Phys 112 2019

Lecture 22

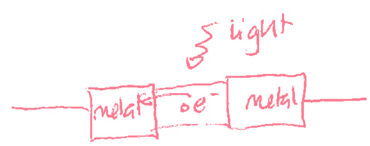
Mon 25 March Warm Up 9

Tues 26 March Review III

Weds 27 March Exam II Covers Ch 22, 23, 24, 25.1→25.4

Physics question Electricity generation via solar panels

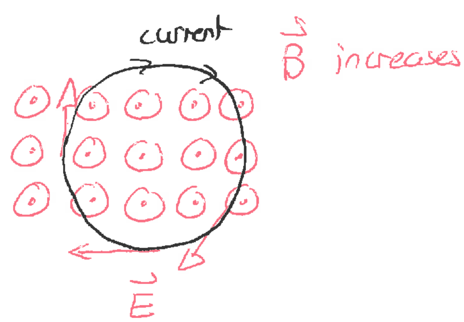
- conventional electricity generated by moving magnet + coil relative to each other.
- ~~pe~~ photovoltaic cells – light incident on semiconductors
  - semiconductor physics – uses quantum physics – results in rearrangement of electrons and this produces current



Electromagnetic Waves

We have seen that a magnetic flux that changes with time can produce an EMF. Alternative we can regard this as producing an electric field that circles.

This electric field exists regardless of whether there is a physical loop present.



Thus:

A time varying magnetic field induces an electric field.

A separate finding is that

A time varying electric field induces a magnetic field.

This can establish a chain

time varying $\vec{E}$ field → time varying $\vec{B}$ field → time varying $\vec{E}$ field

A set of equations, called Maxwell's equations, describes the interplay between these time varying fields and their sources. The ultimately predict that there can exist waves of electric and magnetic fields

Slide 1

Slide 2

<u>Demo:</u> PSU-S Plane Electromagnetic Waves

<u>Demo</u> PhET - Radio Wave

✓ oscillate
✓ $\vec{E}$ field. } observe detection

General description of waves

Much of the description of electromagnetic waves uses the general language that describes any type of wave and we now review this for the simpler example of waves on a string

Demo: PhET W.o.S

✓ oscillate ✓ no end

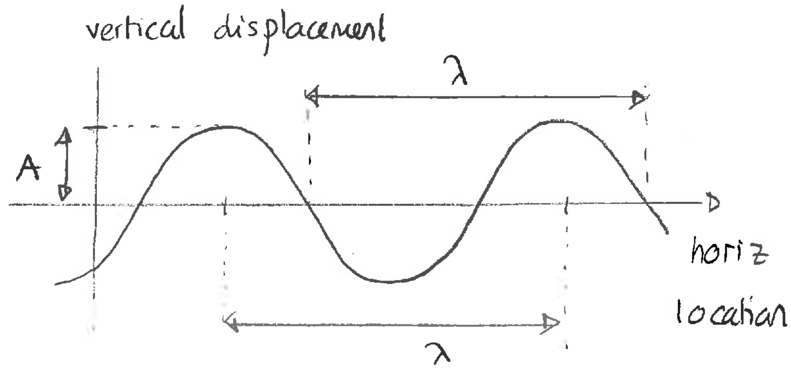
damping = none tension = high

freq = 1.25 Hz

The demonstrate reveals a wave pattern that travels left to right

At any instant a snapshot reveals a sinusoidal curve

We describe the wave with various quantities



Quantity	Idea	Definition	Symbol	Physical connection
Amplitude	Vertical extent	Maximum displacement from equilibrium	A	Energy, loudness, intensity
Wavelength	Horizontal stretch / repetition	Distance between successive points at same location on the pattern	λ "lambda" units: m	pitch / color

Quiz 1 90%

As time passes the wave pattern evolves. We can observe this in two ways:

1) each point on the wave oscillates back + forth / up + down

2) the entire pattern moves right

Demo: PhET W.o.S

* observe single bead * observe crests passing through window

The are described via:

> The period of oscillation, T, is the time taken for a complete cycle of oscillation for each point on the medium

This is measured in seconds. A related quantity is the frequency of the wave:

> The frequency of the wave is
> $$f = \frac{1}{T}$$

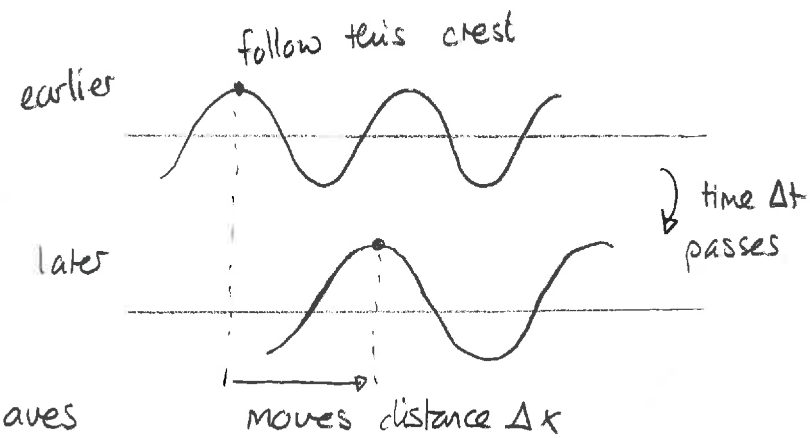
Units: Hertz: $Hz = 1/s$

The frequency quantifies:

1) the number of cycles completed every second at any point
2) the number of crests that pass every second at any point.

Quiz 2 40% - 90%

Finally the wave speed is the speed with which the wave pattern propagates. Refering to the diagram the wavespeed means



$$v = \frac{\Delta x}{\Delta t}$$

A general rule for all waves is

$$v = \lambda f$$

Example: The speed of sound waves in air is 344m/s. The frequency of the middle C note is 256Hz. Determine the wavelength of the associated sound wave.

Answer: $v = \lambda f$

$$\Rightarrow \lambda = v/f = \frac{344 m/s}{256 Hz} = 1.34 m/s$$