



## Chapter 8

# Electromagnetic Wave

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# Electromagnetic Wave

### BOARD:- 2013

1. (i) write Gauss's Law for magnetism in the form of Maxwell's eq<sup>n</sup>.  
(ii) write value of  $\frac{1}{\mu_0 \epsilon_0}$

⇒ (i)  $\oint_S \vec{B} \cdot d\vec{A} = 0$

(ii)  $c = \frac{1}{\sqrt{\mu_0 \epsilon_0}} = 3 \times 10^8 \text{ m/s}$

### BOARD:- 2013 (Supp.)

2. (i) write the mathematical form of Ampere- Maxwell Law.  
(ii) write wavelength range of Infra-red rays. write the name of two gaseous molecules which can absorb it.

⇒ (i)  $\oint \vec{B} \cdot d\vec{l} = \mu_0 i_c + \mu_0 \epsilon_0 \frac{d\phi}{dt}$

- (ii) Range of Infra-red rays - 1mm to 700nm  
 $\text{CO}_2$ ,  $\text{NH}_3$  can absorb infra-red.

### BOARD:- 2014

3. write mathematical eq<sup>n</sup> of Ampere - Maxwell Law.  
4. Identify the radiation of EM spectrum which-  
a. is absorbed by ozone layer in atmosphere.  
b. is produced by bombarding a metal target by high speed electron.  
c. is used in satellite communication.  
d. have wave length range of 400-700nm.

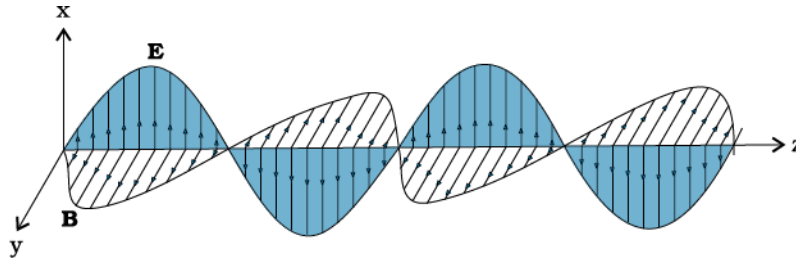
- ⇒ a. UV Rays.  
b. X-Rays  
c. Radio waves  
d. Visible light wave

### BOARD:- 2015

5. write the name of electromagnetic wave generated by vacuum tube magnetron.  
⇒ Microwave.

6. Draw the propagation of EM wave and write two properties.

⇒



- (i) The velocity of EM wave is  $\frac{1}{\sqrt{\mu_0 \epsilon_0}}$  in vacuum and equal to  $C = 3 \times 10^8 \text{ m/s}$
- (ii) No physical medium is required for propagation of EM wave.
- (iii) Electric field and magnetic fields in an EM wave are  $\perp$  to each other and also to the direction of propagation.
- (iv) velocity of EM wave in medium is  $\frac{1}{\sqrt{\mu \epsilon}}$ .

7. The amplitude of magnetic field associated with a EM wave in vacuum is  $B_0 = 50 \times 10^{-8} \text{ T}$ . write the value of amplitude of Electric field associated with wave in V/m.

⇒

$$\frac{E_0}{B_0} = C$$

$$E_0 = C \times B_0$$

$$E_0 = 3 \times 10^8 \times 50 \times 10^{-8}$$

$$E_0 = 150 \text{ V/m.}$$

**BOARD-2016**

8. Which EM waves are used in remote controller (switches)?

⇒ Infrared waves.

9. What is displacement current? obtain an expression of displacement current for charged capacitor. write Ampere - Maxwell's Law.

⇒ (i) Displacement Current - The current due to change in electric field b/w plates of capacitor is called displacement current.

(ii) Expression of displacement current -

$$\phi = \frac{q}{\epsilon_0}$$

$$q = \phi \epsilon_0$$

differentiate w.r.t time both side

$$\frac{dq}{dt} = \frac{d(\phi \epsilon_0)}{dt}$$

$$\mathcal{I}_d = \epsilon_0 \frac{d\phi}{dt}$$

### BOARD-2017

10. A charged particle oscillates about its equilibrium position with a frequency of 100 MHz. what is the frequency of EM waves produced by the oscillator? [1]
- ⇒ Frequency of EM wave = Frequency of charged oscillated particle  
= 100 MHz
11. Which waves normally broadcast the frequencies in ultra high frequency (UHF) range?
- ⇒ Radio waves.
12. Write the name of any four waves produced in EM spectrum.
- ⇒
- | wave          | wavelength Range    |
|---------------|---------------------|
| 1. Radio      | > 0.1m              |
| 2. Microwave  | 0.1m to 1mm         |
| 3. Infra red  | 1mm to 700nm        |
| 4. Light      | 700nm to 400nm      |
| 5. UV rays    | 400nm to 1nm        |
| 6. X-rays     | 1nm to $10^{-3}$ nm |
| 7. Gamma rays | $< 10^{-3}$ nm      |

### BOARD-2017 (Supp.)

13. Write the value, with unit of  $1/\mu_0 \epsilon_0$
- ⇒  $3 \times 10^8$  m/s
14. Write the name of EM waves, which-
- Is absorbed by ozone layer in the atmosphere.
  - Has wavelength range almost b/w 1nm to  $10^3$  nm.
  - Used in video recorders and in Hi-Fi system.
  - Used in Microwaves ovens.
- ⇒
- UV Rays
  - X Rays
  - Infra-red Rays
  - Microwaves.

### BOARD-2018

15. Write any two Maxwell's equation.
- ⇒

Maxwell's equations in vacuum

1. Gauss's Law for electricity -  $\oint \vec{E} \cdot d\vec{A} = q/\epsilon_0$

2. Gauss's Law for magnetism -  $\oint \vec{B} \cdot d\vec{A} = 0$

3. Faraday's Law -  $\oint \vec{E} \cdot d\vec{l} = -\frac{d\phi_B}{dt}$

4. Ampere - Maxwell Law -  $\oint \vec{B} \cdot d\vec{l} = \mu_0 i_c + \mu_0 \epsilon_0 \frac{d\phi_E}{dt}$

**BOARD:-2018 (Supp.)**

16. write definition of displacement current. Prove that displacement current is equals to conduction current.

$\Rightarrow$

$$I_d = \epsilon_0 \frac{d\phi}{dt}$$

$$I_d = \epsilon_0 \frac{d}{dt} \left( \frac{q}{\epsilon_0} \right)$$

$$I_d = \frac{dq}{dt}$$

$$I_d = I_c$$

**BOARD:-2019**

**DRGP Institute**

17. In electromagnetic waves write the value of -

(a) angle (b) Phase difference b/w electric field & magnetic field

$\Rightarrow$

(a) angle =  $90^\circ$

(b) Phase difference =  $0$

18. The magnitude to the electric field  $E$  at any point in free space is  $300 \text{ V/m}$  find magnetic field.

$\Rightarrow$

$$\frac{E}{B} = c$$

$$B = E/c = \frac{300 \text{ V/m}}{3 \times 10^8 \text{ m/s}} = 1 \times 10^{-6} \text{ T}$$

### BOARD:- 2020 (Supp.)

19. Write any four characters of EM waves.

### BOARD:- 2021

20. In electromagnetic wave, the value of angle b/w  $\vec{E}$  &  $\vec{B}$  is -  
 $\Rightarrow 90^\circ$

### BOARD:- 2022

21. Write relation b/w  $\epsilon_0$ ,  $\mu_0$  &  $c$ .

(i)  $\mu_0 \epsilon_0 = c^2$

(ii)  $\frac{1}{\mu_0 \epsilon_0} = c^2$

(iii)  $\sqrt{\mu_0 \epsilon_0} = c^2$

(iv)  $\frac{1}{\sqrt{\mu_0 \epsilon_0}} = c^2$

### BOARD:- 2023

22. The communication frequency band range for FM broadcasting is -  
 $\Rightarrow 88 - 108 \text{ MHz}$

23. Write the name of EM wave generated by magnetron in vacuum.  
 $\Rightarrow$  Microwave.

TABLE 8.1 DIFFERENT TYPES OF ELECTROMAGNETIC WAVES

Type	Wavelength range	Production	Detection
Radio	$> 0.1 \text{ m}$	Rapid acceleration and decelerations of electrons in aerials	Receiver's aerials
Microwave	$0.1 \text{ m to } 1 \text{ mm}$	Klystron valve or magnetron valve	Point contact diodes
Infra-red	$1 \text{ mm to } 700 \text{ nm}$	Vibration of atoms and molecules	Thermopiles Bolometer, Infrared photographic film
Light	$700 \text{ nm to } 400 \text{ nm}$	Electrons in atoms emit light when they move from one energy level to a lower energy level	The eye Photocells Photographic film
Ultraviolet	$400 \text{ nm to } 1 \text{ nm}$	Inner shell electrons in atoms moving from one energy level to a lower level	Photocells Photographic film
X-rays	$1 \text{ nm to } 10^{-3} \text{ nm}$	X-ray tubes or inner shell electrons	Photographic film Geiger tubes Ionisation chamber
Gamma rays	$< 10^{-3} \text{ nm}$	Radioactive decay of the nucleus	-do-

BOARD:- 2024

24. The formula of displacement current -

$$\Rightarrow I_d = \epsilon_0 \frac{d\phi}{dt}$$

25. Write the name of any three waves produced in EM spectrum -

- $\Rightarrow$
- (i) Gamma rays
  - (ii) X-rays
  - (iii) UV rays

