

Physics 102

Lecture 21.

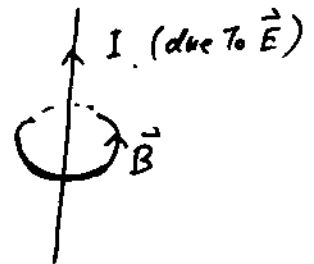
Friday, Oct. 29, 2004

Electromagnetic Waves (ch. 25)

- \vec{E} and \vec{B} are related.

- Ampere's Law:

\vec{E} can cause \vec{B} via a current.



- Faraday's Law:

A varying magnetic field can give rise to an \vec{E} .

$$\left(\frac{d\vec{B}}{dt} \neq 0 \Rightarrow \frac{d\Phi}{dt} \neq 0 \Rightarrow \mathcal{E} \neq 0 \Rightarrow \vec{E} \neq 0 \right)$$

$$\therefore \frac{d\vec{B}}{dt} \neq 0 \quad \begin{array}{c} \longrightarrow \\ \longleftarrow \end{array} \quad \frac{d\vec{E}}{dt} \neq 0$$

i.e. \vec{E} and \vec{B} can induce each other.

(if they are both time-dependent)

- Generalized idea: (Maxwell, 1864).

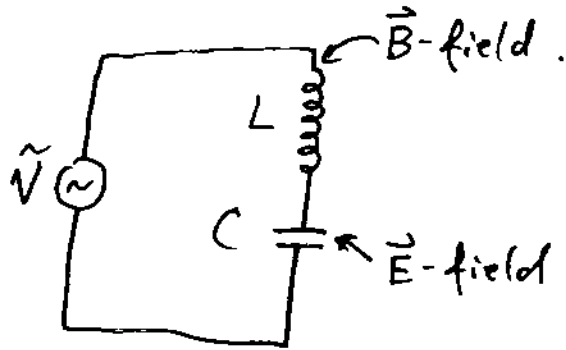
\vec{E} and \vec{B} can induce each other in space.

without charge and current!

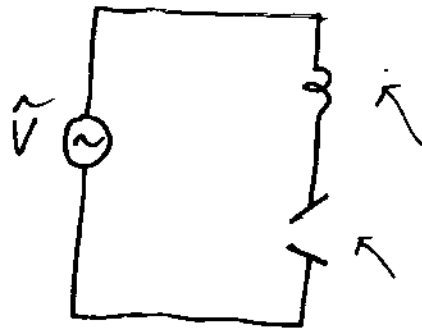
electromagnetic waves!

- A way to generate an electromagnetic wave .

A circuit of LC driven by an ac voltage \tilde{V}

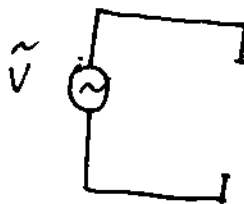


change L and C a little :



\vec{E} and \vec{B} fields are more
in the space,
rather than inside C and L .

An antenna : Driven by a signal \tilde{V}



antenna

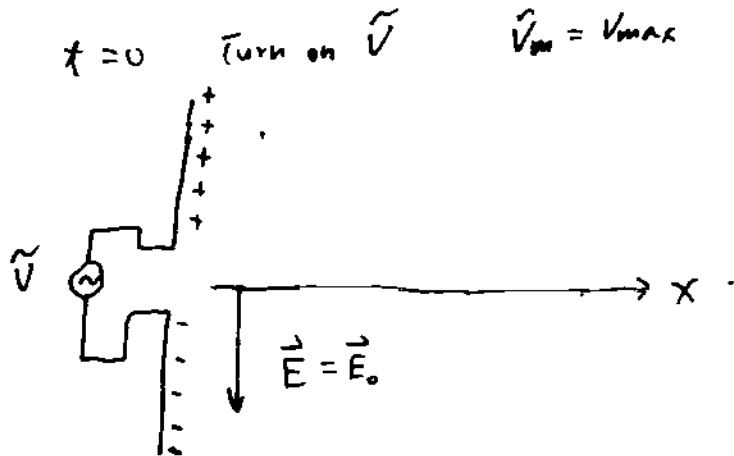
better : \Rightarrow



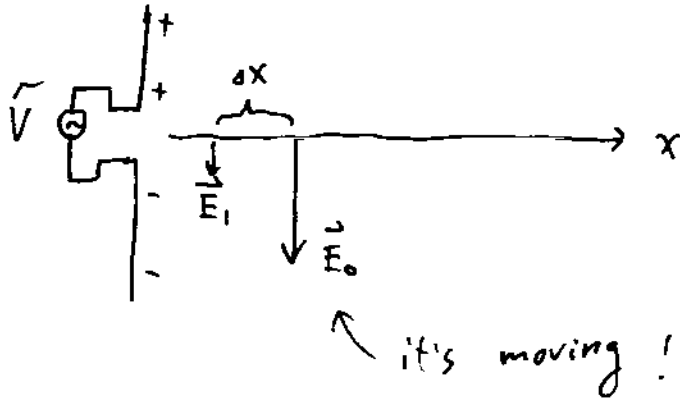
The \vec{E} & \vec{B}
fields are
mostly in
the space .

as an
electromagnetic wave .

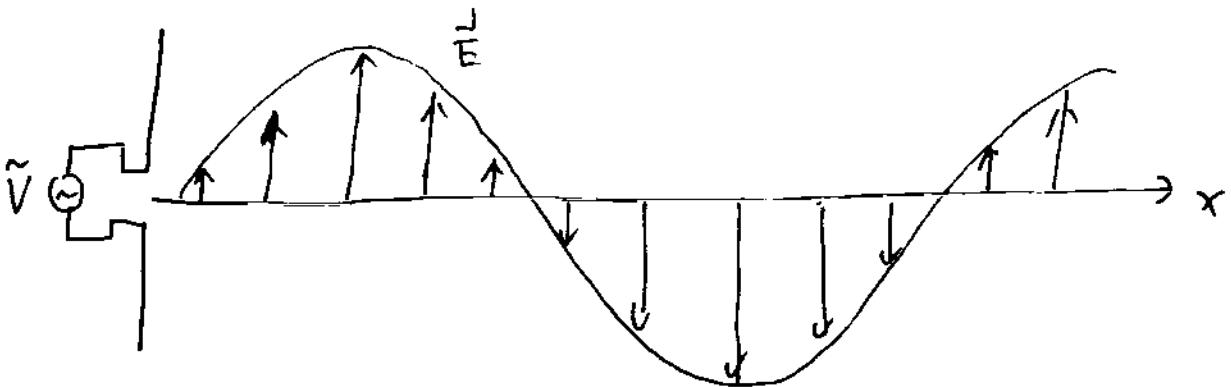
• How does it work?



$t = t_1 > 0$ $\Delta x = c \cdot \Delta t = c \cdot t_1$



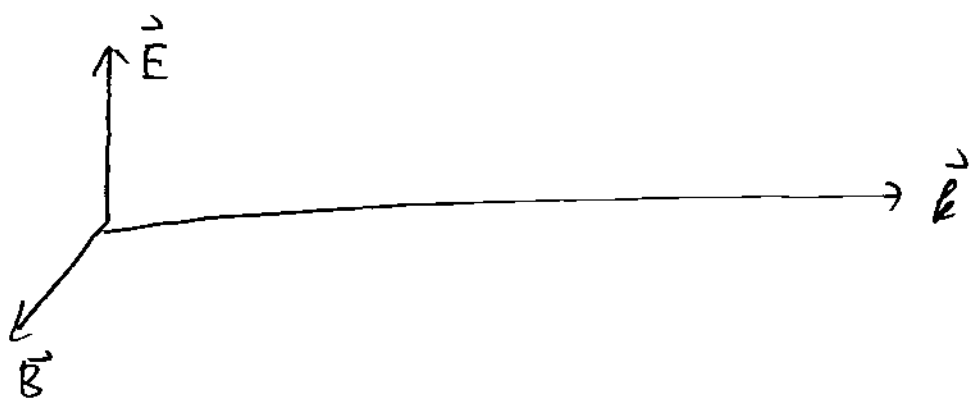
later:



\vec{B} -field? ~~Another right-hand rule.~~ Another right-hand rule.

$$\vec{E} \times \vec{B} \Rightarrow \vec{k} \text{ (direction of propagation)}$$

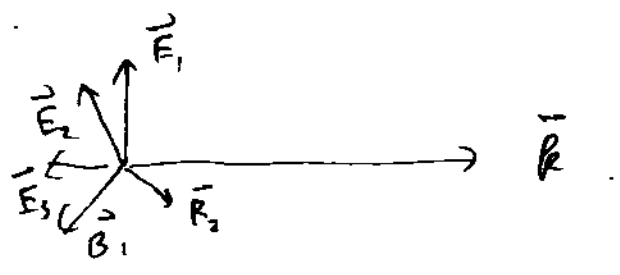
- Directions of \vec{E} , \vec{B} , \vec{k} of an EDM wave.



$\vec{k} \perp \vec{E}$, $\vec{k} \perp \vec{B}$. (Transverse wave)
 (TEM)
 $\vec{E} \perp \vec{B}$.

- e.g. Light is an electromagnetic wave.

From the light bulb, the light is emitted by many atoms.



There is a distribution of \vec{E} in the plane $\perp \vec{k}$.
 (\vec{B} as well).

use a polarizer to select one direction of \vec{E} . (absorb all the others).

↑
 only allow one direction of \vec{E} to pass.

Demo: polarized light vs. unpolarized light.