Physics 12th Guess Questions with answer for CBSE Year 2021

Electromagnetic Waves

VSA

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

   Answer:

   Speed of electromagnetic wave is $c = \frac{E_0}{B_0}$

   Where E_0 = amplitude of electric field, B_0 = amplitude of magnetic field

2. Do electromagnetic waves carry energy and momentum ?

   Answer: Yes.

   Its momentum , $p = \frac{h}{\lambda}$ and energy density $= \frac{1}{2}\varepsilon_0 E^2$.

3. What is the name given to that part of electromagnetic spectrum which is used for taking photographs of earth under foggy conditions from great heights?

   Answer: Infrared waves.

4. In which direction do the electric and magnetic field vector oscillate in an electromagnetic wave propagating along the X- axis?

   Answer:

   Electric field vector oscillates along Y-axis

   And magnetic field vector oscillates along Z-axis.

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

   Answer:

   (a) Ultraviolet radiation (b) Infrared radiation.

6. Which part of the electromagnetic spectrum is used in radar? Give its frequency range.

   Answer:

   Microwaves are used in radar systems of aircraft navigation. Its frequency range is 1 GHz to 300 GHz.

7. How are radio waves produced?

   Answer:

   Radio waves (500 kHz to 1000 MHz) are produced by oscillating electric circuit containing inductor and capacitor.

8. Express the velocity of propagation of an electromagnetic waves in term of the peak value of electric and magnetic fields.

   Answer:

The velocity of propagation of an electromagnetic waves is given by

$$C = \frac{E_0}{B_0}$$

9. Which part of electromagnetic radiation used to destroy cancer cells and write its frequency range.

Answer:

γ- rays and its frequency range is 10^{18} to 10^{22}.

10. What is the frequency of electromagnetic waves produced by oscillating charge of frequency $\nu = 10^5$ Hz

Answer:

The frequency of electromagnetic waves produced by oscillating charge is equal to the frequency of oscillating charge only i.e. 10^5 Hz.

Assertion –reason Type Questions

Following questions have two statements - one labelled Assertion (A) and the other labelled Reason (R).

Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both A and R are true and R is the correct explanation of A
b) Both A and R are true but R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false

1. **Assertion (A)**
A changing electric field produces a magnetic field.
Reason (R)
A changing magnetic field produces an electric field.
Correct option: (b)

2. **Assertion (A)**
Electromagnetic waves are transverse in nature.
Reason (R)
The electric and magnetic fields of an electromagnetic wave are perpendicular to each other also perpendicular to the direction of wave propagation.
Correct option: (a)

3. **Assertion (A)**
Light can travel through vacuum but sound cannot do so.
Reason (R)
Light is an electromagnetic wave and sound is a mechanical wave.
Correct option: (a)

4. **Assertion (A)**
Microwaves are better carrier of signals than optical waves.

Reason (R)
Microwaves move faster than optical waves.
Correct option: (d)

5. **Assertion (A)**
Short wave band are used for transmission of radio waves to a large distance.
Reason (R)
Short waves are reflected from ionosphere.
Correct option: (a)

6. **Assertion (A)**
Environmental damage has increased the amount of ozone in the atmosphere.
Reason (R)
Increase of ozone increases the amount of ultraviolet radiation on the earth.
Correct option: (d)

7. **Assertion (A)**
In an electromagnetic wave, the direction of the magnetic field vector $(\vec{B})$ is parallel to the electric field vector $(\vec{E})$.
Reason (R)
Electric field vector $(\vec{E})$ and magnetic field vector $(\vec{B})$, have the different frequency.
Correct option: (d)

8. **Assertion (A)**
Gamma rays are more energetic than X- rays.
Reason (R)
Gamma rays are of nuclear origin but X- rays are produced due to sudden deceleration of high energy electrons while falling on a metal of high atomic number.
Correct option: (b)

Fill in the blanks

1. The largest wavelength of electromagnetic wave is …….. .
Answer: Radio waves.
2. Radiation of intensity 0.5 Wm^{-2} are striking on a metal plate. The pressure on the metal plate is ……
Answer: 0.33×10^{-8} Nm^{-2}
Explanation:
Pressure, $p = \frac{2I}{c} = \frac{2 \times 0.5}{3 \times 10^8} = 0.33 \times 10^{-8}$ Nm^{-2}.
3. The current which comes into play in a region , where the electric flux is changing with time is called …… .
Answer: Displacement current.

4. The average electrical energy density and average magnetic energy density in vacuum are ..... and ..... respectively.

   Answer: $\frac{1}{2}\varepsilon_0 E^2$; $\frac{B^2}{2\mu_0}$

5. In apparatus, the electric field was found to oscillate with an amplitude of 12 Vm^{-1}. The amplitude of the oscillating magnetic field will be .....

   Answer: 4×10^{-8} T

   Explanation:

   Since $c = \frac{E_0}{B_0}$ Or $B_0 = \frac{E_0}{E} = \frac{12}{3 \times 10^8} = 4 \times 10^{-8}$ T

6. In a plane electromagnetic wave, electric field vibrates sinusoidally with frequency 2.5×10^{12} Hz. Its amplitude is 20 Vm^{-1}. The average electric energy density of the wave is ..... .

   Answer:

   8.85×10^{-10} Jm^{-3}.

   Explanation:

   Average electric energy density of emw is,

   $$u_E = \frac{1}{2}\varepsilon_0 {E_{rms}}^2 = \frac{1}{2}\varepsilon_0 \left(\frac{E_0}{\sqrt{2}}\right)^2 = \frac{1}{4}\varepsilon_0 {E_0}^2$$
   $$= \frac{1}{4} \times 8.85 \times 10^{-12} \times 20^2 = 8.85 \times 10^{-10}\ Jm^{-3}.$$

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

   Answer: $c = \frac{E_0}{B_0}$

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

   Answer: Electric ; magnetic

9. The ratio of $\frac{\omega}{k}$ for a travelling wave (where ω is angular frequency and k is the angular wave number) is its ..... .

   Answer: Speed

10. The cross product of $\vec{A} \times \vec{B}$ always gives the ..... of electromagnetic wave.

    Answer: Direction of propagation.

Study based questions / Based on the given Passage

1. Read the following passes carefully and choose the correct option of questions (i), (ii), (iii) and (iv):

   When a capacitor of capacitance C after charging with a charge Q is connected to an inductor of inductance L, the oscillations of charge takes place with time between the two plates of capacitor. If one plate of capacitor is connected to antenna and other plate is earthed, then electromagnetic waves are produced, which are sinusoidal variation electric and magnetic field vectors, perpendicular to each other as well as perpendicular to the

direction of propagation of wave. The velocity of these waves depends upon the electric and magnetic properties of the medium.

The electromagnetic waves were produced experimentally by Hertz in 1888 using Hertz oscillator, which were of wavelength 6 m. Jagdish Chandra Bose in 1895 produced these waves which were of wavelength of 5 mm to 25 mm. In 1896 G. Marconi is established a wireless communication between two stations of 50 km apart using electromagnetic waves.

In an electromagnetic wave, the amplitude of electric field is 10 Vm^{-1} . The frequency of wave is 5×10^{14} Hz. The wave is propagating along Z- axis.

Answer the following questions:

(i) If μ_0 , μ_r , ε_0 and ε_r as the absolute permeability , relative permeability , absolute permittivity and relative permittivity of the medium, then the velocity of electromagnetic wave in a medium is

(a) $\frac{1}{\sqrt{\mu_r \varepsilon_r}}$ (b) $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

(c) $\sqrt{\frac{\mu_r\ \varepsilon_r}{\mu_0\ \varepsilon_0}}$ (d) $\frac{1}{\sqrt{\mu_0 \varepsilon_0\ \mu_r \varepsilon_r}}$

Correct option: (d)

Explanation:

The velocity of electromagnetic wave in a medium is

$$c = \frac{1}{\sqrt{\mu\ \varepsilon}} = \frac{1}{\sqrt{\mu_0\ \mu_r\ \varepsilon_0 \varepsilon_r}} = \frac{1}{\sqrt{\mu_0 \varepsilon_0\ \mu_r \varepsilon_r}}$$

(ii) In electromagnetic waves, the average energy density due to magnetic field is

(a) $4.42 \times 10^{-10}\ Jm^{-3}$ (b) $2.21 \times 10^{-10}\ Jm^{-3}$

(c) $6.63 \times 10^{-10}\ Jm^{-3}$ (d) $8.85 \times 10^{-10}\ Jm^{-3}$

Correct option: (b)

Explanation:

Average magnetic energy density of emw is ,

$$u_B = \frac{{B_{rms}}^2}{2\mu_0} = \frac{\left(B_0/\sqrt{2}\right)^2}{2\mu_0} = \frac{{B_0}^2}{4\mu_0} = \frac{(E_0/c)^2}{4\mu_0}$$

$$= \frac{{E_0}^2}{4\mu_0\ c^2} = \frac{10 \times 10}{4 \times 4\pi \times 10^{-7} \times 3 \times 10^8 \times 3 \times 10^8}$$

$$= \frac{25 \times 10^{-9}}{36\pi} = 0.221 \times 10^{-9} = 2.21 \times 10^{-10}\ Jm^{-2}.$$

(iii) In electromagnetic wave, the total average energy density is

(a) $6.63 \times 10^{-10}\ Jm^{-3}$ (b) $8.85 \times 10^{-10}\ Jm^{-3}$

(c) $4.42 \times 10^{-10}\ Jm^{-3}$ (d) $2.21 \times 10^{-10}\ Jm^{-3}$

Correct option: (c)

Explanation:

Total average energy density of emw,

$u = u_E + u_B = 2\,u_B$

[Since, in electromagnetic wave electric energy and magnetic are equally distributed]

$= 2 \times 2.21 \times 10^{-10} = 4.42 \times 10^{-10}\ Jm^{-3}.$

(iv) The Sun also sends electromagnetic waves to the earth. Which one of the electromagnetic wave out of visible portion, from the Sun will be reaching the surface of the earth earlier than others :

(a) yellow waves (b) violet waves

(c) red waves (d) green waves

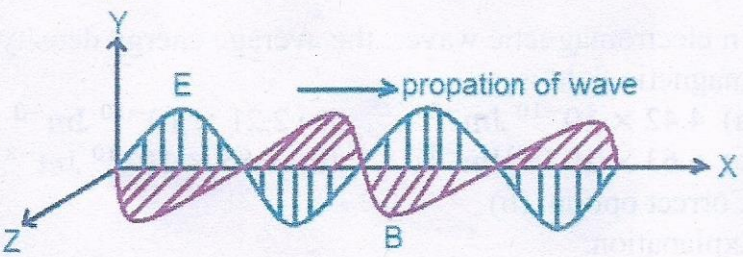
Correct option: (c)

SA (2 marks)

1. How is electromagnetic wave produced? Draw a sketch of a plane EM wave propagating along X-axis depicting the directions of the oscillating electric and magnetic fields.

Answer:

Electromagnetic waves are produced due to oscillation or accelerating charge.



2. 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.

Answer:

During charging a capacitor, electric flux between its plates is changing. Due to this, a displacement current between the plates produces.

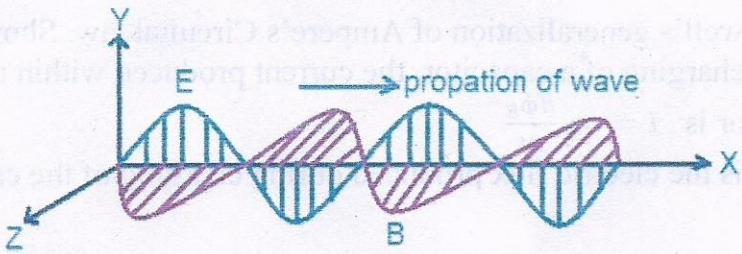
Displacement current is given by

$$i_D = \varepsilon_0 \frac{d\phi_E}{dt} = \varepsilon_0 A \frac{dE}{dt}$$

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

Answer:

Oscillating charge q produces an oscillating electric field in space, which produces an oscillating magnetic field, which is a source of oscillating electric field, and so on. Thus, the oscillating electric and magnetic fields regenerate each other which propagates through the space in the form of electromagnetic waves.



4. A capacitor of capacitance C is being charged by connecting it across a dc source along with an ammeter. Will the ammeter show a momentary deflection during the process of charging? If so, how would you explain this momentary deflection and the resulting continuity of current in the circuit? Write the expression for the current inside the capacitor.

Answer:

Yes.

The momentary deflection is due to the flow of electrons in the circuit during the process of charging. During this process, the electric field between the capacitor plates is changing. Hence, a displacement current flows in the gap.

$$i_D = \varepsilon_0 \frac{d\phi_E}{dt}$$

5. Arrange the following electromagnetic radiations in ascending order to their frequencies:

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

Write two uses of any one of these.

Answer:

Radio waves < Microwaves < X- rays < Gamma rays.

Uses of microwaves:-

(a) Aircraft navigation (b) Microwave ovens.

6. Name the type of EM 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.

Answer:

(i) γ – rays or X-rays

(ii) Ultraviolet rays

(iii) Infrared rays

Production of infrared rays:- Due to vibration of atoms and molecules.

LA-I (3 marks)

1. Write Maxwell's generalization of Ampere's Circuital law. Show that in the process of charging of a capacitor, the current produced within the plates of the capacitor is $i = \varepsilon_0 \frac{d\phi_E}{dt}$

Where ϕ_E is the electric flux produced during charging of the capacitor plates.

Answer:

Ampere's circuital law is given by $\oint \vec{B} \cdot \vec{dl} = \mu_0 i_C$

For a circuit containing capacitor, during charging or discharging the current within the plates of the capacitor varies. Due to this, displacement current (i_D) induces.

Therefore, the above equation is generalized by Maxwell, which is given by

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 i_C + \mu_0 i_D$$

During charging process of a capacitor, electric flux (ϕ_E) between the plates of capacitor changes with time, which produces the current within the plates of capacitor.

This current is directly proportional to $\frac{d\phi_E}{dt}$

$$\therefore \quad i = \varepsilon_0 \frac{d\phi_E}{dt}$$

2. (i) Identify the part of the electromagnetic spectrum which is :

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

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

(ii) Why does a galvanometer shows a momentary deflection at the time of charging or discharging a capacitor ?

Write the necessary expression to explain this observation.

Answer:

(i) (a) Microwaves (b) X-rays

(ii) Due to conduction current in the connecting wires and displacement current between the plates of capacitor, galvanometer shows momentary deflection.

Necessary expression: $i_D = \varepsilon_0 \frac{d\phi_E}{dt}$