PHYSICS

BOOKS - PRADEEP PHYSICS (HINGLISH)

ELECTROMAGNETIC WAVES

Solved Examples

1. How would you establish an instantaneous displacement current of 1.0A in the space between the parallel plates of $1\mu F$ capacitor.

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2. In an electric circuit, there is a capacitor of reactance 100Ω connected across teh source of 220V. Find the displacement current.

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

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4. The magnetic field in a plane electromagnetic wave is given by $B_y = 2 \times 10^7 T \sin(0.5 \times 10^3 x + 1.5 \times 10^{11} t) T$

(a) What is the wavelength and frequency of the wave?

(b) Write an expression for the electric field.

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5. In an electromagnetic wave, the amplitude of electric field is $10 V/m$. The frequency of wave is

$5 \times 10^{14} Hz$. The wave is propagating along Z-axis, find (i) the average

energy density of electric field (ii) the average energy density of magnetic field (iii) the total average energy density of EM wave.

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6. A parallel plate capacitor has circular plates each of radius 6.0cm, It is charged such that the electric field in the gap between its plates rises constantly at the rate of $10^{10} V cm^{-1} s^{-1}$. What is the displacement current?

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7. There is a parallel plate capacitor of capacitances $2.0 \mu F$. The voltage between the plates of parallel plate capacitor is changing at the rate of $6.0Vs^{-1}$. What is the displacement current in the capacitor?

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8. A parallel plate capacitor $C = 0.2\mu F$ is connected across an a.c. source of angular frequncy $400rads^{-1}$. The value of conduction current is 2mA. Find the rms value of the voltage from the source and the displacement current in the region between the two plates.

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9. How would you establish an instantaneous displacement current of 2.0A in the space between the parallel plates of

$1\mu F$ capacitor?

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10. A parallel plate capacitor made of two circular plates each of radius 10 cm and separated by 4.0mm. The capacitor is being charged by an external source. The charging current is constant and equal to 0.10A. Calculate (i) the capacitance (ii) the rate of change of potential difference between the plates (iii) the displacement current.

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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?

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12. Electromangnetic waves travel in a medium at a speed of $2.2 \times 10^8 ms^{-1}$. The relative permeabillity of the medium is 1.0. Find the relative permitivity of the medium.

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13. A plane electromagnetic wave propagating in the x-direction has a wavelength of 5.0 mm. The electric field is in the y-direction and its maximum magnitude is $30V(m^{-1})$. Write suitable equations for the electric and magnetic fields as a function of x and t.

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14. Light with an energy flux of $18W/cm^2$ falls on a non-reflecting surface at normal incidence. If the surface has an area of $20cm^2$, find the average force exerted on the surface during a 30 minute time span.

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15. Calculate the peak values of electric and magnetic fields produces by the radiation coming form a 100watt bulb at a distance of 3m. Assume that the efficiency of the bulb is 2.5% and it is a point source?

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16. The magnetic field in a plane electromagnetic wave is given by

$B = (300\mu T)\sin\left(5.0 \times 10^{-5} x^{-1}\right)(t - x / c)$

Find(i) the maximum electric field and (ii) The average energy density corresponding to the electric field.

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17. A plane electromagnetic wave in the visible region is moving along z-direction. The frequency of the wave is $6 \times 10^{14} Hz$, and the electric field at any point is varying sinusoidally with time with an amplitude of $2Vm^{-1}$. Calculate

(i) average energy density of the electric field and

(ii) average energy density of the magnetic field.

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18. A laser beam has intensity $3.0 \times 10^{14} Wm^{-2}$. Find the amplitudes of electric and magnetic fields in the beam.

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19. A beam of light travelling along x-axis is described by the magnetic field, $B_z = 5 \times 10^{-9} T \sin \omega(t - x/c)$

Calculating the maximum electric and magnetic forces on a charge, i.e. alpha particle

moving along y-axis with a speed of $3 \times 10^7 m/s$, charge on electron $= 1.6 \times 10^{-19} C$

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20. Obtain the temperature ranges for ultraviolet part of radiation of EM waves. Use the formulae $\lambda_m T = 2.9 \times 10^{-3} mK$. Take frequency of ultraviolet part of radiations as $8 \times 10^{14} Hz$ to $5 \times 10^{17} Hz$.

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21. A parallel plate capacitor made of circular plates each of radius 10 cm has a capacitance $200pF$. The capacitor is connected to a 230V a.c. supply with an angular frequency of $400 rads^{-1}$.

(i) What is the r.m.s. value of the conduction current? (ii) Find the amplitude of $\overrightarrow{B}$ at a point 2.0 cm from the axis of the plates.

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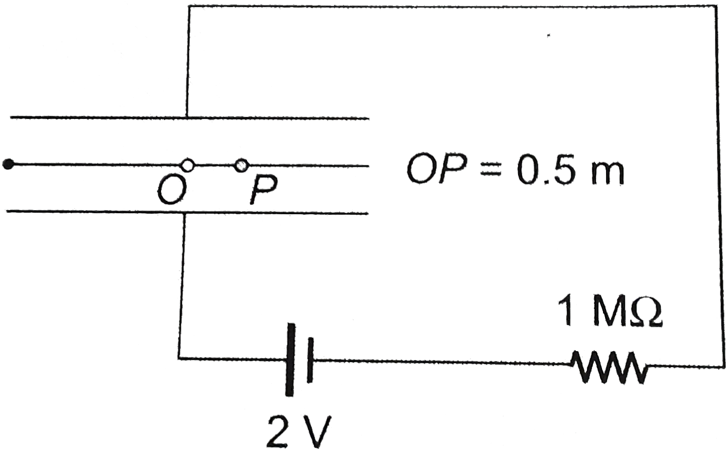
22. A parallel plate capacitor with circular plates of radius $1m$ has a capacitor of $1nF$. At $t = 0$, it is connected for charging in series with a resistor $R = 1M\Omega$ across a $2V$ battery. Calculate the magnetic field at a point P, halfway between the center and the periphery of the plates, after $t = 10^{-3}$ sec.



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23. A capacitor of capacitance C, is being charged up by connecting it across a d.c. voltage source of voltage V. How do the conduction and displacement currents in this set up compare with each other (a) during the charging up process? (b) after the capacitor gets fully charged?

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24. A variable frequency a.c. source is connected to a capacitor. Will the displacement current increase of decrease with increase in frequency?

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25. Light can travel in vacuum whereas sound can not do so. Why?

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26. Show that the average energy density of the electric field $\vec{E}$ equals the average energy density of the magnetic field $\vec{B}$, in electromagnetic waves.

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27. Electromagnetic wave with wavelength

(i) λ_1 are used to treat muscular strain

(ii) λ_2 are used by a FM radio station for broadcasting.

(iii) λ_3 are used to detect fracture in bones

(iv) λ_4 are absorbed by the ozone layer of the atmosphere.

Identify and name the part of elctromagnetic spectrum to which thest radiations belongs. Arrange these wavelengths in decreasing order of magnitude.

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28. Find the wavelength of electromagnetic waves of frequency $6 \times 10^{12} Hz$ in free space. Gives its two applications.

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29. Some scientists have predicted the global nuclear war on the earth would be followed by a serve nuclear winter with a devastating effect on life on earth.What might be the basis of this prediction?

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30. Why are infrared radiations referred to as hear waves also ? Name the radiations which are next to these radiation in electromagnetic spectrum having (i) shorter wavelength (ii) longer wavelength.

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31. Give difference between displacement current and conduction current.

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32. Is the steady electric current the only source of magnetic field? Justify your answer.

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33. Why is the quantity $\in_0 \dfrac{d\phi_E}{dt}$ called the displacement current? Where $d\phi_E / dt$ is the rate of change of electric flux linked with a region or space.

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34. A capacitor has been charged by ad.c. source. What are the magnitudes of conduction and displacement currents, when it is fully charged?

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35. Write down Maxwell's equations for steady electric field.

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36. If you find closed loops of $\vec{B}$ in a region in space, does it necessarily mean that actual charges are flowing across the area bounded by the loops ?

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37. A plane electromagnetic wave travels in vacuum along z-direction. What can you say about the direction of electric and magnetic field vectors?

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38. Write the formula for the velocity of light in a material medium of relative permitivity $\in_r$ and relative magnetic permeability μ_r.

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39. What are the basic sources of electromagnetic waves?

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40. Name the scientists connected with history of electromagnetic wave.

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41. Write the relation for the speed of electromagnetic wave in terms of the amplitudes of electric and magnetic fields.

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42. Do electromagnetic waves carry energy and momentum?

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43. What evidence is there to show that sound is not electromagnetic in nature ?

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44. An electromagnetic wave consists of oscillating electric and magnetic fields. What is the phase relationship between these fields?

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45. An em wave exerts pressure on the surface on which it is incident. Justify?

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46. Find the energy stored in a 90cm length of a laser beam operating at 10mW.

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47. If the intensity of the incident radio wave of $1\text{watt} / m^2$ is reflected by the surface, find the pressure exerted on the surface.

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48. If the intensity of the incident radiowave is $1\text{watt} / m^2$ is absorbed by the surface, find the pressure exerted on the surface.

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49. If the earth did not have atmosphere, would its average surface temperautre be higher or lower than what it is now? Explain

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50. Give the ratio of velocities of light rays of wavelength 4000Å and 8000Å in vacuum.

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51. write the following radiations in ascending order in respect of their frequencies: X-rays, microwaves, UV rays and radio waves.

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52. Arrange Infrared, visible Gamma, X-rays, radiowave and microwave in increasing order of wavelength.

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53. How are radio waves produced?

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54. How are X-rays produced?

Watch Video Solution

55. How are microwaves produced?

Watch Video Solution

56. By which way, the X-rays, and γ-rays can be distinguised?

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57. Why are microwaves considered suitable for radar system used in aircraft nevigation?

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58. Arrrange the following electromagnetic waves in the order of their increasing wavelength:

(a) γ-rays (b) microwaves.

(c) x-rays (d) Radiowaves.

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59. What is the time period of the light for which the eye is most sensitivity?

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60. Name the electromagnetic radiation to which waves of wavelength in the range of $10^{-2}m$ belong. Give one use of this part of EM spectrum.

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61. Name the electromagnetic waves used for studying crystal structure of solids. What is its frequency range?

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62. Which part of electromagnetic spectrum has largest penterating power.

Watch Video Solution

63. The ozone layer absorbs

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64. Name the part of electromagnetic spectrum whose wavelength lies in the range of $10^{-10}m$. Give its one use.

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65. How does Ampere-Maxwell law explain the flow the of current through a capacitor when it is being charged by a battery? Write the expression for the displacement current in terms of the rate of change of electric flux.

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66. What is displacement current? Explain its cause.

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67. Why did Maxwell introduce the concept of displacement current? Explain.

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68. Why does galvanometer show a momentary deflection at the time of charging or discharging a capacitor? Write the necessary expression to explain this observation?

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69. A parallel plate capacitor with plate area A and plate separation d, is charged by a steady current I. Let a plane surface of area $A/3$ parallel to the plates and situated symmetrically between the plates. What is the displacement current through this area?

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70. If you find closed loops of $\vec{B}$ in a region in space, does it necessarily mean that actual charges are flowing across the area bounded by the loops ?

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71. What oscillates in e.m. waves? Give two examples of e.m. waves.

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72. (a) An e.m. wave is travelling in a medium with a velocity $\overrightarrow{v} = v\hat{i}$.Draw a sketch showing the propagation of the e.m. wave, indicating the direction of the oscillating electric and magentic fields.

(b) How are the magnitudes of the electric and magnetic fields related to the velocity of the e.m. wave?

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73. Which of the following, if any, act as a source of electromagnetic waves? (i) A charge moving with a constant velocity (ii) A charge moving in a circular orbit (iii) A charge at rest.Give reason.

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74. The electromagnetic waves are the radiations of large of wavelength. What are their velocity (i) in vacuum and (ii) in a medium?

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75. Write the relation between the following:

(a) Direction of propagation and directions oscillation of the electric and magnetic field vectors in an electromagnetic wave.

(b) Velocity of the electormagnetic wave in vacuum and the permeability and permittivity of free space.

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76. How does a charge q oscillating at certain frequency produce electromangnetic waves? Skecth schematic diatram depiciting electric and magnetic field for an electromagnetic wave propagating along thex-direction.

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77. What are electromagnetic waves? How are they produced?

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78. How are electromagnetic waves produces by osillating charges ? Draw a sketch of linearly polarised em waves propagating in z-direction. Indicate the direction of oscillating electric and magnetic fields

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79. For a plane electromagnetic wave, propagating along the z-axis, write the two possible pair of its oscillating electric and magnetic fields. How are the peak values of these (oscillating) fields related to each other?

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80. What is intesity of electromagnetic wave? Give its relation in terms of electric field E and magnetic field B

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81. What is intensityof electromagnetic wave? Give Its relation in terms of electric field E and magnetic field B

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82. State any four properties of electromagnetic waves.

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83. An electromagnetic wave Y_1, has a wavelength 1 cm while other electromagnetic wave Y_2 has a frequency of $10^{15} Hz$. Name these two types of waves and write one useful application for each.

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84. Identify the electromagnetic waves whose wavelength very as: (a) $10^{-12}m < \lambda < 10^{-8}m$ (b) $10^{-3}m < \lambda < 10^{-1}m$. Write one use each.

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85. Identify the electromagnetic waves whose wavelength very as: (a) $10^{-11}m < \lambda < 10^{-14}m$ (b) $10^{-4}m < \lambda < 10^{-6}m$. Write one use each.

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86. What physical quantity is the same for X- rays of wavelength $10^{10}m$,red light of wavelength $6800A$ and radio waves of wavelength $500m$?

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87. Identify the part of the electromagnetic specturm which is

(i) Suitable for radar systems used in aircraft nevigation

(ii) Adjacent to the low frequency end of the electromagnetic spectrum

(iii) produced in nuclear reaction

(iv) produced by bombarding a metal target by high speed electrons.

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88. Give one use of each of the following:

(i) Infrared rays (ii) Gamma rays

(iii) microwaves (iv) Ultraviolet rays.

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89. Name the electromagnetic waves used for following and arrange them in increasing order of their penetrating power:

(a)water purification (b) remote sensing

(c) treatment of cancer.

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90. Name the parts of the electromagnetic spectrum which is

(a) suitable for radar system used in aircraft navigation

(b) used to treat muscular strain.

(c) Use as a diagnostic tool in medicine.

Write in brief, how these waves can be produced.

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91. Find the wavelength of electromagnetic waves of frequency $4 \times 10^9 Hz$ in free space. Gives its two applications.

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92. Who discovered ultraviolet rays? Give their frequency range and mention at least two uses.

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93. Which waves are used in Radar system? Give their frequency range and mention the source of their production

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94. How are e.m. wave produced?

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95. What do you understand by e.m. wave. Give its four properties.

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96. What is electromagnetic spectrum? Name the important part of the electromagnetic spectrum.

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97. Name the costituent radiation of electromagnetic spectrum which

(a) Is used in satellite communication

(b) is used for studying crystal structure

(c) is similar to the radiations emitted during decay of radioactive nuclei.

(d) has its wavelength range 390 nm to 770 nm

(e) is absorbed from sunlight by ozon layer

(f) produces intense heating effect.

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98. Write the order of frequency range and one use of each of the following electromagnetic radiations:

(i) Microwaves

(ii) Ultraviolet rays

(iii) Gamma rays.

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99. What are the uses of X-ray, ultraviolet ray and infrared ray?

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100. State the uses of electromagnetic radiations.

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101. Suppose the eyes of an alien being are sensitive to microwaves. Do you except the alien being to have larger or smaller eyes than ours?

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102. The electric field of a plane electromagnetic wave in vacuum is represented by $\overrightarrow{E}_x = 0$, $\overrightarrow{E}_y = 0.5\cos\left[2\pi \times 10^8\left(t - \frac{x}{c}\right)\right], \overrightarrow{E}_z = 0$

(a) What is the direction of propagation of electromagnetic wave?

(b) Determine the wavelength of the wave.

(c) Compute the component of associated magnetic field.

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103. Find the energy stored in a 60cm length of a laser beam operating at 6mW.

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104. Electromagnetic waves travel in a medium at a speed of $2.0 \times 10^8 ms^{-1}$. The relative permitivity of the medium is 2.25. Find the relative permeability of the medium.

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105. If a capacitor of $2.0\mu F$ is charged to 20V and then suddenly short-circuited by a coil of negligible resistance and of inductance $8.0\mu H$ Calculate the maximum amplitude and the frequency of the resulting current oscillations.

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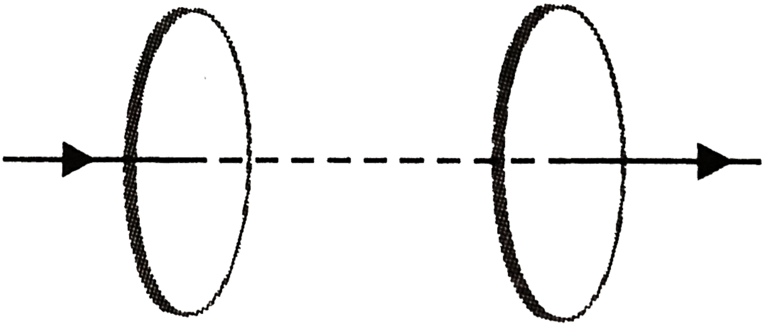
106. Fig. shows a capacitor made of two circular plates each of radius 12 cm and separated by 5.0mm. The capacitor is being charged by an external source (not shown in the figure). The charging current is constant and equal to 0.15A.

(a) Calculate the capacitance and the rate of change of potential difference between the plates.

(b) Obtain the displacement current across the plates.

(c) Is Kirchhoff's first rule valid at each plate of the capacitor ? Explain.



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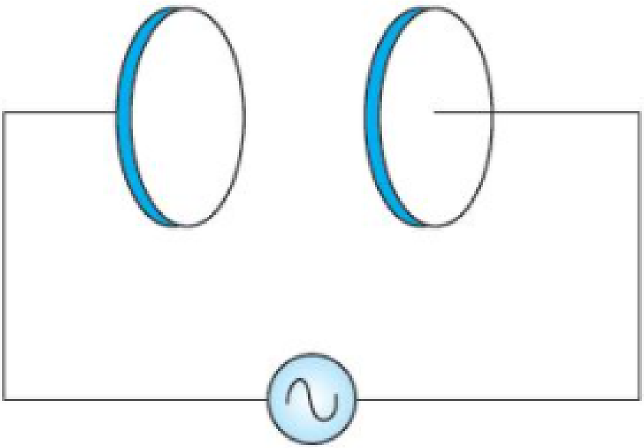
107. A parallel plate capacitor made of circular plates each of radius $R = 6.0$ cm has a capacitance $c = 100pF$. The capacitor is connected to a $230V\,AC$ supply with a (angular) frequency of $300 rad / s$

(a) What is the rms value of the conduction current ?

(b) Is the conduction current equal to the displacement current?

(c) Determine the amplitude of B at a point $3.0cm$ from the axis between the plates.



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108. What physical quantity is the same for X- rays of wavelength $10^{10}m$,red light of wavelength $6800A$ and radio waves of wavelength $500m$?

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109. A plane electromagnetic wave travels in vacuum along z- direction. What can you say about the directions of ots electric and magnetic field vectors. If the frequency of the wave is $30MHz$, what is its wavelength?

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110. A radio can tune into any station in the $7.5MHz$ to $12MHz$ band. What is the corresponding wavelength of band?

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111. A charged particle oscillates about its mean equilibrium position with a frerquency of $10^9 H_z$. The electromagnetic waves produced.

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112. The amplitude of the magnetic field part of a harmonic electromagnetic wave in vacuum is $B_0 = 510 nT$. What is the amplitude of the electric field part of the wave?

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

(a) DetermineB_0, ω, k and λ,

(b) find expressions for E and B.

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114. In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of $2.0 \times 10^{10} H_z$ and amplitude $48 V_m^{-1}$

(a) What is the wavelength o f the wave?

(b) What is the amplitude of the oscillating magnetic field.

(c) Show that the average energy density of the field E

equals the average energy density of the field B. $\left[c = 3 \times 10^8 ms^{-1}\right]$.

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115. Suppose that the electric field part of an electromagnetic wave in vacuume is

$E = 3.1N/C\cos\left[(1.8rad/m)y + \left(5.4 \times 10^8 rad/s\right)t\right]\hat{i}$

(a) Wavelength is the direction of motion?

(b) What is the wavelength λ?

(c) What is the frequency v?

(d) What is the amplitude of the magnetic field part of the wave?

(e) Write an expression for the magnetic field part of the wave.

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116. About 5% of the power of a $100W$ light bulb is converted to visible radiation. What is the average intensity of visible radiation

(a) at a distance of $1m$ from the bulb?

(b) at a distance of $10m$?

Assume that the radiation is esmitted isotropically and neglect reflection.

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117. Use the formula $\lambda_m T = 0.29 cmK$ to obtain the characteristic temperature ranges for different parts of the e.m. spectrum. What do the number that you obtain tell you?

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118. Why is the orientation of the portable radio with respect tp broadcasting station important?

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119. Why dose microwave oven heats up a food item containing water molecules most efficiently?

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120. The charge on a parallel plate capacitor varies as $= q_0 \cos 2\pi ft$. The plates are very large and close together (area=a,separation=d). Neglecting the edge effects, find the displacement current through the capacitor.

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121. A variable frequency AC source is connected to a capacitor. How will the displacement current change with decrease in frequency?

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122. The magnetic field of a beam emerging from a filter facing a floodlight is given by $B = 12 \times 10^{-8} \sin(1.20 \times 10^7 z - 3.60 \times 10^{14} t) T$.

What is the average intensity of the beam?

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123. Polynting vectors $\overrightarrow{S}$ is defined as a vector whose magnitude is equal to the wave intensity and whose direction is along the direction of wave propogation. Mathematically, it is given by $\overrightarrow{S} = \frac{1}{\mu_0} \overrightarrow{E} \times \overrightarrow{B}$. Show the nature of S vs t graph

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124. Professor C.V Raman surprised his students by suspending freely a tiny light ball in a transparent vacuum chamber by shining a laser beam on it. Which property of EM waves was he exhibiting? Give one more example of this property.

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125. Electromangnetic waves with wavelength

(i) λ_1 is used in satellite communication.

(ii) λ_2 used to kill germs in water purifier.

λ used to detect leakage of oil in underground pipelines.

λ_4 used to improve visibility in runways during fog and mist conditions.

(a) Identify and name the part of e.m. spectrum to which these radiations belong.

(b) Arrange these wavelengths in ascending order of their magnitude.

(c) Write one more application of each.

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126. Show that average value of radiant flux density 'S' over a single period 'T' is given by $S = \frac{1}{2c\mu_0}E_0^2$.

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127. You are given a $2\mu F$ parallel plate capacitor. How would you establish an instantaneous displacement current fo 1mA in the space between its plates?

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128. Show that the radiation pressure exerted by an EM wave of intensity I on a surface kept in vacuum is I/c.

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129. Even though an electric field $\vec{E}$ exerts a force $a\vec{E}$ on a charged particle yet the electric field of an EM wave does not contribute to the radiation pressure (but transfer energy). Explain.

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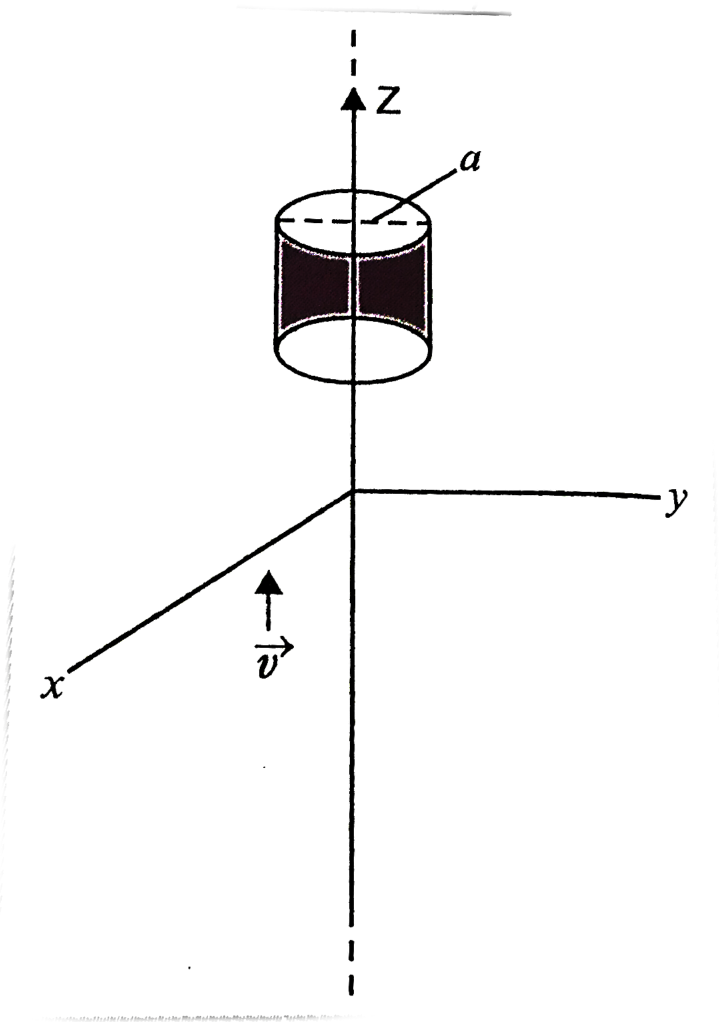
130. An infinitely long thin wire carrying a uniform linear static charge density λ is placed along the z-axis Fig. The wire is set into motion along its length with a uniform velocity $\overrightarrow{v} = v\hat{k}$. Calculate the poynting vector

$$\vec{S} = \frac{1}{\mu_0}\left(\vec{E} \times \vec{B}\right).$$



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131. A plane EM wave travelling along z direction is described by

$$E = E_0 \sin(kz - \omega t)\hat{i} \text{ and } B = B_0 \sin(kz - \omega t)\hat{j}.$$

show that

(i) The average energy density of the wave is given by

$$u_{av} = \frac{1}{4}\varepsilon_0 E_0^2 + \frac{1}{4}\frac{B_0^2}{\mu_0}.$$

(ii) The time averaged intensity of the wave is given by

$$I_{av} = \frac{1}{2}c\varepsilon_0 E_0^2.$$

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132. EM wave in a cavity with conduction walls can exist only in certain modes (i.e., they can not exist, for example, with any arbitrary wavelength). Suggest a simple reason why this should be so?

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133. An e.m. wave with poynting vector $6wa/m^2$ is absorbed by a surface of area $12m^2$. Find the force on the surface.

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134. If the wave-front of e.m.wave travelling in vacuum is given by , $\overrightarrow{r} = \hat{i} + \hat{j} + \hat{k}$, and find the angle made by the direction of propagation of e.m. wave with y-axis.

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135. What features of e.m. wave led Maxwell to conclude that light itself is e.m. wave?

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136. What does an e.m. wave consists of? On what factors does its velocity in vacuum depend?

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137. A plane electromagnetic wave travels in vacuum along z- direction. What can you say about the directions of ots electric and magnetic field vectors. If the frequency of the wave is $30MHz$, what is its wavelength?

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138. Give a simple possible argument to suggest that an accelerated charge must emit electromagnetic radiation.

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139. A lamp emits monochromatic green light uniformly in all direction. The lamp is 5% effiecient in converting electrical power to electromagnetic waves and cosumes 100W of power. What is the amplitude of electric field

associated with the electromagnetic radiation at a distance of 4m from the lamp?

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140. A point source of electromagnetic radiation has an average power output of 800W.

(a) Find the maximum value of electric field at a distance 3.5 m from the source.

(b) What will be the maximum value of magnetic field?

(c) What will be the energy density at a distance at a distance 3.5m from the source?

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141. The electric field of a plane electromagnetic wave in vacuum is represented by $\overrightarrow{E}_x = 0$, $\overrightarrow{E}_y = 0.5\cos\left[2\pi \times 10^8\left(t - \frac{x}{c}\right)\right]$, $\overrightarrow{E}_z = 0$

(a) What is the direction of propagation of electromagnetic wave?

(b) Determine the wavelength of the wave.

(c) Compute the component of associated magnetic field

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142. Find the amplitude of the electric field in a parallel beam of light of intensity $8.0W/m^2$.

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143. Electromagnetic wave travel in medium at a speed of $2.0 \times 10^8 ms^{-1}$. The relative permeability of the medium is 1.0. Find the relative permitivity.

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144. Four persons went on an excursion on a hill top where temperature was quite low One of them fell sick. The other persons put a blanket on him, collect the pieces of dry wood and ignited fire in his vicinity. After sometime the sick person felt better. Read the above passage and answer the following questions:

(i) What are the type of rays coming from fire?

(ii) Why did the sick person feel better while seating near the fine?

(iii) What basic values do you learn from this study?

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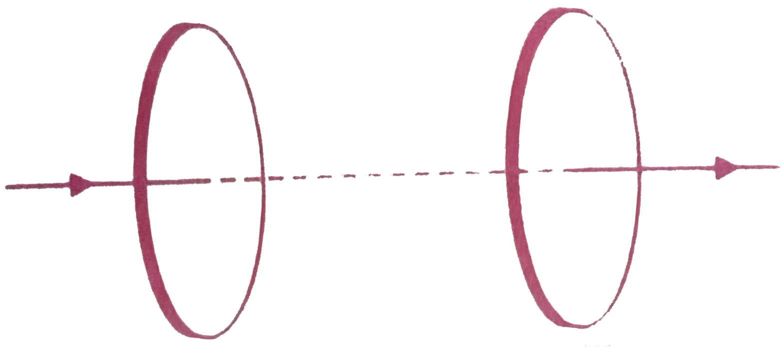
Solved Example

1. (a) Fig shows a capacitor made of two circular plates each of radius 12cm and separated by 5.0mm. The capacitor is being charged by an external source (not shown in the figure). The charging current is constant and equal to 0.15A. Use Ampere's law (modified to include displacement current as given in the text) and the symmetryin the problem to calculate magnetic field between the plates at a point (i) on the axis (ii) 6.5 cm from the axis (iii) 15cm from the axis.

(b) At what distance from the axis is the magnetic field due to displacement current greatest? Obtain the maximum value of the field.



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2. (a) Use the Bio-Savart law to determine the magnetic field due to conduction current outside the plates (refer to Fig) at points $6.5cm$, $12cm$ and $15cm$ from the wire. Do the answer match with those in Ex. ? Explain.

(b) If the conduction wire has a radius of 1.0mm, what is the maximum value of magnetic field due to the conduction current? [When you compare the answer to Ex. (b) and 6(b), you will appreciate why it is not easy to notice magnetic field due to the displacement current].

(c) Suppose the thin wire in Fig. is replaced by rods each of radius $12cm$ (i.e. we now have two long cylinder rods separated by a small gap). Will magnetic field configurations for $r > R$ be identical for the regions between the plates and outside the plates?

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3. A parallel plate capacitor of area $50cm^2$ and plate separation $3.0mm$ is charged initially to $80\mu C$. Due to radio-active source nearby , the medium between the plates gets slightly conducting and the plate loses charge the rate of $1.5 \times 10^{-8} \mathrm{Cs}^{-1}$. what is the magnitude and direction of displacement current ? What is the magnetic field between the plates

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4. A parallel capacitor made of circular plates radius 10.0 cm has a capacitance of 200 pF. The capacitor is connected to a 200 a.c. supply with an angular frequency of $200 \mathrm{rad} \quad s^{-1}$.

(i) What is the r.m.s. value of conduction current

(ii) Is the conduction current equal to displacement current?

(iii) Find peak value of displacement current ?

(iv) Determine the amplitude of magnetic field at a point 2.0cm from the axis between the plates.

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I Conceptual Problems

1. Induced electric field due to to changing magnetic flux are more readily observed than induced magnetic field due to changing electric field. Why?

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Conceptual Problems

1. The four Maxwell's equations and the Lorentz force law (which together constitution the fundations of all the classical electromagnetism) are listed below:

(i) $\oint \overrightarrow{B} \,.\, \overrightarrow{ds} = q/(\in_0)$

(ii) $\oint \overrightarrow{B} \,.\, \overrightarrow{ds} = 0$

(iii) $\oint \overrightarrow{E} \,.\, \overrightarrow{dl} = -\dfrac{d}{dt}\displaystyle\int_s \overrightarrow{B} \,.\, \overrightarrow{ds}$

(iv) $\oint \overrightarrow{B} \,.\, \overrightarrow{dl} = \mu_0 I + \mu_0 \dfrac{d}{dt}\displaystyle\int_s \overrightarrow{b} \,.\, \overrightarrow{ds}$

Lorentz force law: $\overrightarrow{F} = q\left(\overrightarrow{E} + \overrightarrow{v} \times \overrightarrow{B}\right)$

Answer the following question regarding these equation:

(a) Give the name (s) associated with some of the four equation above.

(b) Which equations above contain source $\overrightarrow{E}$ and $\overrightarrow{B}$ and which do not? what do the equations reduce to in a source-free region?

(c) Write down Maxwell's equations for steady (i.e. time independent) electric and magnetic fields.

(d) If magnetic monopoles existed, which of the equations would be modified? Suggest how they might be modified?

(e) Which of the four equations shown that magnetic field lines cannot start from a point nor end at a point?

(f) Which of the four equations show that electrostatic field lines cannot form closed loops?

(g) The equations listed above refer to integrals of $\vec{E}$ and $\vec{B}$ over loops/surfaces Can we write down equations for $\vec{E}$ and $\vec{B}$ for each point in space?

(h) Are the equations listed above true for different types of media: dielectrics, conductors, plasmas etc.?

(i) Are the equation true fora arbitrarily high and low values of $\vec{E}$, $\vec{B}$, q, I?

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2. How are electromagnetic waves produces by osillating charges ? Why is it not possible to produce e.m. waves in the visible region with modern electronic circuit in the laboratory? What is the method of production of x-rays?

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3. Which of the following cocepts applies to both sound waves and electromagnetic wave: (a)Polarisation and (b) intensity? Explain the same.

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Ii Conceptual Problems

1. Consider a plane wavefront of electromagnetic fields travelling with a speed c in the right (say+Z) direction, it is given that $\overrightarrow{E}$ and $\overrightarrow{B}$ are transverse to each other and uniform throughout the left of the wavefront and zero on the right of the wavefront. [This is contrived, but not incorrect, configuration chosen for simplicity. In the usual monochromatic plane wave, $\overrightarrow{E}$ and $\overrightarrow{B}$ very sinusoidally in space and time]. (a) Use Faraday's law to show that $E = cB$.

(b) Use Ampere's law (with displacement current included) to show that $c = 1/\sqrt{\mu_0 \in_0}$

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I Short Answer Questions

1. A parallel plate capacitor is being charged by a time varrying current. Explain briefly how Ampere's circutal law is generalised to incorporate the effect due to the displacement current.

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Short Answer Questions

1. Hertz in his historical experiment, produced stationary electromagnetic waves and measured the distance between two successive nodes. Explain how this measurement enabled him to show that electromagnetic waves travelled with the same speed as the speed of light.

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2. Which constituent radiation of the electromagnetic spectrum is used (i) in radar (ii) to photograph internal part of a human body, and (iii) for taking photographs of the sky during night and foggy conditions? Give one reason for your answer in each case.

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3. Microwave Oven

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Curiosity Questions

1. It is a common belief that the exposure of radiations for long time is dangerous to health. Are the meals cooked in microwaves oven not dangerous to health?

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Advanced Problems For Competitions

1. A silver wire has resistivity $\rho = 1.62 \times 10^{-8} \Omega m$ and cross-sectional area $10.0 mm^2$. The current in the wire is uniform and changing at the rate of $4000 A/s$, when the current is 200A. (a) What is the magnitude of the electric field in the wire when the current in the wire is 200A? (b) What is the displacement current in the wire at that time

(c) What is the ration of the magnitude of the magnetic field due to the displacement current to that due to the current at a distance r from the wire?

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2. A parallel plate capacitor with circular plates of radius 1m has a c apacitance of 1n F. At $t = 0$, it is connected for charging in series with a resistance $R = 1M\Omega$ across2V battery . Calculate the magnetic field at a point P, in between the plates and half way between the centre and the periphery of the plates after $10^{-3}s$.

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Ncert Exercise

1. Given below are some famous numbers associated with electromagnetic radiations in different contexts in physics. State the part of the electromagnetic spectrum to which each belongs. (a) 21 cm (wavelength emitted by atomic hydrogen in interstellar space). (b) 1057 MHz (frequency of radiation arising from two close energy levels in hydrogen, known as Lamb shift). (c) 2.7 K [temperature associated with the isotropic radiation filling all space-thought to be a relic of the 'big-bang' origin of the universe].

(d) $5890\widehat{A} - 5896\widehat{A}$ (double lines of sodium]

(e) 14.4keV energy of a particular transition in $.^{57}Fe$ nucleus associated with a famour high resolution spectroscopic method (mossbauer spectroscopy).

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2. Answer the following question:

(a) Long distance radio broadcasts use short wave bands. Why?

(b) It is necessary to use satallites for long distance T.V. Transmission. Why?

(c) Optical and radio telescope are built on the ground but X-ray astronomy is possible only from satellites orbiting the earth. Why?

(d) The small ozone layer on top of the atmosphere is crucial for human survival. Why?

(e) If the earth did not have atmosphere, would its average surface temperature be higher or lower than what it is now?

(f) Some scientists have predicted that a global nuclear war on the earth would be followed by a severe 'nuclear winter' with a devastating effect on life on earth. What might be the basis of this prediction.

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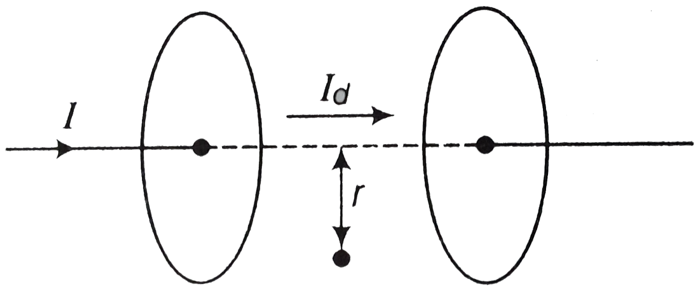
Short Answer Question

1. Show that the magnetic field B at a point in between the plates of a parallel plate capacitor during charging is

$\frac{\mu_0 \varepsilon_0 r}{2} \frac{dE}{dt}$ (symbols having usual meaing). ,



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2. What happens to the intensity of light from a bulb if the distance from the bulb is doubled ? As a laser beam travels across the legth of room, its intesity essentially ramain constant.

What geonetrical characteristric of LASER beam is responsible for the constnat intensity which is missing in the case of light from the bulb?

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Long Answer Question

1. Sea water at frequency $v = 4 \times 10^{8}$ Hz has permittivity $\varepsilon \approx 80\varepsilon_0$ permeability $\mu = \mu_0$ and resistivity $\rho = 0.25$M. Imagine a parallel plate capacitor immersed in sea water and driven by an alternating voltage source $V(t) = V_0 \sin(2\pi vt)$. What fraction of the conduction current density is the displacement current density ?

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2. A long straight cable of length l is placed symmetrically along z-axis and has radius $a(< < l)$. The cable consists of a thin wire and a co- axial conducting tube. An alternating current $I(t) = I_0 \ \sin \ (2\pi v t)$. Flows down the central thin wire and returns along the co-axial conducting tube. the induced electric at a distance s from the wire inside the cable is

$$E(s, t) = \mu_0 I_0 v \ \cos \ (2\pi v t) In\left(\frac{s}{a}\right)\hat{k}.$$

(i) Calculate the displacement current density inside the cable.

(ii) Integrate the displacement current density across the cross- section of the cable to find the total displacement current I^d.

(iii) compare the conduction current I_0 with the displacement current I_0^d.

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3. A plane EM wave travelling in vacuum along z-direction is given by

$E = E_0 \sin(kz - \omega t)\hat{i}$ and $B = B_0 \sin(kz - \omega t)\hat{j}$

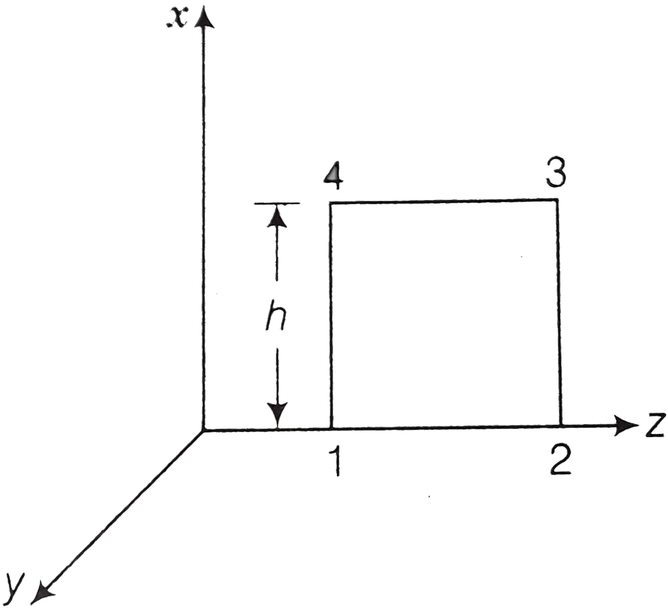
(i) Evaluate $\int E.\,dl$ over the rectangular loop 1234 shown in figure.

(ii) Evaluate $\int B.\,ds$ over the surface bounded by loop 1234.

(iii) Use equation $\int E.\,dl = \frac{-d\phi_B}{dt}$ to prove $\frac{E_0}{B_0} = c.$

(iv) By using similar proces and the equation

$\int B.\,dl = \mu_0 I + \varepsilon_0 \frac{d\phi_E}{dt}$, prove that $c \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$



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Higher Order Thinking Skills

1. A closed loop of $\overrightarrow{B}$ is produced by a changing electric field. Does it necessarily mean that $\overrightarrow{E}$ and $d\overrightarrow{E}/dt$ are non-zero at all points on the loop and in the area enclosed by the loop?

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2. What ideas led Maxwell to think about e.m. wave?

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Value Based Questions

1. Maxwell from his studies concluded that an electric field and a magnetic field changing with time in a direction perpendicular to each other produce a disturbance which propagates in a direction perpendicular to both the fields.

This disturbance is called electromagnetic wave. The em wave is of transverse nature. The velocity of em wave in vacuum is $c = \frac{1}{\sqrt{\mu_0} \in_0}$ where $\mu_0 =$ magnetic permeability of free space and $\in_0$ =electric permittivity of free space. The wavelength of e.m. wave varies over a wide range from 10^{-14} to $10^3 m$. The em wave of different wavelengths travel with same speed in vacuum but move with different speeds in any medium.

(i) What are the various e.m wave invisible to eye whose wavelength is lower than the smallest wavelength of visible light?

(ii) How do you conclude that white light travels in vacuum with a speed $3 \times 10^8 ms^{-1}$?

(iii) What do you learn from the above study?

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2. Rahim was a student of science and was suffering from some disease. He was under treatement of a restered medical practioner. The doctor sent Rahim repeatedly for x-rays examination. Rahim was hestitant for the same. He told the doctor that they had been tanght that the repeated exposure to x-rays would be harmful. The doctor told him not to worry as he knew things better. Read the above passage and answer the following questions:

(i) For what purpose x-ray examination of a patient is required by a doctor?

(ii) Is the doctor right to ask Rahim for repeated x-ray examination?

(iii) What do you learn from this study?

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3. Nitin and Rajeec were studying the effect of certain radiations on flower plants. Nitin expossed his plants to ultraviolet rays, found that his plants got damaged after a few days. Rajeev exposed his plants to infrared rays, found that his plants had a beautiful bloom, after a few days.

(i) What is the difference between ultraviolet rays and infrared rays?

Why were the plants exposed to ultraviolet rays damaged and the plants exposed to infrared rays had a beautiful bloom?

(iii) What are the basic values you have learnt from this study?

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4. During Diwali festival, Rajender brought a new microwave oven in his house and told his wife Sarika to use the same carefully. He also told her that microwave oven is to used for slow heating of the vegetables and food articles upto moderate temperature as that will preserve the from the food. Further, the vegetables or flood items to be heated in oven are to be kept in a porecelain vessel and not in a matallic vessel. Read the above paragraph and answer and following questions:

(i) What is the basic principle of working of microwave oven?

(ii) Why is it advised to use porcelain vessel for heating the food items in microwave oven?

(iii) What basic values do you learn from his study?

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5. Electronicmagnetic wave have wide range of wavelengths starting from $10^{-14}m$ to $10^{3}m$. The em wave of different wavelength are used for different purpose. The γ-rays which have lowest wavelength are least energetic. Read the above the passage and answer the following questions:

(i) What are more energetic waves, x-rays or ultra violet rays?

(ii) Why are teh radio waves not used to detect fracture in the bones of a human body when they can deliver a message at large distances?

(iii) What are the basic values displayed by the above study?

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Exercise

1. Speed of electromagnetic waves is the same

A. for all wavelengths

B. for all intensities

C. for all frequencies

D. in all media

Answer: b

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2. In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of $2.5 \times 10^{10} Hz$ and amplitued $480 V / m$. The amplitude of oscillating magnetic field will be

A. $1.52 \times 10^{-8} Wb / m^2$

B. $1.52 \times 10^{-7} Wb / m^2$

C. $1.6 \times 10^{-6} Wb / m^2$

D. $1.6 \times 10^{-7} Wb / m^2$

Answer: c

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3. Maxwell's equations related to study of electromagnetic waves describe the fundamental laws of

A. electricity only

B. magnetism only

C. mechanics only

D. both (a) and (b)

Answer: d

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4. Microwaves are the electromagnetic waves with frequency, in the range of

A. micro hertz

B. mega hertz

C. giga hertz

D. hertz

Answer: c

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5. One cannot cannot see through fog, because

A. for absorbs the light

B. light suffers total reflection at droplets

C. refractive index of the fog is infinity

D. light is scattered by droplets

Answer: d

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6. The velocity of light in vacuum can be changed by changing

A. frequency

B. amplitude

C. wavelength

D. none of these

Answer: d

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7. A light has a wavelength 6000Å. The energy of this light is

A. $5eV$

B. $2.07eV$

C. $1.07eV$

D. $0.207eV$

Answer: b

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8. which of the following in not true for electromagnetic waves ?

A. They transport energy

B. They have momentum

C. They travel at different speeds in air depending on their frequency

D. They travel at different speeds in medium depending on their frequency

Answer: c

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9. The amplitude of an electromagnetic wave A is a and of another B is 3a. Their frequencies are the same for the Maxwellian waves. Then

A. The energy of wave A is greater than B

B. The energy of wave A is smaller than B

C. The energy of wave A is equal to that of B

D. the given data is not sufficient to decide

Answer: c

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10. The correct arrangement of colours in the descending order of their wavelength is

A. yellow,violet,green,orange

B. orange,yellow, green,violet

C. violet, green ,yellow, orange,

D. yellow, green , orange, violet

Answer: b

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11. An electromagnetic wave consists of oscillating electric and magnetic fields. What is the phase relationship between these fields?

A. 0

B. $\pi / 4$

C. $\pi / 2$

D. π

Answer: a

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12. Which of the following electromagnetic waves has smaller wavelength ?

A. X-rays

B. Microwaves

C. $\gamma - rays$

D. Radiowaves

Answer: c

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13. The waves used in telecommunication are

A. infrared

B. ultraviolet

C. microwaves

D. cosmic rays

Answer: c

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14. ....was considered as a father of wireless communication.

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15. A current which comes into play in a region where the electric field is changing with time is called..........

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16. The electric lines of force............ From continuous closed path whereas the magnetic line of force from .... Path.

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17. The nature of electromagnetic wave is-

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18. The velocity of electromagnetic waves in free space can be given by relation........

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19. The velocity of electromagnetic waves depends entirely on the .... and .... properties of the medium in which these waves travel.

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20. The force exerted by electromagnetic wave on unit area of the surface is called.........

Watch Video Solution

21. If a portion of elctromagnetic wave of energy U is propaging with speed c, then linear momentum of the electromagnetic wave..........

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22. The cross product $\vec{E} \times \vec{B}$ (where $\vec{E}$ =electric field vector and $\vec{B}$ is the magnetic field vector) always gives the.............. of electromagnetic wave.

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23. The ratio of ω / k for a travelling wave (where ω is the angular frequency and k is the angular wave number) is ....

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24. The orderly distrubution of electromagnetic radiations according to their wavelength or frequency is called the ....

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25. The electromagnetic wave is of frequency range from $5 \times 10^5 Hz$ to $10^9 Hz$ are called..............

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26. The ultraviolet rays were discovered by .... in ....

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27. The electromagnetic waves of frequency range 3×10^{18} to 5×10^{22} are called...........

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28. The electromagnetic waves which are used in the working of solar water heaters and cookers are called.........

Watch Video Solution

29. The sequence (order) in which electromagnetic waves of different wavelengths are arranged in accordance of their wavelength is called..........

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30. The spectrum which we can see through our eyes is called.........

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31. 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} sec will be

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32. A parallel plate capacitor has circular plates, each of radius 8cm, It is being charged so that the electric field between the gap of two plates rises steadily at the rate of $10^{13}Vm^{-1}s^{-1}$. Find the value of displacement current?

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33. A parallel plate capacitor is made out of two rectangular metal pates of sides $30cm \times 15cm$ and separated by a distance of 2.0 mm. The capcitor is charged in such a way that the charging current has a constant value of 100mA. What must be the rate of change of potential of the charging source to ensure this and what will be the displacement current in the region between the capacitor plates?

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34. A parallel plate capacitor with circular plates of radius 0.12m is being charged. A circular loop of radius 0.24 m is concentric with the capacitor and half way between the plates. The displacement current through the loop is 2.0 A. At what rate is the electric field between the plates changing?

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35. A capacitor consists of two circular plates each of radius 8.0 cm and separated by 3.0 mm. The capacitor is being charged by an external battery. The charging current is constant and is equal to 0.3 A. Calculate (i) capacitance of capacitor, (ii) the rate of change of potential difference across the plates of capacitor and (iii) the displacement current.

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36. A paralle plate capacitor of capacitance $0.2\mu F$ is connected across an a.c. source of angular frequency $500 rads^{-1}$. The value of conduction current is 2mA. What is the rmsvalue of the voltage from the source? What is the displacement current across the capacitor plates?

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37. A laser beam has intensity $4.0 \times 10^{14} Wm^{-2}$. Find the amplitudes of electric and magnetic fields in the beam.

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38. Find the photon energy in (i) calories (ii) watt hour (iii) electron volt, for e.m. wave of wavelength $300 \mu m$. Give, $h = 6.6 \times 10^{-34} Js$.

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39. In a plane e.m.wave, the electric field oscillates sinusoidally at a frequency $2 \times 10^{10} Hz$ and amplitude $45 V m^{-1}$.

(a) What is the wavelength of wave?

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

(c) Show that the average energy density of the electric field $\vec{E}$ equals to the average energy density of the magnetic field $\vec{B}$.

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40. A magnetic field in a plane e.m. wave is given by,

$B_y = 3 \times 10^{-7} \sin\left[(1.5 rad/m)x + \left(5 \times 10^8 rad/s\right)t\right] tesla.$

(a) What is the wavelength and frequency of the wave? (b)

Write down an expression for the electric field. (x is the metre and t is in second).

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41. An electric field in an e.m.wave is given by

$E = 200 \sin . \frac{2\pi}{\lambda}(ct - x)NC^{-1}.$

Find the energy contained in a cylinder of crossection $20cm^2$ and length 40 cm along the x-axis.

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42. A plane e.m. wave propagating in the x-direction has a wavelength 5.0 mm. The electric field is in the y-direction and its maximum magitude is $50Vm^{-}1$. Write the equation for the electric and magnetic fields as a function of x and t.

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43. The magnetic field in a plane electromangnetic wave is given by

$B = (300\mu T)\sin(5.0 \times 10^{-5} x^{-1})(t - x/c)$

Find(i) the maximum electric field and (ii) The average energy density corresponding to the electric field.

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44. An observer is 1.8 m from an isotropic point light source whose power is 250W. Calculate the rms value of the electric and magnetic fields due to the source at the position of the observer.

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45. In a plane e.m. wave, the electric field oscillates withe amplitude $20Vm^{-1}$. Find (a) energy density of electric field (b) energy density of magnetic field.

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46. In a plane e.m. wave of frequency $1.5 \times 10^{12}Hz$, the amplitude fo the magnetic field is $6.0 \times 10^{-6}T$.

(a) Calculate the amplitude of the electric field.

(b) What is the total average energy density of the e.m. wave?

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47. A plane e.m. wave propagating in the x-direction has a wavelength 6.0 mm. 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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48. A plane e.m. wave propagating in the x-direction has a wavelength 5.5 mm. The electric field is in the y-direction and its maximum magitude is $36Vm{-}1$. Write suitable equation for the electric and magnetic fields as a function of x and t and find energy density of e.m. wave. Calculate the maximum electric and magnetic force on a charge q=2e, moving along y-axis with a speed of $3.0 \times 10^7 ms^{-1}$, where $e = 1.6 \times 10^{-19} C$.

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49. A beam of light travelling along x-axis is described by the magnetic field, $E_y = \left(600Vm^{-1}\right)\sin\omega(t - x/c)$

Calculating the maximum electric and magnetic forces on a charge q=2e,

moving along y-axis with a speed of $3 \times 10^7 m/s$, where $e = 1.6 \times 10^{-19} C$.

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50. In a plane e.m. wave, the electric field varies with time having an amplitude $1Vm^{-1}$. The frequency of wave is $0.5 \times 10^{15} Hz$. The wave is propagating along Z-axis. What is the average energy density of (i) electric field (ii) magnetic field (iii) total (iv) what is the amplitude of magnetic field?

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51. The average energy flux of sunlight is $1.0kWm^{-2}$. This energy of radiation is falling normally on the metal plate surface of area $10cm^2$ which completely abosbs the energy.

How much force is exerted on the plate if it is exposed to sunlight for 10 minutes?

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52. One requires $11eV$ of energy to dissociate a carbon monoxide molecule into carbon and oxygen atoms. The minimum frequency of the appropriate electromagnetic radiation to achieve the dissociation lies in.

A. visible region

B. infrared region

C. ultraviolet region

D. microwave region

Answer: c

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53. A linearly polarised electromagnetic wave given as $E = E_0 \hat{i} \cos(kz - \omega t)$ is incident normally on a perfectly reflecting wall $z = a$. Assuming that the material of the optically inactive, the reflected wave will be give as

A. $\overrightarrow{E}_r = -E_0 \hat{i} \cos(kz - \omega t)$

B. $\overrightarrow{E}_r = E_0 \hat{i} \cos(kz + \omega t)$

C. $\overrightarrow{E}_r = -E_0 \hat{i} \cos(kz + \omega t)$

D. $\overrightarrow{E}_r = E_0 \hat{i} \sin(kz - \omega t)$

Answer: b

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54. 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. $36 \times 10^{-5} Kgm/s$

B. $36 \times 10^{-4} Kgm/s$

C. $108 \times 10^{4} Kgm/s$

D. $1.08 \times 10^{7} Kgm/s$

Answer: b

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55. 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. $E/2$

B. $2E$

C. $E/\sqrt{2}$

D. $\sqrt{2}E$

Answer: A

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

A. $\overrightarrow{E}$

B. $\overrightarrow{B}$

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

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

Answer: d

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57. The ratio of contributions made by the eletric field and magnetic field components to the intensity of an EM wave is.

A. $c:1$

B. $c^2:1$

C. $1:1$

D. $\sqrt{c}:1$

Answer: c

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58. An EM wave radiation outwards from a dipole antenna, with E_0 as the amplitude of its electric field vector. The electric field E_0 which transports signification 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: c

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59. An e.m. wave trevels in vacuum along z direction: $\overrightarrow{E} = \left(E_1\hat{i} + E_2\hat{j}\right)\cos(kz - \omega t)$. Choose the correct option from the following :

A. The associated magnetic field is given as $\overrightarrow{B} = \frac{1}{c}\left(E_1\hat{i} + E_2\hat{j}\right)\cos(kz - \omega t)$

B. The associated magnetic field is given as $\overrightarrow{B} = \frac{1}{c}\left(E_1\hat{i} - E_2\hat{j}\right)\cos(kz - \omega)$

C. The given electromagnetic field circular polarised

D. The given e.m. wave is plane polarised

Answer: (a,d)

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60. A plane electromagnectic wave propagating along x-direction can have the following pairs of E and B.

A. E_x, B_y

B. E_y, B_z

C. B_x, E_y

D. E_z, B_y

Answer: (b,d)

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61. A charged particle oscillates about its mean equilibrium position with a frerquency of $10^9 H_z$. The electromagnetic waves produced.

A. will have frequency of $10^9 Hz$

B. will frequency of $2 \times 10^9 Hz$

C. will have a wavelength of 0.3m

D. fall in the region of radiowaves

Answer: (a,c,d)

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62. The source of electromagnetic waves can be a charge.

A. moving with a constant velocity

B. moving in a circular orbit

C. at rest

D. falling in an electric field

Answer: (b,d)

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63. An electromagnetic wave of intensity I falls on a surface kept in vacuum and exerts radiation pressure p on it.Which of the following are true ?

A. Radiation pressure is I/c if the wave is totally absorbed

B. Radiation pressure is I/c if the wave is totally reflected

C. Radiation pressure is $2I/c$ if the wave is totally reflected

D. Radiation pressure is $I/c < p < 2I/c$ if the wave is totally absorbed

Answer: (a,c,d)

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64. Out of the following options which one can be used produce a propagating electromagnetic wave?

A. A charged moving at constant velocity

B. A stationary charge

C. A chargeless particle

D. An accelerating charge

Answer: d

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

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

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

(1) the wavelength $\lambda$is 188.4m.

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

(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. (3) and (4)

B. (1) and (2)

C. (2) and (3)

D. (1) and (3)

Answer: d

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66. If μ_0 be the permeability and k_0 , the dielectric constant of a medium, its refractive index is given by

A. $\frac{1}{\sqrt{\mu_0 k_0}}$

B. $\frac{1}{\mu_0 k_0}$

C. $\sqrt{\mu_0 k_0}$

D. $\mu_0 k_0$

Answer: c

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67. An em wave going through vacuum is described by

$E = E_0 \sin(kx - \omega t)$

$B = B_0 \sin(kx - \omega t)$

A. $E_0 B_0 = k$

B. $E_0 \omega = B_0 k$

C. $E_0 k = B_0 \omega$

D. None of these

Answer: c

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

A. Wavelength and frequency both become half

B. wavelength is doubled and frequency remains unchanged

C. wavelength and frequency both remain unchanged

D. wavelength is halved and frequency remain unchanged

Answer: d

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69. The amplitude of em wave in vacuum is doubled with no other changes made to wave. As a result of this doubling of the amplitude, which of the following statement is correct.

A. The speed of the wave propagation chages only

B. The frequency of the wave changes only

C. The wavelength of the wave change only

D. None of the above is true.

Answer: d

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70. Dimension of $\frac{1}{\mu_0 \varepsilon_0}$, where symbols have usual meaning, are

A. $L^{-1}T$

B. L^2T^2

C. L^2T^{-2}

D. LT^{-1}

Answer: c

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

A. speed of light in vacuum.

B. recoprocal of speed of light in vacuum

C. the ratio of magnetic permiability to the electric susceptibility of vacuum

D. unity

Answer: b

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72. 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 $66 V m^{-1}$. 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. $E_y = 11 \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

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

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

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

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

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

Answer: d

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73. 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 the x-direction with frequency $10^6 Hz$ and wavelength 100m

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

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

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

Answer: b

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74. 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. 81

B. 10

C. 6

D. 15

Answer: c

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75. The energy contained in a small volume through which an electromagnetic wave os passing oscillates with

A. double the frquency of the wave

B. zero frequency

C. the frequency of the wave

D. half the frequency of the wave.

Answer: a

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76. In an electromagnetic wave, the electric and magnetizing field are $100V/m$ and $0.265A/m$. The maximum energy flow is:

A. $79W/m^2$

B. $13.2W/m^2$

C. $53W/m^2$

D. $26.5W/m^2$

Answer: d

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77. 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. $36 \times 10^6 m/s$

B. $1.7 \times 10^2 m/s$

C. $36 \times 10^8 m/s$

D. $1.7 \times 10^8 m/s$

Answer: d

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78. A small metallic ball is charged positively and negatively in a sinusoidally manner at a frequency of $10^6 cps$. The maximum charge on the ball is $10^{-6} C$. What is the displacement current due to the alternating current?

A. $6.28A$

B. $3.8A$

C. $3.75 \times 10^{-4}A$

D. $122.56A$

Answer: a

Watch Video Solution

79. 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. 6.88

B. 3.44

C. 1.72

D. 0.86

Answer: c

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80. If a 100 watt bulb acts as a point source and has 2.5% efficiency, the intensity of this bulb at 3m is

A. $0.002Wm^{-2}$

B. $0.22Wm^{-2}$

C. $4.4Wm^{-2}$

D. $0.033 Wm^{-2}$

Answer: a

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81. If a 100 watt bulb acts as a point source and has 2.5% efficiency, the intensity of this bulb at 3m is

A. $2.9 Wm^{-1}$

B. $5.8 Wm^{-1}$

C. $1.5 Wm^{-1}$

D. $4.4 Wm^{-1}$

Answer: a

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82. In an e.m. wave the electric and magnetic fields are $200V/m$ and $0.365A/m$. The maximum rate of energy flow is

A. $73.0W/m^2$

B. $36.5W/m^2$

C. $54.7W/m^2$

D. $77.8W/m^2$

Answer: a

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83. 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. $2.56 \times 10^4 W$

B. $6.4 \times 10^5 W$

C. $4.0 \times 10^5 W$

D. $1.6 \times 10^5 W$

Answer: d

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84. In an e.m. wave the electric and magnetic fields are $200V/m$ and $0.365A/m$. The maximum rate of energy flow is

A. $8.53 \times 10^{-5} N$

B. $2.3 \times 10^{-3} N$

C. $1.33 \times 10^{-3} N$

D. $5.53 \times 10^{-4} N$

Answer: d

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85. Light with an enargy flux of $25 \times 10^4 Wm^{-2}$ falls on a perfectly reflecting surface at normal incidence. If the surface area is $15cm^2$, the average force exerted on the surface is

A. $1.25 \times 10^{-6} N$

B. $2.50 \times 10^{-6} N$

C. $1.20 \times 10^{-6} N$

D. $3.0 \times 10^{-6} N$

Answer: b

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86. A plane e.m. wave of wave intensity $6W/m^2$ strikes a small mirror of area $30cm^2$, held perpendicular to the approaching wave. The momentum transfered in $kgms^{-1}$ by the wave to the mirror each second will be

A. 1.2×10^{-10}

B. 2.4×10^{-9}

C. 3.6×10^{-8}

D. 4.8×10^{-7}

Answer: a

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87. 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 5 m from the lamp will be:

A. $1.34V/m$

B. $2.68V/m$

C. $4.02V/m$

D. $5.36V/m$

Answer: b

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88. In an electromagnetic wave in free space the root mean square value of the electric field is $E_{rms} = 6V/m$. The peak value of the magnetic field is

A. $1.41 \times 10^{-8}T$

B. $2.83 \times 10^{-8}T$

C. $0.70 \times 10^{-8} T$

D. $4.23 \times 10^{-8} T$

Answer: b

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89. During the propagation of e.m. wave in a medium

A. electric energy density is equal to the magnetic energy density

B. both electric and magnetic energy densities are zero.

C. electric energy density is double of the magnetic energy density

D. electric energy density is half of the magnetic energy density

Answer: a

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

A. $3.3 \times 10^{-3} Jm^{-3}$

B. $4.58 \times 10^{-6} Jm^{-3}$

C. $6.37 \times 10^{-9} Jm^{-3}$

D. $81.35 \times 10^{-12} Jm^{-3}$

Answer: b

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91. A point source of electromagnetic radiation has an average power output of1500W. The maximum value of electric field at a distance 3m from this source in Vm^{-1} is

A. 500

B. 100

C. $\frac{500}{3}$

D. $\frac{250}{3}$

Answer: b

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92. 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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93. 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: c

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94. The electric field associted with an electromagnetic wave in vacuum is given by $\vec{E} = 40\cos\left(kz - 6 \times 10^8 t\right)\hat{i}$, when E, z and t are in volt/m metre and second respectively

find the wave vector.

A. $2m^{-1}$

B. $0.5m^{-1}$

C. $6m^{-1}$

D. $3m^{-1}$

Answer: a

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95. A red LED emits light of 0.1 watt uniformaly around it. The amplitude of the electric field of the light at a distance of 1m from the diode is

A. $1.73V/m$

B. $2.45V/m$

C. $5.48V/m$

D. $7.75V/m$

Answer: b

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96. 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. Infrared rays

D. Ultra-violet rays

Answer: b

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97. Arrange the following electromagnetic radiations per quantum in the order of increasing energy: A Blue light B: Yellow light C:X-rays D:Radiowave

A. D,B,A,C

B. A,B,D,C

C. C,A,B,D

D. B,A,D,C

Answer: a

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98. The correct option, if in vacuum the speed of γ-rays, x-rays and micro wave are v_g, v_x and v_m respectively, will

A. $v_g < v_x < v_m$

B. $v_g < v_x > v_m$

C. $v_g > v_x > v_m$

D. $v_g = v_x = v_m$

Answer: d

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99. The frequency of $e.m$ wave which is best suit to observe a particle of radius 3×10^{-4} is of order of:

A. $10^{15} Hz$

B. $10^{14} Hz$

C. $10^{13} Hz$

D. $10^{12} Hz$

Answer: a

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100. Consider the following types of electromagnetic radiation: radiowaves, infra-red, vissible light. Which of the following statements are correct?

(i) Only radiowaves can be used to transmite audio information.

(ii) Only infrared radiation is emitted by very hot object.

(iii) Only visible light can be detect by humans.

A. only (i) is correct

B. only (ii) is correct

C. only (iii) is correct

D. None of the above is correct.

Answer: d

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101. Comparing the masses of the two photons, of red light and violet light

A. The mass of photon of violet light is greater than the mass of the red light

B. The mass of photon of violet light is less than the mass of the red light

C. The mass of photon of violet light is equal to the mass of the red light

D. The mass of photon of violet light may be greater or smaller than the mass of the red light depeding upon the surrounding conditions

Answer: a

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102. Consider the following statements about e.m. wave and choose the correct ones S_1: em wave having wavelengths 1000times smaller than light wave are called X-rays.

S_2: Ultraviolet wave are used in the treatment of swollen joints.

S_3: Alpha and gamma rays are e.m. wave

S_4: de-Broglie wave are not electromagentic in nature

S_5: EM wave exhibits polarization while sound wave do not.

A. $S_1, S_4 \text{ and } S_5$

B. $S_3, S_4 \text{ and } S_5$

C. $S_1, S_3 \text{ and } S_5$

D. $S_1, S_3 \text{ and } S_4$

Answer: a

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103. The magnetic field in a plane e.m. wave is given by

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

This e.m. wave is

A. a visible light

B. an infrared wave

C. a microwave

D. a radiowave

Answer: c

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

A. Ultraviolet rays

B. Microwaves

C. $\gamma - rays$

D. X-rays

Answer: a

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105. Why does microwave oven heats up a food item containing water molecules most efficiently?

A. Infra-red wave produce heating in a microwave oven

B. The frequency of the microwave must match the resonant frequency of the water molecules

C. The frequency of the microwave has no relation with natural frequency of water molecules

D. Microwave are heat waves, so they always produce heating

Answer: b

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106. An e.m. wave is travelling through a medium of refractive index μ_1, and is incident on the boundary of a medium of refractive index μ_2. IF the wave reflects at the boundary

A. The wave undergoes a phase change of 180° if $\mu_1 < \mu_2$

B. The wave undergoes a phase change of 180° if $\mu_1 > \mu_2$

C. The wave undergoes a phase change if $\mu_1 < \mu_2$

D. The wave undergoes a phase change if $\mu_1 > \mu_2$

Answer: (a,d)

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107. Using mass (M) , length (L) , time (T) , and electric current (A) as fundamental quantities , the dimensions of permitivity will be

A. $\varepsilon_0 = [M^{-1}L^{-3}T^2I]$

B. $\varepsilon_0 = [M^{-1}L^{-3}T^4I^2]$

C. $\mu_0 = [MLT^{-2}I^{-2}]$

D. $\mu_0 = [ML^2T^{-1}I]$

Answer: (b,c)

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108. An e.m. wave going through vacuum is denoted by $E = E_0 \sin(kx - \omega t)$. Which of the following is /are independent of wavelength?

A. k

B. ω

C. k / ω

D. $k\omega$

Answer: c

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109. The unity of the electriec and magnetic waves was found by Maxwell from

(i) Guss's law in electrostatics

(ii) Gauss's law in magnetism

(iii) Faraday's law of electromagnetic induction.

(iv) Ampere's law with displacement current.

A. (i) and (iii) only

B. (iii) and (iv) only

C. all

D. Velocity of light also

Answer: c

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110. Displacement current goes through the gap between the plates of a capacitor when the charge of the capacitor

A. is zero

B. decreases

C. does not change

D. incease

Answer: (b,d)

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111. If u_E, u_m are the energy density of e.m. wave due to electric and magnetic field vectors, E_{rms}, B_{rms} are the rms value of electric and magnetic field vectors in e.m. wave, then the total energy density of a sinusoidaly e.m wave is

A. u_E

B. $u_E + u_m$

C. $\frac{1}{2} \in_0 E_{rms}^2 + \frac{B_{rms}^2}{2\mu_0}$

D. $\frac{1}{4} \in_0 E_0^2 + \frac{1}{2} \frac{B_0^2}{2\mu_0}$

Answer: (b,c)

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112. Which of the following are not e.m. wave?

A. cosmic rays

B. gamma rays

C. β-rays

D. x-rays

Answer: (a,c)

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113. Which one of the following groups of e.m. wave is/are in order of increasing frequency?

A. microwaves, ultraviolet rays, X-rays

B. radiowaves, infrared radiation and visible light.

C. gamma rays , visible light, ulrtaviolet rays

D. gamma rays, ultraviolet rays, radio waves.

Answer: (a,b)

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114. In terms of potential difference C, electric current$I$, permittivity ε_0, permeability μ_0 and speed of light c, the dimensionally correct equation (s) is (are)

A. $\mu_0 I^2 = \in_0 V^2$

B. $\in_0 I = \mu_0 V$

C. $I = \in_0 cV$

D. $\mu_0 cI = \in_0 V$

Answer: (a,c)

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115. The sun delivers $10^3 W/m^2$ of electromagnetic flux to the earth's surface, which is at a distance of $1.5 \times 10^{11} m$ from the sun. The whole incident electromagnetic flux is absorbed by the earth.

The total electromagnetic power of the sun is

A. $5.6 \times 10^{20} W$

B. $5.6 \times 10^{22} W$

C. $5.6 \times 10^{26} W$

D. $5.6 \times 10^{30} W$

Answer: c

Watch Video Solution

116. The sun delivers $10^3 W / m^2$ of electromagnetic flux to the earth's surface, which is at a distance of $1.5 \times 10^{11} m$ from the sun. The whole incident electromagnetic flux is absorbed by the earth.

Total electromagnetic power that is incident on a roof of dimensions $(8mx10m)$ on the surface of earth is

A. $2.56 \times 10^4 W$

B. $6.4 \times 10^4 W$

C. $4 \times 10^4 W$

D. $8 \times 10^4 W$

Answer: d

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117. The electric field associated with an e.m. wave is described by the equation $E = E_0 \sin(4\pi \times 10^6 x - 1.2\pi \times 10^{15} t)$ volt/meter, where x is in merter and t in second. The wavelength of the wave in the wave in the unit of $10^{-7} m$ is:

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118. The speed of em wave in the unit of $10^8 m/s$, in a medium of dielectric constant 2.25 and relative permeablity 4 is:

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119. The dielectric constant for air is 1.006. The speed of em wave travelling in air is $a \times 10^8 ms^{-1}$, where a is about:

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120. A flood light will be covered with filter that transmits red light. The electric field of the emerging beam is represented by a sinusoidal plane wave

$E_x = 38.8 \sin(1.2 \times 10^7 z - 3.6 \times 10^{15} t) V/m.$

The average intensity of beam inwatt/m^2 will be:

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121. Assertion: Displacement current is a fictious current and has nothing in common with the conduction current.

Reasion: It was proposed by Maxwell only to satisfy Kirchoff's function rule.

A. Both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. Both Assertion and Reason are true, but Reason is not true explanation of the Assertion.

C. Assertion is true, but the Reason is false.

D. both Assertion and Reason is false.

Answer: d

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122. Assertion: Environment damage has increased the amount of ozone in the atmosphere.

Reason: Increase of ozone increases the amount of ultraviolet radiation on earth.

A. Both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. Both Assertion and Reason are true, but Reason is not true explanation of the Assertion.

C. Assertion is true, but the Reason is false.

D. both Assertion and Reason is false.

Answer: d

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123. Statement-1 : A changing electric field produces a magnetic field

Statement-2: A changing magnetic field produces an electric field.

A. Both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. Both Assertion and Reason are true, but Reason is not true explanation of the Assertion.

C. Assertion is true, but the Reason is false.

D. both Assertion and Reason is false.

Answer: b

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124. Assertion: Light can travel in vacuum but sound cannot do so.

Reason: Light is an em wave and sound is a mechanical wave.

A. Both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. Both Assertion and Reason are true, but Reason is not true explanation of the Assertion.

C. Assertion is true, but the Reason is false.

D. both Assertion and Reason is false.

Answer: a

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125. Assertion: EM wave are transwers in nature.

Reason: The electric and magnetic fields of an e.m. wave are perpendicular to each other also perpendicular to the direction of wave propagation.

A. Both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. Both Assertion and Reason are true, but Reason is not true explanation of the Assertion.

C. Assertion is true, but the Reason is false.

D. both Assertion and Reason is false.

Answer: a

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126. Assertion: Like light radiation, thermal radiations are also electromagnetic radiation.

Reason: The thermal radiations require no medium for propagatio.

A. Both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. Both Assertion and Reason are true, but Reason is not true explanation of the Assertion.

C. Assertion is true, but the Reason is false.

D. both Assertion and Reason is false.

Answer: b

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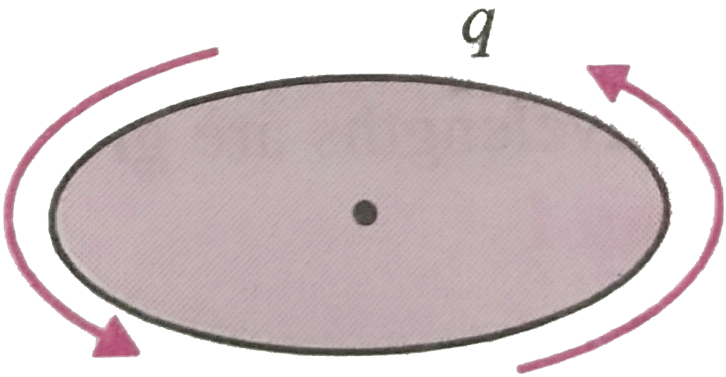
127. Assertion: A charge moving in a circular orbit can produce em wave.



Reason: The source of em wave should be in accelerted motion.

A. Both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. Both Assertion and Reason are true, but Reason is not true explanation of the Assertion.

C. Assertion is true, but the Reason is false.

D. both Assertion and Reason is false.

Answer: a

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128. Statement-1: Short wave band are used for transmission fo radiowaves to a large distance.

Statement-2: Short waves are reflected from ionosphere.

A. Statement-1 is true, Statement-2 is true, Statement-2 is a correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, Statement-2 is not correct explanation of Statement-1.

C. Statement-1 is true, Statement -2 is false.

D. Statement-1 is false, Statement -2 is true.

Answer: a

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129. Statement-1: In an em wave, the direction of the magnetic field induction $\overrightarrow{B}$ is parallel to the electric field $\overrightarrow{E}$.

Statement-2: Electric field $\overrightarrow{E}$ and magnetic field vector $\overrightarrow{B}$, have the same frequency.

A. Statement-1 is true, Statement-2 is true, Statement-2 is a correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, Statement-2 is not correct explanation of Statement-1.

C. Statement-1 is true, Statement -2 is false.

D. Statement-1 is false, Statement -2 is true.

Answer: d

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130. Statement-1: Magnetic field lines cannot start from a point nor end at a point.

Statement-2: The line integral of magnetic field induction over a closed path is not zero.

A. Statement-1 is true, Statement-2 is true, Statement-2 is a correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, Statement-2 is not correct explanation of Statement-1.

C. Statement-1 is true, Statement -2 is false.

D. Statement-1 is false, Statement -2 is true.

Answer: c

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131. Statement-1: Out of the following radiations, microwave, ulrtaviolet and x-rays, microwaves has the shortest wavelength.

Statement-2: The microwave do not deviate from the obstacle in their path while going form one location to another.

A. Statement-1 is true, Statement-2 is true, Statement-2 is a correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, Statement-2 is not correct explanation of Statement-1.

C. Statement-1 is true, Statement -2 is false.

D. Statement-1 is false, Statement -2 is true.

Answer: d

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132. Statement-1: Gamma rays are more energetic than X-rays.

Statement-2: Gamma rays are of nuclear origin but x-rays are produced due to sudden deceleration of high energy electrons while falling on metal of high atomic number.

A. Statement-1 is true, Statement-2 is true, Statement-2 is a correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, Statement-2 is not correct explanation of Statement-1.

C. Statement-1 is true, Statement -2 is false.

D. Statement-1 is false, Statement -2 is true.

Answer: b

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C Problems For Practice

1. Prove that the total current which is the sum of conduction current and displacement current is always continuous and any loss in conduction current (I_C) appears as displacement current (I_D).

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Multiple Choice Questions

1. An electromagnetic wave travelling along z-axis is given as $E = E_0 \cos (kz - \omega t)$. Choose the correct options from the following

A. The associated magnetic field is given as $\overrightarrow{B} = \frac{1}{c} \hat{k} \times \overrightarrow{E}$

B. The e.m. wave field can be written in terms of the associated magnetic field as $\overrightarrow{E} = c\left(\overrightarrow{B} \times \times \hat{k}\right)$

C. $\hat{k} . \overrightarrow{E} = 0, \hat{k} . \overrightarrow{B} = 0$

D. $\hat{k} \times \overrightarrow{E} = 0, \hat{k} \times \overrightarrow{B} = 0$

Answer: (a,b,c)

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I Focus Multiple Choice Question

1. Which of the following statement about e.m. wave is /are / correct

A. 1 and 2

B. 2 and 3

C. 1,2 and 3

D. 2 only

Answer: d

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Ii Focus Multiple Choice Question

1. Which of the following Maxwell's equations have sources of $\overrightarrow{E}$ and $\overrightarrow{B}$?

A. $\oint_S \overrightarrow{E} . \overrightarrow{ds} = \frac{q}{\in_0}$

B. $\oint_S \overrightarrow{B} . \overrightarrow{dl} = \mu_0 I + \mu_0 \in_0 \frac{d}{dt} \oint_S \overrightarrow{E} . \overrightarrow{ds}$

C. $\oint_S \overrightarrow{E} . \overrightarrow{dl} = -\frac{d}{dt} \oint_S \overrightarrow{B} . \overrightarrow{ds}$

D. $\oint_S \overrightarrow{B} . \overrightarrow{ds} = 0$

Answer: (a,b,c)

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2. When a capacitor of capacitance C after charging with a charge Q is connected to inductor of self inductance L, the

oscillation of charge takes place with time between the two plates of capacitor. If one plate of capacitor is connected to antenna and other plate is earthed, then em wave are produced, which are sinusoidal variation of electric and magnetic field vectors, perpendicular to each other as well as perpendicular to the direction of propagation of wave. The velocity of these waves depends upon the electric and magnetic properties of the medium. the em wave were produced experimentally by Hertz in 1888 using Hertz Oscillator, which were of wavelength 6m. Jagdish chander bose in 1895 produced these waves which were of wave length 5mm to 25mm and in 1896, G. Marconi established a wireless communication between two stations 50km apart using em waves. In an em wave, the amplitude of electric field is $10Vm^{-1}$. The frequency of wave is $5 \times 10^{14} Hz.$ the wave is propagating along z-axis.

If $\mu_0, \mu_r, \in_0$ and $\in_r$ as the absolute permeabilty, relative permeability , absolute permitivity and relative permitivity of the medium, then the velocity of em wave in a medium is

A. $\frac{1}{\sqrt{\mu_0 \in_0}}$

B. $\frac{1}{\sqrt{\mu_r \in_r}}$

C. $\frac{1}{\sqrt{\mu_0 \in_r \mu_r \in_r}}$

D. $\sqrt{\frac{\mu_r \in_r}{\mu_0 \in_0}}$

Answer: c

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3. When a capacitor of capacitance C after charging with a charge Q is connected to inductor of self inductance L, the oscillation of charge takes place with time between the two plates of capacitor. If one plate of capacitor is connected to antenna and other plate is earthed, then em wave are produced, which are sinusoidal variation of electric and magnetic field vectors, perpendicular to each other as well as perpendicular to the direction of propagation of wave. The velocity of these waves depends upon the electric and magnetic properties of the medium. the em wave were produced experimentally by Hertz in 1888 using Hertz Oscillator, which were of wavelength 6m. Jagdish chander bose in 1895 produced these waves which were of wave length 5mm to 25mm and in 1896, G. Marconi established a wireless communication between two stations 50km apart using em waves. In an em wave, the amplitude of electric field is $10Vm^{-1}$. The frequency of wave is $5 \times 10^{14} Hz$. the wave is propagating along z-axis. In em wave, the average energy density due to magnetic field is

A. $8.85 \times 10^{-10} Jm^{-3}$

B. $4.42 \times 10^{-10} Jm^{-3}$

C. $2.21 \times 10^{-10} Jm^{-3}$

D. $6.63 \times 10^{-10} Jm^{-3}$

Answer: c

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4. When a capacitor of capacitance C after charging with a charge Q is connected to inductor of self inductance L, the oscillation of charge takes place with time between the two plates of capacitor. If one plate of capacitor is connected to antenna and other plate is earthed, then em wave are produced, which are sinusoidal variation of electric and magnetic field vectors, perpendicular to each other as well as perpendicular to the direction of propagation of wave. The velocity of these waves depends upon the electric and magnetic properties of the medium. the em wave were produced experimentally by Hertz in 1888 using Hertz Oscillator, which were of wavelength 6m. Jagdish chander bose in 1895 produced these waves which were of wave length 5mm to 25mm and in 1896, G. Marconi established a wireless communication between two stations 50km apart using em waves. In an em wave, the amplitude of electric field is $10Vm^{-1}$. The frequency of wave is $5 \times 10^{14} Hz$. the wave is propagating along z-axis. Sun also sends em wave to earth. which one of em wave out of the visible portion, from sun will be reaching the surface of earth earlier than others:

A. violet waves

B. green waves

C. yellow waves

D. red waves

Answer: d

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5. The sun delivers $10^3 W / m^2$ of electromagnetic flux to the earth's surface, which is at a distance of $1.5 \times 10^{11} m$ from the sun. The whole incident electromagnetic flux is absorbed by the earth.

The radiation force on the roof is

A. $2.67 \times 10^{-4} N$

B. $5.34 \times 10^{-4} N$

C. $2.33 \times 10^{-4} N$

D. $1.33 \times 10^{-4} N$

Answer: a

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