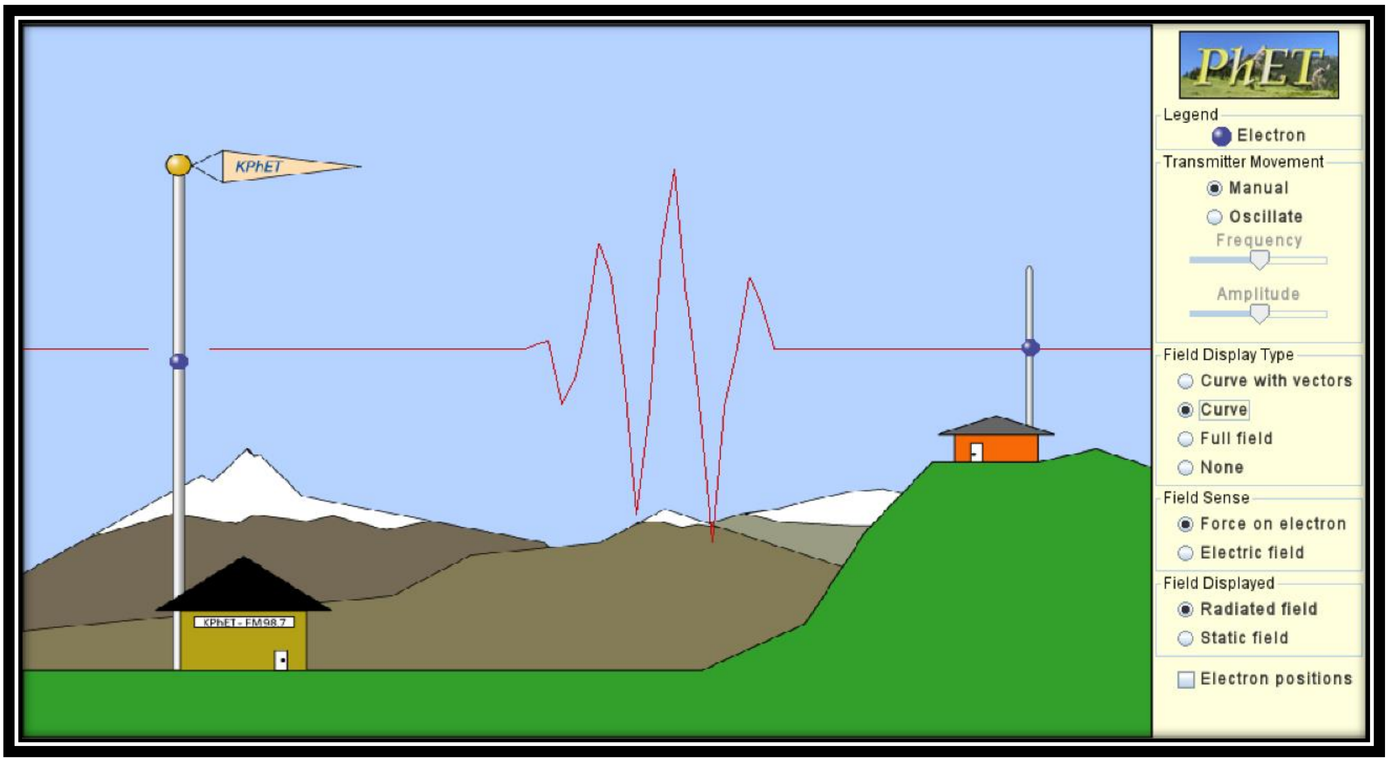
• Snell's law states that the ratio of the sines of the angles of incidence and refraction is equivalent to the ratio of phase velocities in the two media, or equivalent to the reciprocal of the ratio of the indices of refraction:

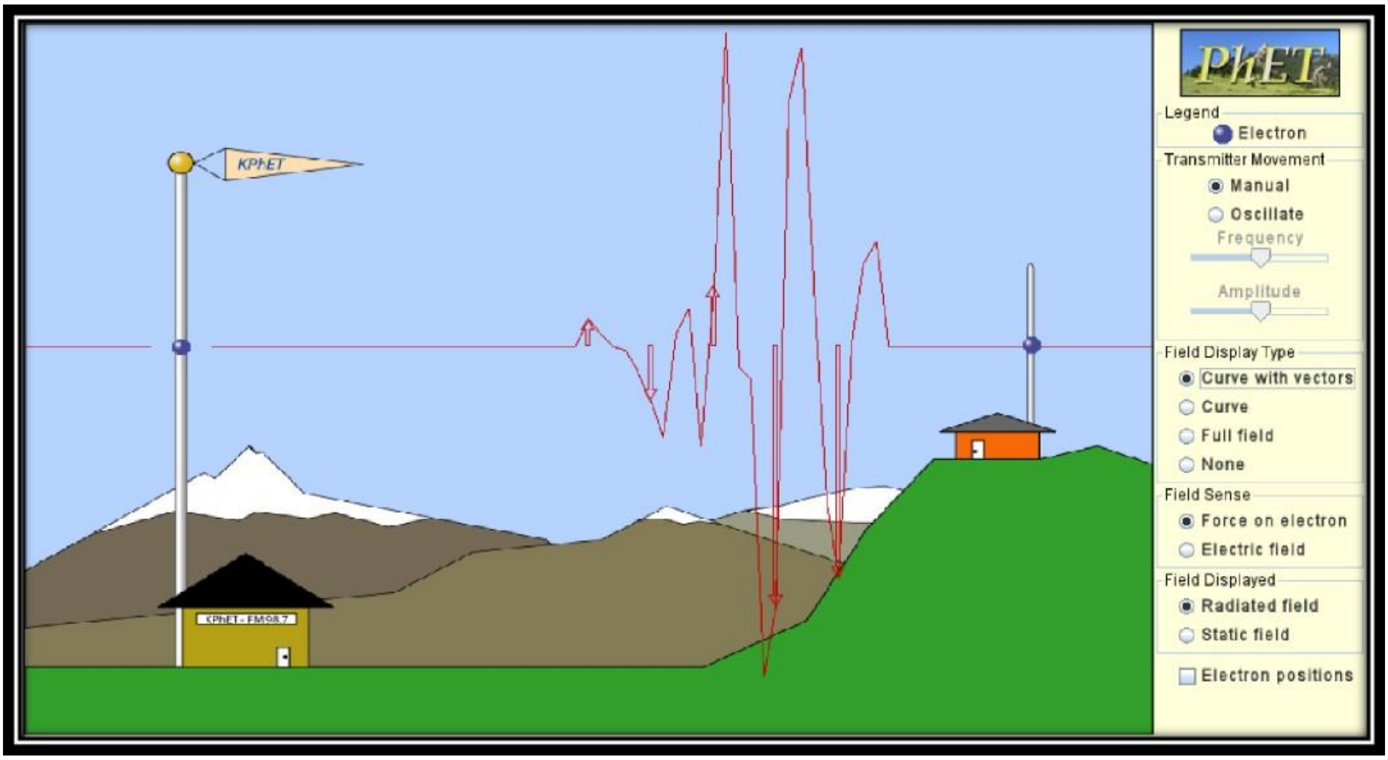
$$\frac{\sin\theta_2}{\sin\theta_1} = \frac{v_2}{v_1} = \frac{n_1}{n_2}$$

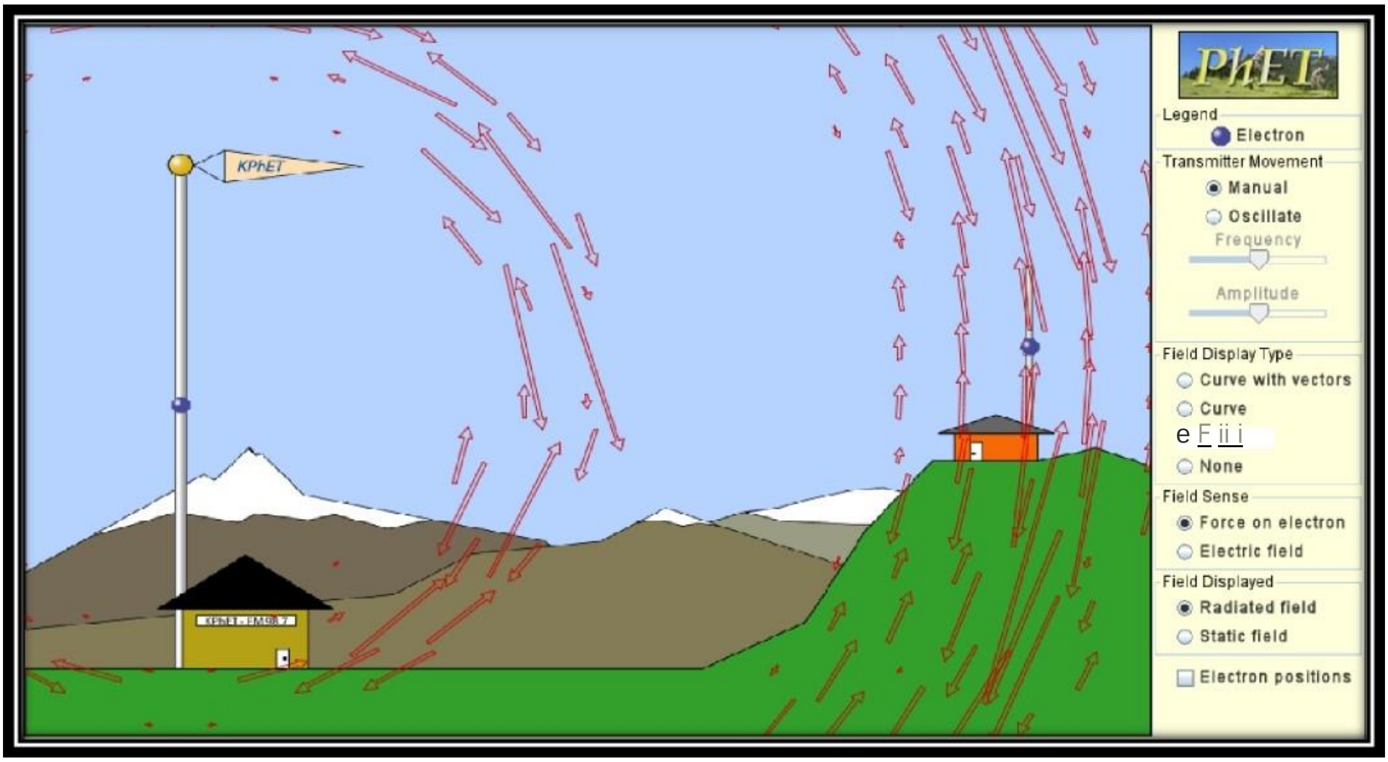




OBSERVATIONS:




KPhET
KPhET - FM98.7
PhET
Legend
Electron
Transmitter Movement
Manual
Oscillate
Frequency
Amplitude
Field Display Type
Curve with vectors
Curve
Full field
None
Field Sense
Force on electron
Electric field
Field Displayed
Radiated field
Static field
Electron positions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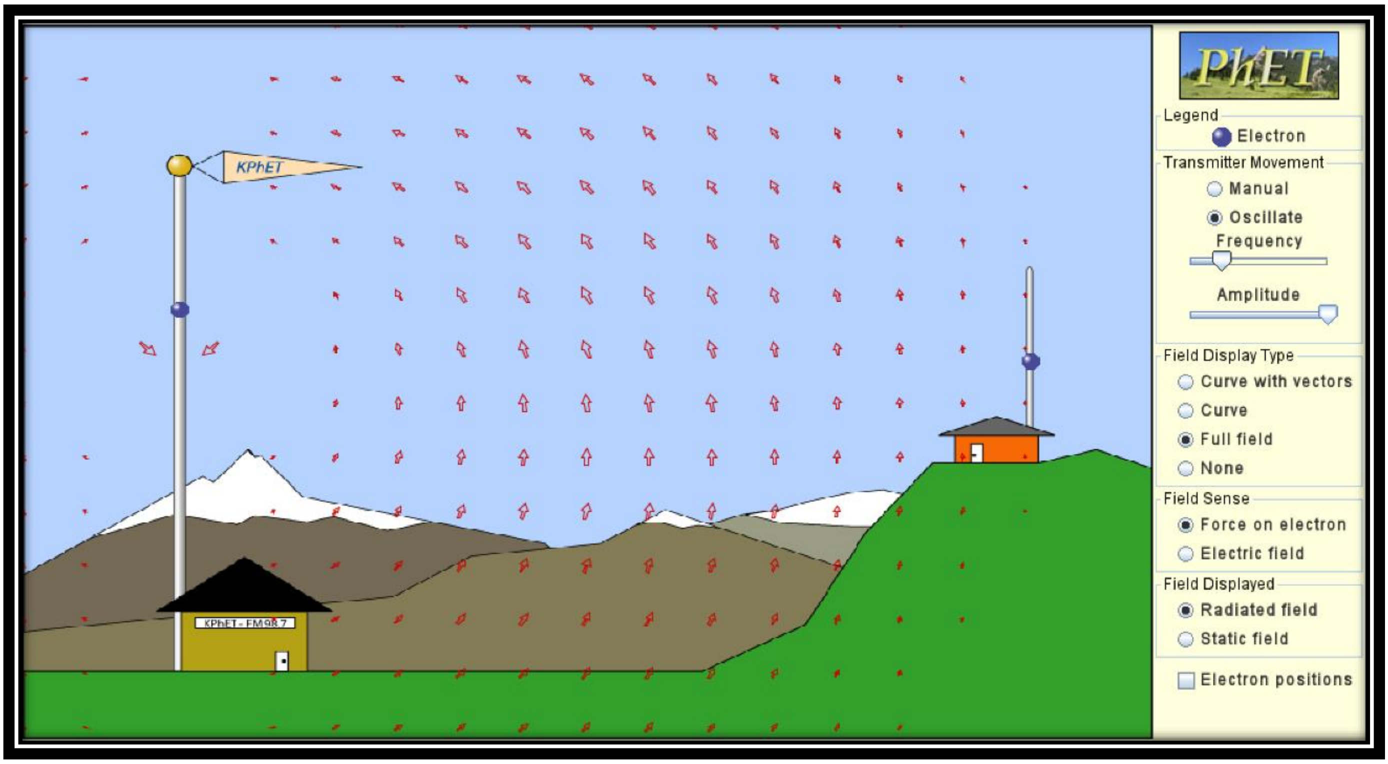
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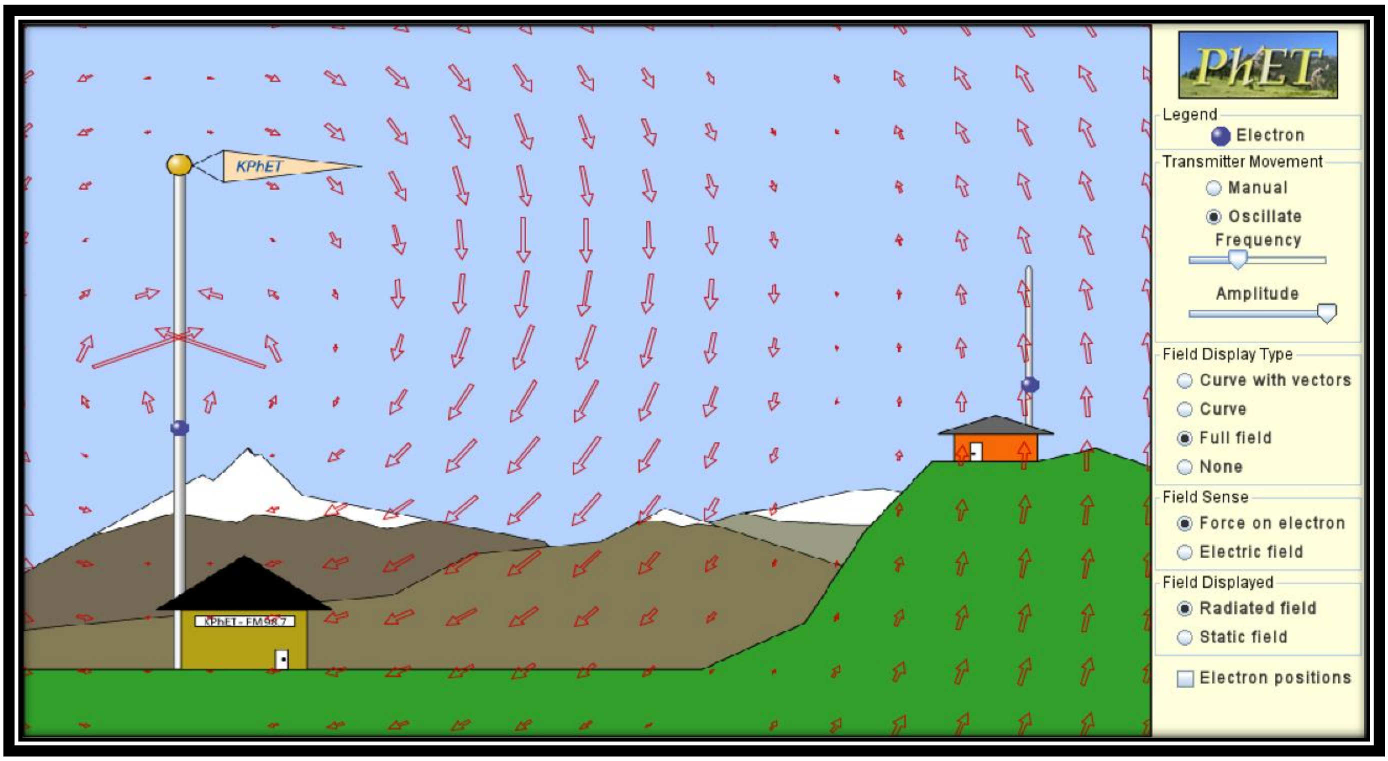
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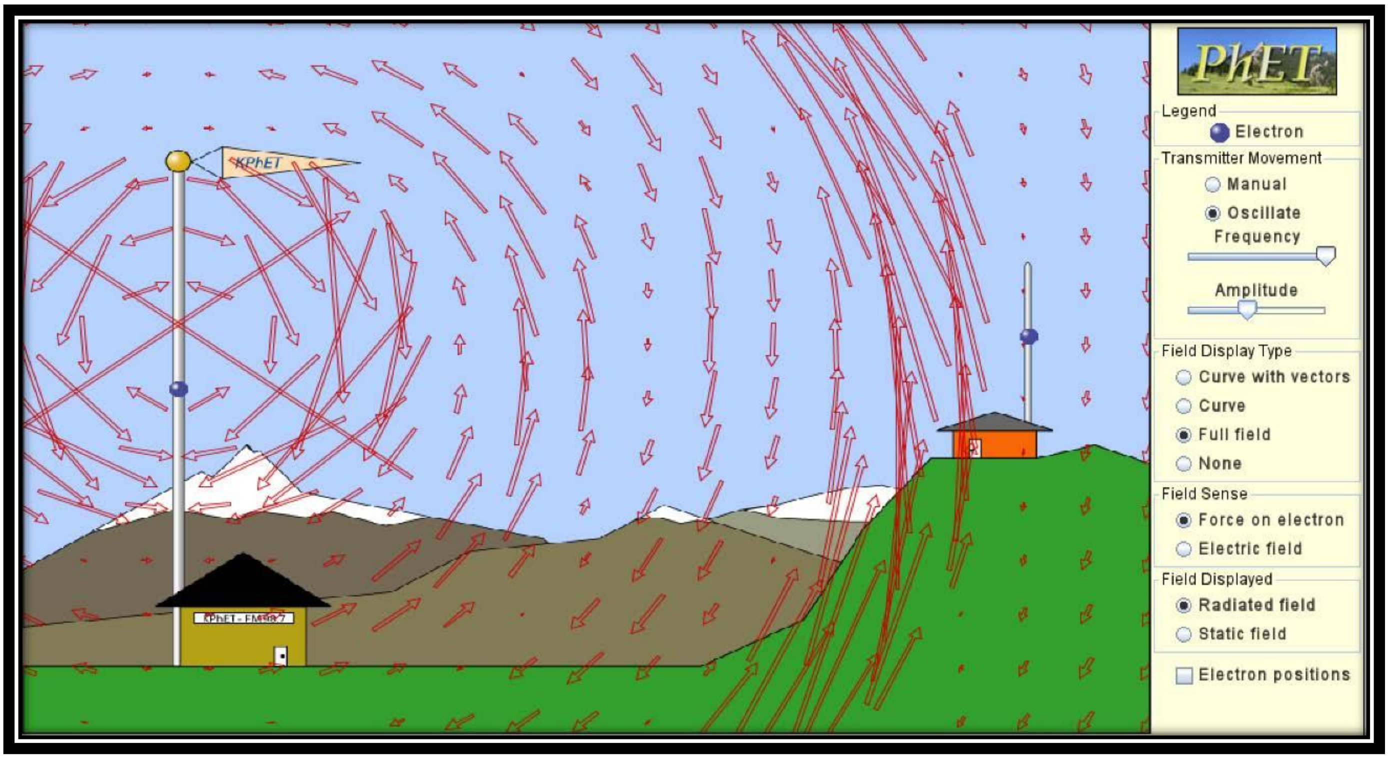

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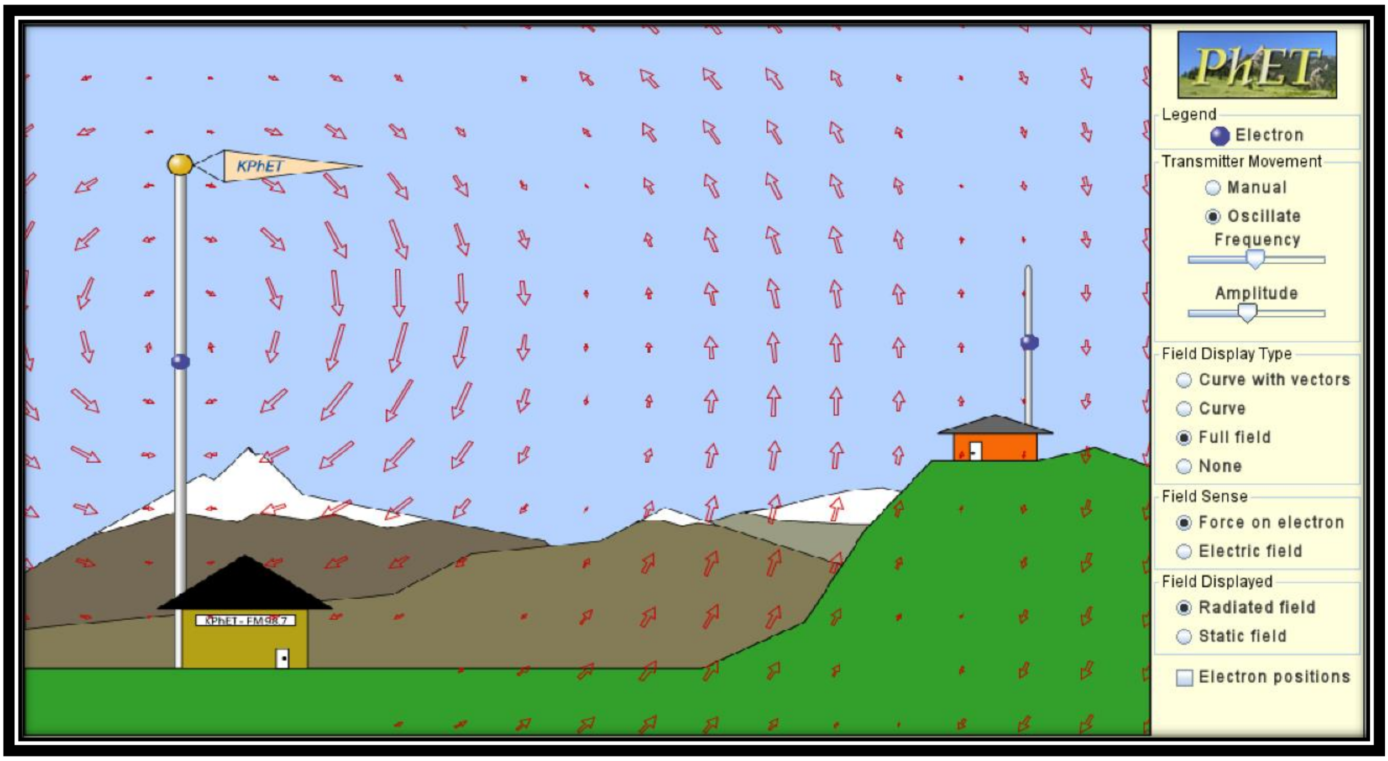

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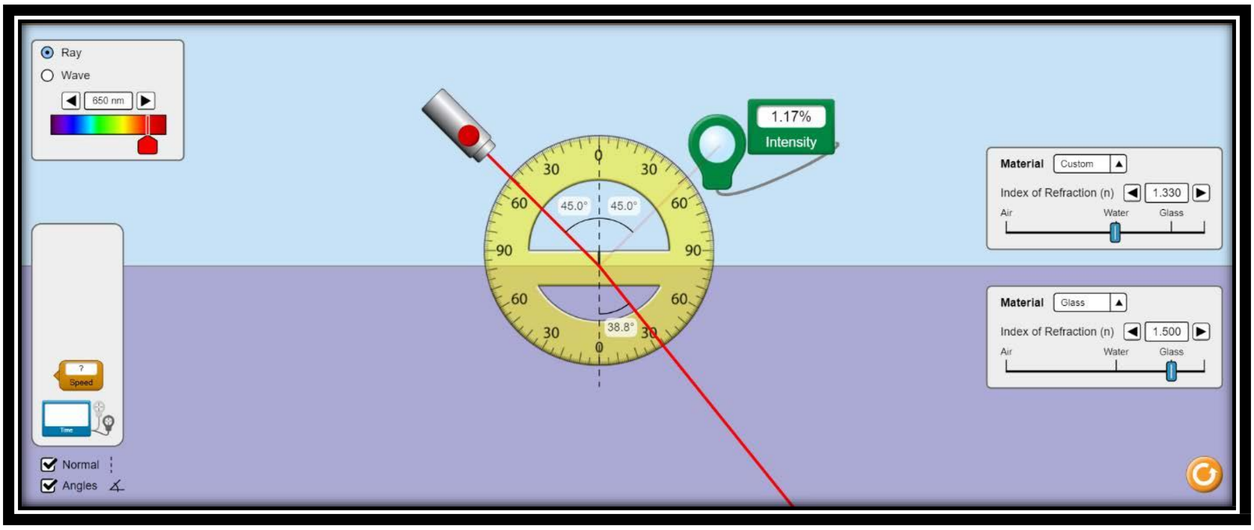
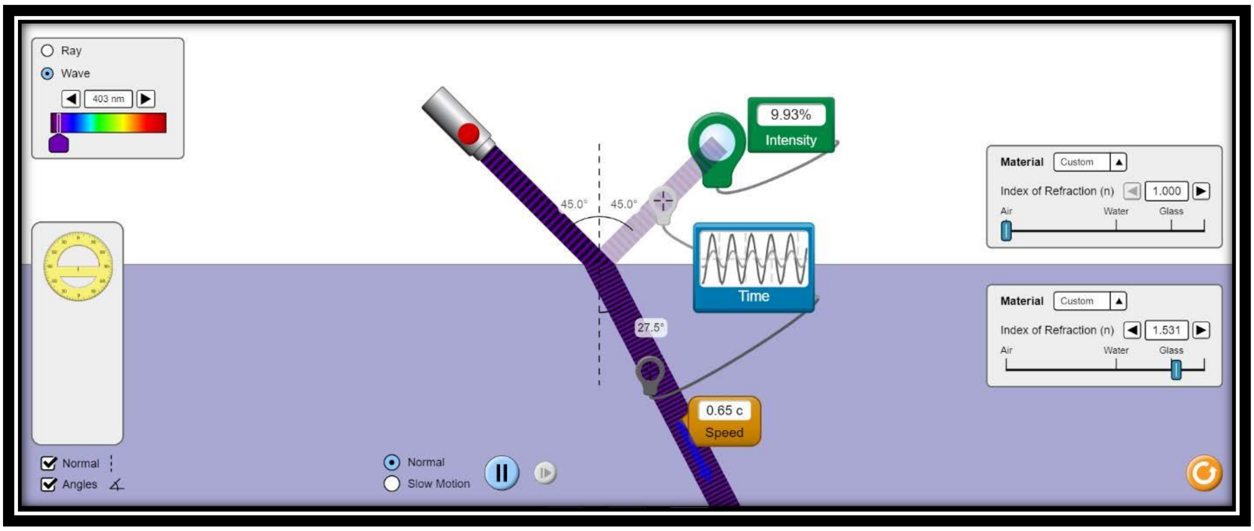
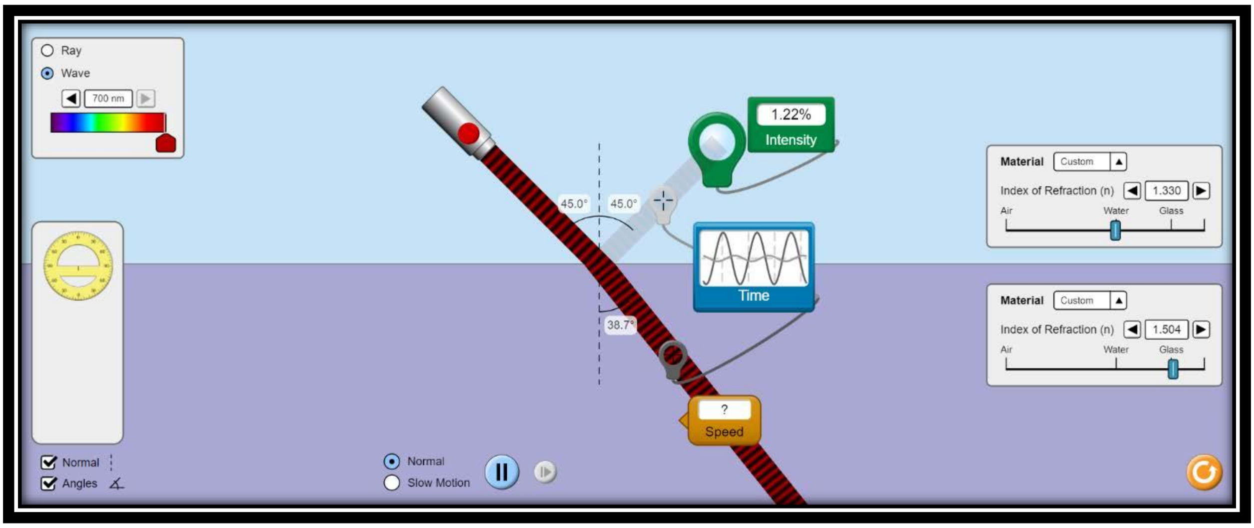






OBSERVATION TABLE:

Sr.No.	Angle of Incidence	Angle Of Refraction	[illegible]	[illegible]	Intensity (%)
1.	**30**	**20**	**1.00**	**1.50**	**5.80**
2.	**6**	**35**	**1.00**	**1.50**	**17..64**
3.	**6**	**50**	**1.33**	**1.50**	**3.55**
4.	**45**	**39**	**1.33**	**1.50**	**1.21**
5.	**45**	**25**	**1.00**	**1.60**	**11.39**
6.	**75**	**38**	**1.00**	**1.60**	**44.42**
7.	**0**	**0**	**1.00**	**1.33**	**100**
8.	**30**	**22**	**1.00**	**1.33**	**3.07**
9.	**60**	**40**	**1.00**	**1.33**	**11.42**
10.	**90**	**90**	**1.00**	**1.33**	**100**

CALCULATIONS:

According to Snell's Law,

$$\frac{\sin\theta_2}{\sin\theta_1} = \frac{v_2}{v_1} = \frac{n_1}{n_2}$$

Calculating for observation 1,
Angle of Incidence = 30
Angle Of Refraction = 20
$\mu i = 1.0$
$\mu r = 1.5$
Therefore, $\frac{30}{20} = \frac{1.5}{1.0}$

Hence this observation satisfies Snell's Law.

ERROR ANALYSIS:

• Due to this being a virtual experiment, the possibility of errors is very low.
• Errors could be caused due to incorrect human measurement or values entered or observed.
• Another cause of error could be due to incorrect programming of the virtual lab experiment.
• Overall errors comprised of less than 0.1 % and since all readings were made by the use of virtual environment in this experiment the actual there were minimal chances of errors, thus, there effect was neglected in the calculations.
• Error can be calculated using the following formulae:

Error: (Measured Value – Expected Value) / Expected Value

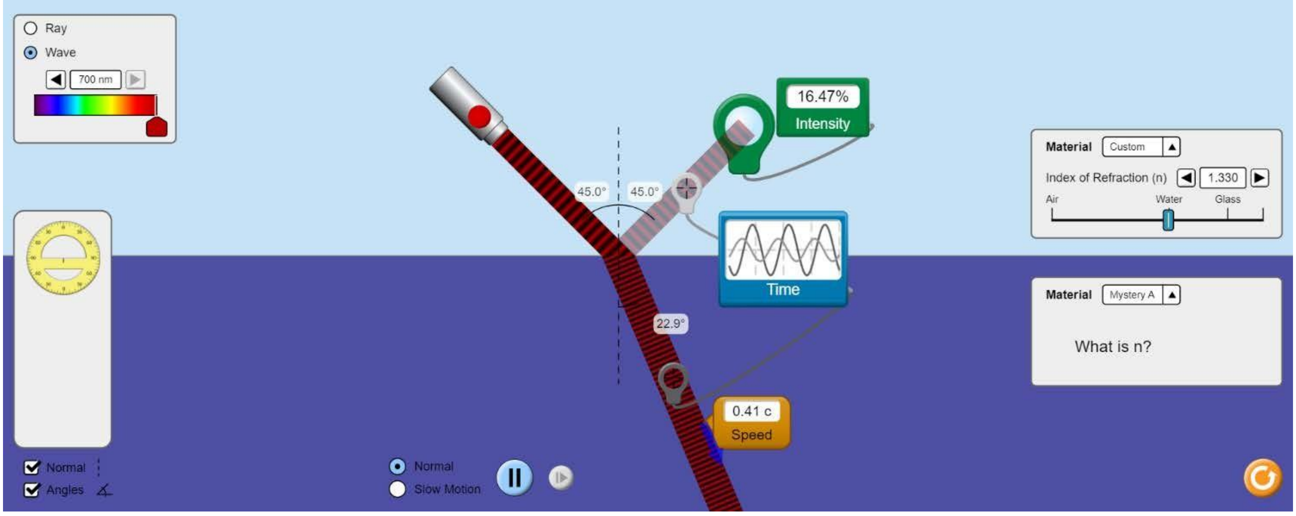
% Error: ((Measured Value – Expected Value)/ Expected Value) * 100

RESULT ANALYSIS:

• We observed the change in intensity with incident angle, relative refractive index of both the medium and frequency.
• We observed changes in velocity with frequency relative refractive index of two medium, incident angle.
• We observed how the phase changes in the cases of reflected and refracted waves from the incident wave.
• We proved the total internal reflection and calculate the critical angle
• We saw that on changing wavelength of the incident wave, change in the intensity, time graph, and speed graph has been observed.
• Light ray passes from a medium of high refractive index to one of low refractive index. Therefore, the light ray is bent away from the normal. Light ray passes from a medium of low refractive index to one of high refractive index. Therefore, the light ray is bent towards the normal.
• We observed in the case of Electromagnetism that the amplitude of the wave decreases slowly.
• We observed that changing the frequency also changes the force on electrons. Increasing the frequency increases the force on electrons and vice versa. Similarly changing the amplitude also changes the force on electrons. Increasing the amplitude increases the force on electrons and vice versa.

Finding Anonymous Mediums:

1.

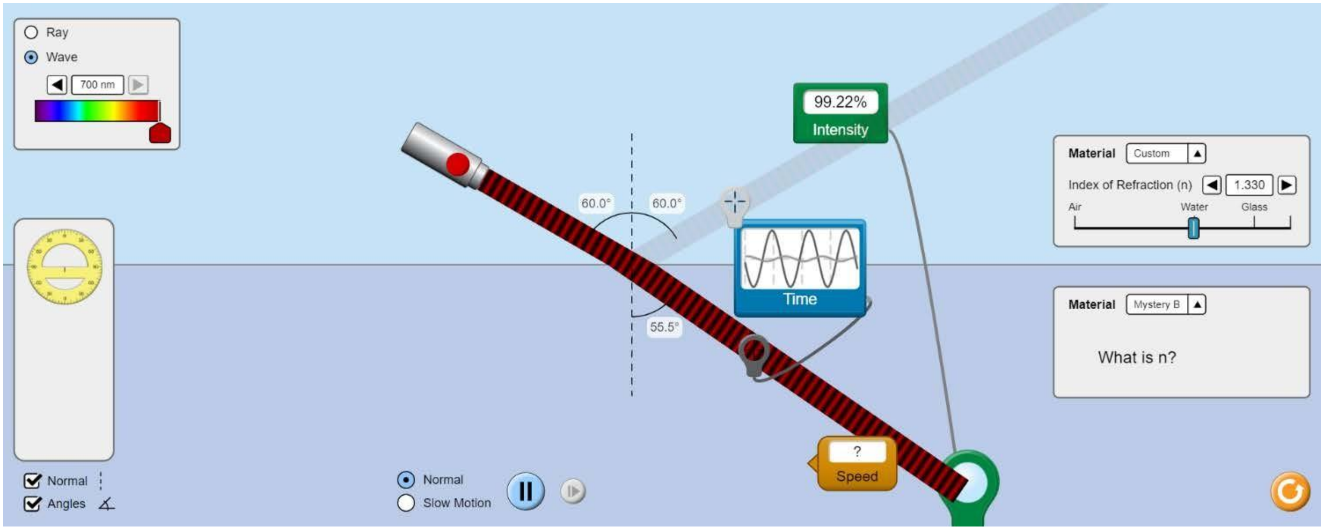


According to Snell's Law,

$$\frac{\sin\theta_2}{\sin\theta_1}=\frac{v_2}{v_1}=\frac{n_1}{n_2}$$

We have,
Angle of Incidence = 45
Angle Of Refraction = 22.9
μi = 1.33
μr = ?
therefore,
(sin(45°))/(sin(22.9°)) = 1.33/ø
=> ø=0.732

2.



Again, applying Snell's Law,

$$\frac{\sin\theta_2}{\sin\theta_1}=\frac{v_2}{v_1}=\frac{n_1}{n_2}$$

Angle of Incidence=60
Angle of Refraction=55.5
μi = 1.33
μr = ?
therefore, (sin(60°))/(sin(55.5 °)) = 1.33/ø => ø=1.2656

Thus, we could easily find the values of refractive indices for the mystery mediums.

Thank you