DPP - Daily Practice Problems

Name : _____ Date : _____

Start Time : _____ End Time : _____

PHYSICS 48

SYLLABUS : EM Waves

Max. Marks : 116 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 29 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.20) : There are 20 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 Light is an electromagnetic wave. Its speed in vacuum is given by the expression

(a) $\sqrt{\mu_o \varepsilon_o}$ (b) $\sqrt{\frac{\mu_o}{\varepsilon_o}}$ (c) $\sqrt{\frac{\varepsilon_o}{\mu_o}}$ (d) $\sqrt{\frac{1}{\mu_o \varepsilon_o}}$

Q.2 The range of wavelength of the visible light is

(a) 10 Å to 100 Å

(b) 4,000 Å to 8,000 Å

(c) 8,000 Å to 10,000 Å

(d) 10,000 Å to 15000 Å

Q.3 Which of the following radiations has the least wavelength?

(a) γ-rays (b) β-rays

(c) α-rays (d) X -rays

Q.4 A parallel plate capacitor with plate area A and seperation between the plates d, is charged by a constant current i. Consider a plane surface of area A/4 parallel to the plates and drawn symetrically between the plates, what is the displacement current through this area?

(a) i (b) 2i (c) i/4 (d) i/2

Q.5 The charging current for a capacitor is 1 A, then the displacement current is

(a) 1 A (b) 0.5 A

(c) 0 (d) 2 A

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

Space for Rough Work

Q.6 If $\vec{E}$ and $\vec{B}$ be the electric and magnetic field of E.M. wave then the direction of propogation of E.M. wave is along the direction.

(a) $\vec{E}$ (b) $\vec{B}$

(c) $\vec{E} \times \vec{B}$ (d) $\vec{B} \times \vec{E}$

Q.7 Which of the following pairs of space and time varying E and B fields would generate a plane electromagnetic wave travelling in (–Z) direction ?

(a) E_x, B_y (b) E_y, B_x

(c) E_z, B_y (d) E_y, B_z

Q.8 Choose the wrong statement for E.M. wave. They-

(a) are transverse

(b) travel in vacuum with the speed of light

(c) are produced by accelerated charges

(d) travel with same speed in all medium

Q.9 The intensity of light from a source is $500/\pi$ W/m^2. Find the amplitude of electric field in this wave-

(a) $\sqrt{3} \times 10^2$ N/C (b) $2\sqrt{3} \times 10^2$ N/C

(c) $\frac{\sqrt{3}}{2} \times 10^2$ N/C (d) $2\sqrt{3} \times 10^1$ N/C

Q.10 A point source of 2 watt is radiating uniformly in all direction in vacuum. Find the amplitude of electric field at a distance 2m from it-

(a) 3×10^{-4} (b) $\sqrt{30}$

(c) $\sqrt{3} \times 10^{-4}$ (d) $\sqrt{3} \times 10^{-2}$

Q.11 In a EM wave the amplitude of electric field is 10 V/m. The frequency of wave is 5×10^4 Hz. The wave is propagating along Z-axis. Then the average energy density of magnetic field is-

(a) 2.21×10^{-10} J/m^3 (b) 2.21×10^{-8} J/m^3

(c) 2×10^{-8} J/m^3 (d) 2×10^{-10} J/m^3

Q.12 Elecromagnetic waves travel in a medium with a speed of 2×10^8 m/s. The relative permeability of the medium is 1. What is the relative permittivity of the medium ?

(a) 2.25 (b) 1.25 (c) 3.25 (d) 0.25

Q.13 A magnetic field of a plane electromagnetic wave is given by $B_y = 2 \times 10^{-7} \sin(0.5 \times 10^3 x + 1.5 \times 10^{11} t)$ T. Fequency of the wave is

(a) 23.9 Hz (b) 13.9 Hz

(c) 33.9 Hz (d) 12.9 Hz

Q.14 The electric field of a plane electromagnetic wave in vacuum is represented by

$E_x = 0$, $E_y = 0.5 \cos[2\pi \times 10^8 (t - x/c)]$ and $E_z = 0$. Determine the wavelength of the wave.

(a) 4 m (b) 5 m (c) 3 m (d) 6 m

Q.15 A light beam travelling in the X-direction is described by the electric field $E_y = (300 \text{ V/m}) \sin\omega(t - x/c)$. An electron is constrained to move along the Y-direction with a speed of 2.0×10^7 m/s. Find the maximum magnetic force (in N) on the electron.

(a) 3.2×10^{-18} (b) 5.1×10^{-16}

(c) 6.5×10^{-11} (d) 7.8×10^{-12}

Q.16 Which of the following waves have minimum frequency ?

(a) Microwaves (b) Audible waves

(c) Ultrasonic waves (d) Radiowaves

Q.17 Electromagnetic waves travel in a medium which has relative permeability 1.3 and relative permittivity 2.14. Then the speed of the electromagnetic wave in the medium will be

(a) 13.6×10^6 m/s (b) 1.8×10^2 m/s

(c) 3.6×10^8 m/s (d) 1.8×10^8 m/s

Q.18 If λ_v, λ_x and λ_m represent the wavelength of visible light *x*-rays and microwaves respectively, then

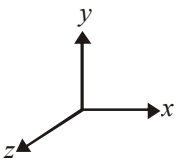
(a) $\lambda_m > \lambda_x > \lambda_v$ (b) $\lambda_v > \lambda_m > \lambda_x$

(c) $\lambda_m > \lambda_v > \lambda_x$ (d) $\lambda_v > \lambda_x > \lambda_m$

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

Space for Rough Work

Q.19 Light wave is travelling along + y-direction. If the corresponding $\vec{E}$ vector at that time is along + x-direction, $\vec{B}$ vector must be directed along.



(a) y-axis
(b) x-axis
(c) + z-axis
(d) – z axis

Q.20 A wave is propagating in a medium of dielectric constant 2 and relative magnetic permeability 50. The wave impedance of such a medium is

(a) 5Ω (b) 376.6Ω
(c) 1883 Ω (d) 3776 Ω

DIRECTIONS (Q.21-Q.23) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct
(b) 1 and 2 are correct
(c) 2 and 4 are correct
(d) 1 and 3 are correct

Q.21 Which of the following statements are true ?

(1) Photographic plates are sensitive to ultraviolet rays.
(2) Photographic plates can be made sensitive to infrared rays.
(3) Infrared rays are emitted by hot objects.
(4) Infrared photon has more energy than the photon of visible light.

Q.22 Which of the following are electromagnetic waves ?

(1) Cosmic rays (2) Gamma rays
(3) X-rays (4) β– rays

Q.23 An electromagnetic wave of frequency ν = 3.0 MHz passes from vacuum into a dielectric medium with permitivity ε = 4.0. Then the wrong statements are

(1) Wavelength is doubled and the frequency remains unchanged
(2) Wavelength is doubled and frequency becomes half
(3) Wavelength and frequency both remain unchanged
(4) Wavelength is halved and frequency remains unchanged

DIRECTIONS (Q.24-Q.26) : Read the passage given below and answer the questions that follows :

The electron density of a layer of ionosphere at a height 150 km from the earth surface is 9×10^{10} per m^3. For the sky wave transmission from this layer upto a range of 250 km, find

Q.24 The critical frequency of the layer

(a) 2.7×10^6 Hz (b) 2.7×10^5 Hz
(c) 4.7×10^6 Hz (d) 4.8×10^5Hz

Q.25 The maximum usuable frequency

(a) 3.17×10^8 Hz (b) 3.17×10^6 Hz
(c) 4.57×10^6 Hz (d) 4.57×10^6Hz

Q.26 The angle of incidence of this layer

(a) 34.5° (b) 25.2°
(c) 31.6° (d) 40°

DIRECTIONS (Q. 27-Q.29) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(c) Statement -1 is False, Statement-2 is True.
(d) Statement -1 is True, Statement-2 is False.

RESPONSE GRID					
	19. ⓐⓑⓒⓓ	**20.** ⓐⓑⓒⓓ	**21.** ⓐⓑⓒⓓ	**22.** ⓐⓑⓒⓓ	**23.** ⓐⓑⓒⓓ
	24. ⓐⓑⓒⓓ	**25.** ⓐⓑⓒⓓ	**26.** ⓐⓑⓒⓓ		

Space for Rough Work

Q.27 **Statement-1:** The electromagnetic waves of shorter wavelength can travel longer distances on earth's surface than those of longer wavelengths.

Statement-2: Shorter the wavelength, the larger is the velocity of wave propagation.

Q.28 **Statement-1:** Ultraviolet radiation are of higher frequency waves and are dangerous to human being.

Statement-2: Ultraviolet radiation are absorbed by the atmosphere.

Q.29 **Statement-1:** Radio waves can be polarised.

Statement-2: Sound waves in air are longitudinal in nature.

RESPONSE GRID	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 48 - PHYSICS			
Total Questions	29	Total Marks	116
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	30	Qualifying Score	48
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

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1. (d) $\mu_0 = 4\pi \times 10_{-7}, \varepsilon_0 = 8.85 \times 10^{-12} \frac{N - m^2}{C^2}$

so $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = 3 \times 10^8 \frac{\text{meter}}{\text{sec}}$.

2. (b) Wavelength of visible spectrum is 3900 Å – 7800 Å.

3. (a) $\lambda_{\gamma\text{–rays}} < \lambda_{x\text{-rays}} < \lambda_{\alpha\text{–rays}} < \lambda_{\beta\text{–rays}}$.

4. (c) Electric field between the plates of the capacitor is given by

$$E = \frac{\sigma}{\epsilon_0} \text{ or } \frac{q}{A \epsilon_0}$$

Flux through the area considered

$$\phi = \frac{q}{A \epsilon_0} \times \frac{A}{4} = \frac{q}{4 \epsilon_0}$$

Displacement corrent $i_d = \epsilon_0 \frac{d\phi_E}{dt}$

$$= \epsilon_0 \times \frac{d}{dt}\left(\frac{q}{4 \epsilon_0}\right) = \frac{i}{4}$$

5. (a) Electric field between the plates is

$$E = \frac{Q}{\epsilon_0 A}$$

$$\therefore \phi_E = E.A \text{ or } \frac{Q}{\epsilon_0 A} \times A$$

$$\therefore i_d = \epsilon_0 \frac{d\phi_E}{dt} \text{ or } \epsilon_0 \frac{d}{dt}\left(\frac{Q}{\epsilon_0}\right)$$

$$\therefore i_d = \frac{dQ}{dt} = i \text{ (charging current)}$$

Hence $i_d = 1A$

6. (c) $E \times B$

7. (b) Since the direction of propogation of EM wave is given by $E \times B \quad \therefore \left(\hat{j} \times \hat{i} = -\hat{k}\right)$

8. (d) Speed of E.M. wave $= \frac{1}{\sqrt{\mu_0 \epsilon_0 \mu_r \epsilon_r}}$ in medium hence it will travel with different speed in different medium.

9. (b) $I = \frac{1}{2} \epsilon_0 c E_0^2$

$$E_0 = \sqrt{\frac{2I}{\epsilon_0 c}} \text{ or } \sqrt{\frac{2 \times 500 \times 10^9 \times 36\pi}{\pi \times 3 \times 10^8}}$$

$$E_0 = 2\sqrt{3} \times 10^2 \text{ N/C}$$

10. (b) $I = \frac{P}{A}$ or $\frac{2}{4\pi \times 4} = \frac{1}{8\pi}$ W/m^2

$$I = \frac{1}{2} \epsilon_0 E_0^2 c$$

$$E_0 = \sqrt{\frac{2I}{\epsilon_0 c}} \text{ or } \sqrt{\frac{2 \times 1 \times 36\pi \times 10^9}{8\pi \times 3 \times 10^8}} = \sqrt{30} \text{ N/C}$$

11. (a) $U_B = \frac{B_0^2}{4\mu_0}$

Also $\frac{E_0}{B_0} = c \quad \therefore B_0 = \frac{E_0}{c}$

Hence $B_0 = \frac{E_0}{\frac{1}{\sqrt{\mu_0 \epsilon_0}}}$

$$\therefore \quad U_B = \frac{E_0^2 \mu_0 \epsilon_0}{4\mu_0} \text{ or } \frac{100 \times 8.84 \times 10^{-12}}{4}$$

$\therefore U_B = 2.21 \times 10^{-10}$ J/m^3

12. (a) The speed of electromagnetic waves and in a medium is given by

$$v = \frac{1}{\sqrt{(\mu\varepsilon)}}$$

Where μ and ε are absolute permeability and absolute permittivity of the medium.

We know that, $\mu = \mu_0 \mu_r$ and $\varepsilon = \varepsilon_0 \varepsilon_r$. Hence

$$v = \frac{1}{\sqrt{(\mu_0 \mu_r . \varepsilon_0 \varepsilon_r)}} = \frac{1}{\sqrt{(\mu_0 \varepsilon_0)}} \times \frac{1}{\sqrt{(\mu_r \varepsilon_r)}}$$

$$\text{or } v = \frac{c}{\sqrt{(\mu_r \varepsilon_r)}} \text{ or } \varepsilon_r = \frac{c^2}{v^2 (\mu_r)}$$

$$\therefore \varepsilon_r = \frac{(3 \times 10^8)^2}{(2 \times 10^8)^2 \times 1} = 2.25$$

13. (a) Given $B_y = 2 \times 10^{-7} \sin(0.5 \times 10^3 x + 1.5 \times 10^{11} t)$

Comparing it with a standard equation for a progresive wave travelling along the negative direction of x-axis is

$$y = r \sin \frac{2\pi}{\lambda}(x + vt) = r \sin\left(\frac{2\pi x}{\lambda} + \frac{2\pi vt}{\lambda}\right)$$

$= r \sin\left(\frac{2\pi x}{\lambda} + 2\pi\nu t\right)$

$2\pi\nu = 1.5 \times 10^{11}$

$\nu = \frac{1.5\times10^{11}}{2\pi} = 23.9 \times 10^9$ Hz $= 23.9$ Hz

14. (c) The given equation

$E_y = 0.5 \cos[2\pi \times 10^8 (t - x/c)]$ ..... (1)

indicates that the electromagnetic waves are propagating along the positive direction of X-axis.

The standard equation of electromagnetic wave is given by $E_y = E_0 \cos\omega(t - x/c)$ ..... (2)

Comparing the given eq. (1) with the standard eq. (2), we get $\omega = 2\pi \times 10^8$

or $2\pi\nu = 2\pi \times 10^8$

$\therefore \nu = 10^8$ per second

Now, $\lambda = \frac{c}{\nu} = \frac{3\times10^8}{10^8} = 3$ m

15. (a) The maximum value of magnetic field (B_0) is given by

$B_0 = \frac{E_0}{c} = \frac{E_0}{c} = 10^{-6}$ tesla

The magnetic field will be along Z-axis

The maximum magnetic force on the electron is

$F_b = |q(\mathbf{v} \times \mathbf{B})| = q\nu B_0$

$= (1.6 \times 10^{-19}) \times (2.0 \times 10^7) \times (10^{-6})$

$= 3.2 \times 10^{-18}$ N

16. (c) β-rays are beams of fast electrons.

17. (b)

18. (d) $v = \frac{c}{\sqrt{\mu_r \varepsilon_r}} = \frac{3\times10^8}{\sqrt{1.3\times2.14}} = 1.8\times10^8$m/sec

19. (c) $\lambda_m > \lambda_v > \lambda_x$

20. (d) Direction of wave propagation is given by $\vec{E}\times\vec{B}$.

21. **(c)** Wave impedance $Z = \sqrt{\frac{\mu_r}{\varepsilon_r}} \times \sqrt{\frac{\mu_0}{\varepsilon_0}}$

$= \sqrt{\frac{50}{2}} \times 376.6 = 1883\Omega$

22. (a)

23. (a) β– rays are beams of fast electrons.

24. (a) Refractive index $= \sqrt{\frac{\mu\varepsilon}{\mu_0\varepsilon_0}}$

$\Rightarrow$ Then refractive index $= \sqrt{\frac{\varepsilon}{\varepsilon_0}} = 2$

$\therefore$ Speed and wavelength of wave becomes half and frequency remain unchanged.

For 25 - 27

$h = 150$ km $= 150 \times 10^3$ m

$N_m = 9 \times 10^{10}$ per m^3

$D = 250$ km $= 250 \times 10^3$ m

25. (a) Critical frequency of layer

$f_c = 9\sqrt{N_m} = 9 \times \sqrt{9\times10^{10}} = 2.7\times10^6$ Hz.

26. (b) Maximum usable frequency

$f = f_c\sqrt{1+\frac{D^2}{4h^2}} = 2.7\times10^6 \times \sqrt{1+\left(\frac{250\times10^3}{4\times150\times10^3}\right)^2}$

$= 3.17 \times 10^6$ Hz.

27. (c) If angle of incidence at this layer is ϕ_i, from second law of $f = f_c \sec \phi_i$.

$\sec\phi_i = \frac{f}{f_c} = \frac{3.17\times10^6}{2.7\times10^6} = 1.174$

$\phi_i = \sec^{-1}(1.174) = 31.6°$

28. (d) The electromagnetic waves of shorter wavelength do not suffer much diffraction from the obstacles of earth's atmosphere so they can travel long distance.

29. (b) The wavelength of these waves ranges between 300 Å and 4000 Å that is smaller wavelength and higher frequency. They are absorbed by atmosphere and convert oxygen into ozone. They cause skin diseases and they are harmful to eye and cause permanent blindness.

30. (b) Radio waves can be polarised because they are transverse in nature. Sound waves in air are longitudinal in nature.