

# PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

## Free electron theory - CSIR NET Physics PYQs

Solid State Physics . All PYQs (2015-2025) with answer key

**5 questions . Answer key included**

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

Solid State Physics &gt; Free electron theory

CSIR NET	2015 Dec	5 M
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A thin metal film of dimension  $2\text{mm} \times 2\text{mm}$  contains  $4 \times 10^{12}$  electrons. The magnitude of the Fermi wavevector of the system, in the free electron approximation, is

1.  $2\sqrt{\pi} \times 10^7 \text{ cm}^{-1}$
2.  $\sqrt{2\pi} \times 10^7 \text{ cm}^{-1}$
3.  $\sqrt{\pi} \times 10^7 \text{ cm}^{-1}$
4.  $2\pi \times 10^7 \text{ cm}^{-1}$

**Q2. [June 2020] . 5.0 marks**

Solid State Physics &gt; Free electron theory

CSIR NET	2020 June	5M
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A certain two-dimensional solid crystallises to a square monoatomic lattice with lattice constant  $a$ . Each atom can contribute an integer number of free conduction electrons. The minimum number of electrons each atom must contribute such that the free electron Fermi circle at zero temperature encloses the first Brillouin zone completely, is

1. 3
2. 1
3. 4
4. 2

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

Solid State Physics &gt; Free electron theory

CSIR NET	2023 Dec	5 M
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The lattice constant of the bcc structure of sodium metal is  $4.22\text{\AA}$ . Assuming the mass of the electron inside the metal to be the same as free electron mass, the free electron Fermi energy is closest to

1. 3.2 eV
2. 2.9 eV
3. 3.5 eV
4. 2.5 eV

**Q4. [Dec 2023] . 5.0 marks**

Solid State Physics &gt; Free electron theory

CSIR NET	2023 Dec	5 M
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The collision time of the electrons in a metal in the Drude model is  $\tau$  and their plasma frequency is  $\omega_p$ . If this metal is placed between the plates of a capacitor, the time constant associated with the decay of the electric field inside the metal is

1.  $\tau + \frac{1}{\omega_p}$
2.  $\omega_p \tau^2$
3.  $\frac{1}{\omega_p^2 \tau}$
4.  $\frac{\tau}{1 + \omega_p \tau}$

**Q5. [Dec 2024] . 5.0 marks**

Solid State Physics &gt; Free electron theory

CSIR NET	2024 Dec	5M
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Consider a free fermion gas in a hypercubic infinite potential well in hypothetical 4-dimensional space. What will be the expression for ground state energy per particle in term of the Fermi energy  $E_F$  ? (Ignore spin degeneracy of the fermions)

1.  $\frac{4}{5} E_F$
2.  $\frac{2}{3} E_F$
3.  $\frac{1}{3} E_F$
4.  $\frac{2}{5} E_F$

## Answer Key

5 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	Solid State Physics	Free electron theory	2
Q2	Solid State Physics	Free electron theory	3
Q3	Solid State Physics	Free electron theory	1
Q4	Solid State Physics	Free electron theory	3
Q5	Solid State Physics	Free electron theory	2

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