Engineering Daily 25 [Set 03] EV

Physical Optics, Modern Physics

Total Marks: 50 **Negative Marks:** 0.25 **Time:** 1 Hour

MCQ 50 marks

1. A nuclear power plant runs continuously for 30 days at a power of 1500 MW. The mass converted into energy during this time is—

(A) 1.8 g (B) 0.0432 g

(C) 130 g (D) 43.2 g

2. Light of wavelength 450 nm and power 3 mW is incident on a metal surface. If 0.2% of the incident photons emit photoelectrons, what is the photocurrent?

(A) 2.17×10^{-4} A (B) 2.17×10^{-6} A

(C) 1.09×10^{-6} A (D) 2.17×10^{-5} A

3. A medium has relative magnetic permeability 1.25 and relative electric permittivity 1.8. The speed of light in the medium is—

(A) 4.5×10^{8} ms^{-1} (B) 1.33×10^{8} ms^{-1}

(C) 2×10^{8} ms^{-1} (D) 1.67×10^{8} ms^{-1}

4. Two coherent waves of intensities 4I and I meet at a point on the screen with a phase difference of $\frac{2\pi}{3}$. What fraction of the maximum intensity is the intensity at that point?

(A) $\frac{1}{3}$ (B) $\frac{5}{9}$ (C) $\frac{2}{3}$ (D) $\frac{1}{9}$

5. A rocket of length 12 m moves along its length at 0.6c relative to an observer on the ground. The length of the rocket as measured by the observer is—

(A) 9.6 m (B) 12 m (C) 7.2 m (D) 15 m

6. A train of rest length 150 m passes at very high speed through a tunnel of length 90 m. At some instant, in the tunnel's frame, the length of the train is measured to be equal to the length of the tunnel. The speed of the train is—

(A) 0.6c (B) 0.4c (C) 0.8c (D) 0.36c

7. A certain order of 640 nm light and the next higher order of 480 nm light, incident normally on a grating, coincide at an angle of 37°. The number of lines per centimetre of the grating is— (sin 37° = 0.6)

(A) 1563 (B) 2083 (C) 4167 (D) 3125

8. Light incident on glass at an angle of 58° is completely polarized in the reflected part. The angle of refraction and the refractive index of the glass are, respectively — (tan 58° = 1.6)

(A) 32°, 1.6 (B) 32°, 1.18

(C) 58°, 1.6 (D) 32°, 0.625

9. Of two 18-year-old twins, one travels in space at 0.6c and returns after 25 years by Earth's reckoning. Their age difference on return is—

(A) 20 years (B) 5 years (C) 10 years (D) 7 years

10. In a Young's experiment using light of wavelength 480 nm, a transparent plate of refractive index 1.6 is placed in front of one slit, shifting the central bright fringe to the position of the former sixth bright fringe. The thickness of the plate is—

(A) 2.4 µm (B) 9.6 µm (C) 4.8 µm (D) 1.8 µm

11. For light of wavelength 200 nm, the stopping potential of a metal surface is 3.2 V. For light of wavelength 250 nm, the stopping potential is—

(A) 1.96 V (B) 2.2 V (C) 4.44 V (D) 2.56 V

12. In free space, the electric field of an electromagnetic wave is $\vec{E} = 4.5\cos(2.0y + 6.0 \times 10^{8}t)\,\hat{i}$ Vm^{-1}. The amplitude and direction of the magnetic field are—

(A) 1.5×10^{-8} T, along $-\hat{k}$ (B) 1.5×10^{-8} T, along $+\hat{k}$

(C) 1.35×10^{9} T, along $+\hat{k}$ (D) 1.5×10^{-8} T, along $+\hat{j}$

13. Light of frequency 1.2×10^{15} Hz is incident on a metal surface, and the maximum kinetic energy of the emitted electrons is 2.0 eV. What is the threshold frequency of the metal?

(A) 1.68×10^{15} Hz (B) 4.83×10^{14} Hz

(C) 6×10^{14} Hz (D) 7.17×10^{14} Hz

14. A muon created at a height of 4.5 km above the ground travels vertically downward at 0.99c. If the mean lifetime of a muon at rest is 2.2 µs, what distance does it cover in the Earth's frame during its mean lifetime?

(A) 0.0922 km (B) 4.5 km

(C) 0.653 km (D) 4.63 km

15. In the rest frame, two lamps flash at the same place with an interval of 2 µs. In a moving frame this interval is measured as 2.5 µs. The distance between the lamps in that frame is—

(A) 360 m (B) 750 m (C) 600 m (D) 450 m

16. The kinetic energy of a particle is 1.5 times its rest energy. The speed of the particle is—

(A) 0.745c (B) 0.6c

(C) 0.917c (D) 0.8c

17. For a metal, the stopping potential is 4 V for light of wavelength λ and 1 V for light of wavelength 2λ. The threshold wavelength of the metal is—

(A) 2λ (B) 4λ (C) 1.5λ (D) 3λ

18. A spaceship passes at 0.8c along a diagonal of a square field of side 40 m. What is the area of the field as measured by the astronaut?

(A) 576 m^2 (B) 960 m^2

(C) 1600 m^2 (D) 1280 m^2

19. A vehicle moves at 0.6c relative to the Earth. An object is thrown forward from it at 0.7c relative to the vehicle. The velocity of the object relative to the Earth is—

(A) 0.915c (B) 0.1c

(C) 0.85c (D) 1.3c

20. X-rays of wavelength 0.20 nm undergo Compton scattering by free electrons. The maximum possible wavelength of the scattered photon is—

(A) 0.1952 nm (B) 0.2024 nm

(C) 0.2 nm (D) 0.2048 nm

21. Unpolarized light of intensity I_0 passes successively through two polarizers whose optical axes make an angle of 45°. The intensity of the transmitted light is —

(A) $\frac{I_0}{2}$ (B) $\frac{I_0}{\sqrt{2}}$ (C) $\frac{I_0}{8}$ (D) $\frac{I_0}{4}$

22. If two coherent sources have an intensity ratio of 25 : 4, the ratio of maximum to minimum intensity in the interference pattern is—

(A) 49 : 9 (B) 25 : 4

(C) 7 : 3 (D) 29 : 21

23. In a double-slit experiment, a 2 µm thick plate of refractive index 1.5 is placed in front of slit S_1. What thickness of a plate of refractive index 1.25 must be placed in front of S_2 to bring the central bright fringe back to its original position?

(A) 1 µm (B) 2.4 µm (C) 4 µm (D) 1.6 µm

24. In single-slit diffraction, immersing the whole setup in a liquid reduces the angular width of the central maximum by 25% (small angles). The refractive index of the liquid is—

(A) $\frac{3}{2}$ (B) $\frac{5}{4}$ (C) $\frac{7}{4}$ (D) $\frac{4}{3}$

25. In a Young's experiment using light of wavelength 4500 Å, 40 fringes are obtained over a certain portion of the screen. For light of wavelength 6000 Å, the number of fringes over the same portion will be —

(A) 53 (B) 45 (C) 30 (D) 35

26. Light of wavelength 560 nm is incident normally on a soap film of refractive index 1.4 in air. The minimum thickness for the film to appear bright in reflected light is—

(A) 200 nm (B) 100 nm (C) 140 nm (D) 50 nm

27. Light of 650 nm is incident normally on a grating with 4000 lines per centimetre. How many maxima, including the central one, can be observed?

(A) 7 (B) 8 (C) 6 (D) 3

28. A rocket moving at 0.95c relative to the Earth sends a light signal forward. The speed of the signal as measured by an observer on the Earth is—

(A) 1.95c (B) 0.05c (C) c (D) 0.975c

29. A glass block of refractive index 1.6 is immersed in water of refractive index $\frac{4}{3}$. What is the polarizing angle for light incident from the water onto the glass?

(A) 53.1° (B) 58° (C) 50.2° (D) 39.8°

30. In Young's double-slit experiment, $\lambda = 500$ nm, the slit separation is 0.5 mm and the slit-to-screen distance is 1.5 m. What is the distance between the fourth bright fringe on one side of the central bright fringe and the third dark fringe on the other side?

(A) 8.25 mm (B) 9.75 mm

(C) 10.5 mm (D) 2.25 mm

31. In Young's double-slit experiment, the slit separation is 0.25 mm and the wavelength of the light is 600 nm. The maximum possible number of bright fringes on the screen is—

(A) 833 (B) 834 (C) 1667 (D) 417

32. If the kinetic energy of a non-relativistic particle is increased 9 times, the percentage change in its de Broglie wavelength is—

(A) 33.3% decrease (B) 66.7% decrease

(C) 200% increase (D) 88.9% decrease

33. In single-slit diffraction with 600 nm light, the first secondary maximum forms at an angle of 30°. What is the slit width?

(A) 2.4 µm (B) 1.2 µm (C) 0.9 µm (D) 1.8 µm

34. In a spaceship moving along the x-axis at 0.6c, a rod of length 80 cm lies at rest at an angle of 30° to the x-axis. The length of the rod as measured by an observer on the ground is—

(A) 68.4 cm (B) 76.3 cm (C) 64 cm (D) 80 cm

35. A third polarizer is placed between two crossed polarizers, so that the transmitted intensity of unpolarized light of intensity I_0 becomes $\frac{I_0}{32}$. What is the minimum angle between the axis of the intermediate polarizer and that of the first polarizer?

(A) 15° (B) 45° (C) 30° (D) 22.5°

36. If the kinetic energy of a particle is $0.25m_0c^2$, what is its momentum?

(A) $1.25m_0c$ (B) $0.75m_0c$

(C) $0.6m_0c$ (D) $0.5m_0c$

37. Person A is 8 years older than person B. A travels in a spaceship and, after 6 years by his own clock, returns to find that B is now 2 years older than he is. What is the speed of the spaceship?

(A) 0.927c (B) 0.8c (C) 0.968c (D) 0.875c

38. A grating has 12000 lines per inch. What is the difference between the diffraction angles of the first and third orders for 500 nm light?

(A) 45.1° (B) 13.7° (C) 31.5° (D) 27.3°

39. Light of 500 nm is incident on a single slit of width 0.4 mm. What is the width of the central maximum on a screen placed 1.6 m from the slit?

Ⓐ 1 mm Ⓑ 4 mm Ⓒ 2 mm Ⓓ 8 mm

40. In frame A, the velocity of a particle is measured as 0.9c along +x, and in frame B the velocity of the same particle is measured as 0.5c along +x. The velocity of B relative to A is—

Ⓐ 0.5c Ⓑ 0.8c

Ⓒ 0.4c Ⓓ 0.727c

41. Light of wavelengths 750 nm and 500 nm is used together in Young's double-slit experiment with a = 0.5 mm and D = 2 m. The minimum distance from the central maximum at which the bright fringes of both lights coincide is—

Ⓐ 6 mm Ⓑ 3 mm Ⓒ 9 mm Ⓓ 12 mm

42. In single-slit diffraction, the first minimum of 600 nm light forms at an angle of 30°. The slit width is—

Ⓐ 0.6 µm Ⓑ 0.3 µm Ⓒ 1.2 µm Ⓓ 2.4 µm

43. Three microbes that double every 15 days of their own time are sent in a vehicle moving at 0.8c. After 250 days by Earth's reckoning, the number of microbes in the vehicle is—

Ⓐ 1536 Ⓑ 3072 Ⓒ 2048 Ⓓ 6144

44. The total energy of a moving particle is 13 J and its relativistic momentum is 12 J c^{-1}. The rest mass of the particle is—

Ⓐ $\sqrt{313}$ J c^{-2} Ⓑ 5 J c^{-2}

Ⓒ 25 J c^{-2} Ⓓ 1 J c^{-2}

45. In Young's double-slit experiment, the position where the sixth dark fringe forms in vacuum is exactly where the eighth bright fringe forms when the whole arrangement is immersed in a liquid. The refractive index of the liquid is—

Ⓐ $\frac{11}{8}$ Ⓑ $\frac{3}{2}$ Ⓒ $\frac{4}{3}$ Ⓓ $\frac{16}{11}$

46. A pendulum with a period of 3 s is placed in a vehicle moving at 0.6c relative to the ground. What is the period as measured by an observer on the ground?

Ⓐ 5 s Ⓑ 3.75 s Ⓒ 3 s Ⓓ 2.4 s

47. Unpolarized light of intensity 80 Wm^{-2} passes through 4 polarizers placed in succession, each with its axis inclined at 20° to the previous one. The intensity emerging from the last polarizer is—

Ⓐ 33.2 Wm^{-2} Ⓑ 24.3 Wm^{-2}

Ⓒ 27.5 Wm^{-2} Ⓓ 55.1 Wm^{-2}

48. White light (400–700 nm) is incident normally on a film of refractive index 1.6 and thickness 375 nm in air. Which wavelength in the visible range has maximum intensity in the reflected light?

Ⓐ 480 nm Ⓑ 800 nm Ⓒ 600 nm Ⓓ 400 nm

49. In the rest frame, two events occur 6 km apart with a time interval of 8 µs. At what speed must a frame move for the two events to be measured as simultaneous?

Ⓐ 2.4×10^8 ms^{-1} Ⓑ 7.5×10^8 ms^{-1}

Ⓒ 3×10^7 ms^{-1} Ⓓ 1.2×10^8 ms^{-1}

50. A vehicle moves at 0.75c along +x relative to the Earth. A rocket is fired from it at 0.9c along −x relative to the vehicle. What is the velocity of the rocket relative to the Earth?

Ⓐ 0.462c, along +x Ⓑ 0.15c, along −x

Ⓒ 0.462c, along −x Ⓓ 0.983c, along −x