Electromagnetic Waves

Assertion & Reason Type Questions

Directions: In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

b. Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

c. Assertion (A) is true but Reason (R) is false.

d. Both Assertion (A) and Reason (R) are false.

Q1. Assertion (A): Displacement current goes through the gap between the plates of a capacitor does not change.

Reason (R): The displacement current arises in the region in which the electric field and hence the electric flux does not change with time.

Answer : (d) Displacement current arises when electric field in a region is changing with time and given by

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

It will be so if the charge on a capacitor is not constant but changing with time.

Q2. Assertion (A): Different electromagnetic waves differ considerably in their mode of interaction with matter.

Reason (R): Different electromagnetic waves have different wavelength or frequency.

Answer : (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not correct explanation of Assertion (A).

Q3. Assertion (A): All electromagnetic waves travel through vacuum with same speed but they have different wavelength or frequency.

Reason (R): The wavelength of the electromagnetic waves is often correlated with the characteristic size of the system that produces and radiates them.

Answer : (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Q4. Assertion (A): High frequency electromagnetic waves are detected by some means based on the physical effects produce on interacting with matter.

Reason (R): The oscillating fields of an electromagnetic wave can accelerate charges and can produce oscillating currents therefore, an apparatus designed to detect EM waves is based on this fact.

Answer : (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Q5. Assertion (A): In an EM wave the magnitude of the electric field vector is more than the magnitude of the magnetic field vector.

Reason (R): Energy of the EM wave is shared equally between the electric and magnetic fields.

Answer : (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not correct explanation of Assertion (A).

Q6. Assertion (A): Long distance radio broadcasts use short-wave bands.

Reason (R): Ionosphere reflects waves in these bands.

Answer : (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Q7. Assertion (A): If the earth did not have an atmosphere, its average surface temperature would have been lower.

Reason (R): In the absence of atmosphere, the green house effect will be absent.

Answer : (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Q8. Assertion (A): Radio waves are diffracted by buildings.

Reason (R): Radio waves are high energy waves.

Answer : (c) Radio waves are electromagnetic waves having low energy. A low energy wave has a low frequency and consequently a large wavelength. Diffraction of waves takes place when the obstacles in the path are of a size comparable to the wavelength

of the wave. For some radio waves whose wavelength is comparable to the size of the building gets diffracted by the building.

Q9. Assertion (A): Microwaves are better carrier of signals than optical waves.

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

Answer : (d) The optical waves used in optical fibre communication are better carrier of signals than microwaves. The speed of microwave and optical wave is same in vacuum.

Q10. Assertion (A): Infrared waves are often called heat waves.

Reason (R): Infrared waves vibrate not only the electrons, but entire atoms or molecules of a substance which increases the internal energy and temperature of the substance.

Answer : (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Q11. Assertion (A): It is necessary to use satellites for long distance TV transmission.

Reason (R): Television signals are not properly reflected by the ionosphere therefore; reflection is affected by satellites.

Answer : (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Q12. Assertion (A): Optical and radio telescopes are built on the ground but X-ray astronomy is possible only from satellites orbiting the earth.

Reason (R): Atmosphere absorbs X-rays, while visible and radio waves can penetrate it.

Answer : (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Q13. Assertion: Electromagnetic wave are transverse in nature.

Reason: The electric and magnetic fields in electromagnetic waves are perpendicular to each other and the direction of propagation.

Q14. Assertion: Electromagnetic waves interact with matter and set up oscillations.

Reason: Interaction is independent of the wavelength of the electromagnetic wave.

Q15. Assertion: Electromagnetic waves carry energy and momentum.

Reason: Electromagnetic waves can be polarised.

Q16. Assertion: Electromagnetic waves exert radiation pressure.

Reason: Electromagnetic waves carry energy.

Q17. Assertion: The electromagnetic wave is transverse in nature.

Reason: Electromagnetic wave propagates parallel to the direction of electric and magnetic fields.

Q18. Assertion: The velocity of electromagnetic waves depends on electric and magnetic properties of the medium.

Reason: Velocity of electromagnetic waves in free space is constant.

Q19. Assertion: The basic difference between various types of electromagnetic waves lies in their wavelength or frequencies.

Reason: Electromagnetic waves travel through vacuum with the same speed.

Q20. Assertion: Microwaves are better carrier of signals than optical waves.

Reason: Microwaves move faster than optical waves.

Q21. Assertion: Infrared radiation plays an important role in maintaining the average temperature of earth.

Reason: Infrared radiations are sometimes referred to as heat waves

ANSWER KEY 13 to 21

Q13 : (a) Transverse waves are those waves in which the particles of the medium oscillate perpendicular to the direction of wave propagation.

Q14 : (c) Electromagnetic waves interact with matter via their electric and magnetic field which in oscillation of charges present in all matter. The detailed interaction and so the mechanism of absorption, scattering, etc. depend of the wavelength of the electromagnetic wave, and the nature of the atoms and molecules in the medium.

Q15 **:** (b) Consider a plane perpendicular to the direction of propagation of the electromagnetic wave. If electric charges are present in this plane, they will be set and sustained in motion by the electric and magnetic fields of the electromagnetic wave. The charge thus acquired energy and momentum from the wave. This illustrate the fact that an electromagnetic wave like other waves carries energy and momentum.

Q16 **:** (a) Electromagnetic waves have linear momentum as well as energy. This concludes that they can exert radiation pressure by falling beam of electromagnetic radiation on an object.

Q17 : (c) This electromagnetic wave contains sinusoidally time varying electric and magnetic field which act perpendicular to each other as well as at right angle to the direction of propagation of waves, so electromagnetic waves are transverse in nature. Electromagnetic wave propagate in the perpendicular direction to both fields.

Q18 : (b)

Q19 : (a) The basic difference between various types of electromagnetic waves lies in their wavelengths or frequencies since all of them travel through vacuum with the same speed. Consequently, the waves differ considerably in their mode of interaction with matter.

Q20 : (d) The optical waves used in optical fibre communication are better carrier of signals than microwaves. The speed of microwave and optical wave is the same in vacuum.

Q21 : (b) Infrared radiation help to maintain the earth warmth through the greenhouse effect. Incoming visible light which passes relatively easily through the atmosphere is absorbed by the earth's surface and re-radiated as infrared radiation. The radiation is trapped by greenhouse gases such as carbon dioxide and water vapour and they heat up and heat their surroundings.