PHYSICS

BOOKS - U-LIKE PHYSICS (HINGLISH)

ELECTROMAGNETIC WAVES

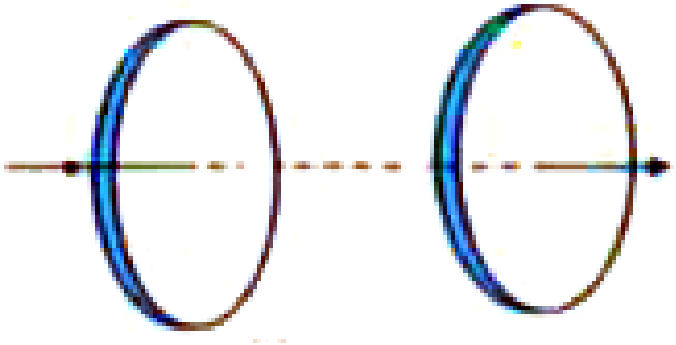
N C E R T Textbook Exercises

1. Figure 8.01 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.

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

(b) Obtain the displacement current across the plates.

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



View Text Solution

2. A parallel plate capacitor (Fig 8.02] 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 a.c. supply with

a (angular) frequency of $300\ \mathrm{rad\ s^{-1}}$.

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

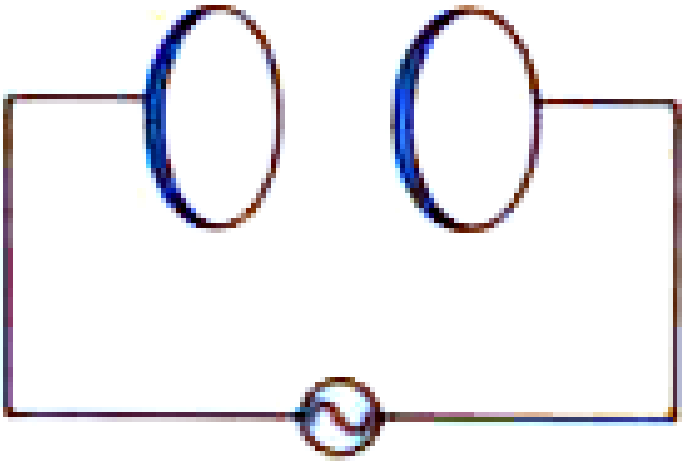
(b) Is the conduction current equal to the displacement current?

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

View Text Solution

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

radiowaves of wavelength 500m?



View Text Solution

4. A plane electromagnetic wave travels in vacuum along sz - direction. What can you say about the direction of its electric and magnetic field vectors? If the frequency of the wave is 30 MHz, what is its waelength?

View Text Solution

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

View Text Solution

6. 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 ocillator?

View Text Solution

7. 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?

View Text Solution

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

(a) Determine $B_0, \omega, k \text{ and } \lambda$

(b) Find expressions for $\overrightarrow{E} \text{ and } \overrightarrow{B}$.

View Text Solution

9. The terminology of 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 for 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?

View Text Solution

10. In a plane electomagnetic wave, the electric field oscillates sinusoidally at a frequency of $2.0 \times 106(10) Hz$ and amplitude $48 Vm^{-1}$.

(a) What is the wavelength of the wave?

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

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

View Text Solution

Additional Exercises

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

(a) What is the direction of propagation?

(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.

View Text Solution

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

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

(b) at a distance of 10 m?

Assume that the radiation is emitted isotropically and neglect reflection.

View Text Solution

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

View Text Solution

4. 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)$5890\text{Å} - 5896\text{Å}$ [double lines of sodium).

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

View Text Solution

5. Answer the following questions :

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

View Text Solution

6. Answer the following questions :

(b) It is necessary to use satellites for long distance TV transmission. Why ?

View Text Solution

7. Answer the following questions :

(c) Optical and radiotelescopes are built on the ground

but X-ray astronomy is possible only from satellites orbiting the earth. Why?

View Text Solution

8. Answer the following questions :

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

View Text Solution

9. Answer the following questions :

(e) If the earth did not have an atmosphere, would its

average surface temperature be higher or lower than what it is now?

View Text Solution

10. Answer the following questions :

(e) 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 ?

View Text Solution

Case Based Source Based Integrated Questions

1. Read the following passage and then answer questions (a) to (e) on the basis of your under- standing of the passage and the related studied concepts.

In accordance with Faraday.s law of electromagnetic induction a magnetic field, changing with time, gives rise to an electric field. Again as per Ampere-Maxwell.s law an electric field, changing with time, gives rise to a magnetic field. It means that if we consider a charge oscillating with some frequency, it produces an oscillating electric field in space, which produces an oscillating mag- netic field, which in turn, is a source of oscillating electric field and so on. The oscillating electric and magnetic fields thus regenerate each other and an electromagnetic wave propagates through space. The energy associated with the propagating wave comes at

the expense of the energy of the oscillating charge.

Electromagnetic wave propagates through free space as a transverse wave in which $\vec{E}$ and $\vec{B}$ are perpendicular to each other as well as perpendicular to the direction of wave propagation. Like other waves electromagnetic waves carry energy and momentum. As electromagnetic waves contains both electric and magnetic fields, it has an electrical energy density $\mu_E = \frac{1}{2} \in_0 E^2$ as well as a magnetic energy density $\mu_B = \frac{B^2}{2\mu_0}$. Both of these vary with time.

The magnetic field in a plane electromagnetic wave is given by :

$B_y = 2 \times 10^{-7} \sin\left[1.5 \times 10^{11} t - 0.5 \times 10^3 x\right] T$

What is the speed of electromagnetic wave?

View Text Solution

2. Read the following passage and then answer questions (a) to (e) on the basis of your under- standing of the passage and the related studied concepts.

In accordance with Faraday.s law of electromagnetic induction a magnetic field, changing with time, gives rise to an electric field. Again as per Ampere-Maxwell.s law an electric field, changing with time, gives rise to a magnetic field. It means that if we consider a charge oscillating with some frequency, it produces an oscillating electric field in space, which produces an oscillating mag- netic field, which in turn, is a source of oscillating electric field and so on. The oscillating electric and magnetic fields thus regenerate each other and an

electromagnetic wave propagates through space. The energy associated with the propagating wave comes at the expense of the energy of the oscillating charge.

Electromagnetic wave propagates through free space as a transverse wave in which $\overrightarrow{E}$ and $\overrightarrow{B}$ are perpendicular to each other as well as perpendicular to the direction of wave propagation. Like other waves electromagnetic waves carry energy and momentum. As electromagnetic waves contains both electric and magnetic fields, it has an electrical energy density $\mu_E = \frac{1}{2} \in_0 E^2$ as well as a magnetic energy density $\mu_B = \frac{B^2}{2\mu_0}$. Both of these vary with time.

What is the frequency and wavelength of the electromagnetic wave?

View Text Solution

3. Read the following passage and then answer questions (a) to (e) on the basis of your under- standing of the passage and the related studied concepts.

In accordance with Faraday.s law of electromagnetic induction a magnetic field, changing with time, gives rise to an electric field. Again as per Ampere-Maxwell.s law an electric field, changing with time, gives rise to a magnetic field. It means that if we consider a charge oscillating with some frequency, it produces an oscillating electric field in space, which produces an oscillating mag- netic field, which in turn, is a source of oscillating electric field and so on. The oscillating electric and magnetic fields thus regenerate each other and an

electromagnetic wave propagates through space. The energy associated with the propagating wave comes at the expense of the energy of the oscillating charge.

Electromagnetic wave propagates through free space as a transverse wave in which $\overrightarrow{E}$ and $\overrightarrow{B}$ are perpendicular to each other as well as perpendicular to the direction of wave propagation. Like other waves electromagnetic waves carry energy and momentum. As electromagnetic waves contains both electric and magnetic fields, it has an electrical energy density $\mu_E = \frac{1}{2} \in_0 E^2$ as well as a magnetic energy density $\mu_B = \frac{B^2}{2\mu_0}$. Both of these vary with time.

In which direction does the electric field oscillates?

View Text Solution

4. Read the following passage and then answer questions (a) to (e) on the basis of your under- standing of the passage and the related studied concepts.

In accordance with Faraday.s law of electromagnetic induction a magnetic field, changing with time, gives rise to an electric field. Again as per Ampere-Maxwell.s law an electric field, changing with time, gives rise to a magnetic field. It means that if we consider a charge oscillating with some frequency, it produces an oscillating electric field in space, which produces an oscillating mag- netic field, which in turn, is a source of oscillating electric field and so on. The oscillating electric and magnetic fields thus regenerate each other and an electromagnetic wave propagates through space. The

energy associated with the propagating wave comes at the expense of the energy of the oscillating charge.

Electromagnetic wave propagates through free space as a transverse wave in which $\vec{E}$ and $\vec{B}$ are perpendicular to each other as well as perpendicular to the direction of wave propagation. Like other waves electromagnetic waves carry energy and momentum. As electromagnetic waves contains both electric and magnetic fields, it has an electrical energy density $\mu_E = \frac{1}{2} \in_0 E^2$ as well as a magnetic energy density $\mu_B = \frac{B^2}{2\mu_0}$. Both of these vary with time.

What is the amplitude of electric field vector?

View Text Solution

5. Read the following passage and then answer questions (a) to (e) on the basis of your under- standing of the passage and the related studied concepts.

In accordance with Faraday.s law of electromagnetic induction a magnetic field, changing with time, gives rise to an electric field. Again as per Ampere-Maxwell.s law an electric field, changing with time, gives rise to a magnetic field. It means that if we consider a charge oscillating with some frequency, it produces an oscillating electric field in space, which produces an oscillating mag- netic field, which in turn, is a source of oscillating electric field and so on. The oscillating electric and magnetic fields thus regenerate each other and an electromagnetic wave propagates through space. The

energy associated with the propagating wave comes at the expense of the energy of the oscillating charge.

Electromagnetic wave propagates through free space as a transverse wave in which $\vec{E}$ and $\vec{B}$ are perpendicular to each other as well as perpendicular to the direction of wave propagation. Like other waves electromagnetic waves carry energy and momentum. As electromagnetic waves contains both electric and magnetic fields, it has an electrical energy density $\mu_E = \frac{1}{2} \in_0 E^2$ as well as a magnetic energy density $\mu_B = \frac{B^2}{2\mu_0}$. Both of these vary with time.

Write an expression for the electric field.

View Text Solution

6. Read the following passage and then answer questions (a) to (d) on the basis of your under- standing of the passage and the related studied concepts.

We are familiar with Ampere.s circuital law which states that for an open surface with a boundary around a current the line integral of magnetic field around the entire boundary of an open surface is equal to μ_0 times the total current passing through the surface i.e.

$$\oint \vec{B} . \vec{dl} = \mu_0 I$$

Later on, Maxwell showed that for logical consistency, a changing electric field must also produce a magnetic field. In this context Maxwell introduced the concept of a displacement current given as per relation

$$I_D = \in_0 \frac{d\phi_E}{dt}$$

Thus, as per generalisation made by Maxwell, the source of a magnetic field is not just the conduction electric current due to following charges but also the time rate of change of electric field. In this way, Maxwell modified Ampere.s circuital law and in its modified the law is expressed as:

$$\oint \vec{B} . \vec{dl} = \mu_0[I_C + I_D] = \mu_0 \left[I_C + \in_0 \frac{d\phi_E}{dt} \right]$$

In all respects, the displacement current has the same physical effects as the conduction current. It is observed that in same cases, e.g., steady electric field in a wire, displacement current may be zero. In other cases, e.g., a capacitor being charged, both conduction and displacement currents may be present in different regions of space. In most of the cases, conduction current and displacement current may be present

simultaneously in the same region of space because there exist no perfectly conducting or perfectly insulating medium. Moreover, there may be large regions of space where there is no conduction current but there is only a displacement current due to time varying electric field.

Define displacement current.

View Text Solution

7. Read the following passage and then answer questions (a) to (d) on the basis of your under- standing of the passage and the related studied concepts.

We are familiar with Ampere.s circuital law which states that for an open surface with a boundary around a

current the line integral of magnetic field around the entire boundary of an open surface is equal to μ_0 times the total current passing through the surface i.e.

$$\oint \vec{B} . \vec{dl} = \mu_0 I$$

Later on, Maxwell showed that for logical consistency, a changing electric field must also produce a magnetic field. In this context Maxwell introduced the concept of a displacement current given as per relation

$$I_D = \in_0 \frac{d\phi_E}{dt}$$

Thus, as per generalisation made by Maxwell, the source of a magnetic field is not just the conduction electric current due to following charges but also the time rate of change of electric field. In this way, Maxwell modified Ampere.s circuital law and in its modified the law is expressed as:

$$\oint \vec{B} \cdot \vec{dl} = \mu_0[I_C + I_D] = \mu_0\left[I_C + \epsilon_0 \frac{d\phi_E}{dt}\right]$$

In all respects, the displacement current has the same physical effects as the conduction current. It is observed that in same cases, e.g., steady electric field in a wire, displacement current may be zero. In other cases, e.g., a capacitor being charged, both conduction and displacement currents may be present in different regions of space. In most of the cases, conduction current and displacement current may be present simultaneously in the same region of space because there exist no perfectly conducting or perfectly insulating medium. Moreover, there may be large regions of space where there is no conduction current but there is only a displacement current due to time varying electric field.

What did Maxwell suggest to make Ampere.s circuital law logical consistent?

View Text Solution

8. Read the following passage and then answer questions (a) to (d) on the basis of your under- standing of the passage and the related studied concepts.

We are familiar with Ampere.s circuital law which states that for an open surface with a boundary around a current the line integral of magnetic field around the entire boundary of an open surface is equal to μ_0 times the total current passing through the surface i.e.

$$\oint \vec{B} . \vec{dl} = \mu_0 I$$

Later on, Maxwell showed that for logical consistency, a

changing electric field must also produce a magnetic field. In this context Maxwell introduced the concept of a displacement current given as per relation

$$I_D = \in_0 \frac{d\phi_E}{dt}$$

Thus, as per generalisation made by Maxwell, the source of a magnetic field is not just the conduction electric current due to following charges but also the time rate of change of electric field. In this way, Maxwell modified Ampere.s circuital law and in its modified the law is expressed as:

$$\oint \vec{B} . \vec{dl} = \mu_0 [I_C + I_D] = \mu_0 \left[I_C + \in_0 \frac{d\phi_E}{dt} \right]$$

In all respects, the displacement current has the same physical effects as the conduction current. It is observed that in same cases, e.g., steady electric field in a wire, displacement current may be zero. In other cases, e.g., a

capacitor being charged, both conduction and displacement currents may be present in different regions of space. In most of the cases, conduction current and displacement current may be present simultaneously in the same region of space because there exist no perfectly conducting or perfectly insulating medium. Moreover, there may be large regions of space where there is no conduction current but there is only a displacement current due to time varying electric field.

In how many ways a magnetic field produced in free space without the presence of permanent magnet?

View Text Solution

9. Read the following passage and then answer questions (a) to (d) on the basis of your under- standing of the passage and the related studied concepts.

We are familiar with Ampere.s circuital law which states that for an open surface with a boundary around a current the line integral of magnetic field around the entire boundary of an open surface is equal to μ_0 times the total current passing through the surface i.e.

$$\oint \vec{B} . \vec{dl} = \mu_0 I$$

Later on, Maxwell showed that for logical consistency, a changing electric field must also produce a magnetic field. In this context Maxwell introduced the concept of a displacement current given as per relation

$$I_D = \in_0 \frac{d\phi_E}{dt}$$

Thus, as per generalisation made by Maxwell, the source of a magnetic field is not just the conduction electric current due to following charges but also the time rate of change of electric field. In this way, Maxwell modified Ampere.s circuital law and in its modified the law is expressed as:

$$\oint \vec{B} . \vec{dl} = \mu_0[I_C + I_D] = \mu_0 \left[I_C + \in_0 \frac{d\phi_E}{dt} \right]$$

In all respects, the displacement current has the same physical effects as the conduction current. It is observed that in same cases, e.g., steady electric field in a wire, displacement current may be zero. In other cases, e.g., a capacitor being charged, both conduction and displacement currents may be present in different regions of space. In most of the cases, conduction current and displacement current may be present

simultaneously in the same region of space because there exist no perfectly conducting or perfectly insulating medium. Moreover, there may be large regions of space where there is no conduction current but there is only a displacement current due to time varying electric field.

Does displacement current need a conductor to flow.

View Text Solution

Multiple Choice Questions

1. Which of the following radiation has the least wavelength?

A. $\gamma -$ rays

B. X - rays

C. Microwaves

D. Infrared rays

Answer: A

View Text Solution

2. Light is an electromagnetic wave. Its peed in vacuum is given by the expression

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

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

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

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

Answer: D

View Text Solution

3. Hertz experimentally proved the existence of e.m. waves.

A. It stops ultraviolet rays.

B. It reduces green house effect

C. It reflects radio waves.

D. Ozone layer controls $\frac{O_2}{H_2}$ ratio in atmosphere.

Answer: A

View Text Solution

4. Which scientist experimentally proved, for the first time, the existence of electromagnetic waves?

A. Sir J.C. Bose

B. Maxwell

C. Marconi

D. Hertz

Answer: D

View Text Solution

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

View Text Solution

6. The ratio of contributions made by the electric field and magnetic field components to the intensity of an e.m. wave is

A. $c:1$

B. $c^2:1$

C. $1:1$

D. $\sqrt{c}:1$

Answer: C

View Text Solution

7. Frequency of an electromagnetic wave is $6.0 \times 10^{15} Hz$. The wave is

A. radio wave.

B. microwave.

C. X - ray.

D. ultraviolet ray.

Answer: D

View Text Solution

8. A plane e.m. wave of frequency 30 MHz travels in free space along the x - direction. The electric field

component of the wave at a particular point of space and time is $E = 6Vm^{-1}$ along y - direction. Its magnetic field component B at this point would be

A. $2 \times 10^{-8}T$ along z - direction.

B. $6 \times 10^{-8}T$ along z - direction.

C. $2 \times 10^{-8}T$ along z - direction.

D. $6 \times 10^{-8}T$ along z - direction.

Answer: A

View Text Solution

9. The magnetic field in a plane electromagnetic 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 electromagnetic wave is

A. a visible light.

B. an infrared wave.

C. a microwave.

D. a radio wave.

Answer: C

View Text Solution

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

A. $\overrightarrow{E} = E_0\hat{j}, \overrightarrow{B} = B_0\hat{k}$

B. $\overrightarrow{E} = E_0\hat{i}, \overrightarrow{B} = B_0\hat{j}$

C. $\overrightarrow{E} = E_0\hat{k}, \overrightarrow{B} = B_0\hat{i}$

D. $\overrightarrow{E} = E_0\hat{j}, \overrightarrow{B} = B_0\hat{i}$

Answer: B

View Text Solution

11. Which of the following type of radiation has maximum wavelength?

A. Blue light

B. $\gamma -$ rays

C. X - rays

D. red light.

Answer: D

View Text Solution

12. Which of the following are not electromagnetic waves?

A. Ultraviolet rays

B. Gamma rays

C. $\beta -$ rays

D. Infrared rays

Answer: C

View Text Solution

13. Energy stored in electromagnetic waves in the form of

A. electrical energy

B. magnetic energy

C. both electrical and magnetic energy

D. neither electrical nor magnetic energy.

Answer: C

View Text Solution

14. In an experiment the electric field was found to oscillate with an amplitude of $18Vm^{-1}$. The amplitude of oscillations of the magnetic field will be

A. $4 \times 10^{-6}T$

B. $6 \times 10^{-8}T$

C. $6 \times 10^{-6}T$

D. $4 \times 0^{-11}T$

Answer: B

View Text Solution

15. The electromagnetic waves do not transport.

A. energy

B. monemtum.

C. information.

D. charge.

Answer: D

View Text Solution

16. Frequency of an electromagnetic wave is $6.0 \times 10^{15} Hz$. The wave is

A. radio wave.

B. microwave.

C. X -rays.

D. UV rays.

Answer: D

View Text Solution

17. The osicllating electric and magnetic vectors of an electromagnetic wave are oriented along

A. the same direction and are in phase.

B. the same direction but differe in phase by $\frac{\pi}{2}$.

C. mutually perpendicular directions and are in phase.

D. mutually perpendicular directions and differ in phase by $\frac{\pi}{2}$.

Answer: C

View Text Solution

18. Pressure exeted by an electromagneti wave os intesnity . I. on a non - reflecting surface is given by [Here c= speed of light]

A. Ic

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

C. Ic^2

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

Answer: B

View Text Solution

19. If λ_v, λ_m and λ_x represent wavlength of visible light, microwaves and X - rays respectively, then

A. $\lambda_m < \lambda_x < \lambda_v$

B. $\lambda_v < \lambda_m < \lambda_x$

C. $\lambda_x < \lambda_v < \lambda_m$

D. $\lambda_m < \lambda_v < \lambda_x$

Answer: C

View Text Solution

20. Radiations of intensity $0.6Wm^{-2}$ are incident on a non - reflecting plate. The pressure exerted on the plate by the radiation is

A. $2 \times 10^{-9}Pa$

B. $1.8 \times 10^{8}Pa$

C. $4 \times 10^{-9}Pa$

D. $2 \times 10^{-8}Pa$

Answer: A

View Text Solution

21. Electromagnetic waves can be produced by

A. a charge at rest

B. a moving charge

C. an accelerated charge.

D. none of these.

Answer: C

View Text Solution

22. In complete electromagnetic spectrum radiation having minimum wavelength is

A. radio wave.

B. microwave.

C. X - rays

D. $\gamma -$ rays.

Answer: D

View Text Solution

23. Which of the following electromagnetic waves have minimum frequency?

A. Ultaviolet rays

B. Green light

C. Microwaves

D. Radio waves

Answer: D

View Text Solution

24. Displacement current I_D is given as

A. $I_D = \in_0 \frac{d\phi_E}{dt}$

B. $I_D = \mu_0 \frac{d\phi_E}{dt}$

C. $I_D = \frac{1}{\in_0} \frac{d\phi_E}{dt}$

D. $I_D = \frac{1}{\mu_0}\frac{d\phi_B}{dt}$

Answer: A

View Text Solution

25. As per Ampere - Maxwell.s circuital law

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

B. $\oint \vec{B} . \vec{d} l = \mu_0 (I_C + I_D)$

C. $\oint \vec{B} \times \vec{d} l = \mu_0 (I_C + I_D)$

D. $\oint \vec{B} \times \vec{d} l = \mu_0 I_C + \in_0 \frac{d\phi_E}{dt}$

Answer: B

View Text Solution

Fill In The Blanks

1. If μ_0 be the magnetic permeability are ε_0 the electric permittivity of free space then speed of em waves in freee space is given as : c = _____.

View Text Solution

2. The electric and magnetic field in an electromagnetic wave are related as _____.

View Text Solution

3. In an electromagnetic wave $\overrightarrow{E}$ and $\overrightarrow{B}$ are _____ to each other.

View Text Solution

4. A changing electric field in space leads to a _____current.

View Text Solution

5. Displacement current can be obtained by using the relation $I_D =$ _____.

View Text Solution

6. Klystrons, _____and_____ are employed to produced microwaves.

View Text Solution

7. When a beam a of high energy electrons is bombarded on a metal target _____are produced.

View Text Solution

8. Wavelegnth of visible light extends from _____to_____.

View Text Solution

9. _____are used to kill germs in water purifires.

View Text Solution

10. _____ waves cause tanning of the skin.

View Text Solution

11. _____are widely used in remote switches of household electronic devices e.g., TV set of AC etc.

View Text Solution

12. _____ can be easily detected with the help of point contact diodes.

View Text Solution

13. _____are used in speed guns to time fast moving cricket balls and automobiles.

View Text Solution

14. As per concept of e.m. waves, the refractive index .n. of a medium can be expressed as n = _____.

View Text Solution

True Or False

1. The speed of electromagnetic waves in vaccum depends upon the source of radiation.

View Text Solution

2. Infrared rays wavelengths ranging from $10^{-1}m$ to $10^{-3}m$.

View Text Solution

3. Microwaves and visible light have different wavelegnth but travel in vaccum with same speed.

View Text Solution

4. In electromagnetic waves the electric and magnetic field, oscillating in space and time, sustain each other in vacuum.

View Text Solution

5. Radio waves lie in upper frequency range of the electromagnetic spectrum.

View Text Solution

Assertion Reason Type Questions

1. Assertion (A) : Microwaves are used in Radar.

Reason (R) : Microwaves are radiowaves having very small wavelengths.

A. If both assertion and rason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: a

View Text Solution

2. Assertion (A) : X - rays are generated when a beam of high energy electrons bombard a metal target.

Reason (R) : X - rays were discovered by Sir William Roeiitgen.

A. If both assertion and rason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: b

View Text Solution

3. Assertion (A) : Ultraiolet radiations are used for LASIK eye surgery.

Reason (R) : Being of shorter wavelength, UV radiations can be focussed into very narrow beams for high precision applications.

A. If both assertion and rason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: a

View Text Solution

4. Assertion (A) : X - ray astronomy is possible only from satellites orbiting the earth.

Reason (R) : X - rays coming from extra terrestrial objects are scattered by the earth.s atmosphere.

A. If both assertion and rason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: a

View Text Solution

5. Assertion (A) : The earth without its atmosphere would be inhospitably cold.

Reason (R) : All heat would escape in the absence of atmosphere.

A. If both assertion and rason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: a

View Text Solution

Very Short Answer Questions

1. What are electromagnetic waves ?

View Text Solution

2. What is the frequency of electromagnetic waves produced by oscillating charge of frequency v ?

View Text Solution

3. What are the directions of electric and magnetic field vectors relative to each other and relative to the direction of propagation of electromagnetic wave.

View Text Solution

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

View Text Solution

5. How is the speed of electromagnetic waves in vacuum determined by electric and magnetic fields ?

View Text Solution

6. How are the magnitudes of the electric and magnetic fields related to the velocity of the electromagnetic wave?

View Text Solution

7. Name the physical quantity which remains same for microwaves of wavelength 1 mm and UV radiations of 16000Å in vacuum.

View Text Solution

8. The speed of an electromagnetic wave in a material medium is given by $v = \frac{1}{\sqrt{\mu\varepsilon}}$, μ being the permeability of the medium and ε its permittivity. How does its frequency change ?

View Text Solution

9. Which part of electromagnetic spectrum is absorbed from sunlight by ozone layer?

View Text Solution

10. Illustrate by giving suitable examples, how you can show that electromagnetic waves carry both energy and momentum.

View Text Solution

11. Do electromagnetic waves carry energy and momentum ?

View Text Solution

12. Arrange the given electromagnetic radiations in the descending order of wavelengths :

X-rays, radio waves, blue light, infrared light.

View Text Solution

13. Write the following radiations in ascending order in respect of their frequencies:

X-rays, microwaves, UV rays and radio waves.

View Text Solution

14. Name the part of the electromagnetic spectrum of wavelength $10^{-2}m$ and mention its one application.

View Text Solution

15. Name the part of the electromagnetic spectrum of wavelength $10^2 m$ and mention its one application.

View Text Solution

16. To which part of the electromagnetic spectrum does the wave of frequency (i) $3 \times 10^{13} Hz$ (ii) $5 \times 10^{11} Hz$ belong?

View Text Solution

17. What is the name given to that part of electromagnetic spectrum which is used in Radar ?

View Text Solution

View Text Solution

18. Why are microwaves considered suitable for radar system used in aircraft navigation ?

View Text Solution

19. Which part of the electromagnetic spectrum has the largest penetrating power ? (] Ans. Y-rays.

View Text Solution

20. Name the part of electromagnetic spectrum which is suitable for

(i) radar systems used in aircraft navigation.

(ii) treatment of cancer tumours.

View Text Solution

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

View Text Solution

22. Name the e.m. waves used for studying crystal structure of solids. What is its frequency range ?

View Text Solution

23. Identify the part of the electromagnetic spectrum which is produced by bombarding a metal target by high speed electrons.

View Text Solution

24. Welders wear special goggles or face masks with glass windows to protect their eyes from electromagnetic radiations. Name the radiations and write the range of their frequency.

View Text Solution

25. Identify the part of the electromagnetic spectrum used in (i) radar, and (ii) eye surgery. Write their frequency range.

View Text Solution

26. The frequency of oscillation of the electric field vector of a certain electromagnetic wave is $5 \times 10^{14} Hz$. What is the frequency of oscillation of the corresponding magnetic field vector and to which part of the electromagnetic spectrum does it belong ?

View Text Solution

27. How are radio waves produced ?

View Text Solution

28. How are infrared waves produced ? What is the range of their wavelength ?

View Text Solution

29. Special devices, like the klystron valve or the magnetron valve, are used for production of electromagnetic waves. Name these waves and also write one of their application.

View Text Solution

30. Name the electromagnetic radiations used for (a) water purification, and (b) LASIC eye surgery.

View Text Solution

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

View Text Solution

32. A variable frequency a.c. source is connected to a capacitor. Will the displacement current change if the frequency of the a.c. source is decreased ?

View Text Solution

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

View Text Solution

34. How does microwave oven heats up a food item containing water molecules most efficiently?

View Text Solution

View Text Solution

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

View Text Solution

Short Answer Questions

1. When an ideal capacitor is charged by a d.c. battery, no current flows. However, when an a.c. source is used, the

current flows continuously. How does one explain this, based on the concept of displacement current ?

View Text Solution

2. A capacitor, made of two parallel plates each of plate are A and separation d, is being charged by an external a.c. source. Show that the displacement current inside the capacitor is the same as the current charging the capacitor.

View Text Solution

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

View Text Solution

4. An electromagnetic wave is travelling in a medium with a velocity $\overrightarrow{v} = v\hat{i}$. Draw a sketch showing the propagation of the electromagnetic wave, indicating the direction of the oscillatign electric and magnetic fields.

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

View Text Solution

5. How does a charge q oscillating at certain frequency produce electromagnetic waves ? Sketch a schematic diagram depicting electric and magnetic fields for an electromagnetic wave propagating along the x-direction.

View Text Solution

6. (a) Why are infra-red waves often called heat waves ? Explain.

(b) What do you understand by the statement, ..Electromagnetic waves transport momentum.. ?

View Text Solution

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

$B_y = \left(8 \times 10^{-6}\right) \sin\left[2 \times 10^{11} t + 300\pi x\right] T$

(i) Calculate the wavelength of the electromagnetic wave.

(ii) Write down the expression for the oscillating electric field.

View Text Solution

8. Identify the electromagnetic waves whose wavelengths vary as

(a) $10^{-12} m < \lambda < 10^{-8} m$

(b) $10^{-3}m < \lambda < 10^{-1}m$

Write one use for each.

View Text Solution

9. Identify the electromagnetic waves whose wavelengths lie in the range

(a) $10^{-11}m < \lambda < 10^{-14}m$

(b) $10^{-4}m < \lambda < 10^{-6}m$

Write one use of each.

View Text Solution

10. Arrange the following electromagnetic radiations in ascending order of their frequencies :

(i) Microwave (ii) Radio wave (iv) Gamma rays (iii) X-rays

Write two uses of any one of these.

View Text Solution

11. Write one method each of (i) production, and (ii) detection of microwaves.

View Text Solution

12. Briefly state the working principle of microwave ovens.

View Text Solution

13. (a) Give one use of electromagnetic radiations obtained in nuclear disintegrations.

(b) Give one example each to illustrate the situation where there is (i) displacement current but no conduction current, and (ii) only conduction current but no displacement current.

View Text Solution

14. The following table gives the wavelength range of some constituents of the electromagnetic spectrum :

S. No.	Wavelength range
1.	1 mm to 700 nm
2.	400 nm to 1 nm
3.	1 nm to 10^{-3} nm
4.	$< 10^{-3}$ nm

Select the wavelength range and name the electromagnetic waves that are (i) widely used in the remote switches of household electronic devices, (ii) produced in nuclear reactions.

View Text Solution

15. (a) Why do welders wear special glass goggles or face masks with glass windows ?

(b) Why are ultraviolet rays used in LASIK eye surgery?

View Text Solution

16. How are infrared waves produced ? Why are these referred to as .heat waves. ? Write their one important use.

View Text Solution

17. (a) Arrange the following electromagnetic waves in the descending order of their wave-lengths:

(i) microwaves (ii) IR rays, (iii) UV radiations (iv) $\gamma -$ rays

(b) Write one use each of any two of them.

View Text Solution

18. Name the types of electromagnetic radiations which (i) are used in destroying cancer cells, (ii) cause tanning of the skin, and (iii) maintain the earth.s warmth.

Write briefly a method of producing any one of these waves.

View Text Solution

19. How does Ampere-Maxwell law explain the flow 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.

View Text Solution

20. Considering the case of a parallel plate capacitor being charged, show how one is required to generalise Ampere.s circuital law to include the term due to displacement current.

View Text Solution

Long Answer Questions I

1. Write the expression for the generalised form of Ampere.s circuital law. Discuss its significance and describe briefly how the concept of displacement current is explained through charging/discharging of a capacitor in an electric circuit.

View Text Solution

2. Name the electromagnetic waves in the wavelength range 10 nm to $10^{-3}nm$. How are these waves generated ? Write their two uses.

View Text Solution

3. Write two applications each of (i) microwaves, (ii) infrared waves, and (ii) radio waves.

View Text Solution

4. Name the parts of the electromagnetic spectrum which is

(a) suitable for radar systems used in aircraft navigation.

(b) used to treat muscular strain.

(c) used as a diagnostic tool in medicine. Write in brief, how these waves can be produced.

View Text Solution

5. (a) Describe briefly how electromagnetic waves are produced by oscillating charges.

(b) Give one use of each of the following : (i) microwaves.

(ii) ultraviolet rays.

(iii) infrared rays. (iv) gamma rays.

View Text Solution

6. Answer the following :

(a) Name the e.m. waves which are suitable for radar systems used in aircraft navigation. Write the range of frequency of these waves.

View Text Solution

7. Answer the following :

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

View Text Solution

8. Answer the following :

(c) An e.m. wave exerts pressure on the surface on which it is incident. Justify.

View Text Solution

9. Answer the following questions:

(i) Why is the thin ozone layer on top of the stratosphere crucial for human survival ? Identify to which part of electromagnetic spectrum does this radiation belong and write one important application of the radiation.

View Text Solution

View Text Solution

10. Answer the following questions:

(ii) Why are infrared waves referred to as heat waves ? How are they produced ? What role do they play in maintaining the earth.s warmth through the green house effect ?

View Text Solution

11. Identify the following electromagnetic radiations as per the wavelengths given below. Write one application of each.

(a) $10^{-3}nm$ (b) $10^{-3}m$ (c) 1nm

View Text Solution

View Text Solution

Self Assessment Test Section A Multiple Choice Questions

1. Human body radiates

A. microwaves.

B. Gamma rays

C. infrared waves.

D. ultraviolet rays

Answer: C

View Text Solution

2. Wavelength of a microwave is 1 mm and that of radio wave 150 m. What is the ratio of their speeds in free space ?

A. $1:1$

B. $1:1500$

C. $150:1$

D. $1:1.5\times10^{4}$

Answer: A

View Text Solution

3. Which medium is needed for propagation of electromagnetic waves?

A. Air

B. Free space

C. Any fluid

D. A gaseous medium

Answer: B

View Text Solution

4. Electromagnetic waves transport

A. momentum and charge.

B. momentum and matter.

C. motion and mass.

D. energy and momentum.

Answer: D

View Text Solution

5. Speed of electromagnetic waves v in a medium of permittivity $\in$ and magnetic permeability μ is given as per relation.

A. $v = \sqrt{\mu \in}$

B. $v = \sqrt{\frac{\in}{\mu}}$

C. $v = \sqrt{\frac{\mu}{\in}}$

D. $v = \frac{1}{\sqrt{\mu \in}}$

Answer: D

View Text Solution

Self Assessment Test Section A Fill In The Blanks

1. During charging process of a capacitor _____ current is set-up between the plates of capacitor.

View Text Solution

2. An electric charge ocillating harmonically is a source of _____ of same frequency.

View Text Solution

3. Intensity of electromagnetic waves I is given as I = _____E_0^2 = _____B_0^2.

View Text Solution

Self Assessment Test Section C

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

(a) Determine B_0, ω, k and λ

(b) Find expressions for $\vec{E}$ and $\vec{B}$.

View Text Solution