

How to use this worksheet. Thirty-four questions, about 40 minutes, with the answer key at the end. Learn the spectrum order once and read it backwards for wavelength. For displacement current find the capacitance first, then the charge, then divide by the time.

Formula sheet

$c = 1/\sqrt{\mu_0\epsilon_0} = 3 \times 10^8 \text{ m/s}$ | $c = f\lambda$ | $E_0/B_0 = c$ | $v = c/n$ in a medium

Displacement current: $I_d = \epsilon_0 d\Phi_E/dt$ | $p = U/c$ | Intensity $\propto E_0^2$ | Rayleigh scattering $\propto 1/\lambda^4$

Rising frequency: radio → microwave → infrared → visible → ultraviolet → X-ray → gamma
(wavelength runs the other way)

Section A · Level 1 — Nature of electromagnetic waves and the spectrum

Ten questions. None should take more than twenty seconds.

1. The speed of electromagnetic waves in vacuum is closest to:

- (1) $3 \times 10^6 \text{ m/s}$ (2) $3 \times 10^8 \text{ m/s}$ (3) $3 \times 10^{10} \text{ m/s}$ (4) $3 \times 10^5 \text{ m/s}$

2. The speed of light in vacuum is given by:

- (1) $\sqrt{\mu_0\epsilon_0}$ (2) $1/\sqrt{\mu_0\epsilon_0}$ (3) $\mu_0\epsilon_0$ (4) $1/\mu_0\epsilon_0$

3. Electromagnetic waves are:

- (1) Longitudinal (2) Transverse (3) Partly longitudinal (4) Neither

4. In an electromagnetic wave, the electric and magnetic field vectors are:

- (1) Parallel to each other (2) Perpendicular to each other and to the direction of propagation (3) At 45° to each other (4) Along the direction of propagation

5. Electromagnetic waves:

- (1) Require a material medium (2) Do not require a material medium (3) Travel only through metals (4) Travel only through air

6. The concept of displacement current was introduced by:

- (1) Faraday (2) Ampere (3) Maxwell (4) Lenz

7. Which of these has the longest wavelength?

- (1) Radio waves (2) Microwaves (3) Infrared (4) X-rays

8. The approximate wavelength range of visible light is:

- (1) 4 to 7 nm (2) 40 to 70 nm (3) 400 to 700 nm (4) 4000 to 7000 μm

9. Which of the following carries photons of the highest energy?

- (1) Radio waves (2) Visible light (3) Ultraviolet (4) Gamma rays

10. Electromagnetic waves carry:

- (1) Energy only (2) Momentum only (3) Both energy and momentum (4) Neither

Working space — Questions 1 to 10

Write the formula before you substitute.

Section B · Level 2 — Wavelength, frequency and uses

Nine questions. Use $c = f\lambda$ and know what each band is used for.

11. An electromagnetic wave in vacuum has a wavelength of 3 m. Its frequency is:

- (1) 10^6 Hz (2) 10^8 Hz (3) 10^{10} Hz (4) 10^4 Hz

12. A radio station broadcasts at 100 MHz. The wavelength of its signal is:

- (1) 0.3 m (2) 3 m (3) 30 m (4) 300 m

13. The ratio of the amplitudes of the electric and magnetic fields in an electromagnetic wave equals:

- (1) 1 (2) c (3) $1/c$ (4) c^2

14. In an electromagnetic wave, the average energy density of the electric field compared with that of the magnetic field is:

- (1) Much greater (2) Much smaller (3) Equal (4) Zero

15. Which region of the spectrum is used in radar and in microwave ovens?

- (1) Radio waves (2) Microwaves (3) Infrared (4) Ultraviolet

16. Infrared radiation is commonly used in:

- (1) Medical imaging of bones (2) Television remote controls (3) Sterilising surgical instruments (4) Long-distance radio broadcasting

17. X-rays are most commonly used for:

- (1) Cooking food (2) Medical imaging of bones (3) FM broadcasting (4) Night vision

18. The ultraviolet radiation reaching the Earth is largely absorbed by:

- (1) Nitrogen (2) The ozone layer (3) Water vapour (4) Carbon dioxide

19. Which of these is chiefly responsible for the greenhouse effect in the atmosphere?

- (1) Absorption of radio waves (2) Absorption of infrared radiation (3) Absorption of X-rays (4) Reflection of gamma rays

Working space — Questions 11 to 19

Write the formula before you substitute.

Section C · Level 3 — Displacement current, propagation and energy

Nine questions. Each needs a formula plus a piece of reasoning.

20. The displacement current between the plates of a charging capacitor is given by:

- (1) $\epsilon_0 d\Phi_E / dt$ (2) $\mu_0 d\Phi_B / dt$ (3) $\epsilon_0 \Phi_E$ (4) dQ / dt only

21. The displacement current in the gap of a charging capacitor is:

- (1) Zero (2) Equal to the conduction current in the leads (3) Twice the conduction current (4) Half the conduction current

22. The direction of propagation of an electromagnetic wave is given by the direction of:

- (1) E (2) B (3) $E \times B$ (4) $B \times E$

23. The speed of an electromagnetic wave in a medium of refractive index n is:

- (1) cn (2) c/n (3) n/c (4) c

24. When an electromagnetic wave enters a denser medium, its frequency:

- (1) Increases (2) Decreases (3) Remains unchanged (4) Becomes zero

25. The intensity of an electromagnetic wave is proportional to:

- (1) E_0 (2) E_0^2 (3) $1/E_0$ (4) E_0^3

26. The momentum delivered by an electromagnetic wave that transfers energy U to a fully absorbing surface is:

- (1) U (2) Uc (3) U/c (4) U/c^2

27. Gamma rays are produced by:

- (1) Heated filaments (2) Transitions within atomic nuclei (3) Oscillating LC circuits (4) Vibrating molecules

28. A parallel plate capacitor of plate area 25 cm^2 and plate separation 5 mm is charged to 100 V in a time of $1 \mu\text{s}$. The average displacement current is closest to:

- (1) 0.44 mA (2) 4.4 mA (3) 44 mA (4) 0.044 mA

Working space — Questions 20 to 28 Write the formula before you substitute.

Section D · Previous year questions — Straight from the AAI ATC papers

Six questions, exactly as they appeared. Four come from the 2023 papers, recovered by optical character recognition of the scanned answer sheets and independently re-solved.

29. Let λ_1 , λ_2 , λ_3 and λ_4 be the wavelengths of microwaves, gamma rays, ultraviolet rays and infrared rays respectively. Then: **[PYQ 2023 · Morning]**

- (1) $\lambda_1 > \lambda_4 > \lambda_3 > \lambda_2$ (2) $\lambda_3 > \lambda_4 > \lambda_1 > \lambda_2$ (3) $\lambda_2 > \lambda_3 > \lambda_4 > \lambda_1$ (4) $\lambda_4 > \lambda_1 > \lambda_3 > \lambda_2$

30. When sunlight passes through the earth's atmosphere it is scattered by atmospheric particles. For light of wavelength λ , the amount of scattering is proportional to: **[PYQ 2023 · Morning]**

- (1) λ^4 (2) $1/\lambda^4$ (3) λ^2 (4) $1/\lambda^2$

31. Infrared waves are produced by: **[PYQ 2023 · Evening]**

- (1) Special vacuum tubes (2) Accelerated motion of charges in a conducting wire (3) Special lamps (4) Hot bodies and molecules

32. A plane electromagnetic wave of frequency 10 MHz travels in free space along the y-direction. At a particular point in space and time, $E = 9.9$ V/m. The magnitude of B at this point is: **[PYQ 2023 · Evening]**

- (1) 3.3×10^{-6} T (2) 3.3×10^{-9} T (3) 3.3×10^{-2} T (4) 3.3×10^{-8} T

33. The frequency of X-rays is less than the frequency of: **[PYQ 2025 · Shift 2]**

- (1) Microwaves (2) Gamma rays (3) Ultraviolet rays (4) Radio waves

34. Assume a parallel plate capacitor which is maintained at a potential of 100 V. If the partition distance between the plates of the capacitor and the area of the plates are 5 mm and 25 cm² respectively, compute the displacement current for a time of 1 μ s. **[PYQ 2021 · Shift 3]**

- (1) 0.44 mA (2) 0.22 mA (3) 4.4 mA (4) 0.88 mA

Working space — Questions 29 to 34 Write the formula before you substitute.

Answer key

Check only after you have attempted every question. Full worked solutions for each one are on the worksheet page at aviatelearnings.com.

1. (2)	8. (3)	15. (2)	22. (3)	29. (1)
2. (2)	9. (4)	16. (2)	23. (2)	30. (2)
3. (2)	10. (3)	17. (2)	24. (3)	31. (4)
4. (2)	11. (2)	18. (2)	25. (2)	32. (4)
5. (2)	12. (2)	19. (2)	26. (3)	33. (2)

6. (3)	13. (2)	20. (1)	27. (2)	34. (1)
7. (1)	14. (3)	21. (2)	28. (1)	

Stuck on any of these? Bring them to a live class.

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