EXERCISE

Select the correct answer of the following questions.

1) Two bodies are said to be in thermal equilibrium if they have the same

a. Temperature b. Amount of heat c. Specific heat d. Thermal capacities

2) In any process the maximum amount of mechanical energy that can be converted to heat

a. Depends upon the amount of friction.

b. Depends upon the intake and exhaust temperature.

c. Depends upon whether kinetic or potential energy is involved.

d. is 100%.

3) In an isothermal change, internal energy

a. Decreases b. Increases c. Becomes zero d. Remains constant

4) A thermos bottle containing hot coffee is vigorously shaken. Consider coffee as the system, then its temperature.

a. Increases b. Decreases below than 0°C

c. Remains the same d. Decreases

5) Maximum work can be obtained in the process called

a. Cyclic b. Isothermal c. Adiabatic d. Isochoric

6) Two ideal heat engines (A) an (B) have their sources at 600K and 400K and their sinks at 300K and 250K respectively. What can you say about their efficiency?

a. A is more than B

b. A is less than B

c. Both are equal efficient

d. The data given is not sufficient

7) If the temperature of the heat source is increased, the efficiency of a Carnot's engine

a. Increases

b. Decreases

c. Remain constant

constant

d. First increases and then becomes

8) Triple point of water is

a. 273.16°F b. 371.16K c. 273.16°F d. 273.16

9) A real gas can be approximated to an idea gas at

a. Low density b. High pressure c. High density d. Low temperature

10) If the volume of the gas is to be increased by 4 times, then

a. Temperature and pressure must be doubled.

b. At constant P the temperature must be increased by four times.

c. At constant T the pressure must be increased by four times.

d. It cannot be increased.

Answers:

1.	(a)	**2.**	(a)	**3.**	(d)	**4.**	(a)	**5.**	(c)
6.	(b)	**7.**	(a)	**8.**	(a)	**9.**	(d)	**10.**	(d)

1) Why is the earth not in thermal equilibrium with the sun?

Answer

Since the temperature of the sun is almost 10^7 Kelvin and that of earth is 330 K (Max). Due to this large temperature difference sun cannot be in thermal equilibrium. The two objects are in thermal equilibrium if both have same temperature. When two objects are in thermal equilibrium heat flow ceased. But we are getting heat energy continuously from the sun i.e. heat continuously flows from sun to the earth. That is why they are not in thermal equilibrium.

2) When a block with a hole in it is heated why does not the material around the hole expand into the hole and make it small?

Answer

When a block with a hole in it is heated the material as well as the hole expand because when the object/material expands, the atoms move apart and the hole increase in size. That is why the hole be expanding the block does not become small.

3) A thermometer is placed in direct sun light. Will it read the temperature of the air, or of the sun, or of something else?

Answer

A thermometer actually measures its own temperature but when thermometer is placed in sun light then it is in thermal equilibrium with air. So when the thermometer is in thermal equilibrium with air, the temperature must be equal. Therefore, one can say that thermometer will read the temperature of the air. Since thermometer is not in thermal equilibrium with the sun. That is why it cannot measure the temperature of the sun.

4) The pressure in a gas cylinder containing hydrogen will leak more quickly than if it is containing oxygen. Why?

Answer

Since the molar mass of hydrogen is 16 times less than the molar mass of oxygen because the rate of leaking of a gas is inversely proportional to the square root of its density.

5) What happens to the temperature of the room in which an air conditioner is left running on the table of the room in the middle?

Answer

In ideal case when air conditioner is placed in the middle of the room absorbs as well as rejects heat in the room at the same rate then the temperature of the room remains constant and unaffected. But in practical, due to working of compressor, some heat evolved during this process, so the temperature of the room may rise slightly. However, this rise in temperature is negligible. Therefore, temperature of the room is almost constant when an air conditioner is left running on the table in the middle of the room.

6) When a sealed thermometer flask bottle full of hot coffee is shaken, what are the changes in (a) Temperature of the coffee (b) The internal energy of coffee?

Answer

When a sealed thermo flask bottle full of hot coffee is shaken then work is done. The system thereby increasing internal energy and hence temperature (as mandated by adiabatic compression). The rapid shaking causes increase in K.E of the molecules. That is why both temperature and internal energy will rise.

7) When an object is heated, not all the energy it absorbs, goes into increasing the velocity of the molecules. Explain where does the remaining energy go?

Answer

When an object is heated, some of the energy goes to increase the velocity of the molecules. Some energy is utilized to overcome intermolecular forces. Remaining energy may be utilized in phase transition.

8) Why does the pressure of the air in automobile tyre increase of the automobile is driven for a while?

Answer

When an automobile is moving on the road, some work must be done to overcome road friction. The work done causes the temperature of the air in tyre. The temperature rises the average K.E of molecules of air. Since from Kinetic Molecular Theory, kinetic energy is directly proportional to pressure of the air in automobile tyre increases if it is driven for a while.

9) On removing the valve, the air escaping from a cycle tube cool. Why?

Answer

On removing, the air escaping from a cycle tube expands rapidly in a nearly adiabatic process, so the temperature of the gas drops. That is why the air escaping from a cycle tube feels cool. This is sometime called adiabatic cooling. The molecules of a compressed gas in a tube are very close to each other and have sufficient intermolecular attractive forces. When the gas is allowed to expand, the molecules move apart from each other. Due to expansion, the molecules have to overcome the intermolecular forces. For this purpose, they need energy which is absorbed from the gas itself. Hence expansion of a compressed air escaping from a cycle tube causes cooling.

10) Can a room be cooled by leaving the door of an electric refrigerator open?

Answer

A room cannot be cooled by leaving the door of a refrigerator open because the heat absorbed by the coil inside the refrigerator from the room is again released in the room by external coil at the back of refrigerator.

11) What are the conditions for a process to be reversible?

Answer

A process in which succession of events bring the system back to its initial condition is called reversible process. Although, no actual change is exactly

reversible. But if the following conditions are satisfied, the process may be reversible.

1) Thermal and mechanical equilibrium must be maintained throughout the process such that dissipation of energy may not occur.

2) The process must be occurred very slowly such that at an instant of time, temperature of the system remains constant.

12) Write the limitations of first law of thermodynamics.

Answer

1) This law is based on the idea that energy is neither created nor destroyed in any thermodynamic system. So, it is a particular form of the law of conservation of energy which deals only with the heat energy.

2) 1st law of thermodynamics tells us that heat energy can be converted into equivalent amount of work, but it is silent about the conditions under which this conversion takes place.

13) Is it possible, according to the second law of thermodynamics, to construct a heat engine that is free from thermal pollution?

Answer

Strictly speaking it is not possible. Because heat energy cannot be converted completely into useful work at any cost. Basically, heat engine takes heat from hot temperature reservoir, partly converted into mechanical work and remaining heat is rejected to low temperature reservoir, thus it produces thermal

pollution. To construct a heat engine which is free from thermal pollution will be clear violation of second law of thermodynamics.

14) When two systems are in thermal equilibrium, do they have the same amount of kinetic energy?

Answer

Two systems are said to be in thermal equilibrium if both have same temperature. Since temperature is the measure of motion of molecules i.e. temperature is directly proportional to average kinetic energy, so when two systems are in thermal equilibrium both have the same amount of kinetic energy.

15) Work can be converted completely into heat, so can heat be converted completely into work?

Answer

Work can be converted completely into heat, but heat cannot be converted completely into work, otherwise it violates the second law of thermodynamics. Also, heat is called the most degraded form of energy which is less useful as compared to other forms of energies.

16) Entropy has often called as "time arrow". Explain?

Answer

Since entropy of the universe always increases because when any type of energy is converted into heat energy, the energy available for doing useful work decreases. When energy is continuously degrading for doing useful work.

Ultimately, the entropy of the universe should reach a maximum which is called heat death of the universe. All processes will cease due to the unavailability of useful energy. That is why entropy is called as time arrow.

17) Can specific heat of a gas be zero or infinity? Can specific heat be negative? Answer

As, $Q = cm\,\Delta T$, Or $C = \frac{Q}{m\Delta T}$, which shows that for zero specific heat, the heat supplied to the system 'Q' must be zero or mass 'm' must be infinite which is not possible. Similarly, for negative specific heat, if 'Q' is given out of the system this specific heat can be negative.

18) An inventor claims to have developed a heat engine, working between 27°C and 227° C having an efficiency of 45%. Is the claim valid? Explain.

Answer

Data:

Temperature of hot reservoir = T_1=227°

$$T_1 = 227°C+273 = 500\ K$$

Temperature of Cold reservoir = T_2=27°

$$T_2 = 27°C+273 = 300\ K$$

As efficiency of the engine is given by

$$\eta = \left[1 - \frac{T_2}{T_1}\right] \times 100 \qquad \ldots\ldots\ldots (1)$$

$$\eta = \left[1 - \frac{300}{500}\right] \times 100 \qquad \ldots\ldots\ldots (2)$$

$$\eta = 40\%$$

His claim is not valid because the efficiency of the engine working between 227°C and 27° C is 40% not 45%.