Electromagnetic Waves Questions – OCR A Level Physics

Praneel Physics

1. State the speed of electromagnetic waves in a vacuum. **(P)**

Working and Answer:

$$c = 3.0 \times 10^8 \, \text{m/s}$$

2. List three properties of all electromagnetic waves. **(P)**

Working and Answer:

1. Transverse waves.
2. Travel at the same speed in a vacuum.
3. Can be reflected, refracted, diffracted and polarised.

3. What is meant by the term 'polarisation'? **(P)**

Working and Answer:

Polarisation is the restriction of wave oscillations to one plane only.

4. Write the wave equation relating speed, frequency and wavelength. **(P)**

Working and Answer:

$$v = f\lambda$$

5. Which electromagnetic wave has the highest frequency? **(P)**

Working and Answer:

Answer: Gamma rays.

6. Explain why only transverse waves can be polarised. **(PP)**

Working and Answer:

In transverse waves, oscillations are perpendicular to the direction of wave travel, so they can be filtered into one direction. Longitudinal waves oscillate in the same direction as travel, so cannot be polarised.

7. A radio wave has a frequency of 5.0×10^6 Hz. Calculate its wavelength in air. **(PP)**

Working and Answer:

$$\lambda = \frac{c}{f} = \frac{3.0 \times 10^8}{5.0 \times 10^6} = 60\,\text{m}$$

8. State one practical use of polarisation and explain how it works. **(PP)**

Working and Answer:

Use: Polaroid sunglasses.
Explanation: They reduce glare by blocking horizontally polarised reflected light.

9. Describe how you could demonstrate polarisation using two polarising filters. **(PP)**

Working and Answer:

Place one polarising filter in front of a light source, then rotate a second filter in front of it. Light intensity decreases as the second filter is rotated and reaches zero when crossed at 90°.

10. Explain how polarisation provides evidence that electromagnetic waves are transverse. **(PP)**

Working and Answer:

Only transverse waves can be polarised. The ability to polarise EM waves confirms their transverse nature.

11. A microwave has a frequency of 2.45×10^9 Hz. Calculate its wavelength. **(PPP)**

Working and Answer:

$$\lambda = \frac{c}{f} = \frac{3.0 \times 10^8}{2.45 \times 10^9} \approx 0.122\,\text{m}$$

12. A wave has a wavelength of 0.5 m and travels at 1.5×10^8 m/s. Find its frequency. **(PPP)**

Working and Answer:

$$f = \frac{v}{\lambda} = \frac{1.5 \times 10^8}{0.5} = 3.0 \times 10^8 \,\text{Hz}$$

13. Describe an experiment to measure the wavelength of microwaves using a receiver and metal reflector. **(PPP)**

Working and Answer:

Place a metal reflector and microwave receiver at a fixed distance from a transmitter. Move the receiver and record intensity maxima/minima. The distance between two adjacent minima is half a wavelength.

14. How does diffraction affect the transmission of radio waves around buildings? **(PPP)**

Working and Answer:

Radio waves have long wavelengths and can diffract around obstacles like buildings, allowing transmission without direct line of sight.

15. Explain how the electromagnetic spectrum is ordered. **(PPP)**

Working and Answer:

The spectrum is arranged in order of increasing frequency and decreasing wavelength: Radio → Microwave → Infrared → Visible → UV → X-ray → Gamma.

16. A UV wave has a wavelength of 3.2×10^{-7} m. Calculate its frequency. **(PPPP)**

Working and Answer:

$$f = \frac{c}{\lambda} = \frac{3.0 \times 10^{8}}{3.2 \times 10^{-7}} = 9.375 \times 10^{14}\,\text{Hz}$$

17. Explain how polarisation supports the wave model of light. **(PPPP)**

Working and Answer:

Only waves with oscillations in directions perpendicular to motion can be polarised. The fact that light can be polarised confirms it behaves as a transverse wave.

18. A microwave oven uses waves with wavelength 12.2 cm. Calculate the frequency. **(PPPP)**

Working and Answer:

$$f = \frac{c}{\lambda} = \frac{3.0 \times 10^8}{0.122} \approx 2.46 \times 10^9 \text{ Hz}$$

19. Compare visible light and X-rays in terms of energy and penetration. **(PPPP)**

Working and Answer:

X-rays have much higher frequency and energy than visible light, allowing them to penetrate soft tissue and be used in imaging, whereas visible light cannot.

20. Describe how interference patterns of electromagnetic waves can be used to determine wavelength. **(PPPPP)**

Working and Answer:

Using a double-slit setup, coherent EM waves interfere to form a pattern of maxima and minima. The fringe spacing can be measured and used with $\lambda = \frac{ax}{D}$ to determine wavelength.

21. Gamma rays have a frequency of 3×10^{20} Hz. Calculate their wavelength. **(PPPPP)**

Working and Answer:

$$\lambda = \frac{c}{f} = \frac{3.0 \times 10^{8}}{3 \times 10^{20}} = 1.0 \times 10^{-12}\,\text{m}$$