# Unit 15
# Electromagnetic Waves

# SUMMARY

| Type | Wavelength Range | Production | Detection |
|---|---|---|---|
| Radio | > 0.1 m | Rapid acceleration and decelerations of electrons in aerials. | Receiver's aerials (conducting wire) |
| Microwave | 0.1 m to 1 mm | Klystron, magnetron valve, Gun diode. | Point contact diodes |
| Infra-red | 1 mm to 700 nm | Vibration of atoms and molecules. | Thermopile, Bolometer, infrared photographic film |
| Visible Light | 700 nm to 400 nm | Electrons in atoms emit light when they move from one energy level to a lower energy level. | The eye, photocells, photographic film, photo diode (LDR), light dependent resistor |
| Ultraviolet | 400 nm to 1 nm | Inner shell electrons in atoms moving from one energy level to a lower level. | solar cell, Photocells, photographic film |
| X-rays | 1 nm to $10^{-3}$ nm | X-ray tubes or inner shell electrons of atom | Photographic film, Geiger tubes, Ionization chamber, |
| Gamma rays | < $10^{-3}$ nm | Radioactive decay of the nucleus. | – do – |

- The oscillating charges are responsible for the generation of periodically varying electric field in the space. Further, the oscillating charges generate varying electric current which in turn is responsible for the generation of periodically varying magnetic field. This way the electromagnetic waves are generated.
- The frequency of generated electromagnetic waves is equal to the frequency of oscillation of the electric charges. In case of electromagnetic waves

  $c$ (Velocity) = $\lambda$ (Wavelength) $\times$ $f$ (Frequency)
- In the region closer to the oscillating charges, the phase difference between $\vec{E}$ and $\vec{B}$ fields is $\frac{\pi}{2}$, and their magnitude quickly decreases as $\frac{1}{r^3}$ (where $r$ = distance from the source). These components of the transmitted waves (or fields) are called inductive components.
- At large distances from the source, $\vec{E}$ and $\vec{B}$ are in phase and the decrease in their magnitude is comparatively slower with distance, as per $\frac{1}{r}$. These components of electromagnetic radiation are called radiated components.



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- Electromagnetic waves are self sustaining oscillations of electric and magnetic fields in free space, or vacuum. No material medium is associated with vibrations of the electric and magnetic fields.
- The velocity of electromagnetic waves in vacuum (free space) is

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = 2.99792 \times 10^8 \text{ ms}^{-1}$$

- The velocity of the electromagnetic waves in any medium is given by $v = \frac{1}{\sqrt{\mu\varepsilon}}$

  where $\mu$ = Permeability of the medium, and

  $\varepsilon$ = Permittivity of the medium.
- The velocity of light depends on electric and magnetic properties of the medium.
- The refractive index of a medium is $n = \frac{c}{v} = \sqrt{\mu_r \varepsilon_r} = \sqrt{\mu_r K}$.
- Electromagnetic waves exert pressure on a surface when they are incident on it, called radiation pressure.
- If $\Delta U$ is the energy of electromagnetic waves incident on a surface of unit area per unit time normal to the direction of flow of energy, then assuming that the energy is completely absorbed, the momentum of the electromagnetic radiation transferred to the surface is $\Delta p = \frac{\Delta U}{c}$

  which also represents radiation pressure ($P_S$).
- The electromagnetic energy per unit volume (energy density) in a region is given by

$$\rho = \rho_E + \rho_B = \frac{1}{2}\varepsilon_0 E^2 + \frac{B^2}{2\mu_0} = \varepsilon_0 E_{rms}^2$$

- The radiant energy passing through unit area normal to the direction of propagation in one second is called the intensity of radiation *I*.
- The energy of the electromagnetic waves is equal to the kinetic energy of the charges oscillating between the two spheres.

# MCQ

**For the answer of the following questions choose the correct alternative from among the given ones.**

(1) Who produced the electromagnetic waves first ?

(A) Marconi (B) Maxwell (C) J.C. Bose (D) Hertz

(2) The dimensional formula of $\ell_o E_o$ is _______________

(A) $L^2T^{-2}$ (B) $L^{-2}T^2$ (C) $L^1T^{-1}$ (D) $L^{-1}T^1$

(3) A plane electromagnetic wave is incident on a material surface. The wave delivers momentum P and energy E

(A) P=0, $E \neq 0$ (B) $P \neq 0$, E=0 (C) $P \neq 0$, $E \neq 0$ (D) P=0, E=0

(4) If $V_\gamma$,$V_x$ and $V_m$ are the velocity of the $v$ rays, x rays, micro waves respectively in space, then

(A) $V_r < V_x < V_m$ (B) $V_r = V_x = V_m$ (C) $V_r > V_x > V_m$ (D) $V_r > V_x < V_m$

(5) If $\lambda_r, \lambda_x and \lambda_m$ are the wave lengths of the r-rays, x rays and micro waves respectively in space then

(A) $\lambda_r > \lambda_x > \lambda_m$ (B) $\lambda_r < \lambda_x < \lambda_m$ (C) $\lambda_r = \lambda_x = \lambda_m$ (D) $\lambda_r < \lambda_m < \lambda_x$

(6) According to Maxwell, a changing electric field produces

(A) emf (B) Electric current

(C) magnetic field (D) radiation pressure

(7) An electromagnetic wave going through vaccum is described by E=$E_o$ sin(kx-$\omega$t). Which of the following is independent of the wavelength?

(A) $\omega$ (B) k/$\omega$ (C) k$\omega$ (D) k

(8) Which of the following have zero average value in a plane electromagnetic wave?

(A) Electric energy (B) Magnetic energy

(C) Electric field (D) None of these.

(9) If the relative permeability and dielectric constant of a given medium are equal to $\ell_r$ nd K respectively, then the refractive index of the medium is equal to__________

(A) $\sqrt{\ell_r K}$ (B) $\sqrt{\ell_r E_o}$ (C) $\sqrt{\ell_o E_o}$ (D) $1/\sqrt{\ell_r k}$

(10) Astraonomers have found that electromagnetic waves of wavelength 21cm are continuously reaching the Earth's surface . Calculate the frequency of this radiation. (c= $3\times 10^8$ m/s)

(A) 14.28 GHz (B) 1.428 kHz (C) 1.428 MHz (D) 1.428 GHz

(11) Electric field in an electromagnetic wave is given by E=50 sin$\omega$(t-x/c) N$C^{-1}$. Intensity of this wave is ___________ $Wm^{-2}$

(A) 50 (B) $1.1\times10^{8}$ (C) 3.3 (D) $5.5\times10^{-19}$

(12) The amplitude of the electric field in a parallel beam of light of intensity 2.0 $Wm^{-2}$ is _______

(A) $38.8NC^{-1}$ (B) $19.4NC^{-1}$ (C) $9.7NC^{-1}$ (D) None of these.

(13) Speed of electromagnetic wave is the same

(A) for all wavelengths (B) in all media

(C) for all intensities (D) for all frequencies

(14) The maximum electric field in a plane electromagnetic wave is $900NC^{-1}$. The wave is going in the x direction and the electric field is in the y direction. The maximum magnetic field in the wave is ____________T

(A) $3\times10^{-8}$ (B) $3\times10^{-6}$ (C) $27\times10^{-6}$ (D) $27\times10^{10}$

(15) Electromagnetic waves are produced by

(A) a static charge (B) a moving charge

(C) an accelerating charge (D) chargeless particles

(16) Maxwells equations are derived from the laws of___________

(A) electricity (B) magnetism

(C) both electricity and magnetism (D) mechanics

(17) Which of the following electromagnetic waves has the longest wavelength?

(A) Radio waves (B) Infrared radiations

(C) x rays (D) visible rays

(18) Which of the following electromagnetic waves has the highest frequency?

(A) radio waves (B) micro waves (C) r rays (D) x rays

(19) Which of the following electromagnetic waves is used in telecommunication?

(A) radio waves (B) visible radiations

(C) ultraviolet rays (D) micro waves

(20) The maximum value of $\vec{E}$ in an electromagnetic waves in air is equal to $6.0\times10^{-4}$ $Vm^{-1}$. The maximum value of $\vec{B}$ is ____________

(A) $1.8\times10^{5}$ T (B) $2.0\times10^{4}$ T (C) $2.0\times10^{-12}$ T (D) $1.8\times10^{13}$ T

(21) Dimensional formula of intensity of radiation is ______________

(A) $M^{1}L^{2}T^{-2}$ (B) $M^{1}L^{0}T^{-2}$ (C) $M^{1}L^{2}T^{-3}$ (D) $M^{1}L^{0}T^{-3}$

(22) The frequency of an electromagnetic wave in free space is 3MHz. When it passes through a medium of relative permeability $\varepsilon_r = 4.0$ , then its frequency

(A) becomes half (B) become doubled

(C) remain same (D) become $\sqrt{2}$ times

(23) The frequency of electromagnetic wave having wavelength 25mm is _________ Hz

(A) $1.2 \times 10^{10}$ (B) $7.5 \times 10^{5}$ (C) $1.2 \times 10^{8}$ (D) $7.5 \times 10^{6}$

(24) Unit of energy density of electromagnetic wave is _________

(A) $Jm^{-3}$ (B) $Jm^{-2}$ (C) $wm^{-2}$ (D) None of these

(25) What is the ratio of velocities of light rays of wavelengths $4000^0$ A and $8000^0$ A in vaccum ?

(A) 1:2 (B) 1:1

(C) 2:1 (D) cannot be determined

(26) Which of the following rays are not electromagnetic waves?

(A) $\propto$ rays (B) $\gamma$ rays (C) $\beta$ rays (D) heat rays

(27) A new system of unit is evolved in which the values of $\ell_0$ and $\varepsilon_0$ are 2 and 8 respectively. Then the speed of light in this system will be

(A) 0.25 (B) 0.5 (C) 0.75 (D) 1

(28) Our eyes respond to wavelength ranging from

(A) 400nm to 700nm (B) $-\infty$ to $+\infty$

(C) 1mm to 700nm (D)700nm to 800nm

(29) In microwave oven, we use electromagnetic oscillators which produce electromagnetic waves in the wavelength range

(A) 1mm to 10m (B) 0.7 $\mu m$ to 1mm

(C) 0.1m to 1mm (D) 0.1 $\mu m$ to 0.7 $\mu m$

(30) What is the direction of $\vec{E} \times \vec{B}$ in an electromagnetic wave?

(A) same as that of $\vec{E}$

(B) same as that of $\vec{B}$

(C) same as the direction of propagation of electromagnetic wave

(D) none of these

(31) The wavelength of x rays is of the order of

(A) 1cm (B) 1m (C) 1micron (D)1angstrom

(32) A plane electromagnetic wave of frequency 25MHz travels in free space along the x direction. At a particular point in space and time $\vec{E} = 6.3\,\hat{j}\ Vm^{-1}$ then $\vec{B}$ at this point is__________

(A) $2.1 \times 10^{-8}\ \hat{i}$ T (B) $2.1 \times 10^{-8}\ \hat{k}$ T (C) $1.89 \times 10^{9}\ \hat{k}$ T (D) $2.52 \times 10^{-7}\ \hat{k}$ T

(33) The magnetic field in a plane electromagnetic wave is given $B_y$ = $2 \times 10^{-7} \sin(0.5 \times 10^{3}x + 1.5 \times 10^{11}t)T$. The expression for electric field is

(A) $E_x = 60\sin(0.5\times10^{3}x+1.5\times10^{11}t)Vm^{-1}$

(B) $E_z = 60\sin(0.5\times10^{3}x+1.5\times10^{11}t)Vm^{-1}$

(C) $E_z = 60\sin(1.5\times10^{11}x+0.5\times10^{3}t)Vm^{-1}$

(D) $E_z = 60\times10^{15}\sin(1.5\times10^{11}x+0.5\times10^{3}t)Vm^{-1}$

(34) Light with an energy flux of $w/m^3$ or $Wm^{-3}$ falls on a non-reflecting surface at normal to surface. If the surface has an area of $20m^2$. The average force exerted on the surface during 30 minutes is________

(A) $6.48\times10^{5}N$ (B) $3.60\times10^{2}N$ (C) $1.2\times10^{-6}N$ (D) $2.16\times10^{-3}N$

(35) Energy density of an electromagnetic wave of intensity $0.02\ Wm^{-2}$ is _______

(A) $6.67\times10^{-11}Jm^{-3}$ (B) $6\times10^{6}Jm^{-3}$

(C) $1.5\times10^{10}Jm^{-3}$ (D) none of the above

(36) The waves used in communication are generally called

(A) $\gamma$ rays (B) $\alpha$ rays (C) microwaves (D) radiowaves

(37) For an electromagnetic wave, the phase difference between vectors $\vec{E}$ and $\vec{B}$ (far away from the source)

(A) 0 (B) $\frac{\pi}{2}$ (C) $\pi$ (D) $\frac{3\pi}{2}$

(38) In an electromagnetic wave, if the amplitude of magnetic field is $3\times10^{-10}T$, the amplitude of the associated electric field will be________

(A) $9\times10^{-2}Vm^{-1}$ (B) $3\times10^{-10}Vm^{-1}$ (C) $3\times10^{-2}Vm^{-1}$ (D) $1\times10^{-18}Vm^{-1}$

(39) The electric and magnetic field of an electromagnetic wave are

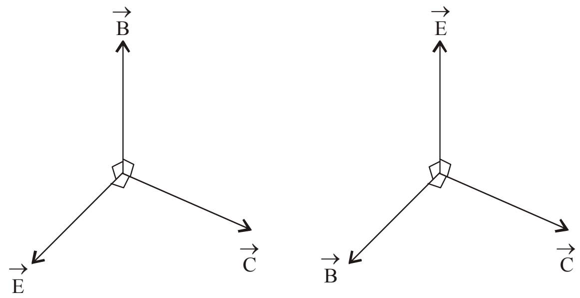
(A) in phase and perpendicular to each other

(B) in phase and parallel to each other

(C) in opposite phase and perpendicular to each other

(D) in opposite phase and parallel to each other

(40) The direction of electric and magnetic vector for an electromagnetic wave travelling along X-axis are shown in fig. A and B then




(A) A is correct, B is wrong
(B) B is correct, A is wrong
(C) Both A and B are correct
(D) Both A and B are wrong

(41) The dimensions of $\frac{1}{\mu\varepsilon}$ are

(A) $M^0L^1T^{-1}$ (B) $M^0L^{-1}T^1$ (C) $M^0L^2T^{-2}$ (D) $M^0L^1T^{-2}$

(42) The dimension of $\sqrt{\mu_r k}$ is

(A) $M^0L^{-1}T^{-1}$ (B) $M^0L^1T^{-1}$ (C) $M^0L^2T^{-2}$ (D) $M^0L^0T^0$

(43) The frequency of light wave of wavelength $5000^0 A$ is _______Hz

(A) $6\times10^{14}$ (B) $1.5\times10^{-2}$ (C) 1.5 (D) $6\times10^1$

(44) Unit of $\mu_0 C$ is same as that of

(A) current (B) resistance (C) electric charge (D) velocity

(45) The amplitude of the magnetic field part of an electromagnetic wave in vaccum is B$m$ = 510 nT. Then the amplitude of the electric part of the wave is_________

(A) $1.53\times10^{11} V/m$ (B) 1.53 V/m
(C) $1.53\times10^{2} V/m$ (D) $1.53\times10^{8} V/m$

(46) If the direction of magnetic field $\vec{B}$ at some instant is along +ve Z direction and the electromagnetic wave is propagating along +ve X direction, then the direction of electric field $\vec{E}$ at that instant is_________

(A) along -ve Y direction (B) along +ve Y direction
(C) along +ve X direction (B) along -ve X direction

(47) Relation between amplitudes of electric and Magnetic field is.............

(A) $E_0 = B_0$ (B) $E_0 = cB_0$ (C) $E_0 = \frac{B_0}{c}$ (D) $E_0 = \frac{c}{B_0}$

(48) If a source is transmitting electromagnetic wave of frequency $8.2\times10^6 Hz$, then the wavelength of the electromagnetic waves transmitted from the source will be______

(A) 36.6m (B) 42.3m (C)40.5m (D)50.9m

(49) The velocity of light in vaccum can be changed by changing____

(A) frequency (B)wavelength (C)amplitude (D) none of these

(50) An electromagnetic wave going through vaccum is described by E=Eo sin(kx-$\omega$t) then B=Bo sin(kx-$\omega$t) then

(A) $E_0B_0 = \omega k$ (B) $E_0k = B_0\omega$ (C) $E_0\omega = B_0k$ (D)none of these

(51) If the wavelength of light is $4000^0$ A then the number of waves in 1mm length will be___

(A)2.5 (B)2500 (C)250 (D)25000

(52) The SI unit of displacement current is_________

(A) coulomb (B)henry (C) ampere (D)faraday

(53) The electromagnetic waves do not transport_______

(A) energy (B) charge (C)momentum (D)information

(54) An electric charge oscillating with a frequency of 1kilo cycles/s can radiates electromagnetic waves of wavelength

(A) 100km (B)200km (C) 300km (D)400km

(55) The frequency 1057MHz of radiation arising from two close energy levels in hydrogen belongs to_____

(A) radio waves (B)infrared waves (C)micro waves (D)$\gamma$ rays

(56) Electromagnetic waves travelling in a medium which has relative permeability 1.3 and relative permeability 2.14 speed of electromagnetic waves in this medium will be_____

(A)$3.6\times10^8 m/s$ (B)$1.8\times10^8 m/s$ (C)$1.8\times10^6 m/s$ (D)$13.6\times10^6 m/s$

(57) A plane electromagnetic wave is incident on a material surface. If the wave delivers momentum p and energy E, then

(A) p=0,E=0 (B) $p \neq 0, E \neq 0$ (C) $p \neq 0, E = 0$ (D) $p = 0, E \neq 0$

(58) Maxwell's modified form of Ampere's circuital law is____

(A) $\oint \vec{B} \cdot d\vec{S}$ (B) $\oint \vec{B} \cdot d\vec{S} = \mu_o i$

(C) $\oint \vec{B} \cdot d\vec{l} = \mu_o i + \mu_o \in_o \frac{d\phi_E}{dt}$ (D) $\oint \vec{B} \cdot d\vec{l} = \mu_o i + \frac{1}{\in_o}\frac{d_q}{dt}$

(59) The wavelength of x rays is of the order of

(A) $10^{-3}$m (B) $10^{-5}$m (C) $10^{-10}$m (D) $10^{-12}$m

(60) A point source of electromagnetic radiation has an average output power of 800W. The maximum value of electric field at a distance of 4.0m from the source is

(A) $64.7Vm^{-1}$ (B) $57.8Vm^{-1}$ (C) $56.72Vm^{-1}$ (D) $54.77Vm^{-1}$

(61) A plane electromagnetic wave $E_z = 100\cos(6\times10^8 t + 4x)Vm^{-1}$ propagate in a medium of refractive index

(A)1.5 (B)2.0 (C)2.4 (D)4.0

(62) A plane electromagnetic wave of wave intensity 10ωm$^{-2}$ strikes a small mirror of area 20 $cm^2$, held perpendicular to the approaching wave. The radiation force on the mirror will be

(A) $6.6\times10^{-11} N$ (B) $1.33\times10^{-11} N$ (C) $1.33\times10^{-10} N$ (D) $6.6\times10^{-10} N$

(63) An observer is at 2m from an isotropic point source of light emitting 40w power. The rm.s value of electric due to the source at the position of the observer is_____

(A) $5.77\times10^{-8} Vm^{-1}$ (B) $17.3Vm^{-1}$ (C) $57.7\times10^{-8} Vm^{-1}$ (D) $1.73Vm^{-1}$

(64) Electromagnetic waves used in medicine to destroy cancer cells

(A) radio waves (B)infrared rays

(C)gamma rays (D)ultraviolet rays

(65) What is the name associated with the equation $\phi\ \vec{E}\ .\ \vec{dt} = -\frac{d\phi\beta}{dt}$

(A) Gauss law for electricity (B) Gauss law for magnetism

(C) ampere's law (D)faraday's law

(66) What oscillates in an electromagnetic wave?

(A) $\vec{E}$ and $\vec{B}$ (B) $\vec{B}$ (C) $\vec{E}$ (D)none of these

(67) Which of the following rays are not electromagnetic waves?

(A) $\alpha$ rays (B) $\gamma$ rays (C) $\beta$ rays (D)heat rays

(68) The rms value of the electric field of the light coming from the sun is 720 N/c. The average tatal energy density of the electromagnetic wave is

(A) $4.58\times10^{-6} Jm^{-3}$ (B) $6.3\times10^{-9} Jm^{-3}$ (C) $81.35\times10^{-12} Jm^{-3}$ (D) $3.3\times10^{-3} Jm^{-3}$

(69) What is the wave length of range of electromagnetic waves?

(A) $10^{-8}$m to $10^{15}$m (B) $10^{-15}$m to $10^{8}$m

(C) $10^{-15}$m to $10^{15}$m (D) $10^{8}$m to $10^{15}$m

(70) What is the wavelength range of visible light?

(A) $10^0$ A to $100^0$ A (B) $4000^0$ A to $7000^0$ A

(C) $8000^0$ A to $10000^0$ A (D) $10000^0$ A to $15000^0$ A

(71) Unit of $\ell$ oC is same as that of

(A)current (B)resistance (C)electric charge (D) velocity

(72) In electromagnetic spectrum, the visible light lie between

(A) radiowaves and microwaves

(B) ultraviolet rays and infrared rays

(C) ultraviolet rays and x rays

(D) infrared rays and microwaves

(73) Which of the following statements is not true in case of electromagnetic waves?

(A) they are light waves (B)theay are transverse waves

(C) propagates through space (D) they are longitudinal waves

(74) The oscillating electric and magnetic field vectors of an electromagnetic waves far away from source are oriented along

(A) Mutually perpendicular direction and differ in phase by $90^0$

(B) Mutually perpendicalar and in same phase

(C) In same direcfi on and in same phase

(D) In same divecfi on and differ in phaseby $90^o$

(75) Which of the following option of electromagnetic waves is in order of increasing frequency ?

(A) microwaves, ultraviolet rays, x rays

(B) gamma rays, ultraviolet rays, radiowaves

(C) radiowaves, visible light, infrared rays

(D) gamma rays, visible light, ultraviolet rays

(77) The sum delivers $10^3$ $Wm^{-2}$ of electromagnetic flux to earth's surface. The total power that is incident on a roof of dimension 8m x 20m will be________

(A) $4\times10^5 w$ (B) $2.56\times10^4 w$ (C) $6.4\times10^5 w$ (D) $1.6\times10^5 w$

(77) Bolometer is used to detect ___________.

(A) infrared rays (B) ultraviolet rays (C) x rays (D) $\gamma$ rays

(78) Range of frequency of microwaves is about__________.

(A)530kHz to 1710kHz (B)54MHz to 890MHz

(C) 3GHz to 300GHz (D) $4\times10^{14} Hz$ to $7\times10^{14} Hz$

(79) SI unit of displacement current is

(A) coulomb (B)ampere (C)faraday (D)

(80) The frequencies of x rays, $\gamma$ rays and ultraviolet rays are respectively p, q and r then

(A) $p<q, q>r$ (B) $p>q, q>r$ (C) $p>q, q<r$ (D) $p<q, q<r$

(81) At room temperature, if the relative permitivity of water is 80 and the realtive permiability be 0.0222 then the velocity of light in water is ___________ m/s

(A) $2.5\times10^{8}$ (B) $2.25\times10^{8}$ (C) $3.5\times10^{8}$ (D) $3\times10^{8}$

(82) If the electric field associated with a radiation of frequency 10MHz is E=10sin(kx-ωt)mV/m then its energy density is______ $Jm^{-3}$ ($\varepsilon_o=8.85\times10^{-12}C^2N^{-1}m^{-2}$)

(A) $4.425\times10^{-16}$ (B) $6.26\times10^{-14}$ (C) $8.85\times10^{-16}$ (D) $8.85\times10^{-14}$

(82) In an electromagnetic wave in free space, the direction of electric field vector $\vec{E}$ is along y axis and magnetic field vector $\vec{B}$ is along z axis then which of the following is true

(A) $(\vec{E}\times\vec{B})\times\vec{E}=1$ (B) $(\vec{E}\times\vec{B})\times\vec{B}=1$

(C) $(\vec{E}\times\vec{B})\times\vec{B}=0$ (D) none of these

(84) When a plane electromagnetic wave travels in vaccum, the average electric energy density is given by (Eo is the amplitude of the electric field)

(A) $\frac{1}{4}\varepsilon_o Eo^2$ (B) $\frac{1}{2}\varepsilon_o Eo^2$ (C) $2\varepsilon_o Eo^2$ (D) $4\varepsilon_o Eo^2$

(85) In a plane electromagnetic wave , the electric field oscillates sinusoidaly at a frequency of $2.0\times10^{10}\,Hz.$ if the peak value of electric field is 60 $Vm^{-1}$ the average energy density (in $Jm^{-3}$) of the magnetic field of the wave will be (given $\mu o=4\pi\times10^{-7}$ Tm/A)

(A) $2\pi\times10^{-7}$ (B) $\frac{1}{2\pi}\times10^{-7}$ (C) $4\pi\times10^{-7}$ (D) $\frac{1}{4\pi}\times10^{-7}$

(86) Which of the following pairs of the component of space and time varying $\vec{E}=(E_x\hat{i}+Ey\hat{j}+Ez\hat{k})$ and $\vec{B}=(B_x\hat{i}+By\hat{j}+Bz\hat{k})$ would generate a plane electromagnetic wave travelling in +ve y direction

(A) $B_x\hat{i}, E_z\hat{i}$ (B) $E_y\hat{i}, B_z\hat{i}$ (C) $E_x\hat{i}, B_x\hat{i}$ (D) $E_z\hat{i}, B_x\hat{i}$

(87) Infrared radiations are detected by

(A) spectrometer (B) bolometer (C) photocells (D) geiger tubes

(88) Electromagnetic wave is produced by oscillating electric and magnetic fields $\vec{E}$ and $\vec{B}$. Choose only the incorrect statement from the following

(A) $\vec{E}$ is perpendicular to $\vec{B}$.

(B) $\vec{E}$ is perpendicular to the direction of propagation of the wave

(C) $\vec{B}$ is perpendicular to the direction of propagation of the wave

(D) $\vec{E}$ is parallel to $\vec{B}$

(89) The potential difference between the plates of a parallel plate capacitor is charging at the rate of $10^6 Vs^{-1}$. If the capatance is $2\mu F$. The displacement current in the dielectric of the capacitor will be

(A) 4A (B)3A (C)2A (D)1A

(90) Which of the following electromagnetic wave has the least frequency?

(A) radiowave (B) infrared radiation (C)microwave (D)x rays

(91) Which of the following electromagnetic wave has the least wavelength?

(A) rradiowave (B)visible wave (C) ultraviolet rays (D) microwaves

(92) Which of the following waves are not transverse in nature?

(A) light emitted from a sodium lamp

(B) sound waves travelling in air

(C) xrays from an x ray machine

(D) microwaves used in radar

(93) An electromagnetic wave

(A) can be deflected by electric field

(B) can be deflected by magnetic field

(C) can be deflected bye both electric and magnetic field

(D) none of these

(94) When an electromagnetic wave encounters a dielectric medium, the transmitted wave has

(A) same frquency but different amplitude

(B) same amplitude but different frequency

(C) same frequency and amplitude

(D) different frequency and amplitude

(95) According to Maxwell, a changing electric field produces_____

(A) emf (B)radiation pressure

(C) electric current (D)magnetic field

(96) ______was the first to predict the existence of electromagnetic waves

(A) Maxwel (B) Faraday (C)Ampere (D) hertz

(97) If the earth were not having atmosphere, its temperature________.

(A) would have been low (B) would have been high

(C)would hav remain constant (D) none of these

(98) _________ is responsible for the green house effect

(A) infrared rays (B)ultraviolet rays (C)x raya (D)radiowaves

(99) The dimensional formula of energy density is

(A) $M^1L^0T^{-2}$ (B) $M^1L^{-1}T^{-2}$ (C) $M^1L^{-1}T^{-3}$ (D) $M^1L^0T^{-3}$

## KEY NOTES

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | D | 18 | C | 35 | A | 52 | C | 69 | B | 86 | A |
| 2 | D | 19 | D | 36 | D | 53 | B | 70 | B | 87 | B |
| 3 | C | 20 | C | 37 | A | 54 | C | 71 | B | 88 | D |
| 4 | B | 21 | D | 38 | A | 55 | A | 72 | B | 89 | C |
| 5 | B | 22 | C | 39 | A | 56 | B | 73 | D | 90 | A |
| 6 | C | 23 | A | 40 | B | 57 | B | 74 | B | 91 | C |
| 7 | B | 24 | A | 41 | C | 58 | C | 75 | A | 92 | B |
| 8 | C | 25 | B | 42 | D | 59 | C | 76 | D | 93 | D |
| 9 | A | 26 | C | 43 | A | 60 | D | 77 | A | 94 | A |
| 10 | D | 27 | A | 44 | B | 61 | B | 78 | C | 95 | D |
| 11 | C | 28 | A | 45 | C | 62 | C | 79 | B | 96 | A |
| 12 | A | 29 | C | 46 | B | 63 | B | 80 | A | 97 | A |
| 13 | C | 30 | C | 47 | B | 64 | C | 81 | B | 98 | A |
| 14 | B | 31 | D | 48 | A | 65 | D | 82 | A | 99 | B |
| 15 | C | 32 | B | 49 | D | 66 | A | 83 | C | | |
| 16 | C | 33 | B | 50 | B | 67 | C | 84 | A | | |
| 17 | A | 34 | A | 51 | B | 68 | A | 85 | B | | |