DPP - Daily Practice Problems

Chapter-wise Sheets

Date : Start Time : End Time :

PHYSICS

CP22

SYLLABUS : Electromagnetic Waves

Max. Marks : 180 **Marking Scheme :** (+4) for correct & (–1) for incorrect answer **Time : 60 min.**

INSTRUCTIONS : This Daily Practice Problem Sheet contains 45 MCQs. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.

1. An electromagnetic wave in vacuum has the electric and magnetic field $\vec{E}$ and $\vec{B}$, which are always perpendicular to each other. The direction of polarization is given by $\vec{X}$ and that of wave propagation by $\vec{k}$. Then

(a) $\vec{X} \| \vec{B}$ and $\vec{k} \| \vec{B} \times \vec{E}$ (b) $\vec{X} \| \vec{E}$ and $\vec{k} \| \vec{E} \times \vec{B}$

(c) $\vec{X} \| \vec{B}$ and $\vec{k} \| \vec{E} \times \vec{B}$ (d) $\vec{X} \| \vec{E}$ and $\vec{k} \| \vec{B} \times \vec{E}$

2. The rms value of the electric field of the light coming from the Sun is 720 N/C. The average total energy density of the electromagnetic wave is

(a) 4.58×10^{-6} J/m^3 (b) 6.37×10^{-9} J/m^3

(c) 81.35×10^{-12} J/m^3 (d) 3.3×10^{-3} J/m^3

3. In order to establish an instantaneous displacemet current of 1 mA in the space between the plates of 2μF parallel plate capacitor, the potential difference need to apply is

(a) 100 Vs^{-1} (b) 200 Vs^{-1} (c) 300 Vs^{-1} (d) 500 Vs^{-1}

4. During the propagation of electromagnetic waves in a medium:

(a) Electric energy density is double of the magnetic energy density.

(b) Electric energy density is half of the magnetic energy density.

(c) Electric energy density is equal to the magnetic energy density.

(d) Both electric and magnetic energy densities are zero.

5. An electromagnetic wave with frequency ω and wavelength λ travels in the $+y$ direction. Its magnetic field is along $+x$-axis. The vector equation for the associated electric field (of amplitude E_0) is

(a) $\vec{E} = -E_0 \cos\left(\omega t + \frac{2\pi}{\lambda} y\right)\hat{x}$

(b) $\vec{E} = E_0 \cos\left(\omega t - \frac{2\pi}{\lambda} y\right)\hat{x}$

(c) $\vec{E} = E_0 \cos\left(\omega t - \frac{2\pi}{\lambda} y\right)\hat{z}$

(d) $\vec{E} = -E_0 \cos\left(\omega t + \frac{2\pi}{\lambda} y\right)\hat{z}$

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

6. An electromagnetic wave of frequency $\nu = 3.0$ MHz passes from vacuum into a dielectric medium with permittivity $\in = 4.0$. Then
(a) wavelength is halved and frequency remains unchanged
(b) wavelength is doubled and frequency becomes half
(c) wavelength is doubled and the frequency remains unchanged
(d) wavelength and frequency both remain unchanged.

7. The average electric field of electromagnetic waves in certain region of free space is 9×10^{-4} NC^{-1}. Then the average magnetic field in the same region is of the order of
(a) 27×10^{-4} T (b) 3×10^{-12} T
(c) $\left(\frac{1}{3}\right) \times 10^{-12}$ T (d) 3×10^{12} T

8. The electric field of an electromagnetic wave travelling through vaccum is given by the equation $E = E_0 \sin(kx - \omega t)$. The quantity that is independent of wavelength is
(a) $k\omega$ (b) $\frac{k}{\omega}$ (c) $k^2\omega$ (d) ω

9. The electric and the magnetic field associated with an E.M. wave, propagating along the +z-axis, can be represented by
(a) $\left[\vec{E} = E_0\hat{i}, \vec{B} = B_0\hat{j}\right]$ (b) $\left[\vec{E} = E_0\hat{k}, \vec{B} = B_0\hat{i}\right]$
(c) $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{i}\right]$ (d) $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{k}\right]$

10. The energy of electromagnetic wave in vacuum is given by the relation
(a) $\frac{E^2}{2\varepsilon_0} + \frac{B^2}{2\mu_0}$ (b) $\frac{1}{2}\varepsilon_0 E^2 + \frac{1}{2}\mu_0 B^2$
(c) $\frac{E^2 + B^2}{c}$ (d) $\frac{1}{2}\varepsilon_0 E^2 + \frac{B^2}{2\mu_0}$

11. A plane electromagnetic wave is incident on a plane surface of area A, normally and is perfectly reflected. If energy E strikes the surface in time t then average pressure exerted on the surface is (c = speed of light)
(a) zero (b) E/Atc (c) 2E/Atc (d) E/c

12. An electromagnetic wave travels along z-axis. Which of the following pairs of space and time varying fields would generate such a wave ?
(a) E_x, B_y (b) E_y, B_x (c) E_z, B_x (d) E_y, B_z

13. The magnetic field in a travelling electromagnetic wave has a peak value of 20 nT. The peak value of electric field strength is :
(a) 3 V/m (b) 6 V/m (c) 9 V/m (d) 12 V/m

14. Microwave oven acts on the principle of :
(a) giving rotational energy to water molecules
(b) giving translational energy to water molecules
(c) giving vibrational energy to water molecules
(d) transferring electrons from lower to higher energy levels in water molecule

15. Displacement current is
(a) continuous when electric field is changing in the circuit
(b) continuous when magnetic field is changing in the circuit
(c) continuous in both types of fields
(d) continuous through wires and resistance only

16. The electric field associated with an e.m. wave in vacuum is given by $\vec{E} = \hat{i}\, 40 \cos(kz - 6 \times 10^8 t)$, where E, z and t are in volt/m, meter and seconds respectively. The value of wave vector k is
(a) $2\ m^{-1}$ (b) $0.5\ m^{-1}$ (c) $6\ m^{-1}$ (d) $3\ m^{-1}$

17. The charge on a parallel plate capacitor varies as $q = q_0 \cos 2\pi\upsilon t$. The plates are very large and close together (area = A, separation = d). The displacement current through the capacitor is
(a) $q_0\, 2\pi\upsilon \sin\pi\upsilon t$ (b) $-q_0\, 2\pi\upsilon \sin 2\pi\upsilon t$
(c) $q_0\, 2\pi \sin\pi\upsilon t$ (d) $q_0\, \pi\upsilon \sin 2\pi\upsilon t$

18. A radiation of energy 'E' falls normally on a perfectly reflecting surface. The momentum transferred to the surface is (C = Velocity of light)
(a) $\frac{2E}{C}$ (b) $\frac{2E}{C^2}$ (c) $\frac{E}{C^2}$ (d) $\frac{E}{C}$

19. Match List - I (Electromagnetic wave type) with List - II (Its association/application) and select the correct option from the choices given below the lists:

	List 1		List 2
1.	Infrared waves	(i)	To treat muscular strain
2.	Radio waves	(ii)	For broadcasting
3.	X-rays	(iii)	To detect fracture of bones
4.	Ultraviolet rays	(iv)	Absorbed by the ozone layer of the atmosphere

	1	2	3	4
(a)	(iv)	(iii)	(ii)	(i)
(b)	(i)	(ii)	(iv)	(iii)
(c)	(iii)	(ii)	(i)	(iv)
(d)	(i)	(ii)	(iii)	(iv)

20. A plane electromagnetic wave travels in free space along X-direction. If the value of $\vec{B}$ (in tesla) at a particular point in space and time is $1.2 \times 10^{-8}\ \hat{k}$. The value of $\vec{E}$ (in Vm^{-1}) at that point is
(a) $1.2\ \hat{j}$ (b) $3.6\ \hat{k}$ (c) $1.2\ \hat{k}$ (d) $3.6\ \hat{j}$

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ

Space for Rough Work

21. If v_s, v_x and v_m are the speed of soft gamma rays, X-rays and microwaves respectively in vacuum, then

(a) $v_s > v_x > v_m$ (b) $v_s < v_x < v_m$

(c) $v_s > v_x < v_m$ (d) $v_s = v_x = v_m$

22. Photons of an electromagnetic radiation has an energy 11 keV each. To which region of electromagnetic spectrum does it belong ?

(a) X-ray region (b) Ultra violet region

(c) Infrared region (d) Visible region

23. A plane electromagnetic wave travels in free space along x-axis. At a particular point in space, the electric field along y-axis is 9.3 V m^{-1}. The magnetic induction (B) along z-axis is

(a) 3.1×10^{-8} T (b) 3×10^{-5} T

(c) 3×10^{-6} T (d) 9.3×10^{-6} T

24. The ratio of amplitude of magnetic field to the amplitude of electric field for an electromagnetic wave propagating in vacuum is equal to :

(a) the speed of light in vacuum

(b) reciprocal of speed of light in vacuum

(c) the ratio of magnetic permeability to the electric susceptibility of vacuum

(d) unity

25. 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) $p = 0, E \neq 0$

26. Intensity of electromagnetic wave will be

(a) $I = c\mu_0 B_0^2 / 2$ (b) $I = c\varepsilon_0 B_0^2 / 2$

(c) $I = B_0^2 / c\mu_0$ (d) $I = E_0^2 / 2c\varepsilon_0$

27. The decreasing order of wavelength of infrared, microwave, ultraviolet and gamma rays is

(a) microwave, infrared, ultraviolet, gamma rays

(b) gamma rays, ultraviolet, infrared, micro-waves

(c) microwaves, gamma rays, infrared, ultraviolet

(d) infrared, microwave, ultraviolet, gamma rays

28. Which radiation in sunlight, causes heating effect ?

(a) Ultraviolet (b) Infrared

(c) Visible light (d) All of these

29. The speed of electromagnetic wave in vacuum depends upon the source of radiation. It

(a) increases as we move from γ-rays to radio waves

(b) decreases as we move from γ-rays to radio waves

(c) is same for all of them

(d) None of these

30. When an electromagnetic waves enter the ionised layer of ionosphere, the motion of electron cloud produces a space current and the electric field has its own capacitative displacement current, then

(a) the space current is in phase of displacement current

(b) the space current lags behind the displacement current by a phase 180°.

(c) the space current lags behind the displacement current by a phase 90°.

(d) the space current leads the displacement current by a phase 90°.

31. The displacement current is

(a) $\varepsilon_0 \, d\phi_E / dt$ (b) $\frac{\varepsilon_0}{R} d\phi_E / dt$

(c) $\varepsilon_0 E / R$ (d) $\varepsilon_0 q C / R$

32. Electromagnetic radiation of highest frequency is

(a) infrared radiations (b) visible radiation

(c) radio waves (d) γ-rays

33. A point source of electromagnetic radiation has an average power output of 1500 W. The maximum value of electric field at a distance of 3m from this sources in Vm^{-1} is

(a) 500 (b) 100 (c) $\frac{500}{3}$ (d) $\frac{250}{3}$

34. Frequency of a wave is 6×10^{15} Hz. The wave is

(a) radiowave (b) microwave

(c) x-ray (d) ultraviolet

35. The electromagnetic waves do not transport

(a) energy (b) charge

(c) momentum (d) information

36. Which of the following statement is false for the properties of electromagnetic waves?

(a) Both electric and magnetic field vectors attain the maxima and minima at the same place and same time.

(b) The energy in electromagnetic wave is divided equally between electric and magnetic vectors

(c) Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of wave

(d) These waves do not require any material medium for propagation.

RESPONSE GRID				
21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ
26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ
31. ⓐⓑⓒⓓ	32. ⓐⓑⓒⓓ	33. ⓐⓑⓒⓓ	34. ⓐⓑⓒⓓ	35. ⓐⓑⓒⓓ
36. ⓐⓑⓒⓓ				

Space for Rough Work

37. Which of the following electromagnetic waves has minimum frequency ?
(a) Microwaves (b) Audible waves
(c) Ultrasonic wave (d) Radiowaves

38. The wave impendance of free space is
(a) zero (b) 376.6 Ω (c) 33.66 Ω (d) 3.76 Ω

39. A plane electromagnetic wave in a non-magnetic dielectric medium is given by $\vec{E} = \vec{E}_0(4\times10^{-7}x - 50t)$ with distance being in meter and time in seconds. The dielectric constant of the medium is :
(a) 2.4 (b) 5.8 (c) 8.2 (d) 4.8

40. We consider the radiation emitted by the human body. Which of the following statements is true?
(a) the radiation emitted lies in the ultraviolet region and hence is not visible.
(b) the radiation emitted is in the infra-red region.
(c) the radiation is emitted only during the day.
(d) the radiation is emitted during the summers and absorbed during the winters.

41. In a plane electromagnetic wave propagating in space has an electric field of amplitude 9×10^3 V/m, then the amplitude of the magnetic field is
(a) 2.7×10^{12} T (b) 9.0×10^{-3} T
(c) 3.0×10^{-4} T (d) 3.0×10^{-5} T

42. Out of the following options which one can be used to produce a propagating electromagnetic wave ?
(a) A charge moving at constant velocity
(b) A stationary charge
(c) A chargeless particle
(d) An accelerating charge

43. Radio waves of constant amplitude can be generated with
(a) rectifier (b) filter
(c) F.E.T. (d) oscillator

44. In an electromagnetic wave
(a) power is transmitted along the magnetic field
(b) power is transmitted along the electric field
(c) power is equally transferred along the electric and magnetic fields
(d) power is transmitted in a direction perpendicular to both the fields

45. If c is the speed of electromagnetic waves in vacuum, its speed in a medium of dielectric constant K and relative permeability μ_r is
(a) $v = \frac{1}{\sqrt{\mu_r K}}$ (b) $v = c\sqrt{\mu_r K}$
(c) $v = \frac{c}{\sqrt{\mu_r K}}$ (d) $v = \frac{K}{\sqrt{\mu_r C}}$

RESPONSE GRID					
	37. ⓐⓑⓒⓓ	38. ⓐⓑⓒⓓ	39. ⓐⓑⓒⓓ	40. ⓐⓑⓒⓓ	41. ⓐⓑⓒⓓ
	42. ⓐⓑⓒⓓ	43. ⓐⓑⓒⓓ	44. ⓐⓑⓒⓓ	45. ⓐⓑⓒⓓ	

DAILY PRACTICE PROBLEM DPP CHAPTERWISE CP22 - PHYSICS			
Total Questions	45	Total Marks	180
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	50	Qualifying Score	70
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

DPP/CP22

1. **(b)** ∵ The E.M. wave are transverse in nature i.e.,

$$=\frac{\vec{k}\times\vec{E}}{\mu\omega}=\vec{H} \quad ...(i)$$

where $\vec{H}=\frac{\vec{B}}{\mu}$

and $\frac{\vec{k}\times\vec{H}}{\omega\varepsilon}=-\vec{E} \quad ...(ii)$

$\vec{k}$ is ⊥ $\vec{H}$ and $\vec{k}$ is also ⊥ to $\vec{E}$

or In other words $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{E}\times\vec{B}$

2. **(a)** $E_{rms}=720$

The average total energy density

$$=\frac{1}{2}\epsilon_0 E_0^2=\frac{1}{2}\epsilon_0[\sqrt{2}E_{rms}]^2=\epsilon_0 E_{rms}^2$$

$$=8.85\times10^{-12}\times(720)^2$$

$$=4.58\times10^{-6}\ J/m^3$$

3. **(d)** $I_d = 1\ mA = 10^{-3}$ A

$C = 2\mu F = 2\times10^{-6}$ F

$$I_D = I_C = \frac{d}{dt}(CV) = C\frac{dV}{dt}$$

Therefore, $\frac{dV}{dt}=\frac{I_D}{C}=\frac{10^{-3}}{2\times10^{-6}}=500\ Vs^{-1}$

Therefore, applying a varying potential difference of 500 V s^{-1} would produce a displacement current of desired value.

4. **(c)** $E_0=CB_0$ and $C=\frac{1}{\sqrt{\mu_0\varepsilon_0}}$

Electric energy density $=\frac{1}{2}\varepsilon_0 E_0^2=\mu_E$

Magnetic energy density $=\frac{1}{2}\frac{Bo^2}{\mu_0}=\mu_B$

Thus, $\mu_E=\mu_B$

Energy is equally divided between electric and magnetic field

5. **(c)** In an electromagnetic wave electric field and magnetic field are perpendicular to the direction of propagation of wave. The vector equation for the electric field is

$$\vec{E}=E_0\cos\left(\omega t-\frac{2\pi}{\lambda}y\right)\hat{z}$$

6. **(a)** Frequency remains constant during refraction

$$v_{med}=\frac{1}{\sqrt{\mu_0\epsilon_0\times4}}=\frac{c}{2}$$

$$\frac{\lambda_{med}}{\lambda_{air}}=\frac{v_{med}}{v_{air}}=\frac{c/2}{c}=\frac{1}{2}$$

∴ wavelength is halved and frequency remains unchanged.

7. **(b)** For electromagnetic waves we know that,

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

$$\therefore \frac{9\times10^{-4}}{B}=3\times10^8\ ms^{-1}$$

$B=3\times10^{-12}$ T.

8. **(b)** Here, $k=\frac{2\pi}{\lambda}$, $\omega=2\pi\upsilon$

$$\therefore \frac{k}{\omega}=\frac{2\pi/\lambda}{2\pi\upsilon}=\frac{1}{\pi\upsilon}=\frac{1}{c} \quad (\because c=\upsilon\lambda)$$

where c is the speed of electromagnetic wave in vacuum. It is a constant whose value is $3\times10^6\ m\ s^{-1}$

9. **(a)** E.M. wave always propagates in a direction perpendicular to both electric and magnetic fields. So, electric and magnetic fields should be along + X– and + Y–directions respectively. Therefore, option (a) is the correct option.

10. **(d)** $\frac{1}{2}\varepsilon_0 E_0^2$ is electric energy density.

$\frac{B^2}{2\mu_0}$ is magnetic energy density.

So, total energy $=\frac{1}{2}\varepsilon_0 E_0^2+\frac{B_0^2}{2\mu_0}$

11. **(c)** Incident momentum, $p=\frac{E}{c}$

For perfectly reflecting surface with normal incidence

$$\Delta p=2p=\frac{2E}{c}$$

$$F=\frac{\Delta p}{\Delta t}=\frac{2E}{ct}$$

$$P=\frac{F}{A}=\frac{2E}{ctA}$$

12. **(a)** E_x and B_y would generate a plane EM wave travelling in z-direction, $\vec{E}$, $\vec{B}$ and $\vec{k}$ from a right handed system

$\vec{k}$ is along z-axis. As $\hat{i}\times\hat{j}=\hat{k}$

$\Rightarrow E_x\hat{i}\times B_y\hat{j}=C\hat{k}$ i.e., E is along x-axis and B is along y-axis.

13. **(b)** From question,

$B_0=20\ nT=20\times10^{-9}T$

(∵ velocity of light in vacuum $C=3\times10^8\ ms^{-1}$)

$$\vec{E}_0=\vec{B}_0\times\vec{C}$$

$$|\vec{E}_0|=|\vec{B}|.|\vec{C}|=20\times10^{-9}\times3\times10^8$$

$=6$ V/m.

14. **(c)** Microwave oven acts on the principle of giving vibrational energy to water molecules.

15. **(a)** Displacement current is set up in a region where the electric field is changing with time.

16. **(a)** On comparing the given equation to

$\vec{E} = a_0\hat{i}\cos(\omega t - kz)$

$\omega = 6 \times 10^{8z}$,

$k = \frac{2\pi}{r} = \frac{\omega}{c}$

$k = \frac{\omega}{c} = \frac{6\times10^8}{3\times10^8} = 2\,\text{m}^{-1}$

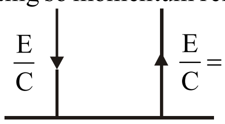
17. **(b)** Displacement current, I_D = conduction current, I_C

$\therefore \frac{dq}{dt} = \frac{d}{dt}[q_0 \cos 2\pi\upsilon t] = -q_0\, 2\pi\upsilon \sin 2\pi\upsilon t$

18. **(a)** Momentum of light falling on reflecting surface $p = \frac{E}{C}$

As surface is perfectly reflecting so momentum reflect

$p^1 = -\frac{E}{C}$



So, momentum transferred

$= P - P^1 = \frac{E}{C} - \left(-\frac{E}{C}\right) = \frac{2E}{C}$

19. **(d)** (1) Infrared rays are used to treat muscular strain because these are heat rays.

(2) Radio waves are used for broadcasting because these waves have very long wavelength ranging from few centimeters to few hundred kilometers

(3) X-rays are used to detect fracture of bones because they have high penetrating power but they can't penetrate through denser medium like dones.

(4) Ultraviolet rays are absorbed by ozone of the atmosphere.

20. **(d)** Given : $\vec{B} = 1.2 \times 10^{-8}\hat{k}T$

$\vec{E} = ?$

From formula,

$E = Bc = (1.2\times10^{-8}T)(3\times10^8\,\text{ms}^{-1}) = 3.6\,\text{Vm}^{-1}$

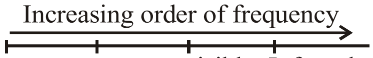
$\vec{B}$ is along Z-direction and the wave propagates along X-direction. Therefore $\vec{E}$ should be along Y-direction.

Thus, $\vec{E} = 3.6\hat{j}\,\text{Vm}^{-1}$

21. **(d)**

22. **(a)** $E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E}$

$\Rightarrow \lambda = \frac{6.6\times10^{-34}\times3\times10^8}{11\times1000\times1.6\times10^{-19}} = 12.4\,\text{Å}$



23. **(a)** Velocity of light

$C = \frac{E}{B} \Rightarrow B = \frac{E}{C} = \frac{9.3}{3\times10^8} = 3.1\times10^{-8}\,T$

24. **(b)** The average energy stored in the electric field

$U_E = \frac{1}{2}\varepsilon_0 E^2$

The average energy stored in the magnetic field = U_B =

$\frac{1}{2}\frac{B^2}{\mu_0}$,

According to conservation of energy $U_E = U_B$

$\varepsilon_0\mu_0 = \frac{B^2}{E^2}$

$\frac{B}{E} = \sqrt{\varepsilon_0\mu_0} = \frac{1}{c}$

25. **(b)** EM waves carry momentum and hence can exert pressure on surfaces. They also transfer energy to the surface so $p \neq 0$ and $E \neq 0$.

26. **(b)**

27. **(a)** The decreasing order of the wavelengths is as given below :

microwave, infrared, ultraviolet, gamma rays.

28. **(b)** Infrared causes heating effect.

29. **(c)** Speed of EM waves in vacuum $= \frac{1}{\sqrt{\mu_0\,\epsilon_0}}$ = constant

30. **(b)**

31. **(a)** $I_D = \varepsilon_0\, d\phi_E / dt$.

32. **(d)** $\nu_{\gamma-\text{rays}} > \nu_{\text{visible radiation}} > \nu_{\text{infrared}} > \nu_{\text{Radio waves}}$

33. **(b)**

34. **(d)** Wave is uv rays.

35. **(b)**

36. **(c)** Electromagnetic waves are the combination of mutually perpendicular electric and magnetic fields.

37. **(b)** Audible waves are not electromagnetic wave.

38. **(b)** Wave impedance $= Z = \sqrt{\frac{\mu_0}{\varepsilon_0}} = 376.6\,\Omega$

39. **(b)**

40. **(b)** Depends on the magnitude of frequency

41. **(d)** $B_0 = \frac{E_0}{c} = \frac{9\times10^3}{3\times10^8} = 3\times10^{-5}\,T.$

42. **(d)** To generate electromagnetic waves we need accelerating charge particle.

43. **(d)**

44. **(d)** For an E.M. wave power is transmitted in a direction perpendicular to both the fields.

45. **(c)** Speed of light of vacuum $c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$ and in another medium $v = \frac{1}{\sqrt{\mu\varepsilon}}$

$\therefore \frac{c}{v} = \sqrt{\frac{\mu\varepsilon}{\mu_0\varepsilon_0}} = \sqrt{\mu_r K} \Rightarrow v = \frac{c}{\sqrt{\mu_r K}}$.