Heat Transfer Chemistry Questions with Solutions

Q1: How is Heat Transferred?

Answer:

Heat can flow from one place to another in many ways. The following are many heat transfer modes:

- Conduction
- Convection
- Radiation

Meanwhile, if the two systems have a temperature difference, heat will find a way to pass from the higher to the lower system.

Q2: What is Convection of Heat? Give an example.

Answer:

Heat is transferred from a higher temperature region to a lower temperature region in liquids and gases during this process. Convection heat transfer occurs partly due to molecular movement and partly as a result of mass transfer.

For example. Heating of milk in a pan.

Q3: Name the general mode of heat transfer in
a) Solids
b) Liquids and gases.

Answer:

(a) The general mode of heat transfer in solids is conduction.
(b) The general mode of heat transfer in liquids and gases is convection.

Q4: State Fourier's law of conduction.

Answer:

The rate of heat conduction is proportional to the area evaluated normal to the direction of heat flow and to the temperature difference in that direction.

$Q = -kAdT / dx$

Q5: Define Radiation. Give an example.

Answer:

It is the method of transferring heat from one body to another without engaging the medium's molecules. Radiation heat transfer does not rely on the medium.

For example: In a microwave, the substances are heated directly without any heating medium.

Q6: Heat transfer takes place according to which of the following law?
a) Newton's second law of motion
b) First law of thermodynamics
c) Second law of thermodynamics
d) Newton's law of cooling

Answer: c) Second law of thermodynamics

Explanation: According to the second law of thermodynamics, the total entropy of an isolated system (the thermal energy per unit temperature that is unavailable for doing meaningful work) can never decrease.

Q7: Which of the following is the rate of heat transfer unit?
a) Joule
b) Pascal
c) Newton
d) Watt

Answer: d) Watt

Explanation: The unit of heat transfer is the joule, and the rate of heat transfer is measured in joules per second, or watts.

Q8: Which way is heat transfer believed to occur in a long, hollow cylinder kept at consistent but varied temperatures on its inner and outer surfaces?
a) Unpredictable
b) Radial only
c) No heat transfer takes place
d) Axial only

Answer: b) Radial only

Explanation: The ambient temperature is uniform on the cylinder's periphery, and the temperature is uniform. As a result, it only happens in the radial direction.

Q9: A person prefers to sit by a fire during the cold winter months. Which of the following heat transfer types gives him the most heat?
a) Radiation will provide quick warmth
b) Convection and radiation together
c) If it is near the fire, convection sounds good
d) Conduction from the fire

Answer: a) Radiation will provide quick warmth

Explanation: Heat transfer via radiation can occur between two bodies even when separated by a medium that is colder than both of them.

Q10: For conduction heat transfer, the heat energy propagation will be minimal for _____
a) Copper
b) Air
c) Water
d) Lead

Answer: b) Air

Explanation: Because of all the possibilities, air has the lowest heat conductivity.

Q11: Define fins or extended surfaces.

Answer:

Fins are surfaces that extend from an object to increase the heat transfer rate to or from the environment by enhancing convection in the study of heat transfer. The amount of heat transferred by an object is determined by its conduction, convection, or radiation.

There are four types of fins which are Straight fin, Radial fin, Annular fin, and Pin fin.

Q12: The non-dimensional parameter known as Stanton number is used in which of the following heat transfer?
a) Natural convection heat transfer
b) Unsteady state heat transfer
c) Condensation heat transfer
d) Forced convection heat transfer

Answer: d) Forced convection heat transfer

Explanation: It is the ratio of the heat transfer coefficient to the heat flow per unit temperature increase due to fluid velocity. It can only be used to transfer heat by forced convection.

Q13: Define a Black Surface.

Answer:

Three characteristics describe a black surface:

- It traps all radiation that strikes it.
- According to Planck's rule, it emits the most energy feasible for a given temperature and radiation wavelength.
- A blackbody's radiation does not have a directed nature (it is a diffuse emitter).

The optimal emitter and absorber of radiation is a black surface. It's an idealistic concept (no surface is perfectly black), and real-world properties are compared to an ideal black surface.

Q14: A greenhouse has an enclosure with high transmissivity at short wavelengths and a very low transmissivity (almost opaque) for high wavelengths. Why does a greenhouse get warmer than the surrounding air during clear days? Will it have a similar effect during clear nights?

Answer:

Solar radiation is discriminatory toward the shorter wavelengths. The greenhouse's glass allows a considerable part of the incident radiation to pass through on a clear day. The various surfaces (plants, for example) inside the greenhouse reflect the radiation, but the reflected radiation is spectrally different, with a higher proportion of long wavelengths. As a result, the reflected radiation does not pass through the glass wall and is reflected back into the greenhouse. Because of the 'trapped' radiation, the interior heats up. Because there is no sun radiation on a clear night, the same effect will not be visible.

Q15: Define fin efficiency and fin effectiveness.

Answer:

The ratio of actual heat transfer to the maximum possible heat transfer by a fin is known as its efficiency.

$\eta fin = Q\ fin\ /\ Q\ max$

Fin effectiveness is the ratio of heat transfer with fin to that without fin.

Fin effectiveness = Q with fin/ Q without fin.

Practise Questions on Heat Transfer

Q1: What is internal energy generation? Give examples where internal energy generation occurs.

Answer:

Internal energy generation occurs when a chemical, electrical, or nuclear activity produces heat within a body. The heating of a nuclear fuel rod (due to fission within the rod), the heating of electrical wires (due to electrical to heat energy conversion), microwave heating, and heat formation within the Earth are all examples. In each scenario, the heat generated is transformed from another form of energy.

Q2: What is the difference between diffusion and radiation heat transfer?

Answer:

Random molecular motion causes diffusion heat transfer. There is no bulk motion, yet neighbouring molecules move randomly and transfer energy to one another. On the other hand, radiation heat transfer refers to the transmission of heat energy via electromagnetic waves.

All living things emit thermal radiation. It's worth noting that, unlike diffusion, radiation heat transfer does not require the presence of a medium, making it the only form of heat transmission in space. Radiative heat transfer has a considerably shorter time scale than diffusive heat transfer.

Q3: Which of the following has the highest overall heat transfer coefficient value?
a) Steam
b) Feedwater heaters
c) Steam condensers
d) Alcohol condensers

Answer: b) Feedwater heaters

Explanation: The overall heat transfer coefficient of feedwater heaters is 8500 W/m^2K, but the heat transfer coefficients of steam, alcohol condensers and ammonia condensers are 5000 W/m^2K, 630 W/m^2K, and 1400 W/m^2K, respectively.

Q4: How is natural convection different from forced convection?

Answer:

The movement of the fluid in *natural convection* is entirely due to density gradients within the fluid (e.g. hot air rises over cold air). Any external instrument or phenomenon does not cause fluid motion. In *forced convection*, the fluid is forced to flow by an external event - e.g. wind in the environment, a fan

blowing air, water being pumped through a pipe. Forced convection heat transfer is typically higher than natural convection for the same fluid.

Q5: What is heat generation in solids? Give examples.

Answer:

The rate of energy generation per unit volume is referred to as internal heat generation in solids.

Examples: 1. Electric coils 2. Resistance heater 3. Nuclear reactor.