# PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

## Plasma - CSIR NET Physics PYQs

Electromagnetism . All PYQs (2015-2025) with answer key

**5 questions . Answer key included**

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**Q1. [Dec 2015] . 5.0 marks**

Electromagnetism > Plasma

| CSIR NET | 2015 Dec | 5 M |
|---|---|---|

The frequency dependent dielectric constant of a material is given by

$$\varepsilon(\omega) = 1 + \frac{A}{\omega_0^2 - \omega^2 - i\omega\gamma}$$

where $A$ is a positive constant, $\omega_0$ the resonant frequency and $\gamma$ the damping coefficient. For an electromagnetic wave of angular frequency $\omega \ll \omega_0$ which of the following is true? (Assume that $\frac{\gamma}{\omega_0} \ll 1$ ).

1. There is negligible absorption of the wave
2. The wave propagation is highly dispersive
3. There is strong absorption of the electromagnetic wave
4. The group velocity and the phase velocity will have opposite sign

**Q2. [Dec 2018] . 5.0 marks**

Electromagnetism > Plasma

| CSIR NET | 2018 Dec | 5M |
|---|---|---|

Electromagnetic wave of angular frequency $\omega$ is propagating in a medium in which, over a band of frequencies the refractive index is $n(\omega) \approx 1 - \left(\frac{\omega}{\omega_0}\right)^2$, where $\omega_0$ is a constant. The ratio $\frac{v_g}{v_p}$ of the group velocity to the phase velocity at $\omega = \frac{\omega_0}{2}$ is

1. 3
2. $\frac{1}{4}$
3. $\frac{2}{3}$
4. 2

**Q3. [Dec 2023] . 5.0 marks**

Electromagnetism > Plasma

| CSIR NET | 2023 Dec | 5 M |
|---|---|---|

The permittivity of a medium $\varepsilon(\vec{k}, \omega)$, where $\omega$ and $\vec{k}$ are the frequency and wavevector, respectively, has no imaginary part. For a longitudinal wave, $\vec{k}$ is parallel to the electric field such that $\vec{k} \times \vec{E} = 0$, while for a transverse wave $\vec{k} \cdot \vec{E} = 0$. In the absence of free charges and free currents, the medium can sustain

1. longitudinal waves with $\vec{k}$ and $\omega$ when $\varepsilon(\vec{k}, \omega) > 0$
2. transverse waves with $\vec{k}$ and $\omega$ when $\varepsilon(\vec{k}, \omega) < 0$
3. longitudinal waves with $\vec{k}$ and $\omega$ when $\varepsilon(\vec{k}, \omega) = 0$
4. both longitudinal and transverse waves with $\vec{k}$ and $\omega$ when $\varepsilon(\vec{k}, \omega) > 0$

**Q4. [Dec 2025] . 5.0 marks**

Electromagnetism > Plasma

| CSIR NET | 2025 Dec | 5M | EMT |
|---|---|---|---|

Electromagnetic waves of frequency $\omega$ are incident on an electron gas, whose relaxation time is $\tau$. Let $\sigma_{low}$ and $\sigma_{high}$ represent the respective electrical conductivities of the gas in low frequency ($\omega\tau \ll 1$) and high frequency ($\omega\tau \gg 1$) limits. The ratio $\left(\sigma_{low}/\sigma_{high}\right)$ is

1. inversely proportional to $\omega^2$.
2. directly proportional to $\omega^2$.
3. independent of $\omega$.
4. directly proportional to $\omega$.

**Q5. [June 2025] . 5.0 marks**

Electromagnetism > Plasma

| CSIR NET | 2025 June | 5M | EMT |
|---|---|---|---|

A gas of electrons (with no source of scattering) is placed in an electric field $\vec{E} = Ee^{i\omega t}(\hat{\imath} + \hat{k})$ and a magnetic field $\vec{B} = B\hat{k}$, where $E$ and $B$ are constants. The frequency at which the conductivity in the $z$-direction, given by the ratio of the current and the electric field, both in the $z$-direction, diverges is

1. 0
2. $\frac{eB}{m}$
3. $-\frac{eB}{m}$
4. $\frac{eB}{2m}$

# Answer Key

5 questions . Subject and topic for quick revision

| Q. No | Subject | Topic | Answer |
|---|---|---|---|
| Q1 | Electromagnetism | Plasma | **1** |
| Q2 | Electromagnetism | Plasma | **1** |
| Q3 | Electromagnetism | Plasma | **3** |
| Q4 | Electromagnetism | Plasma | **4** |
| Q5 | Electromagnetism | Plasma | **1** |

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