Unit 2 - Introduction to Drude's free electron theory of metals, electrical conductivity Ohm's law and Hall effect

Assignment 1

The due date for submitting this assignment has passed. **Due on 2019-02-13, 23:59 IST.**

As per our records you have not submitted this assignment.

1) *1 point*

Take a straight metal wire that can be considered as one dimensional. Then the specific heat (C_v) due to conduction electron is (which will satisfy Drude's theory)

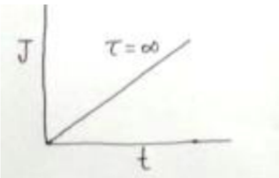
- (3/2)R
- 3R
- R
- R/2

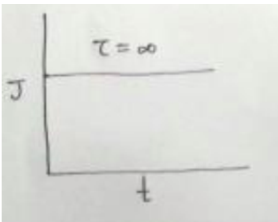
No, the answer is incorrect.
Score: 0

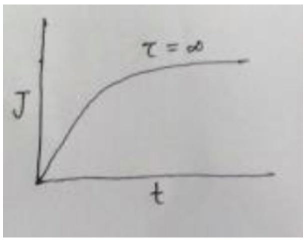
Accepted Answers:
R/2

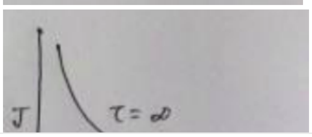
2) *1 point*

A metal has very large scattering time (τ), which can be taken to be infinity. Then using Drude's model in the presence of DC electric field the behaviour of the current density (J) as a function of time will be





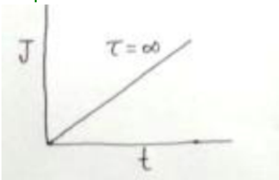




Superconductivity
Solutions of Assignments

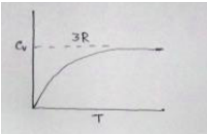
Score: 0

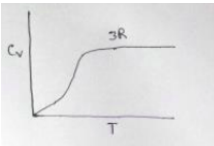
Accepted Answers:

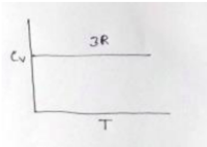


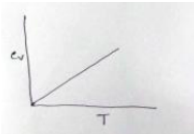
3) 1 point

Sketch the behaviour of specific heat of a pure 3D metal as a function of temperature (T)

- 

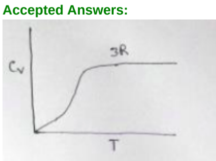
- 

- 

- 

No, the answer is incorrect.
Score: 0

Accepted Answers:



4) 1 point

Electrons are drifting in a metal with an average velocity v_0 when an electric field $\vec{E}$ is present. At $t = 0$ the electric field is switched off. Then the time dependence of the average velocity of the electron as a function of time will be

- $v = v_0 e^{-t/\tau}$
- $v = v_0 e^{t/\tau}$
- $v = v_0 e^{-2t/\tau}$
- $v = v_0 e^{-\frac{t^2}{\tau}}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$v = v_0 e^{-t/\tau}$

5) 1 point

Amongst the materials given below which one can have both $-ve$ and $+ve$ Hall coefficients:

- Metal
- Doped semiconductor
- Insulator

Intrinsic semiconductor

No, the answer is incorrect.
Score: 0

Accepted Answers:

Doped semiconductor

6) **1 point**

Aluminium has scattering time $\tau = 10^{-15}$ sec. Within Drude model if at time t the momentum is $\vec{P}(t)$ then what will be the momentum of the electron after time interval of $3*10^{-16}$ sec from 't' (consider $\vec{E} = 0$ and $\vec{B} = 0$)

- $0.7\ \vec{P}(t)$
- $1.3\ \vec{P}(t)$
- 0
- $5\ \vec{P}(t)$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$0.7\ \vec{P}(t)$

7) **1 point**

A metal is subjected to an electric field $\vec{E} = \vec{E}_0 e^{-i\omega t}$. Write the steady state velocity of the electron in the metal (assume velocity has the same time dependence as the applied electric field and take the collision time τ)

- $v = -\frac{eE_0 e^{-i\omega t}}{m(i\omega + \frac{1}{\tau})}$
- $v = \frac{eE_0 e^{-i\omega t}}{m(-i\omega + \frac{1}{\tau})}$
- $v = -\frac{eE_0 e^{-i\omega t}}{m(-i\omega + \frac{1}{\tau})}$
- $v = -\frac{eE_0 e^{-i\omega t}}{m(-i\omega - \frac{1}{\tau})}$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$v = -\frac{eE_0 e^{-i\omega t}}{m(-i\omega + \frac{1}{\tau})}$

8) **1 point**

Using the equation derived above the frequency dependent electrical conductivity (σ) of the metal is –

- $\frac{\sigma_0}{1-i\omega\tau}$
- $\frac{\sigma_0}{1+i\omega\tau}$
- $\frac{\sigma_0 \omega}{1+i\omega\tau}$
- $\frac{1}{1+i\omega\tau}$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$\frac{\sigma_0}{1-i\omega\tau}$

9) **1 point**

The mobility of electron μ_e is an important quantity in a solid. It is defined as $\vec{v} = -\mu_e \vec{E}$, wh velocity of electron and $\vec{E}$ is electric field applied to the metal. Using Drude theory the expressic is,

- $\frac{e\tau}{m_e}$

$-\frac{e\tau}{m_e}$

$\frac{e^2\tau}{m_e}$

$\frac{\tau}{m_e}$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$\frac{e\tau}{m_e}$

10) **1 point**

Mean free path of an electron l_e of a one dimensional wire made of copper at temperature $T =$ ⋮
of the order of (use $\tau = 4 \times 10^{-14} sec$),

- 24 Å
- 100 Å
- 1 Å
- 1000 Å

No, the answer is incorrect.
Score: 0

Accepted Answers:

24 Å

11) **1 point**

If density of copper is $n = 8.45 \times 10^{28} m^{-3}$ then the Hall coefficient of copper is expected to be

$-0.074 \times 10^{-9} \frac{m^3}{c}$

$0.074 \times 10^{-9} \frac{m^3}{c}$

$-0.74 \times 10^{-9} \frac{m^3}{c}$

$0.0074 \times 10^{-9} \frac{m^3}{c}$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$-0.074 \times 10^{-9} \frac{m^3}{c}$

12) **1 point**

R_H^s and R_H^m are magnitudes of Hall coefficients of an intrinsic semiconductor and a metal, respe
Then which one of the following is true

$R_H^s > R_H^m$

$R_H^s < R_H^m$

$R_H^s = R_H^m$

$R_H^s = R_H^m = 0$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$R_H^s > R_H^m$

13) **1 point**

According to Drude' model, what is the change in the magnitude of the longitudinal resistance of
when a magnetic field (B) is applied perpendicular to it,

$\Delta\rho = 0$

$\Delta\rho \propto B$

$\Delta\rho \propto 1/B$

$\Delta\rho \propto B^2$

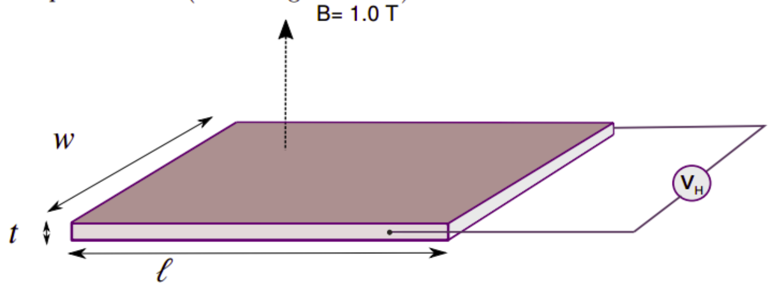
No, the answer is incorrect.
Score: 0

Accepted Answers:

$\Delta\rho = 0$

14) **1 point**

A copper thin film of thickness(t) 1 nm, width(w) 1 mm, and length(ℓ) 2 mm is carrying curren
If a magnetic filed of strength 1 Tesla(T) is applied perpendicular to the film then the Hall volta
is expected to be (see the figure below)



- $V_H = 0.5 \times 10^{-4}$V
- $V_H = 10^{-2}$V
- $V_H = 10^{-5}$V
- $V_H = 10^{-4}$ **V**

No, the answer is incorrect.
Score: 0

Accepted Answers:

$V_H = 10^{-4}$ **V**

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