PHYSICS

BOOKS - DC PANDEY PHYSICS (HINGLISH)

ELECTROMAGNETIC WAVES

Example

1. A parallel - plate capacitor is being charged.Show that the displacement current across an area in the region between the plates and parallel to it is equal to the conduction current in the connecting wires.

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

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

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

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

(b) Write an expression for the eletric field.

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

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5. In the above example what is the average force if surface is perpectly reflecting?

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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 $3m$. Assume that the efficiency of the bulb is $25\ \%$ and it is a point source.

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Solved Example

1. Long distance radio broadcasts use short wave bands. Explain why?

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2. It is necessary ton use satellites for long distance TV transmission. Explain why?

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3. The ozone layer on the top of the stratosphere is crucial for human survival.Explain why?

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4. optical and radio telecopes are build on ground but X-ray astronomy is possible only from satellites or biting the earth. Explain why?

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

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

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

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

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9. A light beam travelling in the x- direction is described by the electric field $E_y\left(300V\left(m^{-1}\right)\sin\omega(t-(x/c)\right)$. An electron is constrained to move along the y-direction with a speed $\left(2.0\times\left(10^7\right)m\left(s^{-1}\right)\right)$. Find the maximum electric force and the maximum magnetic force on the electron.

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10. A parallel- plate capacitor having plate-area A and plate separation d is joined to a battery of emf epsilon and internal resistance R at t=0. Consider a plane surface of area A/2, parallel to the plates and situated

symmetrically between them. Find the displacement current through this surface as a function of time.

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

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

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

Assume that the radiation is esmitted isotropically and neglect reflection.

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12. Suppose that the electric field of an electromagnetic wave in vacuum is $E = \{(3.0N/C)\cos[1.8rad/m)y + (5.4 \times 10^6 rad/s)t]\}\hat{i}$

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

(b) What is the wavelength lambda ?

(c) What is the frequency f ?

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

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

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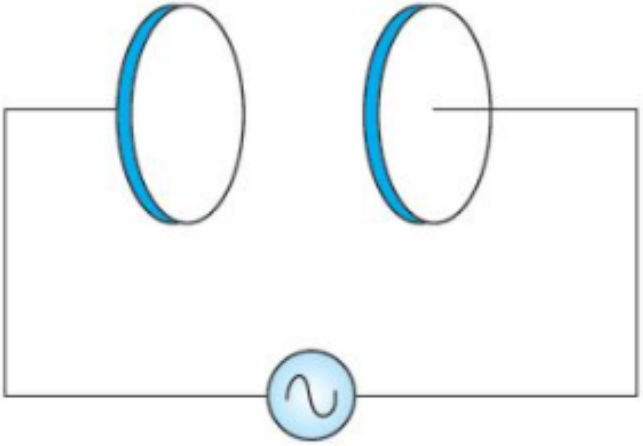
13. A parallel plate capacitor made of circular plates each of radius $R = 6.0$ cm has a capacitance $c = 100pF$. The

capacitor is connected to a $230VAC$ supply with a (angular) frequency of $300rad/s$

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

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

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



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Exercise 29 1

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

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Exercise 29 2

1. Show that the unit of $\frac{1}{\sqrt{\varepsilon\theta\mu\theta}}$ is (m/s).

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2. A capacitor is connected to an alternating- current source. Is there a magnetic field between the plates ?

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3. The sunlight reaching the earth has maximum electric field of 810V $\left(m^{-1}\right)$. What is the maximum magnetic field in this light?

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4. The electric field in an electromagnetic wave is given by $E = \left(50N\left(C^{-1}\right)\right)\sin\omega\left(t - \frac{x}{c}\right)$. Find the energy contained in a cylinder of cross section $10cm^2$ and length 50 cm along the x- axis.

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Exercise Single Correct

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

A. E

B. B

C. $B \times E$

D. $E \times B$

Answer: D

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

A. $c:1$

B. $c^2:1$

C. $1:1$

D. $\sqrt{c}:1$

Answer: C

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

A. $36\times10^5kg-m/s$

B. $36\times10^4kg-m/s$

C. $1.08 \times 10^4 kg - m/s$

D. $1.08 \times 10^7 kg - m/s$

Answer: B

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Exercise More Than One Correct

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

A. E_x, B_y

B. E_y, B_z

C. B_x, E_y

D. E_z, B_y

Answer: B::D

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2. 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 eletric field

Answer: B::D

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

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

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

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

D. Radiation pressure is in the range $I/c < p < 2I/c$ for real surfaces.

Answer: A::C::D

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

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

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

C. will have a wavelength of $0.3m$

D. fall in the region of radio waves.

Answer: A::C::D

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Exercise Subjective

1. Can an electromagnetic wave be deflected by an electric field? By a magnetic field ?

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

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

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

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5. 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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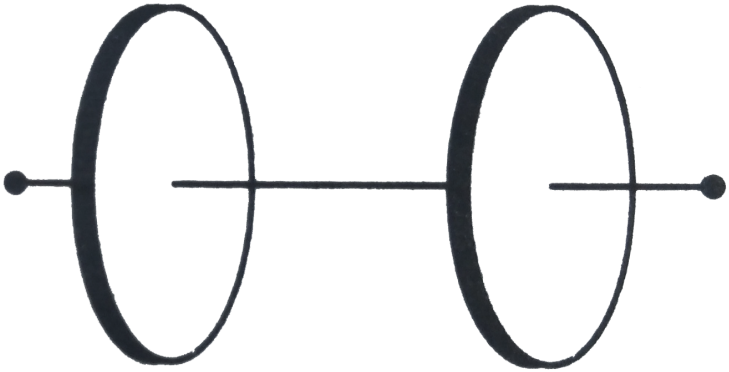
6. Figure shows a capacitor made of two circular plates each of radius $12cm$, and separated by $5.0cm$. the

capacitor is being charged by an external source (not shown in the figure). The charging current is constant and equal to $0.15A$

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

(b) Obtain the displacement current across the plates

(c) Is kirchhoff's first rule(junction rule) vaild at each plate of the capacitor ? Explain.



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

(a) Determine B_0, ω, k and λ,

(b) find expressions for E and B.

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

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9. A laser beam has intensity $2.5 \times (10^{14}) W(m^{-2})$. Find the amplitudes of electric and magnetic fields in the beam.

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

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

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

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

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

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

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Examples

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

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

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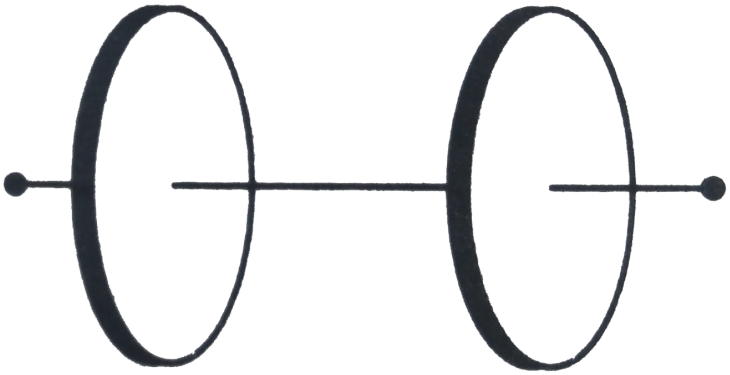

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2. A parallel plate capacitor consists of two circular plate of radius $R = 0.1m$. They are separated by a short distance. If electric field between the capacitor plates changes as $\frac{dE}{dt} = 6 \times 10^{13} \frac{V}{m \times s}$. Find displacement current between the plates.

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3. Consider a parallel plate capacitor is charged by a constant current I, with plate area A and separation between the plates d. Consider a plane surface of area $A/4$ parallel to the plates and drawn symmetrically

between the plates. Find the displacement current through this area.

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4. An L-C resonant circuit contains a $100\mu F$ capacitor an a $400\mu H$ inductor. It is not set into oscillation coupled to an antenna. Find the frequency of the radiated electromagnetic waves.

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5. Electromanetic waves travel in a medium with a speed of $2 \times 10^8 ms^{-1}$. The relative magnetic permeability of

the medium is 1. Find the relative electrical permittivity.

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

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7. Find the amplitude of electric and magnetic fields in parallel beam of light of intensity $4.0Wm^{-2}$

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

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

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

(b) Write an expression for the eletric field.

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

$$B = (200(\mu)T)\sin\left[\left(4.0 \times \left(10^{15}\right)\left(s^{-1}\right)\left(t - \left(\frac{x}{c}\right)\right)\right)\right].$$

Find the maximum electric field and the average energy density corresponding to the electric field .

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10. The electric field in an electromagnetic wave is given by $E = \left(50N\left(C^{-1}\right)\right)\sin\omega\left(t - \frac{x}{c}\right)$. Find the energy contained in a cylinder of cross section $10cm^2$ and length 50 cm along the x- axis.

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11. In a region of free space, the elctric field at some instant of time is, $E = \left(80\hat{i} + 32\hat{j} - 64\hat{k}\right)Vm^{-1}$ and the magnetic field is $B = \left(0.2\hat{i} + 0.08\hat{j} + 0.29j\hat{k}\right)\mu T$.

(i) Show that these two fields are perpendicular to each

other.

(ii) Determine the poynting vector for these fields.

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12. (i) Find the energy stored in a 90 cm length of a laser beam operating at $6mW$.

(ii) Find the amplitude opf electric field in a parallel beam of light of intensity $17.7W/m^2$.

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13. Light with an energy flux of $18Wcm^{-2}$ falls on a non-reflecting surface at normal incidence. If the surface at

normal incidence. If the surface has an area of $20cm^2$, find the average force exerted on the surface during a span of 30 min.

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14. Evaluate the amplitude of electric and magnetic field produced by the radiation coming from a 20π W bulb $20\ \%$ and it is a point source.

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Check Point 8 1

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

A. an emf

B. electric current

C. mangetic field

D. pressure radiant

Answer: C

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2. Maxwell in his famous equations of electro-magnetism introduced the concept of

A. AC curent

B. DC current

C. displacement current

D. impendance

Answer: C

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3. Dimensions of $\varepsilon_0 \frac{d\phi_E}{dt}$ are same as that of

A. charge

B. potential

C. capacitance

D. current

Answer: D

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4. The law which states that the variations of electric field causes magnetic field is

A. Faraday's law

B. Biot-Savart law

C. modified Ampere's law

D. Lenz's law

Answer: C

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5. The conduction current in ideal case through a circuit is zero when charge on capacitor is

A. zero

B. maximum

C. any transient value

D. depends on capacitor used

Answer: B

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6. Write the mathmatical equation of Ampere-maxwell law.

A. $\oint E.\, dS = \frac{q}{\varepsilon_0}$

B. $\oint E.\, dl = -\frac{d\phi_E}{dt}$

C. $\oint B.\, dS = 0$

D. $\oint B.\, dl = \mu_0\left(l_c + \varepsilon_0 \frac{d\phi_E}{dt}\right)$

Answer: D

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7. What is the displacement current between the square plate of side 1cm is of a capacitor, if electric field

between the plates is changing at the rate of $3 \times 10^6 Vm^{-1}s^{-1}$?

A. $2.7 \times 10^{-9} A$

B. $3.2 \times 10^{-5} A$

C. $4.2 \times 10^{-6} A$

D. $4.0 \times 10^{-5} A$

Answer: A

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8. A capacitor has been charged by a DC source. What are the magnitude of conduction and displacement current when it is fully charged?

A. $I_d = I_c = 1$

B. $I_d = I_c = 0$

C. $I_d = 1, I_c = 0$

D. $I_d = 0, I_c = 1$

Answer: B

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

A. $1.062 \times 10^{-2} A$

B. $2.062 \times 10^{-2} A$

C. $3.062 \times 10^{-2} A$

D. $5.062 \times 10^{-2} A$

Answer: A

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10. Maxwell's euqations describe the fundamental laws opf

A. Only electricity

B. Only magnetism

C. Only machanics

D. Both (a) and (b)

Answer: D

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Check Point 8 2

1. A L-C resonant circuit contains a 200 pF capacitor and a $100\mu G$ inductor. It is set into oscillation coupled to an antenna. The wavelength of the radiated electromagnetic waves is

A. $272m$

B. $0.0272m$

C. $377cm$

D. $3.77cm$

Answer: B

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2. The velocity of electromagnetic wave is parallel to

A. $B \times E$

B. $E \times B$

C. E

D. B

Answer: B

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

A. k

B. ω

C. k / ω

D. $k\omega$

Answer: C

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

A. These are transverse in nature

B. These are produced by accelerating charges

C. They travel with the same speed in all media

D. They travel in free space with the speed of light

Answer: C

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5. In electromagnetic wave, the phase difference between electric and magnetic field vectors E and B is

A. zero

B. $\pi/2$

C. π

D. $\pi/4$

Answer: A

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6. The oscillating electric and magnetic vectors of an electromagnetic wave are oriented along

A. the same direction but differ in phase by 90°

B. the same direction and are in phase

C. mutually perpendicular directions and are in phase

D. mutually perpendicular directions and differ in phase by 90°

Answer: C

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7. Which of the following relation is correct?

A. $\sqrt{\varepsilon_0}E_0 = \sqrt{\mu_0}B_0$

B. $\sqrt{\mu_0\varepsilon_0} = B_0 / E_0$

C. $E_0 = \sqrt{\mu_0\varepsilon_0}B_0$

D. $\sqrt{\varepsilon_0}E_0 = \sqrt{\varepsilon_0}B_0$

Answer: B

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

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

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

C. $9 \times 10^{-9} T$

D. $11 \times 10^{-11} T$

Answer: B

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

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

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

C. $3.5 \times 10^{-3} Jm^{-3}$

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

Answer: D

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

A. 13.29×10^{-12}

B. 8.86×10^{-12}

C. 17.72×10^{-12}

D. 4.43×10^{-12}

Answer: B

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11. Radiations of intensity $0.5W/m^2$ are striking a metal plate. The pressure on the plate is

A. $0.166 \times 10^{-8} Nm^{-2}$

B. $0.332 \times 10^{-8} Nm^{-2}$

C. $0.111 \times 10^{-8} Nm^{-2}$

D. $0.083 \times 10^{-8} Nm^{-2}$

Answer: B

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12. In an electromagnetic wave, the electric and magnetising fields are $100 V m^{-1}$ and $0.265 A m^{-1}$. The maximum energy flow is

A. $26.5 W m^{-2}$

B. $36.5 W m^{-2}$

C. $46.7 W m^{-2}$

D. None of these

Answer: A

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

A. X-rays

B. IR-rays

C. UV-rays

D. Radio waves

Answer: D

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14. Which of the following electromagnetic waves are used in weather forecasting?

A. Infrared waves

B. Radio waves

C. Microwaves

D. Visible rays

Answer: A

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15. Electromagnetic radiation of highest frequency is

A. infrared radiations

B. visible radiation

C. radio waves

D. γ-rays

Answer: D

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Sec A

1. Wave which cannot travel in vacumm is

A. X-rays

B. infrasonic

C. ultraviolet

D. radio waves

Answer: B

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2. Energy of electromagnetic waves is due to their

A. wavelength

B. frequnecy

C. electric and mangnetic fields

D. None of these

Answer: C

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3. Which of the following represents an infrared wavelength

A. $10^{-4}cm$

B. $10^{-5}cm$

C. $10^{-6}cm$

D. $10^{-7}cm$

Answer: A

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4. The shortest wavelength is for

A. X-rays

B. γ-rays

C. Microwaves

D. Radio waves

Answer: B

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

A. $10^{14} Hz$

B. $10^{10} Hz$

C. $10^{6} Hz$

D. $10^{4} Hz$

Answer: A

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6. The structure of solid crystals is investigated by using

A. cosmic rays

B. X-rays

C. γ-rays

D. infrared radiations

Answer: B

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

A. electrical energy

B. magnetic energy

C. Both (a) and (b)

D. None of these

Answer: C

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8. The wavelength of light visible to eye is of the order of

A. 10Å to 100Å

B. 4000Å to 8000Å

C. 8000Å to 10000Å

D. 10000Å to 15000Å

Answer: B

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9. Which of the following electromagnetic waves have the longest wavelength ?

A. Heat waves

B. Light waves

C. radio waves

D. Microwaves

Answer: C

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10. Radio wave diffract around building although light waves do not. The reason is that radio waves

A. travel with speed larger than c

B. have energy wavelength tha light

C. carry news

D. are not electromagnetic waves

Answer: B

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11. Frequency of a wave is 6×10^{15} Hz. The wave is

A. radiowave

B. microwave

C. X-ray

D. None of these

Answer: D

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12. The ferequency $1057MHz$ of radiation arising from two close energy levels in hydrogen belong to:

A. radio waves

B. infrared waves

C. microwaves

D. γ-rays

Answer: A

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13. The part of the spectrum of the electromagnetic radiation used to cook food is

A. ultraviolet rays

B. cosmic rays

C. X-rays

D. Microwaves

Answer: D

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14. What is the cause of "Green house effect"?

A. Ultraviolet rays

B. Infrared rays

C. X-rays

D. None of these

Answer: B

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15. Which force in nature exits everywhere?

A. Nuclear force

B. Electromagnetic force

C. Weak force

D. Gravitation

Answer: D

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

A. X-rays

B. Infrared rays

C. Ultraviolet rays

D. Microwaves

Answer: D

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17. In an electromanetic wave, the average energy density associated with electric field is

A. $CV^2/2$

B. $Q^2/2C$

C. $\varepsilon_0^2/2E_0$

D. $\varepsilon_0 E^2/2$

Answer: D

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

A. $Li_0^2/2$

B. $B^2/2\mu_0$

C. $\mu_0 B^2/2$

D. $\mu_0/2B^2$

Answer: B

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

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

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

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

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

Answer: D

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

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

A. $24 \times 10^{-10}m$

B. $1.5 \times 10^{-2}m$

C. $4.16 \times 10^{8}m$

D. $3 \times 10^{8}m$

Answer: B

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21. Consider the following statement regarding a beam of LASER.

(I) It is highly monochromatic.

(II) It is an electromagnetic radiation from a source.

(III) It travels with the speed of light.

Which of the statements given above are correct?

A. Both I and II

B. Both II and III

C. Both I and III

D. I, II and III

Answer: D

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

A. $\sqrt{\mu / E}$

B. $\sqrt{\mu\varepsilon}$

C. $1 / \sqrt{\mu\varepsilon}$

D. $\sqrt{\varepsilon / \mu}$

Answer: C

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23. The speed of electromagnetic wave in vacuum depends upon the source of radiation. It

A. increases as we move fromγ-rays of radio waves

B. decreases as we move from γ-rays to radio waves

C. is same for all of them

D. None of these

Answer: C

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

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

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

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

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

Answer: D

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25. Which one of the following is the property of a monochromatic, plane electromagnetic wave in free space?

A. Electrica and magnetic fields have a plane difference of $\pi / 2$

B. The energy contribution of both electric and magnetic fields are equal

C. The direction of propagation is in the direction of $B \times E$

D. The pressure exerted by the wave is the product of its speed and energy density

Answer: B

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26. The essential distinction between X - rays and γ - rays is that

A. γ-rays have smaller wavelength than X-rays

B. γ-rays emanate from nucleus while X-rays emanate from outer part of the atom

C. γ-rays greater ionising power than X-rays

D. γ-rays are more penetrating than X-rays

Answer: B

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

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

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

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

D. remain constant

Answer: C

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28. The sum delilvers $10^4 W/m^2$ of electromagnetic flux to earth's surface. The total power that is incident on a ro of dimensions $(10 \times 10)m^2$ will be:

A. $10^4 W$

B. $10^5 W$

C. $10^6 W$

D. $10^7 W$

Answer: C

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

A. E

B. B

C. $B \times E$

D. $E \times B$

Answer: D

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30. If ε_0 and μ_0 are respectively, the electric permittivity and the magnetic permeability of free space, ε and μ the corresponding quantities in a medium, the refractive index of the medium is

A. $\sqrt{\frac{\mu\varepsilon}{\mu_0\varepsilon_0}}$

B. $\frac{\mu\varepsilon}{\mu_0\varepsilon_0}$

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

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

Answer: A

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31. Which is the correct expression of velocity of light?

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

B. $\frac{E_0}{B_0}$

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

D. All of these

Answer: D

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

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

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

C. Both electric and magnetic filed vector are parallel to each other and perpendicular to the direction of propagation of wave

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

Answer: C

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33. The average electric field of electromagnetic waves in certain region of free space is $9 \times 10^{-4} NC^{-1}$. Then the average magnetic field in the same region is of the order of

A. $27 \times 10^{-4} T$

B. $3 \times 10^{-12} T$

C. $\left(\frac{1}{3}\right) \times 10^{-12} T$

D. $3 \times 10^{12} T$

Answer: B

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34. The electric and the magnetic field, associated with a electromagnetic, wave, propagating along the $+z-\text{axis}$, can be represented by

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

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

C. $E=E_0\hat{j}, B=B_0\hat{k}\Big]$

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

Answer: D

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35. The magnetic field amplitude of an electromagnetic wave is $2 \times 10^{-7} T$. Its' electirc field amplitude if the wave is traveling in free space is

A. $6V/m$

B. $60V/m$

C. $10/6V/m$

D. None of these

Answer: B

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36. A parallel plate capacitor is charged to $60\mu C$. Due to a radioactive source, the plate losses charge at the rate of $1.8 \times 10^{-8} Cs^{-1}$. The magnitued of displacement current is

A. $1.8 \times 10^{-8} Cs^{-1}$

B. $3.6 \times 10^{-8} Cs^{-1}$

C. $4.1 \times 10^{-11} Cs^{-1}$

D. $5.7 \times 10^{-12} Cs^{-1}$

Answer: A

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37. The pressure exerted by an electromagnetic wave of intensity $I\left(Wm^{-2}\right)$ on a non-reflecting surface is (c is the velocity of light)

A. Ic

B. Ic^2

C. I/c

D. I/c^2

Answer: C

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38. An $L-c$ resonant circuit contains a $200pF$ capacitor and a $200\mu H$ inductor. It is into oscillation coupled to an antenna. The wavelength of the radiated electromagnetic waves is

A. $377mm$

B. $377m$

C. $377cm$

D. $3.77cm$

Answer: B

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39. Radiation of intensity $1W/m^2$ are striking on a metal plate. The pressure on the plate is

A. $0.66 \times 10^{-8} N/m^2$

B. $0.25 N/m^2$

C. $2 N/m^2$

D. $4 N/m^2$

Answer: A

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40. A linearly polarised electromagnetic wave given as $E = E_0 \hat{i} \cos(kz - \omega t)$ is incident normally on a

perfectly reflecting wall $z = a$. Assuming that the material of the optically inactive, the reflected wave will be give as

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

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

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

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

Answer: B

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41. 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

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42. An em wave going through vacuum is described by

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

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

A. $E_0 k = B_0 \omega$

B. $E_0 \omega = B_0 k$

C. $E_0 B_0 = \omega k$

D. None of these

Answer: A

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43. A plane electromagnetic wave propagating in the x-direction has wavelength of $6.0mm$. The electric field is in the y-direction and its maximum magnitude of $33Vm^{-1}$. The equation for the electric field as function of x and l is

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

B. $33 \sin \pi \times 10^{11}(t - x/c)$

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

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

Answer: B

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44. if $\vec{E} = E_0 \cos(kz)\cos(\omega t)\hat{i}$ then $\vec{B}$ for electromagentic wave is

A. The associted magnetic field is given as

$$B = \frac{1}{c}\left(E_1 \hat{i} - E_2 \hat{j}\right)\cos(kz - \omega t)$$

B. The associated magnetic field is given as

$$B = \frac{1}{c}\left(E_1\hat{i} - E_2\hat{j}\right)\cos(kz - \omega t)$$

C. The given electromagnetic field is circularly polarised.

D. The given electromagnetic wave is plane polarised.

Answer: D

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45. A place electromagnetic wave is propagating along the direction $\left(\hat{i} + \hat{j}\right)$, then which of the following is the direction of the magnetic field component.

A. $\left(-\hat{i} + \hat{j} \right)$

B. $\left(\hat{i} - \hat{j} \right)$

C. $\left(-\hat{i} - \hat{j} \right)$

D. $\left(\hat{i} + \hat{j} \right)$

Answer: A

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

A. $c : 1$

B. $c^2 : 1$

C. $1 : 1$

D. $\sqrt{c} : 1$

Answer: C

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47. A perfectly reflecting mirror has an area of $1cm^2$ Light enery is allowed to fall on it 1 h at the rate of $10Wcm^2$. The force that acts on the mirror is

A. $3.35 \times 10^{-8}N$

B. $6.7 \times 10^{-8}N$

C. $1.34 \times 10^{-7} N$

D. $2.4 \times 10^{-4} N$

Answer: B

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48. 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 ragion

Answer: C

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

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

B. $2E$

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

D. $\sqrt{2}E$

Answer: C

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

A. $36 \times 10^5 kg - m/s$

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

C. $108 \times 10^4 kg - m/s$

D. $1.08 \times 10^7 kg - m/s$

Answer: B

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51. Manitude of the electric and magnetic field in an electromagnetic wave radiated by a $200W$ bulb at a distance 2m from it is assuming efficiency of bulb is 5% and it behaves like a point source.

A. $12.27N/C, 4.09 \times 10^{-8}T$

B. $10N/C, 10^{-5}T$

C. $11.7N/C, 5 \times 10^{-6}T$

D. $5N/C, 10^{-4}T$

Answer: A

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Sec B

1. Assertion Microwaves are used in microwave oven for cooking purpose.

Reason The frequency of microwaves is from 10^{14} to $10^{17}Hz$.

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

B. If both Assertion and Reason are true but Reason is not correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

Answer: C

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2. Assertion In electromagnetic wave, if direction of veriations of electric and magnetic field are perpendicular to each other and also perpendicular to

the direction of wave propagation.

Reason Electronegative waves are transverse in nature.

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

B. If both Assertion and Reason are true but Reason is not correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

Answer: A

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3. Assertion: Ultraviolet radiation are of higher frequency waves are dangerous to huhman beaing.

Reasion: Ultraviolet radiation are absorbed by the atmosphere

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

B. If both Assertion and Reason are true but Reason is not correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

Answer: B

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Watch Video Solution

4. Assertion The frequency of the electromagnetic wave naturally equals equals the frequency of oscillations of the charge.

Reason The energy associated with the propagating wave comes at the expense of the energy of the source.

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

B. If both Assertion and Reason are true but Reason is not correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

Answer: B

View Text Solution

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

Reason: The thermal radiations require no medium for propagation.

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

B. If both Assertion and Reason are true but Reason is not correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

Answer: B

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Match The Columns

1. Math column I with Column II and select the correct options from the choices given below the columns.

	Column I		Column II
(A)	$\oint_S \mathbf{E}\cdot d\mathbf{S} = q/\varepsilon_0$	(p)	Faraday's law of EMI
(B)	$\oint_S \mathbf{B}\cdot d\mathbf{S} = 0$	(q)	Gauss's law in magnetism
(C)	$\oint \mathbf{B}\cdot d\mathbf{l} = -\frac{d\phi_B}{dt}$	(r)	Maxwell-Ampere's circuital law
(D)	$\oint \mathbf{B}\cdot d\mathbf{l} = \mu_0\left[I_c + \varepsilon_0\frac{d\phi}{dt}\right]$	(s)	Gauss's law in electrostatics

A. $A \to r, B \to q, C \to p, D \to s$

B. $A \to s, B \to q, C \to p, D \to r$

C. $A \to p, B \to q, C \to s, D \to r$

D. $A \to s, B \to r, C \to p, D \to q$

Answer: B

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2. Match Column I (electromagnetic wave type) with Column II (its application) and select the correct option

from the choices given below the columns.

	Column I		Column II
(A)	Infrared waves	(p)	to treat muscular strain
(B)	Radio waves	(q)	for broadcasting
(C)	X-rays	(r)	to detect of fracture of bones
(D)	Ultraviolet	(s)	absorbed by the ozone layer of the atmosphere

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Sec C

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

A. A stationary charge

B. A chargeless particle

C. An accelerating charge

D. A charge moving at constant velocity

Answer: C

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

A. $p > q, \ > r$

B. $p < q, q > r$

C. $p < q, q < r$

D. $p > q, g < r$

Answer: B

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3. The electric vector vibration of an electromagnetic wave is given by $E = \left(50NC^{-1}\right)\sin\omega\left(t - \frac{x}{c}\right)$, The intensity of the wave is

A. $2.3Wm^{-2}$

B. $4.3Wm^{-2}$

C. $3.3Wm^{-2}$

D. $1.8Wm^{-2}$

Answer: C

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4. Which radiations are used in treatment of muscles ache?

A. Ultraviolet

B. Infrared

C. microwaves

D. X-rays

Answer: B

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5. In case of linearly polarised light, the magnitude of the electric field vector

A. does not change with time

B. varies periodically with time

C. is parallel to the direction of propagation

D. increases and decreases linearly with time

Answer: B

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6. A leaf which contains only green pigments, is illuminated by a laser light of wavelength $0.6328\mu m$. It

would appear to be

A. black

B. green

C. brown

D. red

Answer: A

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

A. the speed of light in vaccum

B. reciprocal of speed of light in vacuum

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

D. unity

Answer: B

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8. In electromagnetic wave , according to Maxwell , changing electric field gives

A. stationary magnetic field

B. conduction current

C. eddy current

D. displacement current

Answer: D

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9. The speed of light in an isotropic medium depends on

A. the nature of the source

B. its direction of propagation

C. its intensity

D. None of these

Answer: D

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10. The energy of gamma (γ) ray photon is E_γ and that of an X-rays photon is E_X. If the visible light photon has an energy of E_v, then we can say that

A. $E_X > E_\gamma > E_v$

B. $E_\gamma > E_v > E_X$

C. $E_\gamma > E_X > E_v$

D. $E_X > E_v > E_\gamma$

Answer: C

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11. The speed of electmagnetic waves in vacuum is equal to

A. $\mu_0\varepsilon_0$

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

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

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

Answer: C

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12. A plane electromagnetic wave of frequency $20MHz$ travels through a space along x-direction. If the electric field vector at a certain point in space is $6Vm^{-1}$,then what is the magnetic field vector at that point?

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

B. $\frac{1}{2} \times 10^{-8}T$

C. $2T$

D. $\frac{1}{2}T$

Answer: A

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13. In electromagnetic spectrum, the frequencies of γ-rays and $X-$ rays and ultraviolet rays are denoted by n_1, n_2 and n_3 respectively, then

A. $n_1 > n_2 > n_3$

B. $n_1 < n_2 < n_3$

C. $n_1 > n_2 < n_3$

D. $n_1 < n_2 > n_3$

Answer: A

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14. The electromagnetic waves detected using a thermopile and used in physical therapy are

A. gamma radiations

B. X-rays

C. ultraviolet radiations

D. infrared radiations

Answer: D

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15. The wavelength of X-rays is in the range

A. $0.01Å$ to $1Å$

B. $0.001nm$ to $1nm$

C. $0.001\mu m$ to $1\mu m$

D. $0.001cm$ to $1cm$

Answer: B

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16. The wavelength of the short radio waves, microwaves, ultraviolet waves are λ_1, λ_2 and λ_3, respectively, Arrange them in decreasing order.

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

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

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

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

Answer: A

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17. The transverse nature of electromagnetic waves is proved by which of the following?

A. Interference phenomena

B. Diffraction phenomena

C. Dispersion phenomena

D. Polarisation phenomena

Answer: D

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18. Which component of electromagnetic spectrum have maximum wavelength?

A. radio waves

B. Visible spectrum

C. Gamma rays

D. X-rays

Answer: A

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

A. the frequency of the microwave must match the resonant frequency of the water molecules

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

C. microwave are heat waves, so always produce heating

D. infrared wave produce heating in a microwave oven

Answer: A

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20. If c is the velocity of light in free space, the time taken by light to travel a distance x in a medium refractive index μ is

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

B. $\frac{\mu x}{c}$

C. $\frac{x}{\mu c}$

D. $\frac{c}{\mu x}$

Answer: B

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

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

A. $2m^{-1}$

B. $0.5m^{-1}$

C. $6m^{-1}$

D. $3m^{-1}$

Answer: A

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22. The wave function (in SI unit) for a light wave is given as $\Psi(x, t) = 10^3\pi\left(3 \times 10^6 x - 9 \times 10^{14} t\right)$.

The frequency of the wave is equal to

A. $4.5 \times 10^{14} Hz$

B. $3.5 \times 10^{14} Hz$

C. $3.5 \times 10^{10} Hz$

D. $2.5 \times 10^{10} Hz$

Answer: A

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