PHYSICS

BOOKS - KUMAR PRAKASHAN KENDRA PHYSICS (GUJRATI ENGLISH)

ELECTROMAGNETIC WAVES

Section A Questions Answers Introduction

1. What suggestion was done to correct discrepencies in Ampere circuital law ?

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2. What are Maxwell's equation ? Write these equation.

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3. Write inferences from Maxwell's equation.

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4. Explain - "Changing electric field produces magnetic field". Explain importance of this statement.

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5. What contradiction is found by using ampere circuital law to obtain magnetic field during charging of capacitor ?

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6. Derive equation of missing term in Ampere circuital law. Write its definition and unit.

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7. Write effect of displacement current.

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8. What are Maxwell's equation ? Write these equation.

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9. How electromagnetic waves are produced ?

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10. Write caracteristics of electromagnetic waves

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11. Write information regarding electromagnetic waves in short.

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12. Write source of radio waves, types and uses.

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13. Write source of microwaves and their uses.

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14. Write source of infrared waves. Also write their uses.

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15. Write source of visible rays and its uses.

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Watch Video Solution

16. Write source of ultraviolet rays and uses.

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17. Write source and uses of X - rays.

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18. Write source and uses of gamma rays.

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Section A Questions Answers Try Yourself

1. According to Maxwell which is missing term in Maxwell's - Ampere circuital law ?

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2. What are Maxwell's equation ? Write these equation.

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3. What are electromagnetic waves ?

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4. Who obtained electromagnetic wave first time in the laboratory ?

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5. Which scientist showed that by changing magnetic field electric field can be obtained ?

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6. Who invented first time that by changing electric field magnetic field can be obtained ?

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7. Which current flows inside capacitor when it is being charged ?

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8. In charging of capacitor what is contradiction in Ampere circuital law ?

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9. Write Ampere - Maxwell law in form of equation.

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10. Write SI unit of $\in_0 \left(\frac{d\Phi_E}{dt}\right)$.

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11. According to Maxwell which is missing term in Maxwell's - Ampere circuital law ?

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12. What is called as displacement current ?

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13. Write meaning of $i = i_c + i_d$.

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14. According to Maxwell, when charges emit electromagnetic waves?

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15. Jagdish Chandra Bose produced electromagnetic waves of which range ?

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16. If electromagnetic wave is propagating in x - direction and electric and magnetic field are in y and z - direction respectively then write equation of Ey and Bz.

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17. Who obtained electromagnetic wave first time in the laboratory ?

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18. Ratio of electric field and magnetic field gives dimension of which physical quantity ?

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19. Write standard equation for waves.

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20. Which scientist discarded postulate of ether ?

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21. Write equation of energy density of electromagnetic waves.

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22. If radiation is totally absorbed and energy incident on surface in time t be U then write equation of momentum imparted to surface.

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23. What is radiation pressure ?

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24. What is force exerted on surface having area of $10cm^2$ due to radiation of Sun ?

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25. What is called as electromagnetic spectrum ?

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26. How radio waves are produced ?

Watch Video Solution

27. Write range of frequencies of radio wave.

Watch Video Solution

28. How microwaves are produced ?

Watch Video Solution

29. Write range of frequencies for FM band radio.

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30. In microwave oven which type of waves are used ?

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31. How infrared waves are produced ?

Watch Video Solution

32. What are called heat waves ?

Watch Video Solution

33. In household appliances which waves are used to operate remote control switch ?

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34. Write range of frequencies of visible light.

Watch Video Solution

35. Snake can detect which type of waves ?

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36. Write source of ultraviolet rays and uses.

Watch Video Solution

37. Write range of ultraviolet waves.

Watch Video Solution

38. When human body skin get dark when it is exposed to sunlight for longer period of time ?

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39. Which waves are used for LASIK surgery ?

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40. What protects us from UV light emitted by the sun ?

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41. How X - rays are produced ?

Watch Video Solution

42. Write range of wave length of X - rays.

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43. Which waves are used in treatment of cancer ?

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44. How gamma rays are produced ?

Watch Video Solution

45. Which waves are used in treatment of cancer ?

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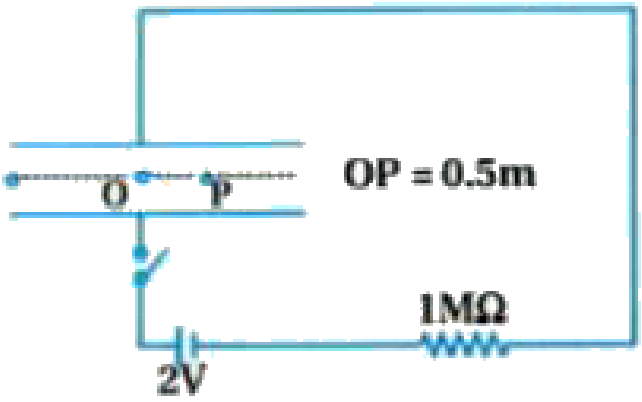
Section B Numericals Numerical From Textual Illustrations

1. A parallel plate capacitor with circular plates of radius 1 m has a capacitance of 1 nF. At t = 0, it is connected for charging in series with a resistor $R = 1MO\neg a$ across a 2V battery. Calculate the magnetic field at a point P, halfway between the centre and the periphery of the plates, after $t = 10^{-3}s$. (The charge on the capacitor at time t is q (t) = CV [1 -

exp $(-t/\tau)$], where the time constant τ is equal to CR.)



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2. A plane electromagnetic wave of frequency 25 MHz travels in free space along the x-direction. At a particular point in space and time, $E = 6.3\hat{j}$ V/m. What is B at this point?

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

What is the wavelength and frequency of the wave?

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

Write an expression for the electric field.

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

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6. Calculate the electric and magnetic fields produced by the radiation coming from a 100 W bulb at a distance of 3 m. Assume that the efficiency of the bulb is 2.5% and it is a point source.

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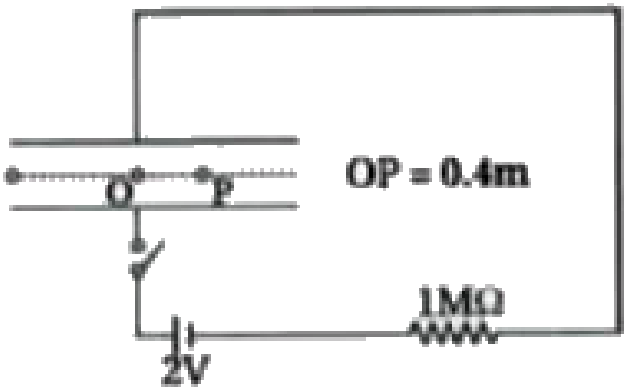
7. A parallel plate capacitor with circular plates of radius 0.8 m has a capacitance of 1 nF. At t = 0, it is connected for charging in series with a resistor $R = 1M\Omega$ across a 4V battery. Calculate the magnetic field at a point P, halfway between the centre and the perpendicular of the plates after $t = 10^{-3}s$. (The charge on the capacitor at time t is q (t) = CV [1 - exp $(-t/\tau)$], where the time constant τ is equal to CR.)



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8. When ac source V = 220 sin $(100\pi t)$ volt is connected to a parallel plate capacitor, displacement current is obtained maximum equal to 7600 mA.

If diameter of plate of a capacitor is 36 cm then find perpendicular distance between the plates of this capacitor.

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9. Find magnetic induction at 4.5 cm from the centroid of region between the plates of capacitor in above case.

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10. A plane electromagnetic wave of frequency 52 MHz travels in free space along the x - direction. At a particular point in space and time, $\overrightarrow{E} = 8.4\hat{k}V/m$. What is $\overrightarrow{B}$ at this point ?

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11. For one electromagnetic wave propagating along + Z axis frequency is 10^{15} Hz and amplitude of oscillations of electric field is 51 N/C. Find

amplitude of oscillations of magnetic field and its rms value.

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12. In above case, if instantaneous value of electric field at a given point on the direction of propagation of wave is $24\hat{i}\frac{N}{C}$ then find magnetic field at the same point at the same instant. What would be its frequency of oscillations ?

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13. The electric field in a plane electromagnetic wave propagating along + Y axis is given by $E_y = 30\sin\left[2 \times 10^{11}t + 300\pi x\right]\hat{j}Vm^{-1}$.

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

(b) Write an expression for the magnetic field.

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14. For a plane electromagnetic wave propagating along + Y axis, magnetic field is,

$B_x = 8 \times 10^{-6} \sin\{(3 \times 10^8)t - (0.4 \times 10^3)y\}\hat{i}T.$

Find periodic time, wave no and write equation of corresponding electric field.

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15. For a plane electromagnetic wave propagating along + X axis, electric field is $E_y = 48 \sin\{-10^3 x + 10^{11}t\}$ V/m. Find wavelength and frequency of above wave. Also write equation of corresponding magnetic field. (All values are in SI units).

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16. A dish antenna with radius 10 m completely absorbs the radio waves with amplitude $2 \times 10^{-7} Vm^{-1}$ incident on it perpendicularly. Find force

exerted on this antenna.

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17. A bulb of 100 W electrical power emits visible light with 3% efficiency. Find amplitude of oscillations of electric field at 5 m from the bulb.

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18. A bulb of 800 W electrical power has efficiency 6%. It is kept at the centre of a sphere of diameter 20 cm. If surface of this sphere is a perfect reflector then find force exerted on it.

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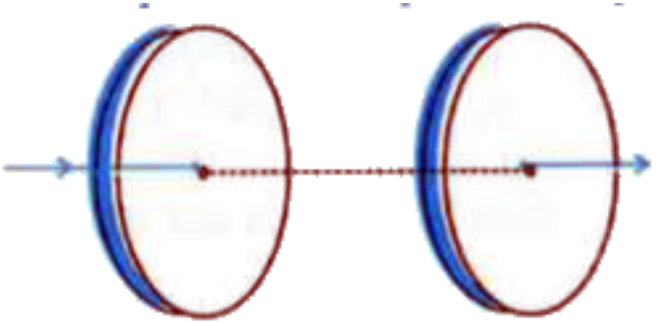
Section B Numericals Numerical From Textual Exercise

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



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

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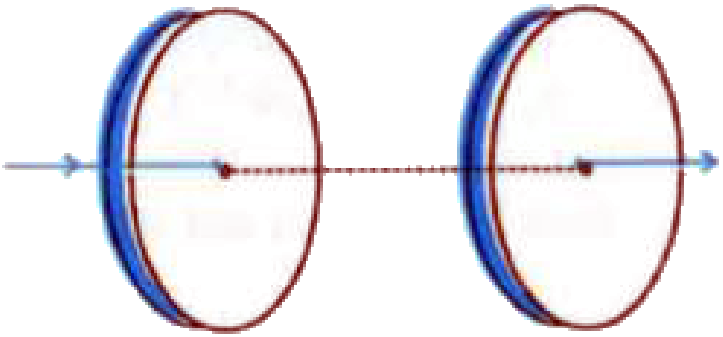
2. Figure shows a capacitor made of two circular plates each of radius 12 cm, and separated by 5.0 cm. The capacitor is being charged by an external source (not shown in the figure). The charging current is constant and equal to 0.15 A.



Obtain the displacement current across the plates.

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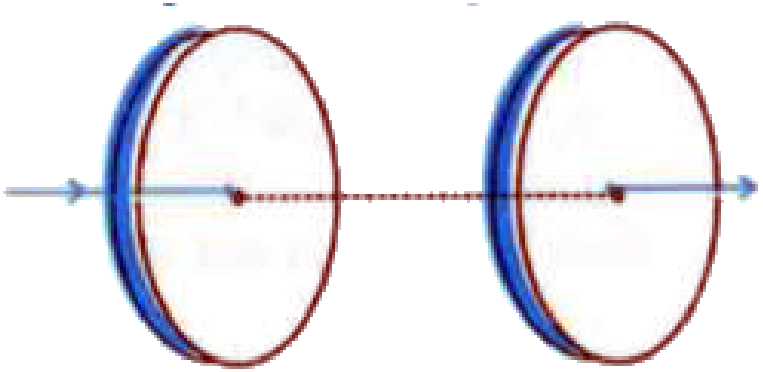
3. Figure shows a capacitor made of two circular plates each of radius 12 cm, and separated by 5.0 cm. The capacitor is being charged by an external source (not shown in the figure). The charging current is constant and equal to 0.15 A.



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

Explain.

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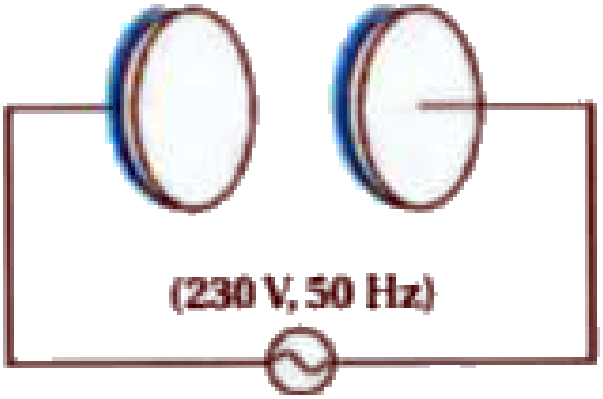
4. A parallel plate capacitor made of circular plates each of radius R = 6.0 cm has a capacitance C = 100 pF. The capacitor is connected to a 230 V ac supply with a (angular) frequency of 300 rad s^{-1}.



What is the rms value of the conduction current ?

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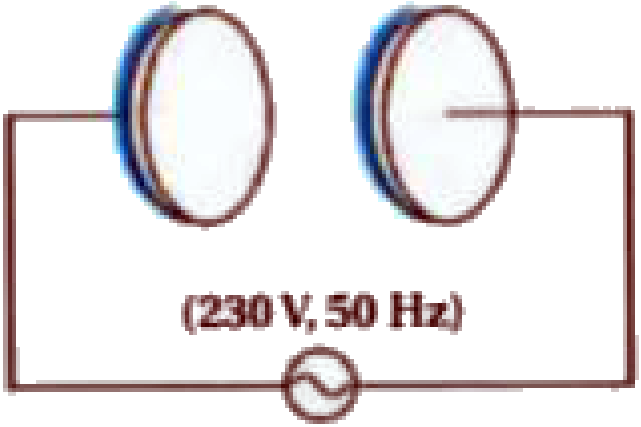
5. A parallel plate capacitor made of circular plates each of radius R = 6.0 cm has a capacitance C = 100 pF. The capacitor is connected to a 230 V ac supply with a (angular) frequency of 300 rad s^{-1}.



Is the conduction current equal to the displacement current ?

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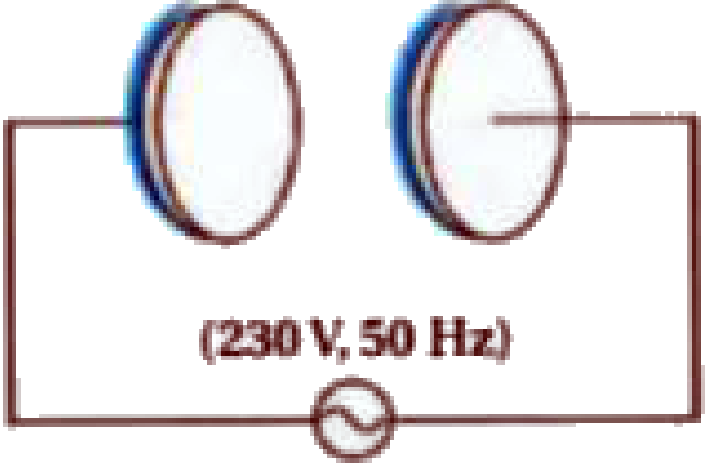
6. A parallel plate capacitor made of circular plates each of radius R = 6.0 cm has a capacitance C = 100 pF. The capacitor is connected to a 230 V ac supply with a (angular) frequency of 300 rad s^{-1}.



Determine the amplitude of B at a point 3.0 cm from the axis between the plates.

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7. What physical quantity is the same for X-rays of wavelength $10^{-10}m$, red light of wavelength 6800Å and radiowaves of wavelength 500m?

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8. A plane electromagnetic wave travels in vacuum along z - direction. What can you say about the directions of its electric and magnetic field

vectors ? If the frequency of the wave is 30 MHz, what is its wavelength ?

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9. A radio can tune in to any station in the 7.5 MHz to 12 MHz band. What is the corresponding wavelength band ?

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10. A charged particle oscillates about its mean equilibrium position with a frequency of 10^9 Hz. What is the frequency of the electromagnetic waves produced by the oscillator?

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

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12. Suppose that the electric field amplitude of an electromagnetic wave is $E_0 = 120N/C$ and that its frequency is ν = 50.0 MHz. (a) Determine, $B_0\omega, k, \text{ and } \lambda$. (b) Find expressions for E and B.

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13. The terminology different parts of the electromagnetic spectrum is given in the text. Use the formula E = hv (for energy of a quantum of radiation : photon) and obtain the photon energy in units of eV different parts of the electromagnetic spectrum. In what way are the different scales of photon energies that you obtain related to the sources of electromagnetic radiation ?

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

(a) What is the wavelength of the wave?

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

(c) Show that the average energy density of the E field equals the average energy density of the B field. $[c = 3 \times 10^8 m s^{-1}.]$

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

(a) What is the wavelength of the wave?

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(a) What is the wavelength of the wave?

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

(c) Show that the average energy density of the E field equals the average energy density of the B field. $[c = 3 \times 10^8 ms^{-1}.]$

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17. Suppose that the electric field part of an electromagnetic wave in vacuum is $\vec{E} = \{(3.1N/C)\cos[(1.8rad/m)y + (5.4 \times 10^6 rad/s)]\}\hat{i}$

What is the direction of propagation ?

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18. Suppose that the electric field part of an electromagnetic wave in vacuum is $\vec{E} = \{(3.1N/C)\cos[(1.8rad/m)y + (5.4 \times 10^6 rad/s)]\}\hat{i}$

What is the wavelength λ ?

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19. Suppose that the electric field part of an electromagnetic wave in vacuum is $\vec{E} = \{(3.1N/C)\cos[(1.8rad/m)y + (5.4 \times 10^6 rad/s)]\}\hat{i}$

What is the frequency v ?

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20. Suppose that the electric field part of an electromagnetic wave in vacuum is $\vec{E} = \{(3.1N/C)\cos[(1.8rad/m)y + (5.4 \times 10^6 rad/s)]\}\hat{i}$

What is the amplitude of the magnetic field part of the wave ?

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21. Suppose that the electric field part of an electromagnetic wave in vacuum is $\vec{E} = \{(3.1N/C)\cos[(1.8rad/m)y + (5.4 \times 10^6 rad/s)]\}\hat{i}$

Write an expression for the magnetic field part of the wave.

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

at a distance of 1m from the bulb ?

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

at a distance of 10 m ?

Assume that the radiation is emitted isotropically and neglect reflection.

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24. Use the formula $\lambda_m T = 0.29$ cm K to obtain the characteristic temperature ranges for different parts of the electromagnetic spectrum. What do the numbers that you obtain tell you ?

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25. 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.

21 cm (wavelength emitted by atomic hydrogen in interstellar space).

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26. 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.

1057 MHz (frequency of radiation arising from two close energy levels in hydrogen , known as Lamb shift).

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27. 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.

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].

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28. 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.

5890 Å - 5896 Å [double lines of sodium]

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29. 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.

14.4 keV [energy of a particular transition in ^{57}Fe nucleus associated with a famous high resolution spectroscopic method (Mossbauer spectroscopy)].

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30. Long distance radio broadcasts use short - wave bands. Why ?

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31. It is necessary to use satellites for ling distance TV transmission. Why ?

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32. Optical and radiotelescopes are built on the ground but X - ray astronomy is possible only from satellites orbiting the earth. Why ?

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33. The small ozone layer on top of the stratosphere is crucial for human survival. Why ?

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34. If the earth did not have an atmosphere, would its average surface temperature be higher or lower than what it is now ?

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35. 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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Section B Numericals Numerical From Darpan Based On Textbook

1. The maximum electric field at a distance of 10m from an isotropic point source of light is $3.0Vm^{-1}$. Calculate (a) the maximum value of magnetic field, (b) average intensity of light at that place and (c) the power of the source. $\left[c = 3 \times 10^8 ms^{-1}, \varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}\right]$

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2. An observer is at 2 m from an isotropic point source of light emitting 40 W power. What are the rms values of the electric and magnetic fields due to the source at the position of the observer ? $\left[c = 3 \times 10^8 ms^{-1}, \varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}\right]$

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3. A plane electromagnetic wave travelling along X - direction has electric field of amplitude $300Vm^{-1}$, directed along the Y - axis (a) What is the intensity of the wave ? (b) If the wave falls on a perfectly absorbing sheet of area $3.0m^2$, at what rate is the momentum delivered to the sheet and

what is the radiation pressure exerted on the sheet ?

$[\varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}, c = 3 \times 10^8 m s^{-1}]$

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4. An electromagnetic wave of electric field $E = 10 \sin(\omega t - Kx) N/C$ is incident normal to the cross - sectional area of a cylinder of $10 cm^2$ and having length 100 cm, lying along X - axis. Find (a) the energy density, (b) energy contained in the cylinder, (c) the intensity of the wave, (d) momentum transferred to the cross - sectional area of the cylinder in 1 s, considering total absorption, (e) radiation pressure.

$[\varepsilon_0 = 8.854 \times 10^{12} C^2 N^{-1} m^{-2}, c = 3 \times 10^8 m s^{-1}]$

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5. 3% of energy of 100 W bulb is converted into visible light. Find the average intensity on a spherical surface 1 m away from the bulb consider the bulb is point source and medium is isotropic.

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6. Find E_0, B_0, intensity I and force exerted on surface for a spherical surface 20 m away from the point source bulb of 2000 W. Efficiency of bulb is 2% and consider the bulb as point source. $\left(\varepsilon_0 = 8.85 \times 10^{-12} SI\right.$ and $\left. c = 3 \times 10^8 ms^{-1}\right)$

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7. 10 % of the total energy of a 100 W bulb is converted into visible light. Calculate the average intensity out a spherical surface which is at a distance of 1m from the bulb, consider the bulb to be a point source and let the medium be isotropic.

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8. Area of a surface is $1256m^2$. If $25Js^{-1}$ radiant energy is incident on it at each second and absorbed completely, then find

B_{rms}

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9. Area of a surface is $1256m^2$. If $25Js^{-1}$ radiant energy is incident on it at each second and absorbed completely, then find

Wave intensity

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10. Area of a surface is $1256m^2$. If $25Js^{-1}$ radiant energy is incident on it at each second and absorbed completely, then find

Magnitude of energy density

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11. Area of a surface is $1256m^2$. If $25Js^{-1}$ radiant energy is incident on it at each second and absorbed completely, then find

E_{rms}

Watch Video Solution

12. Area of a surface is $1256m^2$. If $25Js^{-1}$ radiant energy is incident on it at each second and absorbed completely, then find

B_{rms}

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Section C Ncert Exemplar Solution Multiple Choice Questions

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

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

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

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

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

Answer: B

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3. 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 $30cm^2$, the total momentum delivered (for complete absorption) during 30 minutes is:

(a) 36×10^{-5} kg m/s

(b) 36×10^{-4} kg m/s

(c) 108×10^{4} kg m/s

(d) 1.08×10^{7} kg m/s

A. 36×10^{-5} kg m/s

B. 36×10^{-4} kg m/s

C. 108×10^{4} kg m/s

D. 1.08×10^{7} kg m/s

Answer: B

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

(a) $\frac{E}{2}$

(b) $2E$

(c) $\frac{E}{\sqrt{2}}$

(d) $\sqrt{2}E$

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

B. 2E

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

D. $\sqrt{2}E$

Answer: C

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5. If $\vec{E}$ and $\vec{B}$ represent electric and magnetic field vectors of the electromagnetic wave, the direction of propagation of electromagnetic wave is along

A. $\vec{E}$

B. $\vec{B}$

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

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

Answer: D

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6. The ratio of contributions made by the electric 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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7. An EM wave radiates outwards from a dipole antenna, with E_0 as the amplitude of its electric field vector. The electric field E_0 which transports significant energy from the source falls off as

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

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

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

D. remains constant

Answer: C

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8. An electromagnetic wave travels in vacuum along z - direction : $\vec{E} = \left(E_1\hat{i} + E_2\hat{j}\right)\cos(kz - \omega t)$. Choose the correct options from the following :

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

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

C. The given electromagnetic field is circularly polarised.

D. The given electromagnetic wave is plane polarised.

Answer: D

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9. An electromagnetic wave travels in vacuum along z - direction : $\vec{E} = \left(E_1\hat{i} + E_2\hat{j}\right)\cos(kz - \omega t)$. Choose the correct options from the

following :

A. The associated magnetic field is given as $\vec{B} = \frac{1}{C}\hat{k} \times \vec{E} = \frac{1}{\omega}\left(\hat{k} \times \vec{E}\right)$

B. The electromagnetic field can be written in terms of the associated magnetic field as $\vec{E} = C\left(\vec{B} \times \hat{k}\right)$

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

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

Answer: A::B::C

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10. A plane electromagnetic wave propagating along x - direction can have the following pairs of $\vec{E}$ and $\vec{B}$.

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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11. A charged particle oscillates about its mean equilibrium position with a frequency of 10^9 Hz. What is the frequency of the electromagnetic waves produced by the oscillator?

A. will have frequency of 10^9 Hz

B. will have frequency of 2×10^9 Hz

C. will have a wavelength of 0.3 m.

D. fall in the region of radiowaves.

Answer: A::C::D

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12. 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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13. An EM 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 $\frac{I}{c}$ if the wave is totally absorbed.

B. Radiation pressure is $\frac{I}{c}$ if the wave is totally reflected.

C. Radiation pressure is $\frac{2I}{c}$ if the wave is totally reflected.

D. Radiation pressure is in the range $\frac{I}{c} < p < \frac{2I}{c}$ for real surfaces.

Answer: A::C::D

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Section C Ncert Exemplar Solution Very Short Answer Type Questions

1. Why is the orientation of the portable radio with respect to broadcasting station important ?

Watch Video Solution

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

Watch Video Solution

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

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

Watch Video Solution

5. The magnetic field of a beam emerging from a filter facing a floodlight is given by $B = 12 \times 10^{-8} \sin\left(1.20 \times 10^{7} z - 3.60 \times 10^{15} t\right)$ T. What is the average intensity of the beam ?

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6. Pointing 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 propagation. Mathematically, it is given by $\overrightarrow{S} = \frac{1}{\mu_0}\left(\overrightarrow{E} \times \overrightarrow{B}\right)$. Show the nature of $\overrightarrow{S}$ vs graph.

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7. 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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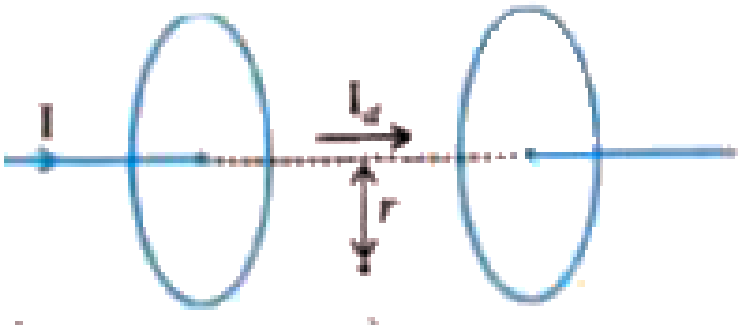
Section C Ncert Exemplar Solution Short Answer Type Questions

1. Show that the magnetic field B at a point in between the plates of a parallel plate capacitor during charging is $B = \frac{\mu_0 \in_0 r}{2}.\frac{dE}{dt}$ (symbols

having usual meaning).



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2. Electromagnetic waves with wavelength

(i) λ_1 is used in satellite communication.

(ii) λ_2 is used to kill germs in water purifies.

(iii) λ_3 is used to detect leakage of oil in underground pipelines.

(iv) λ_4 is used to improe visibility in runways during fog and mist conditions.

Identify and name the part of electromagnetic spectrum to which these radiations belong.

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3. Electromagnetic waves with wavelength

(i) λ_1 is used in satellite communication.

(ii) λ_2 is used to kill germs in water purifies.

(iii) λ_3 is used to detect leakage of oil in underground pipelines.

(iv) λ_4 is used to improe visibility in runways during fog and mist conditions.

Arrange these wavelengths in ascending order of their magnetude.

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4. Electromagnetic waves with wavelength

(i) λ_1 is used in satellite communication.

(ii) λ_2 is used to kill germs in water purifies.

(iii) λ_3 is used to detect leakage of oil in underground pipelines.

(iv) λ_4 is used to improe visibility in runways during fog and mist conditions.

Write one more application of each.

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5. A plane EM wave travelling along z - direction is desctribed $\vec{E} = E_0 \sin(kz - \omega t)\hat{i}$ and $veC(B) = B_0 \sin(kz - \omega)\hat{j}$. Show that The time averaged intensity of the wave is given by $I_{av} = \frac{1}{2} c \in_0 E_0^2$.

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

Watch Video Solution

7. Show that the radiation exerted by an EM wave of intensity I on a surface kept in vacuum is $\frac{I}{c}$.

Watch Video Solution

8. 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 length of a room, its intensity essentially remains constant. What geometrical characteristic of LASER beam is responsible for the constant intensity which is missing in the case of light from the bulb ?

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9. Even though an electric field E exerts a force qE on a charged particle yet the electric field of an EM wave does not contribute to the radiation pressure (but transfers energy). Explain.

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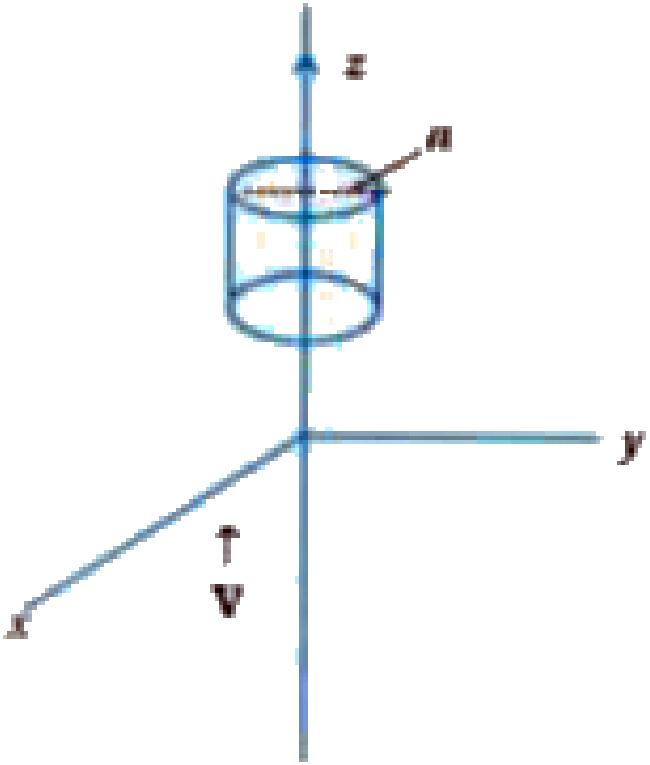
Section C Ncert Exemplar Solution Long Answer Type Questions

1. An infinitely long thin wire carrying a uniform linear static charge density λ is placed along the z - axis. The wire is set into motion along its

length with a uniform velocity $V = v\hat{k}_z$. Calculate the pointing vector $S = \frac{1}{\mu_0}\left(\vec{E} \times \vec{B}\right)$.



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2. Sea water at frequency $v = 4 \times 10^8$ Hz has permittivity $\in \approx 80 \in_0$, permeability $\mu = \mu_0$ and resistivity $\rho = 0.25\Omega$, 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 current density ?

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3. 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 thin wire and returns along the coaxial conducting tube. The induced electric field at a distance s from the wire inside the cable is $\vec{E}(s, t) = \mu_0 I_0 v \cos(2\pi vt) \ln\left(\frac{s}{a}\right)\hat{k}$ Calculate the displacement current density inside the cable.

Watch Video Solution

4. 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 thin wire and returns along the coaxial conducting tube. The induced electric field at a distance s from

the wire inside the cable is $\vec{E}(s,t) = \mu_0 I_0 v \cos(2\pi vt) \ln\left(\frac{s}{a}\right)\hat{k}$

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

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5. 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 thin wire and returns along the coaxial conducting tube. The induced electric field at a distance s from the wire inside the cable is $\vec{E}(s,t) = \mu_0 I_0 v \cos(2\pi vt) \ln\left(\frac{s}{a}\right)\hat{k}$

Compare the conduction current I_0 with the displacement current I_0^d.

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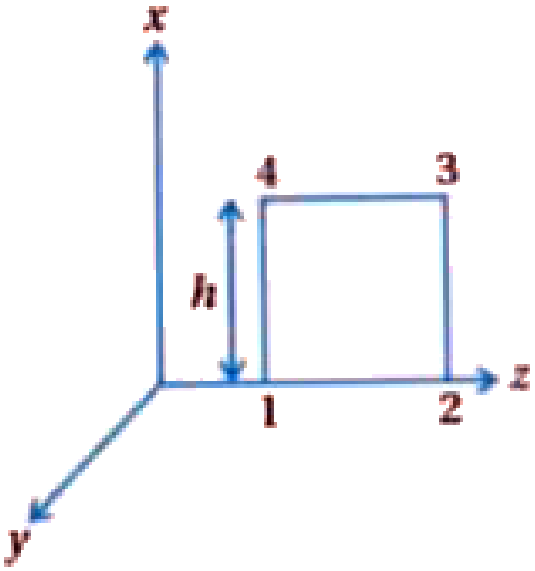
6. A plane EM wave travelling in vacuum along z - direction is given by $\vec{E} = E_0 \sin(kz - \omega t)\hat{i}$ and $\vec{B} = B_0 \sin(kz - \omega t)\hat{j}$.



Evaluate $\int \overrightarrow{E} . Vec(d)l$ over the rectangular loop 134 shown in figure.

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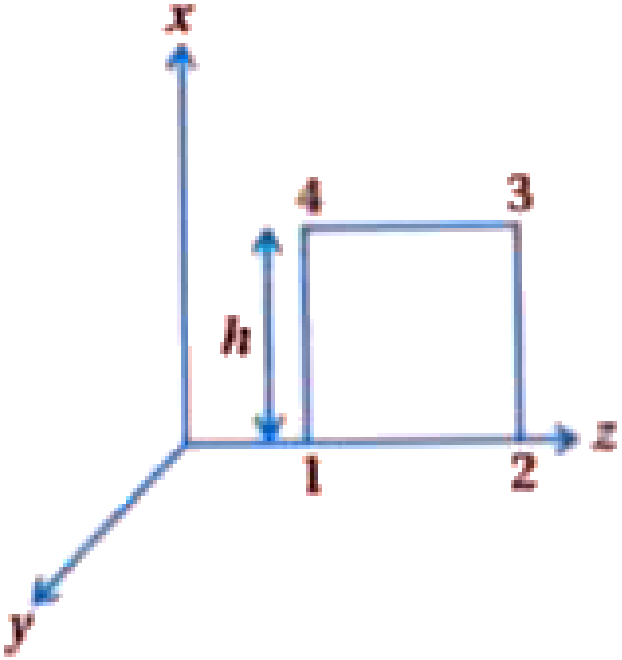
7. A plane EM wave travelling in vacuum along z - direction is given by $\overrightarrow{E} = E_0 \sin(kz - \omega t)\hat{i}$ and $\overrightarrow{B} = B_0 \sin(kz - \omega t)\hat{j}$.



Evaluate $\int \vec{B} . \vec{d} s$ over the surface bounded by loop 1234.

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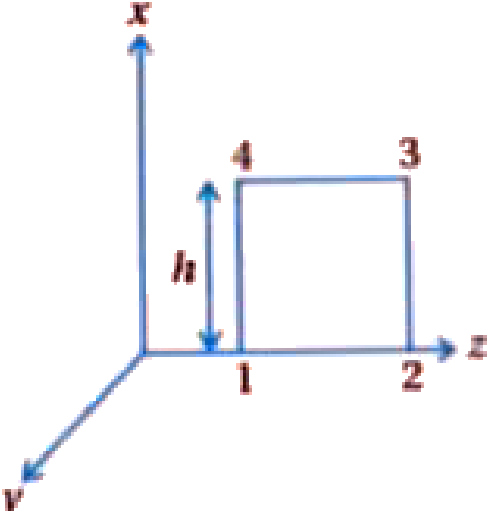
8. A plane EM wave travelling in vacuum along z - direction is given by $\vec{E} = E_0 \sin(kz - \omega t)\hat{i}$ and $\vec{B} = B_0 \sin(kz - \omega t)\hat{j}$.



Use equation $\int \vec{E} \cdot \vec{d} l = -\frac{d\phi_B}{dt}$ to prove $\frac{E_0}{B_0} = c$.

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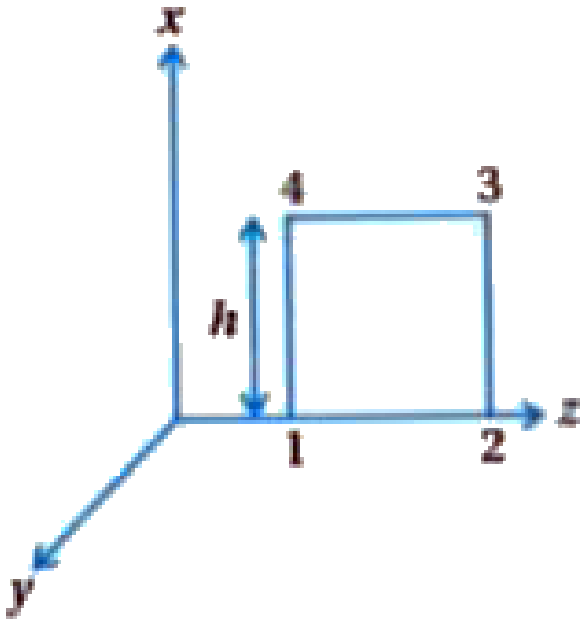
9. A plane EM wave travelling in vacuum along z - direction is given by $\vec{E} = E_0 \sin(kz - \omega t)\hat{i}$ and $\vec{B} = B_0 \sin(kz - \omega t)\hat{j}$.



By using similar process and the equation $\int \vec{B} . \vec{d} l = \mu_0 I + \in_0 \frac{d\phi_E}{dt}$, prove that $c = \frac{1}{\sqrt{\mu_0 \in_0}}$

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10. A plane EM wave travelling along z - direction is desctribed $\vec{E} = E_0 \sin(kz - \omega t)\hat{i}$ and $veC(B) = B_0 \sin(kz - \omega)\hat{j}$. Show that

The average energy density of the wave is given by $U_{av} = \frac{1}{4} \in_0 E_0^2 + \frac{1}{4} . \frac{B_0^2}{\mu_0}$.

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11. A plane EM wave travelling along z - direction is desctribed $\vec{E} = E_0 \sin(kz - \omega t)\hat{i}$ and $veC(B) = B_0 \sin(kz - \omega)\hat{j}$. Show that The time averaged intensity of the wave is given by $I_{av} = \frac{1}{2} c \in_0 E_0^2$.

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Section D Multiple Choice Questions Mcqs

1. Maxwell's equations describe fundamental laws of .....

A. only electricity

B. only magnetism

C. only mechanics

D. both (A) and (B)

Answer: D

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2. One capacitor with plate area A is being charged up. At a particular instant when charging current is I, what will be displacement current through a planar loop of area $\frac{A}{2}$, imagined between the plates and parallel to them ?

A. I

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

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

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

Answer: B

Watch Video Solution

3. ....is the scientist postulated electromagnetic waves.

A. Hertz

B. Faraday

C. Marconi

D. Maxwell

Answer: D

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4. ..... gave the proof for the existance of electromagnetic wave in the laboratory.

A. Hertz

B. Ampere

C. Gauss

D. Maxwell

Answer: A

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5. Name the scientist who proved the missing link in differential equations of electromagnetic waves.

A. Hertz

B. Maxwell

C. Ampere

D. Gauss

Answer: B

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6. In which form the missing link in the differential equations of electromagnetic waves were provided ?

A. Displacement current

B. Electric current

C. Heat current

D. Alternate current

Answer: A

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7. Which from the following represents displacement current ?

A. $\varepsilon_0 \frac{dB}{dt}$

B. $\varepsilon_0 \frac{d\phi_E}{dt}$

C. $\varepsilon_0 \frac{d\phi_B}{dt}$

D. $\varepsilon_0 \frac{dI}{dt}$

Answer: B

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8. Give the equation which represents law of gauss for magnetism.

A. $\oint \vec{E} \cdot d\vec{a} = \frac{q}{\varepsilon_0}$

B. $\oint \vec{B} \cdot d\vec{a} = 0$

C. $\oint \vec{B} \cdot d\vec{l} = -\frac{d\phi_B}{dt}$

D. $\oint \vec{E} \cdot d\vec{l} = \mu_0(i_c + i_d)$

Answer: B

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9. The SI nit of displacement current is

A. Coulomb

B. Faraday

C. Ampere

D. Weber

Answer: C

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10. If electric charge on capacitor formed by two plates of area A is Q, then electric field between them is .....

A. $E = \frac{Q}{\varepsilon_0 A}$

B. $E = \frac{Q}{2\varepsilon_0 A}$

C. $E = \frac{2Q}{\varepsilon_0 A}$

D. $\frac{\varepsilon_0 A}{Q}$

Answer: A

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11. Capacitance of capacitor is 2pE. Electric field inside capacitor is changing with the rate of $10^{12} V s^{-1}$. Then displacement current is ..... A.

A. 2

B. 3

C. 6

D. 9

Answer: A

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12. Electromagnetic waves possess

A. only energy, not momentum

B. only momentum, not energy

C. both energy and momentum

D. none of above

Answer: C

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13. ..... Can be produced by magnetic field.

A. Moving electric charge.

B. Variable electric charge

C. Both (A) and (B)

D. None of these

Answer: C

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14. Corrected form of Ampere's is circuital law by Maxwell is .....

A. $\oint \vec{B} . \vec{d} A = 0$

B. $\oint \vec{B} \vec{d} A = \mu_0 I$

C. $\oint \vec{B} . \vec{d} l = \frac{d\phi_B}{dt}$

D. $\oint \vec{B} \cdot \vec{d} l = \mu_0 i_C + \mu_0 \in_0 \frac{d\phi_B}{dt}$

Answer: D

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15. Which of the following law is represented by equation given by Maxwell ?

A. Ampere's law

B. Gauss's law for electrics

C. Faraday's law

D. Gauss's law for magnetics

Answer: C

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16. If electric field in electromagnetic wave propagating along north is verically upward then magnetic field will be towards .....

A. north

B. east

C. west

D. vertically downward

Answer: B

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17. Speed of electromagnetic waves in vacuum,

A. depends on type of source.

B. increases from γ - rays to radio waves.

C. decreases from γ - rays to radio waves.

D. is same for all the parts of electromagnetic spectrum.

Answer: D

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18. In one complete cycle, which field's average value is zero in the propagation of electromagnetic wave ?

A. Both electric and magnetic field.

B. Only electric field.

C. Only magnetic field.

D. Only magnetic energy.

Answer: A

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19. Unit of permittivity is .....

A. $C^2N^{-2}m^{-2}$

B. $C^2N^{-1}m^{-2}$

C. $C^2N^{-1}m^{-1}$

D. $C^2N^{-2}m^{-1}$

Answer: B

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20. Electric field in one electromagnetic wave, propagating in vacuum is $E = 40\cos\left(kz - 6 \times 10^8 t\right)\hat{i}$ (where all the values are in SI units). Then value of wave vector of this wave is ..... .

A. $2m^{-1}$

B. $0.5m^{-1}$

C. $6m^{-1}$

D. $3m^{-1}$

Answer: A

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21. Electric field of one plane progresive electromagnetic wave is $E_Z = 100\cos\left(6 \times 10^8 t + 4x\right) Vm^{-1}$. Then refreactive index of medium pf propagation would be .....

A. 1.5

B. 2.0

C. 2.4

D. 4.0

Answer: B

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22. Electromagnetic radiation of intensity I is made incident normally on a perfect nonreflecting surface (i.e perfect absorber). Then pressure developed on this surface would be ..... .

A. Ic

B. Ic^2

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

D. $\frac{I}{c^2}$

Answer: C

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23. What is the order of radiation pressure of visible light in Nm^{-2} ?

A. 10^{-2}

B. 10^{-4}

C. 10^{-6}

D. 10^{-8}

Answer: C

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24. If E and B are respectively values of electric and magnetic fields, then which of following is dimensionless ?

A. $\sqrt{\mu_0 \in_0} \frac{E}{B}$

B. $\mu_0 \in_0 \frac{E}{B}$

C. $\mu_0 \in_0 \left(\frac{B}{E}\right)^2$

D. $\frac{E}{B} \cdot \frac{\mu_0}{\in_0}$

Answer: A

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25. Relation of amplitude of corelate of electric and magnetic field is .....

A. (A) $E_0 = B_0$

B. (B) $E_0 = cB_0$

C. (C) $E_0 = \frac{B_0}{c}$

D. (D) $E_0 = \frac{c}{B_0}$

Answer: B

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26. Using $B_0 = \mu_0 H_0$ formula find ratio of $\frac{E_0}{H_0}$ for plane electromagnetic wave.

A. $\frac{c}{\mu_0}$

B. $\mu_0 c$

C. $\frac{\mu_0}{c}$

D. $\mu_0 c^2$

Answer: B

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27. For the electromagnetic waves propagating in the X - direction, oscillation of $\vec{E}$ takes places along y - axis. What from the following is right ?

A. $E_x = E_y = 0, E_z \neq 0$

B. $E_x = E_z = 0, E_y \neq 0$

C. $E_x \neq E_y, E_z \neq 0$

D. $E_x = E_y = E_z$

Answer: B

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28. The direction of electromagnetic wave is in the direction of

A. (A) $\frac{\vec{E}}{\vec{B}}$

B. (B) $\vec{E} \times \vec{B}$

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

D. (D) $\vec{B}$

Answer: B

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29. Speed of electromagnetic wave in a medium of $\in_r = 1.3$ and $\mu_r = 2.14$ is ..... .

A. $3.6 \times 10^8 m/s$

B. $1.8 \times 10^8 m/s$

C. $1.8 \times 10^6 m/s$

D. $13.6 \times 10^6 m/s$

Answer: B

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30. Two opposite charaged particles oscillate about their mean equilibrium position in free space, with a frequency of 10^9 Hz. The wavelength of the corresponding electromagnetic wave produced is .....

A. 0.3 m

B. $3 \times 10^{17} m$

C. $10^9 m$

D. 3.3 m

Answer: A

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31. The frequency of na electromagnetic wave in free space is 2 MHz. When it passes through a region of relative permittivity $\varepsilon_r = 4.0$, then its wavelength ..... and frequency .....

A. becomes double, becomes half.

B. becomes double, remains constant.

C. becomes half, becomes double.

D. becomes half, remains constant.

Answer: D

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32. Dielectric constnat of air is 1.005 and velocity of electromagnetic wave propagating in air is $a \times 10^{10} cm / s$ then a = ...

A. 3

B. 3.55

C. 2.5

D. 2.8

Answer: A

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33. Frequency of electromagnetic wave is 25MHz. The value of electric field intensity at any point at any time in wave in wave is $6.3Vm^{-1}$. The value of magnetic field at that point is ..... Wb/m^2.

A. 3.9×10^{-2}

B. 2.52×10^{-7}

C. 2.1×10^{-8}

D. 7.5×10^{-3}

Answer: C

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34. Values of μ_r and $\in_0$ are respectively $2NA^{-2}$ and $8C^2N^{-1}m^{-2}$, then speed of light is ....

A. 0.25

B. 0.5

C. 0.75

D. 1.0

Answer: A

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35. Relative permeability of medium of refractive index 1.5 and dielectric constant 2 is ..... TmA^{-1}. $\left(\mu_0 = 4\pi \times 10^{-7} TmA^{-1}\right)$

A. (A) $0.45\pi \times 10^{-7}$

B. (B)$5\pi \times 10^{-7}$

C. (C) $5\pi \times 10^{-7}$

D. (D) $4.5\pi \times 10^{-7}$

Answer: D

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36. Magnitude of an electromagnetic wave is $E = 4.24 \sin\left[(7.54 \times 10^6)\left(t - \frac{x}{3 \times 10^8}\right)\right] \frac{mV}{m}$.

Then energy density associated with magnetic field of this wave is .....

(a) $796 \times 10^{-19} J$

(b) $796 \times 10^{-19} J/m^3$

(c) $7.96 \times 10^{-19} J/m^3$

(d) $796 \times 10^{-19} W$

A. $796 \times 10^{-19} J$

B. $796 \times 10^{-19} J/m^3$

C. $7.96 \times 10^{-19} J/m^3$

D. $796 \times 10^{-19} W$

Answer: B

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37. Component of electric field of electromagnetic wave is as following :

$E_x = 10^2 \sin\left(\pi\left(9 \times 10^{14} t - 3 \times 10^6 z\right)\right)$,

$E_y = 0, E_z = 0$, then intensity of wave is ....

A. $13.3 Wm^{-2}$

B. $0.133 Wm^{-2}$

C. $1.33 Wm^{-2}$

D. $13.3 \times 10^{-12} Wm^{-2}$

Answer: A

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38. Electric field of electromagnetic wave is represented by $E = 50 \sin\left(\omega t - \frac{x}{c}\right) NC^{-1}$. Intensity of wave is ..... Wm^{-2}.

A. (A) 50

B. (B) 1.1×10^{-8}

C. (C) 3.3

D. (D) 5.5×10^{-19}

Answer: C

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39. If the electric field associated with a radiation of frequency 10 MHz is $E = 10\sin(kx - \omega t)$ mV/m then its energy density is .... Jm^{-3}. [epsilon_(0) = 8.85xx10^(-12)C^(2)N^(-1)m^(-2)]`

A. 4.425×10^{-16}

B. 6.26×10^{-14}

C. 8.85×10^{-16}

D. 8.85×10^{-14}

Answer: A

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40. If plane electromagnetic wave of momentum p and E are collied with the surface of any object then the value of p and E will be .....

A. p = 0, E = 0

B. $p \neq , E = 0$

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

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

Answer: D

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41. The intensity of plane electromagnetic wave with $B_0 = 1.0 \times 10^{-4} T$ is ..... Wm^{-2}.

$\left[c = 3 \times 10^8 ms^{-1}, \mu_0 = 4\pi \times 10^{-7} NA^{-2}\right]$

A. 2.38×10^6

B. 1.19×10^6

C. 6×10^5

D. 4.76×10^6

Answer: B

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42. Intensity of electromagnetic wave is 0.02 wattmeter^{-2} and its velocity in space is $3 \times 10^8 ms^{-1}$ then energy density of radiation is ..... Jm^{-2}

A. 6.67×10^{11}

B. 6.67×10^{-11}

C. 1.5×10^{10}

D. 1.5×10^{-10}

Answer: B

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43. Radiated energy per second gain by an electric bulb is 25 Joule/second and velocity of electromagnetic wave is c then force gain by the surface per second is ....

A. $8.33 \times 10^{-8} J$

B. $8.33 \times 10^{-8} J$

C. $75 \times 10^{8} N$

D. $75 \times 10^{8} N$

Answer: B

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44. Which of the following is dimensional formula of intensity of radiation ?

A. $M^1L^2T^{-2}$

B. $M^1L^0T^3$

C. $M^1L^0T^{-3}$

D. $M^0L^2T^{-2}$

Answer: C

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45. Which of following waves are used for satellite communication ?

A. (A) Microwave

B. (B) Infrared waves

C. (C) Radio waves

D. (D) Ultrasonic waves

Answer: A

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46. Which of following waves are used for sonography ?

A. Microwave

B. Infrared waves

C. Radio waves

D. Ultrasonic waves

Answer: D

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47. Which of following waves cannot propagate in vacuum ?

A. X - rays

B. Radio waves

C. Infrasonic waves

D. UV waves

Answer: C

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48. Which of following statements are correct ?

(1) Wavelength of microwaves is greater than that of UV rays.

(2) Wavelength of infrared radiation is less than that of UV rays.

(3) Wavelength of microwaves is less than that of infrared waves.

(4) Gamma rays have shortest wavelength in electromagnetic spectrum.

A. (1) and (2)

B. (2) and (3) true

C. (3) and (4)

D. (1) and (4)

Answer: D

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49. Which of following are not electromagnetic waves ?

A. X - rays

B. Gamma rays

C. Cathode rays

D. Infrared rays

Answer: C

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50. In the following list of different electromagnetic waves and its source, which one is not correct ?

A. Gamma rays $\rightarrow$ decay of a radioactive nucleus

B. Ultraviolet rays $\rightarrow$ magnetron valve

C. Infrared rays $\rightarrow$ oscillations of atoms and molecules

D. X - rays $\rightarrow$ coolidged tube

Answer: B

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51. Crystalline structures can be studied using .... .

A. UV rays

B. X - rays

C. ultraviolet rays

D. microwaves

Answer: B

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52. In vacuum, X - rays, Gamma rays and Microwave have .... .

A. same wavelength but different velocity

B. same frequency but different velocity

C. same velocity but different wavelength

D. same velocity and same frequency

Answer: C

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53. For navigation in sea, ... waves are useful.

A. radio

B. infrared

C. UV

D. microwave

Answer: D

Watch Video Solution

54. .... radiation is emitted by hot bodies.

A. (A) Radio waves

B. (B) Microwaves

C. (C) Infrared

D. (D) UV

Answer: C

Watch Video Solution

55. In microwave oven, if frequency of rotation of water molecules is v_1 and frequency of microwave is v_2 then ....

A. $v_1 < v_2$

B. $v_1 > v_2$

C. $v_1 = v_2$

D. $v_1 = 0$ and $v_2 = \infty$

Answer: C

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56. Given the frequency of microwave used by microwave oven to cook food.

A. 0.951 GHz

B. 0.501 GHz

C. 0.651 GHz

D. 0.5051 GHz

Answer: A

Watch Video Solution

57. ..... are used in the interceptor van used by traffic police.

A. (A) Radio

B. (B) Microwaves

C. (C) Infrared

D. (D) UV

Answer: B

Watch Video Solution

58. ..... can be used to cook the food.

A. (A) Radio

B. (B) Gamma rays

C. (C) X - rays

D. (D) Microwaves

Answer: D

Watch Video Solution

59. .... Lamp is used in physiotherapy treatement.

A. (A) Infrared

B. (B) Ultraviolet

C. (C) X - rays

D. (C) UV

Answer: A

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60. When skin gets exposed UV radiation for a long time, it develops .....

A. manganese

B. manganine

C. melamine

D. melanin

Answer: D

Watch Video Solution

61. Which of following is CFC gas ?

A. O_3

B. CO_2

C. CO

D. Freon

Answer: D

Watch Video Solution

62. Cracks in bones can be detected using .....

A. (A) X - rays

B. (B) gamma rays

C. (C) infrared rays

D. (D) UV rays

Answer: A

Watch Video Solution

63. ..... are used to kill cancerous cells.

A. X - rays

B. Gamma rays

C. Infrared rays

D. Ultraviolet rays

Answer: B

Watch Video Solution

64. In communication system and RADAR microwave are used, because .....

A. its wavelength is very small.

B. its interference is very less.

C. its interference is more.

D. they propogates very fast.

Answer: B

Watch Video Solution

65. Ozone layer absorbs .....

A. Infrared radiation

B. X - rays

C. Ultraviolet rays

D. γ rays

Answer: C

Watch Video Solution

66. The wavelength less than ..... $\mathring{A}$ almost all the electromagnetic waves are absorb in ozone layer.

A. $4000\mathring{A}$

B. $3000\mathring{A}$

C. $5000\mathring{A}$

D. $6000\mathring{A}$

Answer: B

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67. Wavelengths of some electromagnetic waves are given below. Arrange them in increasing order. Short radiowaves $-\lambda_1$, Microwaves $-\lambda_2$, Ultraviolet waves $-\lambda_3$

A. $\lambda_1, \lambda_3, \lambda_2$

B. $\lambda_1, \lambda_2, \lambda_3$

C. $\lambda_3, \lambda_2, \lambda_1$

D. $\lambda_2, \lambda_1, \lambda_3$

Answer: B

Watch Video Solution

68. Wavelength of infrared waves is .....

A. 400 nm to 1 nm

B. 1 mm to 700 nm

C. $> 0.1m$

D. 0.1 m to 1 mm

Answer: B

Watch Video Solution

69. The wavelength 5890Å and 5896Å of sodium doublet correspond to .... region of the electromagnetic spectrum.

A. (A) infrared

B. (B) visible light

C. (C) ultraviolet

D. (D) microwave

Answer: B

Watch Video Solution

70. In electromagnetic spectrum ..... the light has lowest wavelength.

A. Ultraviolet

B. Infrared rays

C. Gamma rays

D. Microwave

Answer: C

Watch Video Solution

71. Which of the following electromagnetic wave has maximum wavelength ?

A. Radiowaves

B. Microwaves

C. Ultraviolet rays

D. γ rays

Answer: A

Watch Video Solution

72. Which of the following group has the frequency of electromagnetic ray in the ascending form ?

A. Microwave, ultraviolet, x - rays.

B. Radiowave, visible light, infrared radiation.

C. Gamma rays, visible light, ultraviolet rays.

D. Gamma rays, ultraviolet rays, radio waves.

Answer: A

Watch Video Solution

73. Which of the following is not electromagnetic waves ?

A. Cosmic rays

B. Gamma rays

C. Microwaves

D. X - rays

Answer: A

Watch Video Solution

74. For communication which electromagnetic waves are used by cellular phones ?

A. Microwaves

B. Infrared waves

C. Ultraviolet waves

D. Ultra high frequency

Answer: D

Watch Video Solution

75. Which type of rays are used for LASIK eye surgery ?

A. (A) Gamma

B. (B) X - rays

C. (C) Infrared

D. (D) Ultraviolet

Answer: D

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76. ..... frequency is use in TV.

A. 530 kHz to 1710 kHz

B. 88 MHz to 108 MHz

C. 0.3 GHz to 300 GHz

D. 54 MHz to 890 MHz

Answer: D

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Section D Multiple Choice Questions Mcqs Mcqs Asked In Competitive Exams

1. Maximum value of magnetic field of progressive electromagnetic wave is 20 nT, then maximum value of electric field is .....

A. $12\frac{V}{m}$

B. $3\frac{V}{m}$

C. $6\frac{V}{m}$

D. $9\frac{V}{m}$

Answer: C

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2. Match List - I(Electromagnetic wave type) with List - II (Its association / application) and select the correct option from the choices given below the lists.

	List - I		List - II
(a)	Infrared waves	(i)	To treat muscular strain
(b)	Radiowaves	(ii)	For broadcasting
(c)	X - rays	(iii)	To detect fracture of bone
(d)	Ultraviolet rays	(iv)	absorbed by the ozone layer of the atmospher

A. (A) - (iii), (B)-(ii), (C)-(i), (D)-(iv)

B. (A)-(i), (B)-(ii), (C)-(iii), (D)-(iv)

C. (A)-(iv), (B)-(iii), (C)-(ii), (D)-(i)

D. (A)-(i), (B)-(ii),(C)-(iv),(D)-(iii)

Answer: B

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3. During the propagation of electromagnetic waves in a medium :

A. (A)Electric energy density is equal to the magnetic energy density.

B. (B) Both electric and magnetic energy densities are zero.

C. (C) Electric energy density is double of the magnetic energy density.

D. (D) Electric energy density is half of the magnetic energy density.

Answer: A

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4. A Red LED emits light 0.1 watt uniformly around it. The amplitude of the electric field of the light at a distance of 1 m from the diode is :

A. (A) 1.73 V/m

B. (B) 2.45 V/m

C. (C) 5.48 V/m

D. (D) 7.75 V/m

Answer: B

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5. Arrange the following electromagnetic radiations per quantum in the order of increasing energy :

A : Blue light

B : Yellow light

C : X - ray

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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6. An EM wave from air enters a medium. The electric fields are $\overrightarrow{E}_1 = E_{01}\hat{x}\cos\left[2\pi v\left(\frac{z}{c} - t\right)\right]$ in air and $\overrightarrow{E}_2 = E_{02}\hat{x}\cos[k(2z - ct)]$ in medium, where the wave number k and frequency v refer to their values in air. The medium is non - magnetic. If $\in_{r_1}$ and $\in_{r_2}$ refer to relative permittivities of air and medium respectively, which of the following options is correct ?

A. $\frac{\in_{r_1}}{\in_{r_2}} = 4$

B. $\frac{\in_{r_1}}{\in_{r_2}} = 2$

C. $\frac{\in_{r_1}}{\in_{r_2}} = \frac{1}{4}$

D. $\frac{\in_{r_1}}{\in_{r_2}} = \frac{1}{2}$

Answer: C

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7. Given magnetic field equation is $\overrightarrow{B} = 3 \times 10^{-8} \sin[\omega t - kx + \phi]\hat{j}$ then appropriate equation for electric field $\left(\overrightarrow{E}\right)$ will be .....

A. $3 \times 10^{-9} \sin(\omega t - kx + \phi)\hat{k}$

B. $9 \sin(\omega t - kx + \phi)\hat{k}$

C. $16 \times 10^{-9} \sin(\omega t - kx + \phi)\hat{k}$

D. $20 \times 10^{-9} \sin(\omega t - kx + \phi)\hat{k}$

Answer: B

Watch Video Solution

8. The relative permittivity and relative permeability of a medium are 3 and $\frac{4}{3}$ respectively, the critical angle for this medium is

A. 15°

B. 30°

C. 45°

D. 60°

Answer: B

Watch Video Solution

9. Formula for velocity of electromagnetic wave in vacuum (C) is .....

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

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

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

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

Answer: B

Watch Video Solution

10. Which of the following group has the frequency of electromagnetic ray in the ascending form ?

A. Microwave, ultraviolet, x - rays.

B. Radiowave, visible light, infrared radiation.

C. Gamma rays, visible light, ultraviolet rays.

D. Gamma rays, ultraviolet rays, radio waves.

Answer: A

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

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

B. $\frac{2E}{c}$

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

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

Answer: B

Watch Video Solution

12. Energy of one photon of radiant energy is 15 keV. Then this radiation belongs to ..... Parts of electromagnetic waves.

A. ultraviolet

B. gamma waves

C. X - rays

D. infrared

Answer: C

Watch Video Solution

13. A 100Ω resistance and a capacitor of 100Ω reactance are connected in series across a 220 V source. When the capacitor is 50% charged, the peak value of the displacement current is:

(a) $4.4A$

(b) $11\sqrt{2}A$

(c) $2.2A$

(d) $11A$

A. $4.4A$

B. $11\sqrt{2}A$

C. $2.2A$

D. $11A$

Answer: C

Watch Video Solution

14. An em wave is propagating in a medium with a velocity $\vec{V} = V\hat{i}$. The instantaneous oscillating electric field of this em waves is along + y axis. Then the direction of oscillating magnetic field of the em wave will be along

A. $-x$ direction

B. $-z$ direction

C. $-y$ direction

D. $+z$ direction

Answer: D

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15. A $20\mu F$ capacitor is being charged by some constant voltage source. When p.d. across capacitor changes with time at a rate 3 V/s, find conduction current in the wires joining battery with capacitor and displacement current in the space between the plates.

A. 0, 0

B. $0, 60\mu A$

C. $60\mu A, 60\mu A$

D. $60\mu A, 0$

Answer: C

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16. Which colour of the light has the longest wavelength ?

A. Violet

B. Red

C. Blue

D. Green

Answer: B

Watch Video Solution

17. Velocity of light = ...

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

B. $\sqrt{\frac{\in_0}{\mu_0}}$

C. $\frac{\in_0}{\mu_0}$

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

Answer: D

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18. Which electromagnetic waves can be used to obtain electrical energy ?

A. Radio waves

B. Ultraviolet waves

C. Visible light

D. Microwaves

Answer: B

Watch Video Solution

19. The dimensional formula of $\mu_0 \in_0$ is .....

A. $M^0L^{-2}T^2$

B. $M^0L^2T^{-2}$

C. $M^0L^1T^{-1}$

D. $M^0L^{-1}T^1$

Answer: A

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20. Frequency of various radiations are given as

$f_v \rightarrow$ Visible light, $f_r \rightarrow$ Radio waves

$f_{UV} \rightarrow$ Ultra Violet waves

Then which of following is true ?

A. $f_{UV} < f_v < f_r$

B. $f_r < f_v < f_{UV}$

C. $f_v < f_r < f_{UV}$

D. $f_{UV} < f_r < f_v$

Answer: B

Watch Video Solution

21. Dimension of $\frac{1}{\mu e}$ is same as dimension of.....

A. square of velocity

B. velocity

C. acceleration

D. momentum

Answer: A

Watch Video Solution

22. Frequency of FM radio band is from.....

A. 88 MHz to 108 MHz

B. 88 kHz to 108 kHz

C. 54 MHz to 890 MHz

D. 54 kHz to 890 kHz

Answer: A

Watch Video Solution

23. To destroy cancer cells..... Are used.

A. X - rays

B. Gamma rays

C. Ultraviolet rays

D. Infrared rays

Answer: B

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Board S Question Paper March 2020 Part A

1. According to Ohm's law $\left(R = \frac{V}{I}\right)$ as current flowing through a conductor increases, resistance of conductor

A. decreases

B. increases

C. remains constant

D. nothing can be said

Answer: B

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2. Kichhoff's junction role represents.....

A. conservation of linear momentum.

B. conservation of energy.

C. conservation of angular momentum.

D. conservation of charge.

Answer: D

Watch Video Solution

3. Two resistors when connected in series net resistance is 5Ω and when they are connected in parallel net resistance is 1.2Ω What are these resistors?

A. $2\Omega, 3\Omega$

B. $1\Omega, 4\Omega$

C. $0.6\Omega, 0.6\Omega$

D. $1\Omega, 0.2\Omega$

Answer: C

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4. A straight wire of mass 200g and length 1.5m carries a current of 2A. To suspend it in a air by a uniform horizontal magnetic field, value of required magnetic field is.... T

A. 6.5

B. 0.45

C. 0.65

D. 4.5

Answer: B

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5. Unit of Bohr magneton is .....

A. Am

B. Cm^2

C. Am^{-2}

D. Am^2

Answer: D

Watch Video Solution

6. Current sensivity of galvanometer in inversely proportional to.....

A. number of turns

B. torsional constant

C. area

D. magnetic field

Answer: A

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7. Frequency of cyclotron is independent of .....

A. radius of its trajectory

B. charge of a particle

C. applied magnetic field

D. mass of a particle

Answer: C

Watch Video Solution

8. A circular coil of a wire containing 100 turns each of radius 2cm carries a current of 0.20A. The magnetic field at the centre of the coil is.....

A. $2\pi \times 10^{-4}$

B. $\pi \times 10^{-4}$

C. $3\pi \times 10^{-4}$

D. 10^{-4}

Answer: C

Watch Video Solution

9. Which one of the following represent Curie's law?

A. $M = \frac{C\chi}{T}$

B. $M = \frac{CB_0}{T}$

C. $M = \frac{C\chi}{T - T_e}$

D. $M = \frac{CT}{B_0}$

Answer: A

Watch Video Solution

10. At the place, on the surface of the earth, ratio of horizontal and vertical component of the magnetic field is $\sqrt{3}$ then angle of dip at this place is.....rad

A. $\frac{\pi}{3}$

B. $\frac{\pi}{6}$

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

D. zero

Answer: A

Watch Video Solution

11. Meissner effect is observed in.....substances.

A. ferromagnetic

B. paramagnetic

C. superconducting

D. permanent magnetic

Answer: B

Watch Video Solution

12. Dimensional formula of mutual inductance is .....

A. $M^1L^2T^{-2}A^{-2}$

B. $M^1L^2T^{-2}A^{-1}$

C. $M^1L^{-2}T^2A^2$

D. $M^{-1}L^{-2}T^2A^{-1}$

Answer: C

Watch Video Solution

13. The magnitude of the induced emf is equal to the time rate of change of..

A. magnetic force

B. electric flux

C. magnetic flux

D. electric force

Answer: B

Watch Video Solution

14. Which one of the following is an equation of magnetic energy density?

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

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

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

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

Answer: A

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15. A $15\mu F$ capacitor is connected to a 220V, 50Hz a.c source Value of capacitance reactance is .....Ω

A. 106

B. 424

C. 212

D. 21.2

Answer: B

Watch Video Solution

16. Electric quantity .....is equivalent to mechanical quantity, force constant (k)

A. charge (Q)

B. inductance (L)

C. reciprocal of inductance $\left(\frac{1}{L}\right)$

D. reciprocal of capacitance $\left(\frac{1}{C}\right)$

Answer: D

Watch Video Solution

17. In L-C capacitor oscillator at..... Time energy in capacitor and energy in inductor are equal.

A. $\frac{T}{8}$

B. $\frac{T}{4}$

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

D. T

Answer: C

Watch Video Solution

18. A power transmission line feeds input power at 3300V to a step down transformer with its primary windings having 2000 turns. What should be the number of turns in the secondary in order to get output power at 330V.

A. 400

B. 200

C. 33

D. 40

Answer: A

Watch Video Solution

19. Dimension of $\frac{1}{\mu e}$ is same as dimension of.....

A. square of velocity

B. velocity

C. acceleration

D. momentum

Answer: C

Watch Video Solution

20. Frequency of FM radio band is from.....

A. 88 MHz to 108 MHz

B. 88 MHz to 108 MHz

C. 54 MHz to 890 MHz

D. 54 kHz to 890 kHz

Answer: C

Watch Video Solution

21. To destroy cancer cells..... Are used.

A. X - rays

B. Gamma rays

C. Ultraviolet rays

D. Infrared rays

Answer: A

Watch Video Solution

22. In optical fiber the refractive index of the material of the core is..... That of the cladding.

A. higher than

B. less than

C. equal to

D. half

Answer: C

Watch Video Solution

23. A magician during a show makes a glass lens with n=1.47 disappear in the trough of liquid. What is the refractive index of the liquid.

A. zero

B. ∞

C. equal to refractive index of water

D. 1.47

Answer: D

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24. If a size of particle is a and wavelength of light is λ for $a << \lambda$ scattering is directly proportional to....

A. $\frac{1}{\lambda^4}$

B. λ^4

C. λ^2

D. $\frac{1}{\lambda^2}$

Answer: C

Watch Video Solution

25. In a Young double slit experiment, the width of the source slit is increased then.....

A. instead of interference, diffraction appears.

B. fringe pattern gets more and more sharp.

C. angular distance between fringes increased.

D. fringe pattern gets less and less sharp

Answer: D

Watch Video Solution

26. V_{radial} is considered.....when the source moves away from the observer.

A. negative

B. positive

C. zero

D. infinite

Answer: A

Watch Video Solution

27. Assume that light of wavelength 6000Å is coming from a star. What is the limit of resolution of a telescope whose objective has a diameter of 100 inch?

A. 2.9×10^{-7} radian

B. 10^{-7} radian

C. 2.9×10^{-5} radian

D. 9.2×10^{-7} radian

Answer: C

Watch Video Solution

28. Unpolarised light is incident on a plane glass surface. What would be the angle of incidence so that the reflected and refracted rays are perpendicular to each other.

A. 33°

B. 37°

C. 53°

D. 57°

Answer: D

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29. Work function of .....is the lowest.

A. caesium

B. platinum

C. nickel

D. copper

Answer: C

Watch Video Solution

30. By applying electric field of the order of.....Vm^{-1} to a metal, electrons can be pulled out of the metal.

A. 10^5

B. 10^6

C. 10^8

D. 10^2

Answer: B

Watch Video Solution

31. Value of stopping potential depends on..... Of incident light.

A. frequency

B. intensity

C. momentum

D. velocity

Answer: C

Watch Video Solution

32. Monochromatic light of frequency $6 \times 10^{14} Hz$ is produced by laser. Each photon has an energy=.....

A. 4×10^{-19}

B. 6×10^{14}

C. 4×10^{-20}

D. 6×10^{-14}

Answer: C

Watch Video Solution

33. is found experimentally that 13.6 eV energy is required to separate a hydrogen atom into a proton and an electron. Compute the orbital radius and the velocity of the electron in a hydrogen atom.

A. $10.6 \times 10^{-11} m$

B. $5.3 \times 10^{11} m$

C. $2.65 \times 10^{-11} m$

D. $1.33 \times 10^{-11} m$

Answer: A

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34. To excite the hydrogen atom from its ground state to second excited state.... eV energy is required.

A. 3.4

B. 12.09

C. 1.51

D. 13.6

Answer: A

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35. What is the shortest wavelength present in the Paschen series of spectral lines?

A. 6563 Å

B. 820 nm

C. 911 nm

D. 656 nm

Answer: A

Watch Video Solution

36. In case of head on collision, when the impact parameter is minimum θ =..... Rad

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

B. 0

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

D. π

Answer: D

Watch Video Solution

37. Chlorine has two isotopes having masses 34.98u and 36.98u. The relative abundances of these isotopes are 75.4 and 24.6 percent. Then average mass of chlorine atom is....u

A. 34.91

B. 35

C. 35.47

D. 34.01

Answer: B

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38. The binding energy per nucleon is almost constant for the nuclei having atomic mass number.....

A. $30 < A < \ < 170$

B. $30 < A < 240$

C. $170 < A < 230$

D. $156 < A < 192$

Answer: C

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39. Tritium has half life of 12.5 years undergoing beta decay. What fraction of sample of tritium will remain undecayed after 50 years?

A. $\frac{1}{8}$

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

C. $\frac{1}{16}$

D. $\frac{1}{4}$

Answer: B

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40. In an n type silicon, which of the following statements is true:

A. Electrons are minority carriers and pentavalent atoms are the dopants.

B. Electrons are majority carriers and trivalent atom are the dopants.

C. Holes are minority carries and pentavalent atoms are the dopants.

D. Holes are majority carriers and trivalent atoms are the dopants.

Answer: B

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41. When a forward bias is applied to a p-n junction, it.....

A. raises the potential barrier.

B. reduces the majority carrier to zero

C. lowers the potential barrier

D. none of the above

Answer: C

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42. In half wave rectification, what is the output frequency if the input frequency is 50 Hz.

A. 100 Hz

B. 0

C. 50 Hz

D. 25 Hz

Answer: B

Watch Video Solution

43. .....as a impurity, when added in Si or Ge P- type semiconductor is obtained.

A. Arsenic

B. Antimony

C. Phosphorus

D. Boron

Answer: D

Watch Video Solution

44. The charge equivalent to 6×10^{18} electrons is

A. 1 C

B. $-1C$

C. 1 mC

D. $-1mC$

Answer: A

Watch Video Solution

45. The ratio of electric force and gravitational force between a proton and an electron at a certain distance is.....

A. 10^{41}

B. 2.4×10^{41}

C. 2.4×10^{39}

D. 3.9×10^{24}

Answer: B

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46. Unit of surface charge density (σ) is.....

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

B. $\frac{C}{m^3}$

C. $\frac{C}{m}$

D. Cm

Answer: C

Watch Video Solution

47. Electric field due to dipole at large distance (r) falls off as.....

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

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

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

D. $\frac{1}{r^4}$

Answer: B

Watch Video Solution

48. Value of dielectric strength of air is.....Vm^{-1}

A. 3×10^4

B. 3×10^6

C. 6×10^3

D. 4×10^3

Answer: A

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49. Three capacitors of 2pF,3pF and 4pF are connected in parallel . What is the total capacitance of a network?

A. 9 pF

B. $\frac{12}{13}pF$

C. $\frac{13}{12}pF$

D. $\frac{1}{9}pF$

Answer: C

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50. Equipotential surface through a point is..... to the electric field at that point.

A. parallel

B. normal

C. at an angle of 45°

D. at an angle of 30°

Answer: A

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Board S Question Paper March 2020 Part B Section A

1. Derive expression for the capacitance of the parallel plate capacitor,

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Watch Video Solution

2. Write a note on Mobility.

Watch Video Solution

3. The resistance of the platinum wire of a platinum resistance thermometer at the ice point is 5Ω and at steam point is 5.23Ω. When it is inserted in a hot bath, the resistance of the wire is 5.795Ω. Calculate the temperature of the bath.

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4. Derive an expression for magnetic potential energy .for a magnetic dipole kept in a uniform magnetic field.

Watch Video Solution

5. What is called self inductance? Derive an expression for Self induced emf.

Watch Video Solution

6. A plane electromagnetic wave of frequency 25 MHz travels in free space along the x-direction. At a particular point in space and time, $E = 6.3\hat{j}$ V/m. What is B at this point?

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7. Derive i+e=A+δ for a triangular glass prism.

Watch Video Solution

8. Summarise the photon picture of electromagnetic radiation .

Watch Video Solution

9. What is the de - Broglie wavelength associated with an electron, accelerated through a potential difference of 100 Volts ?

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10. Explain Alpha Decay.

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Board S Question Paper March 2020 Part B Section B

1. An electron falls through a distance of 1.5cm in a uniform electric field of magnitude $2 \times 10^4 NC^{-1}$. The direction of the field is reversed keeping its magnitude unchanged and a proton falls through the same distance. Compute the time of fall in each case.

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2. A 600pF capacitor is charged by a 200V supply. It is then disconnected from the supply and is connected to another unchanged 600pF capacitor. How much electrostatic energy is lost in the process.

Watch Video Solution

3. Derive an expresion for the magnetic field at any point on the axis of a circular current loop.

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4. A horizontal power line carries a current of 90 A in east to west direction. What is the magnitude and direction of the magnetic field due to the current 1.5 m below the line ?

Watch Video Solution

5. Draw schematic diagram of Young experiment and drive $B = \frac{\lambda D}{d}$ for the distance between two consecutive bright interference fringes.

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6. In accordance with the Bohr's model find the quantum number than characterises the Earth revolution around the sun in an orbit of radius $1.5 \times 10^{11} m$ with orbital speed $3 \times 10^{4} m s^{-1}$

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7. Explain the use of Zener diode as a voltage regulator.

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8. Draw the logic symbol and give the truth table of NAND gate. Why this gate is called universal gate?

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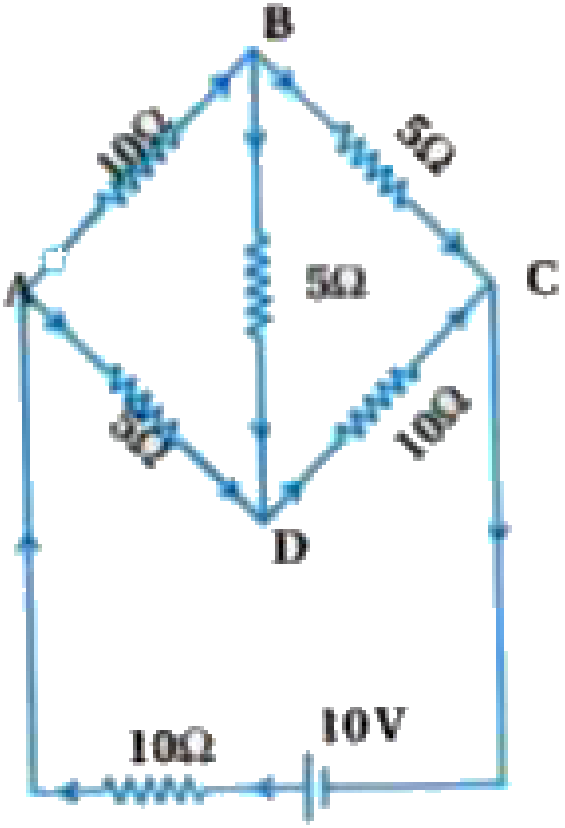
Board S Question Paper March 2020 Part B Section C

1. Determine the current in each branch of the given network.



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2. Derive an expression for current I passing through an AC circuit containing only inductor L. Draw a Phasor diagram and graph of v and I versus ωt. Explain instantaneous power and the average power.

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3. Derive lensmaker's formula for thin lens.

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4. The distance between the two slits in Young experiment is 0.1mm. The perpendicular distance between the slits and the screen is 1.5 m. The wavelength of the incident light is 6000A. Calculate the distance between third brighta and fifth dark fringes dark fringes obtain on the screen.

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5. Explain Polarisation by scattering.

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