10+2 PCM NOTES

BY

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(PDF version handwritten notes of Maths, Physics and Chemistry for 10+2 competitive exams like JEE Main, WBJEE, NEST, IISER Entrance Exam, CUCET, AIPMT, JIPMER, EAMCET etc.)

10+2

With best wishes from Joyoshish Saha

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Electromagnetic Waves.

* General Expression of Ampere's circuital law:

$$\int \vec{B} \cdot d\vec{l} = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt} = \mu_0 (i_c + i_d).$$

$i_d = \varepsilon_0 \frac{d\phi_E}{dt}$ (displacement current, produced by changing electric field).

$i_c \rightarrow$ conduction current due to flow of charge.

* During charging of capacitor i_c along the wire is equal to i_d between the plates.

* Faraday's Law of electromagnetic induction says that changing magnetic field gives rise to an electric field and its line integral (emf) is given by $\oint \vec{E} \cdot d\vec{l} = -\frac{d\phi_B}{dt}$

A changing electric field gives rise to a magnetic field, in the consequence of displacement current. $\oint \vec{B} \cdot d\vec{l} = \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$.

- Time dependent electric & magnetic field gives rise to each other.

* Maxwell's Equ^ns:

1. $\oint \vec{E} \cdot d\vec{s} = \frac{q_{in}}{\varepsilon_0}$ (Gauss's Law for electricity)
2. $\oint \vec{B} \cdot d\vec{s} = 0$ (Gauss's Law for magnetism)
3. $\oint \vec{E} \cdot d\vec{l} = -\frac{d\phi_B}{dt}$ (Faraday's Law)
4. $\oint \vec{B} \cdot d\vec{l} = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$ (Ampere-Maxwell's Law)

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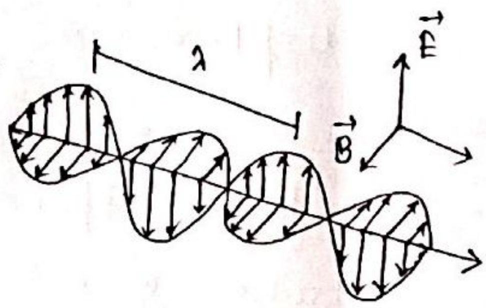
- ELECTROMAGNETIC WAVES :

* Stationary charges produce only electric field; charges in uniform motion produce electric and magnetic field ; accelerated charges produce electric , magnetic fields & radiate electromagnetic waves.

* The oscillating electric field & magnetic fields regenerate each other & electromagnetic wave propagates through space. The frequency of EM wave is equal to the frequency of oscillation of the charge.

* When EM waves propagates in space then electric & magnetic fields oscillate in mutually perpendicular directions. Further they are perpendicular to the direction of prolongation of EM waves also.

* EM wave propagating along z-axis. The $\vec{E}$ is along x-axis & $\vec{B}$ along y-axis , both varies sinusoidally. Then,



$$E_x = E_0 \sin(\omega t - Kz).$$

$$B_y = B_0 \sin(\omega t - Kz)$$

Thus, EM wave travels in the direction of $\vec{E} \times \vec{B}$.

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EM Wave

* We can write,

$$K = \frac{2\pi}{\lambda}, \quad \omega = 2\pi f, \quad c = \frac{\omega}{K} = f\lambda.$$

$$c = \frac{E_0}{B_0} = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}.$$

* EM wave does not require any medium. But, the velocity of EM wave depends on electric & magnetic properties of the medium.

$$v = \frac{1}{\sqrt{\mu \varepsilon}}.$$

* Energy density in electric field $= \frac{1}{2} \varepsilon_0 E^2$

Energy density in magnetic field $= \frac{B^2}{2\mu_0}$.

* Consider a plane perpendicular to the direction of propagation of the EM wave. If the total energy transferred to a surface in time t is E, then total momentum delivered is $\Delta p = \frac{E}{c}$ (for complete absorption). If totally reflected $\Delta p = \frac{2E}{c}$.

* The energy transferred per unit area per unit time perpendicular to the direction of propagation of EM wave is called intensity of wave. $I = \frac{1}{2} \varepsilon_0 E_{rms}^2 c$.