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Courses » Micro and nano scale energy transport

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Unit 7 - Week 6

Course outline

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Fundamentals of statistical thermodynamics part 4

Kinetic theory of energy carriers part 1

Kinetic theory of energy carriers part 2

Quiz : Week 6 Assignment 1

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Week 6 Assignment 1

The due date for submitting this assignment has passed. **Due on 2017-09-11, 23:59 IST.**

Submitted assignment

Answer all the questions. More than one option may be correct.

1) Identify the correct statements

1 point

- A) The value of Fermi energy level is constant for all metals, semiconductors etc.
- B) Fermi-Dirac distribution function depends upon energy of the states, temperature and the chemical potential.
- C) The dispersion curve provides the details of the energy associated with conduction and valence bands
- D) Maxwell Boltzmann distribution can be applicable for molecules and electron distribution in the system.

No, the answer is incorrect.

Score: 0

Accepted Answers:

B) Fermi-Dirac distribution function depends upon energy of the states, temperature and the chemical potential.

C) The dispersion curve provides the details of the energy associated with conduction and valence bands

2) Choose the wrong arguments

1 point

- A) Fermi-Dirac distribution is applicable for electron distribution in the system
- B) The total energy of the system can be calculated using summation over all the quantum states energy.
- C) Density of states expression is introduced in conversion of energy calculation from summation to continuous integral.
- D) None of the above

No, the answer is incorrect.

Score: 0

Accepted Answers:

D) None of the above

3) The distribution versus energy curve of the metals depicts the following statements

1 point

- A) At 0 K, all the valence band is filled with the electrons
- B) As the temperature increases the probability of filling the conduction band decreases
- C) At higher temperatures, there is equal probability of filling electrons in both valence and conduction bands
- D) At 0 K. till Fermi energy level, the curve is a step function with a value of 1

No, the answer is incorrect.

Score: 0

Accepted Answers:

A) At 0 K, all the valence band is filled with the electrons

C) At higher temperatures, there is equal probability of filling electrons in both valence and conduction bands

D) At 0 K, till Fermi energy level, the curve is a step function with a value of 1

4) Considering the variation of volumetric heat capacity with temperature, choose the correct answers **1 point**

- A) For electrons, heat capacity vary linearly with the temperature
- B) For phonons, this variation is non-linear for all temperatures.
- C) For low temperatures, heat capacity is constant upto certain limit of temperature for phonons
- D) For phonons, the heat capacity is constant at high temperatures.

No, the answer is incorrect.

Score: 0

Accepted Answers:

A) For electrons, heat capacity vary linearly with the temperature

D) For phonons, the heat capacity is constant at high temperatures.

5) Calculate the mean free path of the molecules at temperature of 450 K with a diameter of 5×10^{-10} m at atmospheric pressure where $K_B = 1.38 \times 10^{-23}$ J/K **1 point**

- A) 55 nm
- B) 75 nm
- C) 85 nm
- D) 95 nm

No, the answer is incorrect.

Score: 0

Accepted Answers:

A) 55 nm

6) Kinetic theory of gases provides the information of **1 point**

- A) Heat capacity of the system
- B) Internal energy of the system in terms of kinetic energy of the molecules
- C) Transport properties like thermal conductivity can be calculated.
- D) None of these

No, the answer is incorrect.

Score: 0

Accepted Answers:

A) Heat capacity of the system

B) Internal energy of the system in terms of kinetic energy of the molecules

C) Transport properties like thermal conductivity can be calculated.

7) Calculate the thermal conductivity (W/m-K) of phonon gas with heat capacity of 200 kJ/K, at a temperature of 300 K with a diameter of 2×10^{-10} m and velocity of 1000 m/s at 1 atmosphere pressure. **1 point**

- A) 50
- B) 100
- C) 150
- D) 200

No, the answer is incorrect.

Score: 0

Accepted Answers:

A) 50

8) Choose the wrong statements **1 point**

- A) Transport properties like thermal conductivity, viscosity etc can be estimated using kinetic theory of gases
- B) Size effects on thermal conductivity can be estimated using Kinetic theory of gases
- C) Kinetic theory of gases can also be applicable to electron and phonons
- D) Boltzmann transport equation can be used to capture size effects on transport properties

No, the answer is incorrect.

Score: 0

Accepted Answers:

B) Size effects on thermal conductivity can be estimated using Kinetic theory of gases

9) Identify the correct statements from the following 1 point

- A) Mean free path is defined as the distance travelled by particles to collide each other.
- B) Relaxation time is defined as the time taken by molecules to collide each other
- C) Pressure applied by molecules can be estimated from their kinetic energy
- D) Translational kinetic energy results in the property of Internal energy

No, the answer is incorrect.

Score: 0

Accepted Answers:

*A) Mean free path is defined as the distance travelled by particles to collide each other.
B) Relaxation time is defined as the time taken by molecules to collide each other
C) Pressure applied by molecules can be estimated from their kinetic energy
D) Translational kinetic energy results in the property of Internal energy*

10) Consider a system of molecules with a mass of 10^{-28} kg and number density of 10^{25} molecules/m³. The velocity is of order of 10^4 m/s at a temperature of 300 K. Calculate the pressure (bar) and internal energy (J/m³) respectively. 1 point

- A) 1 bar, 65 kJ/m³
- B) 0.66 bar, 135 kJ/m³
- C) 1 bar, 135 kJ/m³
- D) 0.66 bar, 65 kJ/m³

No, the answer is incorrect.

Score: 0

Accepted Answers:

D) 0.66 bar, 65 kJ/m³

11) Assuming the number of electrons per unit volume is 10^{27} at a temperature of 400 K (chemical potential $\mu = 3.6 \times 10^{-19}$ J), the heat capacity of the system is 1 point

- A) 2.2 kJ
-

B) 1.1 kJ

C) 2.5 kJ

D) 4.5 kJ

No, the answer is incorrect.

Score: 0

Accepted Answers:

B) 1.1 kJ

12 For the above system at atmospheric pressure and particle velocity of **1 point** order of 10^5 m/s. Calculate the thermal conductivity (w/m-K)(assume particle size of diameter of 10^{-10} m)

A) 200

B) 300

C) 400

D) 500

No, the answer is incorrect.

Score: 0

Accepted Answers:

A) 200

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