PHYSICS

FOR IIT JEE ASPIRANTS OF CLASS 12 FOR PHYSICS

ELECTROMAGNETIC WAVES

Illustration

1. A circular parallel plate capacitor with plate radius R is charged by means of a cell, at time $t = 0$. The initial conduction current is i_0. Consider a circular area of radius $R/4$ coplanar with the capacitor plates and

located symmetrically between them. Find the time rate of electric flux change through this area after one time constant.

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2. Show that displacement current is equal to conduction current during chargeing of a capacitor.

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3. A parallel plate capacitor consits of two circular plates of radius R = 0.1 m. they are separated by a distance d = 0.5 mm. If electric field between the

capacitor plates charges as $\frac{dE}{dt} = 5 \times 10^{13} \frac{V}{m \times s}$. Find displacement current between the plates.

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4. What is the instantaneous displacement current in space between plates of parallel plate capacitor of capacitor $1\mu F$, which is charging at rate of $10^6 V / S$

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5. Electro magnetic waves travel in a medium with speed of $2 \times 10^8 m / \sec$. The relative permeability of

the medium is 1 find relative permittivity.

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6. Suppose that the electric field amplitude of an electromagnetic wave us $E_0 = 120N/C$ and that its frequency is $50.0MHz$.

(a) Determine B_0, ω, k and λ,

(b) find expressions for E and B.

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7. In a plane electromagnetic wave, the electric field oscillates sinnusoidally at a frequency of $2 \times 10^{10} Hz$

and amplitude $48V/m$. The amplitude of oscillating magnetic field will be

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8. In the above problem , the wavelength of electromagnetic wave is

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9. The electric field in an electromagnetic wave is given by e = 50 sin $\omega(t - x/c)\left(\text{in}NC^{-1}\right)$ Find the energy contained in a cylindrical space of cross-section 10 cm^2

and length 100 cm along the x-axis. Also find the intensity of wave

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10. Find the amplitude of the electric field in a parallel beam of light of intensity 10 watt/m^2 .

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11. In a plane electromagnetic wave the electric field oscillates sinusoidally at a frequency $3 \times 10^{10} Hz$ and amplitude $50 V / m$. (a) What is the wavelength of the

wave? (b) What is the amplitude of the oscillating magnetic field?

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12. A plane e.m. wave propagating in the x-direction has a wavelength $6.0mm$. The electric field is in the y-direction and its maximum magitude is $33Vm^-1$. Write suitable equation for the electric and magnetic fields as a function of x and t.

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Evaluate Yourself 1

1. If potential difference between the plates of capacitor changes with rate of $\frac{dV}{dt} = 10^6 \frac{\text{volt}}{\text{sec}}$, and capacitance 1 μ F, then find displacement current between tha plates.

A. 1.0A

B. 0.1A

C. 2A

D. 0.2A

Answer: A

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2. A parallel plate capacitor consits of two circular plates of radius 0.5m. If electric field between the plates changed as $\frac{dE}{dt} = 10^{10}. \frac{V}{m-c}$, then find displacement current between the plates

A. 7 mA

B. 0.07 mA

C. 0.7 mA

D. 70 mA

Answer: C

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3. An electromagnetic wave is propagating in vacuum along x-axis, which is produced by oscillating charge of frequency 3×10^{10} Hz. The amplitude of magnetic field, 1×10^{-7}T along z-axis find equation for oscillating electric field

A. $\vec{E} = 30 \sin\left(6\pi \times 10^{10} t - 628X\right) \hat{j} \frac{N}{C}$

B. 2) $\vec{E} = \sin\left(6\pi \times 10^{10} t - 628X\right) \hat{J} \frac{N}{C}$

C. 3) $\vec{E} = 30 \sin\left(6\pi \times 10^{10} t - X\right) \hat{j} \frac{N}{C}$

D. 4) $\vec{E} = 30 \tan\left(6\pi \times 10^{10} t - X\right) \hat{j} \frac{N}{C}$

Answer: A

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4. The electric field part of an electromagnetic wave in vacuum is given by E = 6 cos $\left[1.2\frac{\text{rad}}{m}y + 3.6 \times 10^8 \frac{\text{red}}{s}t\right]\hat{i}\frac{N}{C}$, then find

i) frequency of propagation (f)

(ii) Ampitude of magnetic field in electromagnetic wave

A. $5.7 \times 10^7 Hz, 2 \times 10^{-8}$ T

B. $57 \times 10^7 Hz, 0.2 \times 10^{-8}$ T

C. $5.7 \times 10^4 Hz, 2 \times 10^{-6}$ T

D. $5.7 \times 10^{10} Hz, 2 \times 10^{-10}$ T

Answer: A

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5. The magnetic field in plane electromagnetic wave is given by

$B_y = 4 \times 10^{-6} \sin\left(0.2 \times 10^4 x + 0.6 \times 10^{12} t\right)$ T, then find

i) Wavelength

(ii) Speed of the wave

A. 31.4 $\times 10^{-3} m$, 0.3×10^8 m/s

B. $3.14 \times 10^{-3} m$, 3×10^8 m/s

C. $3.14 \times 10^{-6} m$, 3×10^6m/s

D. $3.14 \times 10^{-2} m$, 3×10^2m/s

Answer: B

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Evaluate Yourself 2

1. An L – C circuit contain a 400 pF capacitor and a $100\mu F$ inductor. It is set into oscillation coupled to an antenna. The wavelength of the radiated electromagnetic waves is :

A. 377 mm

B. 377 metre

C. 377 cm

D. 3.77 cm

Answer: B

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2. Which of the following statement is incorrect about electromagnetic waves?

A. Are transverse in nature

B. Are produced by accelerating charges

C. Travel with the same speed in all media

D. Travel in free space with the speed of light

Answer: C

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3. Total energy of density of electromagnetic waves in vacuum is given by the relation

A. $\frac{1}{2}, \frac{E^2}{\varepsilon_0} + \frac{B^2}{2\mu_0}$

B. $\frac{1}{2}\varepsilon_0 E^2 + \frac{1}{2}\mu_0 B^2$

C. $\frac{E^2 + B^2}{c}$

D. $\frac{1}{2}\varepsilon_0 E^2 + \frac{B^2}{2\mu_0}$

Answer: D

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4. In an electromagnetic wave, the electric field is 100 V/m. The maximum intensity flow will be $\frac{1}{\mu_0}$ times of

A. 79 W/m^2

B. 13.2 W/m^2

C. 53.0 W/m^2

D. 26.5 W/m^2

Answer: D

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5. 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. 13.6×10^8m/s

B. 1.8×10^6 m/s

C. 3.6×10^8 m/s

D. 1.8×10^8 m/s

Answer: D

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6. A radiation of energy E falls normally on a perfctly refelecting surface . The momentum transferred to the surface is

A. E / c

B. 2E /c

C. Ec

D. E/c^2

Answer: B

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7. If the energy of the photon is increased by a factor of 4, then its momentum

A. Does not change

B. Decreases by a factor of 4

C. Increases by factor of 4

D. Decreases by a factor of 2

Answer: C

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8. In an electromagnetic wave, the direction of propagation is in the direction of

A. $\overrightarrow{E}$

B. $\overrightarrow{B}$

C. $\overrightarrow{E} \times \overrightarrow{B}$

D. None of these

Answer: C

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9. An electromagnetic radiation has an energy $14.4KeV$. To which region of elctromagnetic spectrum does it belong?

A. Ultraviolet region

B. Visible region

C. X-ray region

D. ray region

Answer: A

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10. In an electromagnetic wave, the amplitude of electric firld is $1\frac{V}{m}$. The frequency of wave is $5 \times 10^{14} Hz$. The wave is propagating along z-axis. The average energy density of electric field, in joule/m^3,will be

A. $2.2 \times 10^{-12} J/m^2$

B. $22 \times 10^{-12} J/m^2$

C. $2.2 \times 10^{12} J/m^2$

D. $22 \times 10^{12} J/m^2$

Answer: A

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11. A point source of electromagnetic radiation has an average power output of $800W$. The maximum value of electric field at a distance $3.5m$ from the source will be $62.6\frac{V}{m}$, the energy density at a distance $3.5m$ from the source will be- (in joule/m^3)

A. 626 V/m

B. 62.6 V/m

C. 6.26 V/m

D. 0.626 V/m

Answer: B

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12. In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of 2.0×10^{10}Hz and amplitude $48Vm^{-1}$. The total energy density of the electromagnetic field of the wave is :

A. $0.1 \times 10^{-8} J/m^3$

B. $1.0 \times 10^{-6} J/m^3$

C. $1.0 \times 10^{-8} J/m^3$

D. $100 \times 10^{-8} J/m^3$

Answer: C

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CUQ

1. If E and B represent electric and magnetic field vectors of the electromagnetic wave, the direction of propagation of eletromagnetic wave is along.

A. $\vec{E}$

B. $\vec{B}$

C. $\vec{E} \times \vec{B}$

D. $\vec{B} \times \vec{E}$

Answer: C

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2. The electromagnetic waves do not transport

A. energy

B. charge

C. momentum

D. information

Answer: B

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3. A capcitor is connected in an electric circuit with an open key, immediately after pressing the key, the current in the circuit is-

A. zero

B. maximum

C. any transient value

D. depends on capacitor used

Answer: B

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4. Displacement current is continuous-

A. When electric field is changing in the circuit

B. When magnetic field is changing in the circuit

C. in both types of fields.

D. through wire and resistance only

Answer: A

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5. The conduction current is the same as displacement current when the source is

A. A.C. only

B. D.C. only

C. both A.C and D.C .

D. neither for A.C. nor for D.C

Answer: B

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6. The maxwells four equations are written as

i. $\oint \overrightarrow{E} . \overrightarrow{dS} = \frac{q}{\varepsilon_0}$

ii. $\oint \overrightarrow{B} . \overrightarrow{dS} = 0$

iii. $\oint \overrightarrow{E} . \overrightarrow{dl} = \frac{d}{dt} \oint \overrightarrow{B} . \overrightarrow{dS}$

iv. $\oint \overrightarrow{B} . \overrightarrow{dl} = \mu_0 \varepsilon \frac{d}{dt} \oint \overrightarrow{E} . \overrightarrow{dS}$

The equations which have sources of $\overrightarrow{E}$ and $\overrightarrow{B}$ are

A. (i), (ii),(iii)

B. (i), (ii)

C. (i) and (iii) only

D. (i) and (iv) only

Answer: D

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7. Out of the above four equations, the equations which do not contain source field are-

A. (i) and (ii)

B. (ii) only

C. all of four

D. (iii) only

Answer: B

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8. Out of the four Maxwell's equations above, which one shows non-existence of monopoles?

A. (i) and (iv)

B. (ii) only

C. (iii) only

D. None of these

Answer: B

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9. Which of the above Maxwell's equations shows that electric field lines do not form closed loops ?

A. (i) only

B. (ii) onlu

C. (iii) only

D. (iv) onlu

Answer: A

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10. The displacement current flows in the dielectric of a capacitor when the potential difference across its plates-

A. becomes zero

B. has assumed a constant value

C. is increasing with time

D. decreasing with time

Answer: C

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11. In an electromagnetic wave the average energy density is associated with-

A. electric field only

B. magnetic field only

C. equally with electric and magnetic fields.

D. average energy density is zero.

Answer: C

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12. In an electromagnetic wave, the average energy density associated with magnetic field is:

A. $\frac{1}{2}\mathrm{Lt}^2$

B. $\frac{B^2}{2\mu_0}$

C. $\frac{1}{2}\mu_0 B^2$

D. $\frac{1}{2}\frac{\mu_0}{B^2}$

Answer: B

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13. In the above problem, the energy density associated with the electric field will be

A. $\frac{1}{2}CV^2$

B. $\frac{1}{2}\frac{q^2}{C}$

C. $\frac{1}{2}\frac{\varepsilon^2}{E}$

D. $\frac{1}{2}\frac{\varepsilon_0}{E^2}$

Answer: D

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14. If three wave no atmosphere, the average temperature on the surface of earth would be :-

A. Lower

B. Higher

C. same

D. 0^0C

Answer: A

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15. The zone of atmosphere in which the ozone layer is

A. troposphere

B. stratosphere

C. Ionosphere

D. Mesosphere

Answer: B

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16. The ozone layer is earth's atmosphere is crucial for human survival because it

A. has ions

B. reflects radio signals

C. reflects ultraviolet rays

D. reflects infra red rays

Answer: C

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17. The frequency from 3×10^9 Hz to 3×10^{10} Hz is

A. High frequency band

B. super high frequency band

C. ultra high frequency band

D. very high frequency band

Answer: B

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18. The frequency range of 3 MHz to 30 MHz is used for

A. audio band

B. medium frequency band

C. very high frequency band

D. high frequency band

Answer: B

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19. The AM range of radiowaves have frequency

A. less than 30 MHz

B. more than 30 MHz

C. less than 20000 HZ

D. more than 20000 HZ

Answer: A

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20. Select wrong statement from the following for EMW

A. are transverse

B. travel with same speed in all medium

C. travel with the speed of light

D. are produced by accelerating change

Answer: B

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21. The waves related to tele communication are

A. infrared

B. visible light

C. microwaves

D. ultraviolet rays

Answer: C

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22. Which of the following wavelength falls in X - ray region

A. $1A^0$

B. $10A^0$

C. $10^{-2}A^0$

D. $10^{-3}A^0$

Answer: A

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23. 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 $\vec{K} \| \vec{B} \times \vec{E}$

Answer: B

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24. The nature of electromagnetic wave is-

A. logitudinal

B. longitudinal stationary

C. transverse

D. transverse stationary

Answer: C

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25. The frequencies of X-rays, γ-rays and ultraviolet rays are respectively $a, b \text{ and } c$ .Then

A. a $<$ b, b $<$ c

B. a $>$ b, b $>$ c

C. a $>$ b, b $>$ c

D. a $<$ b, b, $>$ c

Answer: D

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26. Electromagnetic radiation of frequency 3×10^5 MHz can be produced by which of the following wave

A. Radiowave

B. X-rays

C. Ultraviolet

D. Microwave

Answer: D

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27. Maxwell's equations describe the fundamental laws of

A. electricity only

B. magnetism only

C. mechanics only

D. both 1 and 2

Answer: D

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28. Which of the following statements is not correct ?

A. Photographic plates are sensitive to infrared rays

B. Photographic plates are sensitive to ultraviolet rays

C. Infra-red rays are invisible but can cast shadows like visible light

D. infrared photons have more energy than photons of visible light

Answer: D

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29. Radio waves and visible light in vacuum have

A. same velocity but different wavelength

B. continuous emission spectrum

C. band absorption spectrum

D. line emission spectrum

Answer: A

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30. Energy stored in electromagnetic osicllations is in the form of

A. electrical energy

B. magnetic energy

C. both 1 and 2

D. neither of the above

Answer: C

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31. Which of the following is not an electromagnetic wave?

A. micro

B. radio

C. X-ray

D. audio

Answer: D

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32. Total energy of EM waves in free space is given by

A. $\frac{E^2}{2\varepsilon_0} + \frac{B^2}{2\mu_0}$

B. $\frac{\varepsilon_0 E^2}{2} + \frac{\mu_0 B^2}{2}$

C. $\frac{E^2 + B^2}{c}$

D. $\frac{\varepsilon_0 E^2}{2} + \frac{B^2}{2\mu_0}$

Answer: D

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33. Which of the following waves have the maximum wavelength?

A. Ultraviolet rays

B. I.R. rays

C. UV rays

D. radio waves

Answer: D

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34. Electrimagnetic waves are transverse is nature is evident by

A. polarization

B. interference

C. reflection

D. diffraction

Answer: A

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35. Which of the following are not electromagnetic waves ?

A. secondary cosmic rays

B. gamma rays

C. β - rays

D. X-rays

Answer: C

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36. Let $\overrightarrow{E}$, $\overrightarrow{B}$ and $\overrightarrow{C}$ represent the electric field, magnetic field and velocity of an electromagnetic wave respectively. Their directions, at any instant point along the unit vectors given below in order. Which of the following cannot be true?

A. $\hat{k}, \hat{i}, \hat{j}$

B. $\hat{k}, \hat{j}, -\hat{i}$

C. $\hat{i}, \hat{j}, \hat{k}$

D. $-\hat{j}, -\hat{k}, -\hat{i}$

Answer: D

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37. A radiation of energy E falls normally on a perfctly refelecting surface . The momentum transferred to the surface is

A. E/C

B. 2E/C

C. Ec

D. E/c^2

Answer: B

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38. An electromagnetic wave going through vacuum is described by

$E = E_0 \sin(kx - \omega t), B = B_0 \sin(kx - \omega t).$

Then

A. $E_0 = B_0$

B. $E_0\omega = B_0$k

C. $E_0 B_0 = \omega k$

D. $E_0 k = B_0\omega$

Answer: D

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39. The frequnecy of visible light is of the order of

A. 10^{15}Hz

B. 10^{10} Hz

C. 10^{6}Hz

D. 10^{4}Hz

Answer: A

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Exercise 1 C W

1. The charging current for a capacitor is $0.25A$. What is the displacement current across its plates?

A. 0.15 amp

B. 0.25 amp

C. 0.55 amp

D. 0.35 amp

Answer: B

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2. v22

A. 6.9 μ A

B. 2.3 μ A

C. 9.2 μ A

D. 4.6 μ A

Answer: A

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3. A parallel plate capacitor of plate separation 2 mm is connected in an electric circuit having source voltage 400 V . if the plate area is $60cm^2$, then the value of displacement current for 10^{-6}sec will be

A. 1.062 amp

B. 1.062×10^{-2} amp

C. 1.062×10^{-3} amp

D. 1.062×10^{-4} amp

Answer: B

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4. A parallel plate capacitor consists of two circular plates each of radius $12cm$ and separated by $5.0mm$. The capacitor is being charge by an external source. The charging current is constant and is equal to 0.15 A.

The rate of change of potential difference between the plate will be

A. 8.17310^7V /sec

B. 7.81710^7 V/sec

C. 1.873×10^9 V/sec

D. 3.781×10^{10} V /sec

Answer: C

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5. An electruc field of $300V/m$ is confined to a circular area $10cm$ in diameter. If the field is increasing at the

rate of $20V/m-s$, the magnitude of magnetic field at a point $15cm$ from the centre of the circle will be-

A. 1.85×10^{-15} T

B. 1.85×10^{-16} T

C. 1.85×10^{-17} T

D. 1.85×10^{-18} T

Answer: D

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6. The magnetic field between the plates of a capacitor when $r > R$ is given by-

A. $\frac{\mu_0 I_D r}{2\pi R^2}$

B. $\frac{\mu_0 I_D}{2\pi R}$

C. $\frac{\mu_0 I_D}{2\pi r}$

D. zero

Answer: C

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7. A condenser is charged using a constant current. The ratio of the magnetic field at a distance of $\frac{R}{2}$ and R from the axis of condenser (R is the radius of plate) while charging is

A. $1:1$

B. $2:1$

C. $1:2$

D. $1:4$

Answer: C

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8. The magnetic field between the circulate plates of radius $12cm$ separted by distance of $4mm$ of a parallel plate capacitor of capacitance $100pF$. Along the axis of plates having conduction current of $0.15A$ is

A. zero

B. 1.5 T

C. 15 T

D. 0.15 T

Answer: A

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9. The magnetic field of an electromagnetic wave is given by $3 \times 10^{-7} \sin\left(10^3 x + 6.28 \times 10^{12} t\right)$. The wave length of the electromagnetic wave is

A. 6.28 cm

B. 3.14 cm

C. 0.63 cm

D. 0.32 cm

Answer: C

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10. If a source is transmitting electro magnetic waves of frequency 8.196×10^6 Hz, then the wavelength of the electromagnetic waves transmitted from the source will be

A. 5090 cm

B. 4050 cm

C. 4230 cm

D. 3660 cm

Answer: D

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11. The wave function (in $S.Iunit$) for an electromagnetic wave is given as-

$\psi(x, t) = 10^3 \sin \pi \left(3 \times 10^6 x - 9 \times 10^{14} t\right)$

The speed of the wave is

A. 9×10^{14} m/s

B. 3×10^{8} m/s

C. 3×10^{6} m/s

D. 3×10^{7}m/s

Answer: B

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12. The velocity of all radiowaves in free space is 3×10^{8}, $/s$, the frequency of a wave of wavelength $150m$ is

A. 45 MHz

B. 2 MHz

C. 2 KHz

D. 20 KHz

Answer: B

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13. The relative permeability of glass is $3/8$ and the dielectric constant of glass is 8. The refractive index of glass is

A. 1.5

B. 1.1414

C. 1.732

D. 1.6

Answer: C

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14. An electromagnetic wave of frequency $v = 3.0MHz$ passes from vacuum into a dielectric medium with permittivity $\varepsilon = 4.0$. Then

A. Wave length doubled and frequency remains unchanged

B. wave length is doubled and frequency becomes half

C. wave length is halved and freqency remains unchanged

D. wave length and frequency both remain unchanged

Answer: C

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15. In a plane electromagnetic wave propagating in space has an electric field of amplitude $9 \times 10^3 V/m$,

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

Answer: D

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16. The amplitude of the magnetic field part of a harmonic electromagnetic wave in vacuum is

$B_0 = 510nT$. What is the amplitude of the electric field part of the wave?

A. 140 NC^{-1}

B. 153 NC^{-1}

C. 163 NC^{-1}

D. 133 NC^{-1}

Answer: B

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17. In a plane electromagnetic wave, the electric field oscillates sinnusoidally at a frequency of $2 \times 10^{10} Hz$

and amplitude $48V/m$. The amplitude of oscillating magnetic field will be

A. $\frac{1}{16} \times 10^{-8}$ Wb/m^2

B. 16×10^{-8}Wb/m^2

C. 12×10^{-7}Wb/m^2

D. $\frac{1}{12} \times 10^{-7}$Wb/$m^2$

Answer: B

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18. In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of $2 \times 10^{10} Hz$

and amplitude $48V/m$. The wavelength of the wave will be-

A. 1.5 m

B. 66.6 m

C. 1.5 cm

D. 66.6 cm

Answer: C

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19. In an apparatus the electric field was found to oscillate with an amplitude of $18\ V/m$. The magnitude

of the oscillating magnrtic field will be

A. 6×10^{-8}T

B. 4.23×10^{-8} T

C. 9×10^{-8} T

D. 7.0×10^{-8} T

Answer: B

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20. The amplitude of the sinusodially oscillating electric field of a plane wave is $60V/m$. Then the amplitude of the magnetic field is

A. 12×10^7 T

B. 6×10^7T

C. 6×10^{-7}T

D. 2×10^{-7} T

Answer: D

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21. Light with energy flux of $18W/cm^2$ falls on a non reflecting surface of area $20cm^2$ at normal incidence the momentum delivered in 30 $\min utes$ is

A. 1.2×10^{-6} kgms^{-1}

B. $2.16 \times 10^{-3} \text{kgms}^{-1}$

C. $1.18 \times 10^{-3} \text{ kgms}^{-1}$

D. $3.2 \times 10^{-3} \text{ kgms}^{-1}$

Answer: B

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22. Light with energy flux of $24 Wm^{-2}$ is incident on a well polished disc of radius $3.5cm$ for one hour. The momentum transferred to the disc is

A. 1.1μ kg ms^{-1}

B. 2.2 μ kg ms^{-1}

C. 3.3 μ kg ms^{-1}

D. 4.4 μ kg ms^{-1} \

Answer: B

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23. The magnetic field in a plane electromagnetic wave is given by $B = (200(\mu)T)\sin\left[\left(4.0 \times \left(10^{15}\right)\left(s^{-1}\right)\left(t - \left(\frac{x}{c}\right)\right)\right]\right.$. Find the maximum electric field and the average energy density corresponding to the electric field .

A. 0.016 J/m^3

B. 0.015 J $/m^3$

C. 0.014 J $/m^3$

D. 0.02 J $/m^3$

Answer: A

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24. The average value of electric energy density in an electromagnetic wave is (E_0 is peak value):

A. $\frac{1}{2}\varepsilon_0 E_0^2$

B. $\frac{E_0^2}{2\varepsilon_0}$

C. $\varepsilon_0 E_0^2$

D. $\frac{1}{4}\varepsilon_0 E_0^2$

Answer: D

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25. The electric field of a plane electromagnetic wave varies with time of amplitude $2Vm^{-1}$ propagating along z-axis. The average energy density of the magentic field is (in Jm^{-3})

A. 13.29 $X10^{-12}$

B. $8.86X10^{-12}$

C. $17.72x10^{-12}$

D. $4.43x10^{-12}$

Answer: B

Watch Video Solution

26. The maximum electric field of a plane electromagnetic wave is $88V/m$. The average energy density is

A. $3.4 \times 10^{-8} Jm^{-3}$

B. $13.7 \times 10^{-8} Jm^{-3}$

C. $6.8 \times 10^{-8} Jm^{-3}$

D. $1.7 \times 10^{-8} Jm^{-3}$

Answer: C

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27. The rms value of electric field of a plane electromagnetic wave is $314V/m$.The average energy density of electric field and the average energy density are

A. $4.3 \times 10^{-7} Jm^{-3}, 2.15 \times 10^{-7} Jm^{-3}$

B. $4.3 \times 10^{-7} Jm^{-3}, 8.6 \times 10^{-7} Jm^{-3}$

C. $2.15 \times 10^{-7} Jm^{-3}, 4.3 \times 10^{-7} Jm^{-3}$

D. $8.6 \times 10^{-7} Jm^{-3}, 4.3 \times 10^{-7} Jm^{-3}$

Answer: B

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28. The magnetic of pointing vector and electric field vector are respectively S and E, then

A. $S = E^2\sqrt{\frac{\varepsilon_0}{\mu_0}}$

B. $S = E^2\sqrt{\varepsilon_0\mu_0}$

C. $S = E^2\sqrt{\frac{\mu_0}{\varepsilon_0}}$

D. $S^2 = \frac{E^2}{\mu_0}$

Answer: A

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29. The intensity of the sunlight reaching the earth is $1380W\left(m^{-2}\right)$. Assume this light to be a plane, monochromatic wave. Find the amplitudes of electric and magnetic field in this wave.

A. 3.4×10^{-6} T

B. 4.4×10^{-5} T

C. 1.4×10^{-5} T

D. 2.4×10^{-1} T

Answer: A

Watch Video Solution

30. The sun delivers $10^3 W/m^2$ of electromagnetic flux to the earth's surface.The total power that is inclident on a roof of dimensions $8m \times 20m$, will be

A. 6.4×10^3 W

B. 3.4×10^4 W

C. 1.6×10^3 W

D. None of these

Answer: C

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31. If a source of power $4kW$ produces 10^{20} photons / second, the radiation belongs to a part of the spectrum called:

A. X -rays

B. Ultraviolet rays

C. microwaves

D. γ rays

Answer: A

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32. The intensity of electromagnetic wave at a distance of $1Km$ from a source of power $12.56Kw$. Is

A. $10^{-3}\ \mathrm{W}m^{-2}$

B. $4 \times 10^{-3}\ \mathrm{W}m^{-2}$

C. $12.56 \times 10^{-3}\ \mathrm{W}\ m^{-2}$

D. $1.256 \times 10^{-3}\ \mathrm{W}\ m^{-2}$

Answer: A

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Exercise 1 H W

1. The voltage between the plates of a parallel plate condenser of capacity $2.0\mu F$ is charging at a rate of $10Vs^{-1}$. The displacement current

A. 2 mA

B. 2μA

C. 20μ A

D. $2A$

Answer: C

Watch Video Solution

2. A parallel plate condenser of capacity $10\mu F$ is charged with a constant charging current of $0.16A$. The displacement current is

A. 0.16 μA

B. 0.16A

C. 0.96 A

D. 9.6 A

Answer: B

Watch Video Solution

3. A parallel plate capacitor of plate separation $2mm$ is connected in an electric circuit having source voltage $400V$. If the plate area is $60cm^2$, then the value of displacement current for $10^{-6}\,\text{sec}$ will be

A. 1.062 amp.

B. 1.062×10^{-2} amp

C. 1.062×10^{-3} amp

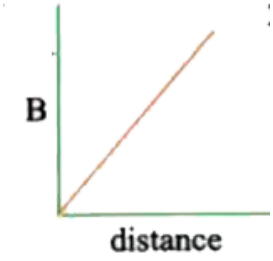
D. 1.062×10^{-4} amp

Answer: B

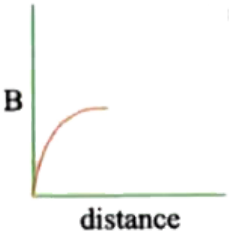
Watch Video Solution

4. The graph representing the variation of induced magnetic field in the gap of the condenser plates during its charging with the distance from the axis of the gap is

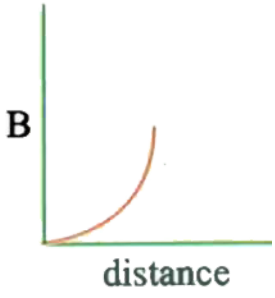
A.

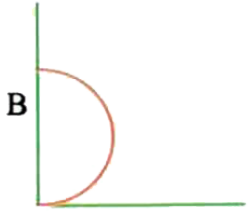


B.



C.





D.

Answer: A

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5. The electrical field in the gap of a condenser charges as $10^{12} Vm^{-1}s^{-1}$. If the radius of each plate of the condenser is $3cm$, the magnetic field at the edge of plate in the gap is

A. 1.67 mT

B. 0.167 μT

C. 0.5 μT

D. 5 μ T

Answer: B

Watch Video Solution

6. An LC current contains inductance $L = 1\mu$ H and capacitance $C = 0.01\mu F.$ The wavelength of electromagnetic wave generated is nearly:

A. 0.5 m

B. 5m

C. 188m

D. 30 m

Answer: C

Watch Video Solution

7. The wave length of the Green light of mercury is $550nm$. If the refractive index of the glass is 1.5, the time period of the electrical vector in glass nearly ($C_0 = 3 \times 10^8 mS^{-1}$)

A. 1.8×10^{-9} S

B. 3.6×10^{-15} S

C. 9×10^{-15} S

D. 2.75×10^{-15} S

Answer: D

Watch Video Solution

8. The all India Radio, station at Vijayawada transmits its signals at $840KC/s$. The wave length of the radio wave is

A. 35.7m

B. 357 m

C. 35.7 km

D. 3.57 m

Answer: B

Watch Video Solution

9. A point source of electromagnetic radiation has an average power output of 800W. The mximum value of electric field at a distance 3.5 m from the source will be 62.6 V/m, the maximum value of magnetic field will be -

A. 2.09×10^{-5} T

B. 2.09×10^{-6} T

C. 2.09×10^{-7} T

D. 2.09×10^{-8} T

Answer: C

Watch Video Solution

10. A plane $E.M.$ wave of frequency $40MHz$ travels along X-axis. At same point at same instant, the electric field E has maximum value of $750N/C$ in Y-direction. The magnitude and direction of magnetic field is

A. 2.5 μt along X-axis

B. 2.5 μt along Y-axis

C. 2.5 μt along Z-axis

D. 5 μt along Z-axis

Answer: C

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11. A plane electromagnetic wave of frequency $25Mhz$ travels in free space along the x-direction. At a particular point in space and time, $E = (6.3j)V/m$. What is B at this point?

A. $4.2 \times 10^{-8}\hat{k}$T

B. $2.1 \times 10^{8}\hat{k}$T

C. $18.9 \times 10^{8}\hat{k}$T

D. $2.1 \times 10^{8}\hat{k}$T

Answer: B

Watch Video Solution

12. An electruc field of $300V/m$ is confined to a circular area $10cm$ in diameter. If the field is increasing at the rate of $20V/m - s$, the magnitude of magnetic field at a point $15cm$ from the centre of the circle will be-

A. 1.85×10^{-15} T

B. 1.85×10^{-16} T

C. 1.85×10^{-17} T

D. 1.85×10^{-18} T

Answer: A

Watch Video Solution

13. A lamp emits monochromatic green light uniformly in all directions. The lamp is 3% efficient in converting electrical power to electromagnetic waves and consumes $100W$ of power. The amplitude of the electric field associated with the electromagnetic. radiation at a distance of $10m$ from the lamp will be

A. 1.34 V/m

B. 2.68 V/m

C. 5.36 V/m

D. 9.37 V/m

Answer: D

Watch Video Solution

14. Light with energy flux $36w/cm^2$ is incident on a well polished metal square plate of side $2cm$. The force experienced by it is

A. 0.96 μ N

B. 0.25 μ N

C. 0.12 μ N

D. 0.36 μ N

Answer: A

Watch Video Solution

15. The rms value of the electric field of the light from the sun is $720 N / C$ The total energy density of the electromagnetic wave is

A. 3.3×10^{-3} J/m^3

B. 4.58×10^{-6} J/m^3

C. 6.37×10^{-9} J/m^3

D. 81.35×10^{-12} J/m^3

Answer: B

Watch Video Solution

16. In an electromagnetic wave, the amplitude of electric firld is $1\frac{V}{m}$. The frequency of wave is $5 \times 10^{14} Hz$. The wave is propagating along z-axis. The average energy density of electric field, in joule/m^3,will be

A. 1.1×10^{-11}

B. 2.2×10^{-12}

C. 3.3×10^{-13}

D. 4.4×10^{-14}

Answer: B

Watch Video Solution

17. About 5% of the power of a 100W bulb is converted to visible radiation. What is the average intensity of visible adiation.

At a distance 1 m from the bulb ?

A. 0.4 W/m^2

B. 0.5 W/m^2

C. 0.6 W/m^2

D. 0.8 W/m^2

Answer: A

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18. The sun radiates electromagnetic energy at the rate of $3.9 \times 10^{26} W$. Its radius is $6.96 \times 10^{8} m$. The intensity of sun light at the solar surface will be (in W / m^{2})

A. 1.4×10^{4}

B. 2.8×10^{5}

C. 64×10^{6}

D. 5.6×10^{-7}

Answer: C

Watch Video Solution

19. The intensity of TV broad cast station of $E = 800\sin\left(10^9 t - kx\right)V/M$ is.....and the wave length in meter is.....

A. 850 Wm^{-2}, 0.6 π

B. $425Wm^{-2}, 0.6\pi$

C. $850Wm^{-2}, 0.3\pi$

D. $425Wm^{-2}, 0.3\pi$

Answer: A

Watch Video Solution

20. v22

A. 6.4×10^3 W

B. 3.4×10^4 W

C. 1.6×10^5 W

D. 3.2×10^5 W

Answer: C

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Exercise 2 C W

1. A parallel plate capacitor consists of two circular plates each of radius $2cm$, separated by a distance of $0.1mm$. Ifvoltage across the plates is varying at the

rate of $5 \times 10^{13} V / s$, then the value of displacement current is :

A. 5.50 A

B. 5.56×10^{2} A

C. 5.56×10^{3} A

D. 2.28×10^{4} A

Answer: C

Watch Video Solution

2. A parallel plate condenser has conducting plates of radius 12 cm separated by a distance of 5mm. It is

charged with a constant charging current of 0.16 A, the rate at which the potential difference between the plate change is

A. $1 \times 10^{9} Vs^{-1}$

B. $2 \times 10^{10} Vs^{-1}$

C. $3 \times 10^{12} Vs^{-1}$

D. $2 \times 10^{9} Vs^{-1}$

Answer: D

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3. A condenser has two conducting plates of radius $10cm$ separated by a distance of $5mm$. It is charged with a constant current of $0.15A$. The magnetic field at a point $2cm$ from the axis in the gap is

A. 1.5×10^{-6} T

B. 3×10^{-8} T

C. 6×10^{-8} T

D. 3×10^{-6} T

Answer: C

Watch Video Solution

4. An $ACrms$ voltage of $2V$ having a frequency of $50KHz$ is applied to a condenser of capacity of $10\mu F$. The maximum value of the magnetic field between the plates of the condenser if the radius of plate is $10cm$ is

A. 0.4 p μ

B. 4 $\pi\mu$ T

C. 2μ T

D. $40\pi\mu$ T

Answer: C

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5. The wave emitted by any atom or molecule must have some finite total length which is known as the coherence length. For sodium light, this length is $2.4cm$. The number of oscillations in this length will be Given $\lambda = 5900A^{\circ}$

A. 4.068×10^5 Hz

B. 4.068×10^4Hz

C. 4.068×10^6 Hz

D. 4.068×10^8 Hz

Answer: B

Watch Video Solution

6. A wave is propagating in a medium of dielectric constant 2 and relative permeability 50. The wave impedance is

A. 5Ω

B. 376.6Ω

C. 3776Ω

D. 1883Ω

Answer: D

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7. A plane electromagnetic wave propagating in the x-direction has wavelength of 60 mm. The electric field is in the y-direction and its maximum magnitude is $33V/m^{-1}$.The equation for the electric field as function of x and t is:

A. $11\sin\pi(t-x/c)$

B. $33\sin\pi\times10^{10}(t-x/c)$

C. $33\sin\pi(t-x/c)$

D. $11\sin\pi\times10^{10}(t-x/c)$

Answer: B

Watch Video Solution

8. The magnetic field In a travelling electromagnetic wave has a peak value of $20nT$ The peak value of electric field strength is :

A. 6 V/m

B. 9 V/m

C. 12 V/m

D. 3V/m

Answer: A

Watch Video Solution

9. A plane electromagnetic wave of frequency $40MHz$ travels in free space in the X-direction. At some point and at some instant, the electric field $\vec{E}$ has its maximum value of $750N/C$ in Y- direction. The wavelength of the wave is-

A. 3.5 m

B. 5.5 m

C. 7.5 m

D. 9.5 m

Answer: C

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10. A plane electromagnetic wave of wave intensity $6W/m^2$ strikes a small mirror of area $40cm(2)$, held perpendicular to the approaching wave. The momentum transferred by the wave to the mirror each second will be

A. 6.4×10^{-7} kg-m/s

B. 4.8×10^{-8} kg-m/s

C. 3.2×10^{-9} kg-m/s

D. 6×10^{-10}-m/s

Answer: D

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11. In the above question the radiation force on the mirror will be

A. 6.4×10^{-7}N

B. 4.8×10^{-8} N

C. 3.2×10^{-9}N

D. 1.6×10^{-10} N

Answer: D

View Text Solution

12. The sun delivers $10^3 W/m^2$ of electromagnetic flux is incident on a roof of dimension $8m \times 20m$ is 1.6×10^5 W, the radiation force on the roof will be-

A. 3.33×10^{-5} N

B. 5.33×10^{-4} N

C. 7.33×10^{-3} N

D. 9.33×10^{-2} N

Answer: B

Watch Video Solution

13. A point source of electromagnetic radiation has an average power output of $800W$. The maximum value of electric field at a distance $3.5m$ from the source will be $62.6\frac{V}{m}$, the energy density at a distance $3.5m$ from the source will be- (in joule/m^3)

A. 1.73×10^{-5}

B. 1.73×10^{-6}

C. 1.73×10^{-7}

D. 1.73×10^{-8}

Answer: D

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14. An electromagnetic radiation has an energy $14.4KeV$. To which region of elctromagnetic spectrum does it belong?

A. Infra red region

B. Visible region

C. X-rays region

D. γ -ray region

Answer: D

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15. A lamp radiates power P_0 uniformly in all directions, the amplitude of elctric field strength E_0 at a distance r from it is

A. $E_0 = \frac{P_0}{2\pi\varepsilon_0 cr^2}$

B. $E_0 = \sqrt{\frac{P_0}{2\pi\varepsilon_0 cr^2}}$

C. $E_0 = \sqrt{\frac{P_0}{4\pi\varepsilon_0 cr^2}}$

D. $E_0 = \sqrt{\frac{P_0}{8\pi\varepsilon_0 cr^2}}$

Answer: B

 Watch Video Solution

16. A laser beam can be focussed on an area equal to the square of its wavelength. A $He - Ne$ laser radiates energy at the rate of $1mW$ and its wavelength is $600nm$. The intensity of focussed beam will be

A. 3.2×10^9 W $/m^2$

B. 2.8×10^{13} W $/m^2$

C. 2.7×10^9 W$/m^2$

D. 3.2×10^{13} W $/m^2$

Answer: C

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17. The intensity of solar radiation of the earths surface is $1KWm^{-2}$. The power entering the pupil of an eye of diameter $0.5cm$ is

A. 39.2 mw

B. 19.6 mw

C. 9.8 mw

D. 4.9 mw

Answer: B

Watch Video Solution

18. A flood light is covered with a fitter than transmits red light. The electric field of the emerging beam is represented a sinusolidal plane wave

$$E_x = 36\sin\left(1.20 \times 10^7 z - 3.6 \times 10^{15} t\right) V/m$$

The average intensity of beam is $\text{watt}/(\text{metre})^2$ will be

A. 0.86 W/m^2

B. 1.72 W/m^2

C. 3.44 W/m^2

D. 6.88 W/m^2

Answer: B

Watch Video Solution

19. The sun delivers $10^3 W/m^2$ of electromagnetic flux to the earth's surface.The total power that is inclident on a roof of dimensions $8m \times 20m$, will be

A. 6.4×10^3 W

B. 3.4×10^4 W

C. 1.6×10^5 W

D. None of these

Answer: C

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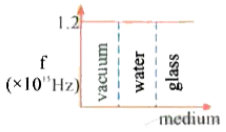
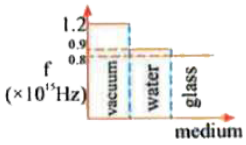
20. Electromagnetic waves of frequency $1.2 \times 10^{15} Hz$ enters into water and subsequently into glass from vacuum. Which of the following graphs correctly represent the variation of frequency f with medium? (Given that indices of refraction for water and glass are $4/3$ and $3/2$ respectively).

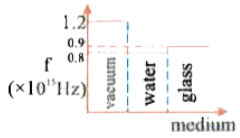
A.



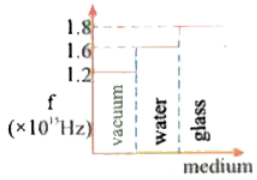
B.



C.



D.



Answer: A

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Exercise 2 H W Displacement Current

1. The area of each plate of parallel plated condenser is $144cm^2$. The electrical field in the gap between the plates changes at the rate of $10^{12}Vm^{-1}s^{-1}$. The displacement current is

A. $\frac{4}{\pi}A$

B. $\frac{0.4}{\pi}$

C. $\frac{40}{\pi}$

D. $\frac{1}{10\pi}A$

Answer: B

Watch Video Solution

2. A condenser having circular plates having radius $2cm$ and separated by a distance of $3mm$. It is charged with a current of $0.1A$. The rate at which the potential difference between the plates change is

A. $9 \times 10^{10} V / S$

B. 1.8×10^{10} V/S

C. 2.7×10^{6} V/S

D. 2.7×10^{10} V/S

Answer: D

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3. An AC source having a frequency of $50Hz$ and voltage supply of $300v$ is applied directly to the condenser of capacity $100\mu F$. The peak and rms values of displacement current are

A. $9.42A, \frac{9.42}{\sqrt{2}}$ A

B. $\frac{9.42}{\sqrt{2}}A, 9.42\sqrt{2}A$

C. $9.42\sqrt{2}A, 9.42A$

D. $9.42A, 9.42A$

Answer: C

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4. The capacity of a parallel plate condenser is $50pF$. A magnetic field of $4 \times 10^{-7}T$ is produced at a distance of $10cm$ from the axis of the gap. The charging current is

A. 0.1 A

B. 0.2 A

C. 0.3 A

D. 0.15 A

Answer: B

Watch Video Solution

5. The diameter of the condenser plate is $4cm$. It is charged by an external current of $0.2A$.The maximum magnetic field induced in the gap

A. $2\mu T$

B. 4μ T

C. 6μ T

D. 8μ T

Answer: A

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6. A condenser of capacity $50pF$ is connected to an AC supply of $220V50Hz$. The rms value of magnetic field at a distance of $5cm$ from the axis is

A. $22\pi \times 10^{-14}$ T

B. $22\pi \times 10^{-12}$ T

C. $44\pi \times 10^{13}$ T

D. $\frac{11}{5}\pi \times 10^{-12}$ T

Answer: B

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7. The velocity of an electromagnetic wave in a medium is $2 \times 10^8 mS^{-1}$. If the relative permeability is 1 the relative permittivity of the medium is $\left(C_0 = 3 \times 10^8 mS^{-1}\right)$

A. 2.25

B. 1.5

C. $4/9$

D. $2/3$

Answer: A

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8. In a plane electromagnetic wave, the electric field oscillates sinnusoidally at a frequency of $2 \times 10^{10} Hz$ and amplitude $48 V/m$. The amplitude of oscillating magnetic field will be

A. $\frac{1}{16} \times 10^{-8}$ Wb/ m^2

B. $16 \times 10^{-8} WB/m^2$

C. $12 \times 10^{-7} Wb/m^2$

D. $\frac{1}{12} \times 10^{-7} Wb/m^2$

Answer: B

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9. In an apparatus the electric field was found to oscillate with an amplitude of $18\ V/m$. The magnitude of the oscillating magnrtic field will be

A. 4×10^{-6} T

B. 6×10^{-8} T

C. 9×10^{-9} T

D. 11×10^{-11} T

Answer: B

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10. Light with energy flux $36Wm^{-3}$ is incident on a circular part of radius $1.4m$ of a perfectly balck body. The force experienced by the body and the momentum delivered in 10 min $utes$ are

A. $2.2\mu N, 7.2\mu \text{kgms}^{-1}$

B. $3.5\mu N, 7.4\mu \text{kgms}^{-1}$

C. $0.74\mu N, 444\mu \text{kgms}^{-1}$

D. $7.4\mu N, 2.2\mu \text{kgms}^{-1}$

Answer: C

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11. Light with energy flux $18wcm^{-2}$ is incident on a mirror of size $2cm \times 2cm$ normally. The force experienced by it and momentum delivered in one minute are

A. $0.48\mu N, 28.8\mu \text{kgms}^{-1}$

B. $48\mu N, 4.8\mu \text{kgms}^{-1}$

C. $28\mu N, 4.8\mu kgms^{-1}$

D. $0.24\mu N, 28.8\mu kgms^{-1}$

Answer: A

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12. Electromagnetic radiation with energy flux $50Wcm^{-2}$ is incident on a totally absorbing surface normally for $1hour$: If the surface has an area of $0.05m^2$, then the avergae force due to the radiaton pressure, on it is,

A. 8.3×10^{-7} N

B. 8.3×10^{-5} N

C. 1.2×10^{-7} N

D. 1.2×10^{-5}N

Answer: B

Watch Video Solution

13. In an electromagnetic wave in vacuum. The electrical and magnetic fields are $40\pi V/m$ and $0.4 \times 10^{-7}T$. The poynting vector

A. $4.4 \times 10^{7}m^{-1}$

B. $0.44Wm^{-1}$

C. $5.65Wm^{-1}$

D. $4.0Wm^{-1}$

Answer: D

Watch Video Solution

14. The amplitude of magnetic field at a region carried by an electromagnetic wave is $0.1\mu T$. The intensity of wave is

A. $4\mu Wm^{-2}$

B. $1.2Wm^{-2}$

C. $4Wm^{-2}$

D. $1.2\mu Wm^{-2}$

Answer: B

Watch Video Solution

Exercise 3 Previous Year Questions

1. The energy of the electromagetic wave is of the order of 15 keV. To which part of the spectrum dose it belong?

A. γ - rays

B. X-rays

C. Infra -red rays

D. Ultraviolet rays

Answer: C

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2. A radiation of energy E falls normally on a perfectly reflecting surface. The momentum transferred to the surface is (c = velocity of light)

A. $\frac{E}{C^2}$

B. $\frac{E}{C}$

C. $\frac{2E}{C}$

D. $\frac{2E}{C^2}$

Answer: C

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3. The condition under which a microwave oven heats up a food item containing water molecules most efficiently is:

A. The frequency of the microwaves has no relation with natural frequency of water molecules

B. Microwaves are heat waves so always produce heating

C. Infra -red waves produce heating in a microwave oven

D. The frequency of the microwves must maathc the resonant frequency of the water molecules

Answer: A

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4. Astronomical wavelength increase due to doppler effect known as

A. Red shift

B. Voilet shift

C. UV

D. IR shift

Answer: A

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5. The electric field associated with an electromagnetic wave in vacuum is given by $\vec{E} = 40\cos\left(kz - 6 \times 10^8 t\right)\hat{i}$,

where E, z and t are in volt per meter, meter and second respectively. The value of wave vector k is

A. $6m^{-1}$

B. $3m^{-1}$

C. $2m^{-1}$

D. $0.5m^{-1}$

Answer: C

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6. The ratio of amplitude of magnetic field to the amplitude of electric field for an electromagnetic wave propagating in vacumm is equal to

A. The speed of light in vacuum

B. Reciprocal speed of light in vacuum

C. The ratio of magnetic permeability to the electric susceptibility of vacuum

D. unity

Answer: A

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7. The frequency order of for γ-rays (b) X-rays (a) UV-rays (c):

A. $B > A > C$

B. $A > B > C$

C. $C > B > A$

D. $A > C > B$

Answer: A

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8. Voltage of modulating wave of 5 V with 10 MHz frequency was superimposed on carrier wave of frequency 20 MHz and voltage 20 V then the modulation index is

A. 0.25

B. 1.25

C. 2.43

D. 64.0

Answer: A

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9. The electric and the magnetic field, associated with an e.m. wave propagating along the $+z$axis, can be represented by

A. $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{k}\right]$

B. $\left[\vec{E} = E_0\hat{i}, \vec{B} = B_0\hat{j}\right]$

C. $\left[\vec{E} = E_0\hat{k}, \vec{B} = B_0\hat{i}\right]$

D. $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{i}\right]$

Answer: C

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

A. Infrared microwave ultraviolet gamma rays

B. Microwave infrared, ultraviolet ,gamma raays

C. Gamma rays ,ultra violet , infrared , microwaves

D. Microwaves , gamma rays , infrared , ultraviolet

Answer: D

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

A. These waves do not require any material medium for propagation

B. Both electric and magnetic field vectors attain the maxima and minima at the same place and same time

C. The energy in electromagnetic wave is divided equally between electric and magnetic vectors

D. Both electric and magnetic field vectors are parallel to each other and perpendicular to the

direction of propagation of wave .

Answer: C

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12. The electric field on an electromagnetic wave in free space is given by

$E = 10\cos\left(10^7 t + kx\right)\hat{j}V/m,$

Where t and x are in seconds and metres respectively. It can be inferred that

(1) the wavelength λ is $188.4m$.

(2) the wave number k is $0.33rad/m$

(3) the wave amplitude is $10V/m$

(4) the wave is propagating along +x direction.

which one of the following pairs of statement is correct?

A. (c) & (d)

B. (a) & (b)

C. (b) & (c)

D. (a) & (c)

Answer: A

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13. The electric field part of an electromagnetic wave in a medium is represented by

$$E_x = 0,$$

$$E_y = 2.5\frac{N}{C}\cos\left[\left(2\pi \times 10^6 \frac{rad}{m}\right)t - \left(\pi \times 10^{-2}\frac{rad}{s}\right)x\right]$$

$$E_z = 0.$$

The wave is

A. moving along x - direction with frequency 10^6 Hz and wavelength 100 m

B. Moving along x - direction with frequency 10^6 Hz and wavelength 200 m

C. Moving along-x - direction with frequency 10^6 Hz and wavelength 200 m

D. Moving along y- direction with frequency $2\pi \times 10^6$ Hz and wavelength 200 m

Answer: D

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14. If ν_s, ν_x and ν_m are the speeds of gamma rays X-rays and microwaves respectively in vacuum then

A. $\nu_s > \nu_x > \nu_m$

B. $\nu_s < \nu_x < \nu_m$

C. $\nu_s > \nu_x < \nu_m$

D. $\nu_s = \nu_x = \nu_m$

Answer: D

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15. The velocity of electromagnetic radiatior in a medium of permittivity ε_0 and permeability μ_0 is given by

A. $9.42A, \frac{9.42}{\sqrt{2}}$ A

B. $\frac{9.42}{\sqrt{2}}A, 9.42\sqrt{2}A$

C. $\sqrt{\frac{\varepsilon_0}{\mu_0}}$

D. $\sqrt{\mu_0\varepsilon_0}$

Answer: A

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16. The velocity of electromagnetic radiatior in a medium of permittivity ε_0 and permeability μ_0 is given by

A. $\sqrt{\frac{\mu_0}{\varepsilon}}$

B. $\sqrt{\frac{\varepsilon_0}{\mu_0}}$

C. $\sqrt{\mu_0 \varepsilon_0}$

D. $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

Answer: D

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17. The electric and magnetic field of an electromagnetic wave is

A. In opposite phase and perpendicular to each other

B. In opposite phase and parallel to each other

C. In phase and parallel to each other

D. In phase and parallel to each other

Answer: D

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18. Which wavelength of sun is used finally as electric energy ?

A. Radio waves

B. Infrared waves

C. Visible light

D. Micro waves

Answer: B

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19. The pressure exerted by an electromagnetic wave of intensity I $\left(\text{watt}/\text{m}^2\right)$ on a nonreflecting surface is [c is the velocity of light]

A. Ic

B. Ic^2

C. I/c

D. I/c^2

Answer: C

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20. Velocity of light is equal to

A. $\sqrt{\varepsilon_0 \mu_0}$

B. $\sqrt{\varepsilon_0 / \mu_0}$

C. ε_0 / μ_0

D. $\sqrt{\frac{1}{\varepsilon_0 \mu_0}}$

Answer: D

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21. Light propagates rectilinearly because of its

A. frequency

B. velocity

C. wavelength

D. waave nature

Answer: D

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22. X-ray beams are affected by

A. electric field

B. magntic field

C. both 1 and 2

D. none ofthese

Answer: D

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23. A light of intensity I_0 passes through a material of thickness d. The resultant intensity is

A. $I = I_0 e^{-dt}$

B. $I = I_0\left(Ie^{-d\gamma}\right)$

C. $I = I_0 e^{-d\gamma}$

D. $I = I_0\left(I = e^{-d\gamma}\right)$

Answer: C

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24. 'SONAR' emits which of the following waves

A. ultrasound

B. Radio

C. Light

D. None of these

Answer: A

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25. Energy is not carried by which of the following waves

A. Electromagnetic

B. Transverse

C. Stationary

D. Progressive

Answer: C

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26. Light appears to travel in straight lines since

A. its wavelength is very small

B. It is not absorbed by surrounding

C. its velocity is very large

D. its is reflected by sorrounding

Answer: A

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27. According to Maxwell's hypothesis, a changing electrio field gives rise to

A. magnetic field

B. electric current

C. an e.m.f

D. pressure radiant

Answer: A

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28. Which of the following represents an infrared wavelength

A. 10^{-4} cm

B. 10^{-5} cm

C. 10^{-6} cm

D. 10^{-7} cm

Answer: A

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29. In general the wavelength of microwaves is

A. more than of infrared waves

B. more than that of radiowaves

C. less than that of infrared waves

D. less than that of ultraviolet waves

Answer: A

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30. The velocity of all radiowaves in free space is 3×10^8, $/s$, the frequency of a wave of wavelength $150m$ is

A. 20 kHz

B. 45 MHz

C. 2k Hz

D. 2 MHz

Answer: D

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Exercise 4

1. Light with an energy flux$20W/cm^2$ falls on a non-reflecting surface at normal incidence. If the surface has an area of $30cm^2$. the total momentum delivered (for complete absorption)during 30 minutes is

A. $36x10^5$ kg -m/s

B. $36x10^4$ kg m/s

C. $108x10^4$ kg -m/s

D. $1.08x10^7$ kg -m/s

Answer: B

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2. The electric field intensity produced by the radiations coming from 100W bulbs at a 3m distance is E. The electric field intensity produced by the radiations coming from 50W bulb at the same distance is

A. $\frac{E}{2}$

B. 2 E

C. $\frac{E}{\sqrt{2}}$

D. $\sqrt{2}$ E

Answer: C

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3. A brilliant are lamp delivers a liminous flux of 100 w to a $1cm^2$ absorber . The force due to radiation pressure is :

A. 3.3×10^{-4} N

B. 16.5×10^{-7} N

C. 3.3×10^{-6} N

D. 3.3×10^{-7} N

Answer: D

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4. A plane electromagnetic wave is incident on a material surface. The wave delivers momentum p and energy E.

A. $p = 0, E = 0$

B. $p \neq 0, E \neq 0$

C. $p \neq 0, E = 0$

D. $p = 0, E \neq 0$

Answer: B

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5. Find the radiation pressure of solar radiation on the surface of the earth . Solar constant is $1.4 \times 10^3 Wm^{-2}$:

A. 4.7×10^{-5} Pa

B. 4.7×10^{-6} Pa

C. 2.37×10^{-6} Pa

D. 9.4×10^{-6} Pa

Answer: B

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6. A radio station on the surface of the earth radiates 50 kW . If transmitter radiates equally in all directions avove the surface of the earth . Find the amplitude of electric field detected 100 km away :

A. $2.45Vm^{-1}$

B. $2.45 \times 10^{-1}Vm^{-1}$

C. $2.45 \times 10^{-2}Vm^{-1}$

D. $2.45 \times 10^{-3}Vm^{-1}$

Answer: A

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7. An EM wave radiates out wards from a dipole antenna with E_0 as the amplitude of its electric filed vector. The electric field E_0 which transports significant energy from the source falls off as

A. $\frac{1}{r^3}$

B. $\frac{1}{r^2}$

C. $\frac{1}{r}$

D. Remains constant

Answer: A

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8. The intensity of a plane electromagnetic wave is 5W / m^2 . It is incident on a perfectly reflecting surface. Find the radiation pressure:

A. $3.33 \times 10^{-19} N/m^2$

B. $3.33 \times 10^{-8} N/m^2$

C. $8.0 \times 10^{-8} N/m^2$

D. $8.0 \times 10^{-9} N/m^2$

Answer: B

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9. The amplitude of electric field in a parallel light beam of intensity $4Wm^{-2}$ is

A. $35.5NC^{-1}$

B. $45.5NC^{-1}$

C. $49.5NC^{-1}$

D. $55.5NC^{-1}$

Answer: D

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10. Find the value of magnetic field between plates of capacitor at distance $1m$ from center, where electric field varies by $10^{10}V/m$ per second.

A. 5.56 T

B. 5.56μ T

C. 5.56 nT

D. 55.6 nT

Answer: D

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11. A point source of electromagnetic radiation has an average power output of $800W$. The maximum value of elecvtric field at a distance $4.0m$ from the source is

A. 64.7V/m

B. 57.8V /m

C. 56.72 V/m

D. 54.77 V/m

Answer: D

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12. A parallel- plate capacitor with plate area A and separation between the plates d, is charged by a constant current i. Consider a plane surface of area A/2 parallel to the plates and drawn summetrically between the plates. Find the displacement current through this area.

A. I

B. $\frac{I}{2}$

C. $\frac{I}{4}$

D. $\frac{I}{8}$

Answer: B

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13. A plane e.m. wave travelling along the x-direction has a wavelength of 3mm. The variation in the electric field occurs in the y-direction with an amplitude $66Vm^{-1}$. The equation for the electric and magnetic fields as a function of x and t are respectively

A. $E_y = 33\cos\pi \times 10^{11}\left(t - \frac{x}{C}\right)$

$B_z = 1.1 \times 10^{-7}\cos\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

B. $E_y = 11\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

$B_y = 1.1 \times 10^{-7}\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

C. $E_x = 33\cos\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

$B_x = 11 \times 10^{-7}\cos\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

D. $E_y = 66 \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

$$B_z = 2.2 \times 10^{-7} \cos 2\pi \times 10(11)\left(t - \frac{x}{c}\right)$$

Answer: D

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14. The refractive index and the permiability of a medium are respectively 1.5 and $5 \times 10^{-7} Hm^{-1}$. The relative permitivity of the medium is nearly

A. 25

B. 15

C. 81

D. 6

Answer: D

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15. The electric field of a plane electromagnetic wave varies with time of amplitude $2Vm^{-1}$ propagating along z-axis. The average energy density of the magentic field is (in Jm^{-3})

A. 13.29×10^{-12}

B. 8.86×10^{12}

C. 17.72×10^{-12}

D. 4.43×10^{-12}

Answer: B

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