Q. No. 2 Part (i) <u>Earth is not equilibrium with the sun.</u>

Distance between them 149.6 million km

<u>**Reason**</u>:- •- Very small amount of heat reaches earth from sun due to very large distance (approx 149.6 million km)

•- Also, earth absorbs heat from sun, but also releases the heat in the form of radiation itself

•- Earth & sun are not touching each other (usually objects come reach equilibrium quickly if they are in contact with each other).
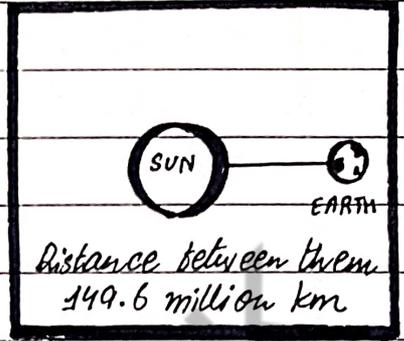
<u>**Conclusion**</u>:- Because of above justifications we say that sun & earth are not in equilibrium.

Q. No. 2 Part (ii) <u>**Reasons**</u>:- •- If you heat the ring it expands, making the circumference bigger.

•- When a block is heated its temperature increases.

•- The block will expand on heating in outward direction and it's all dimensions increase.

Before heating

After heating

<u>**Conclusion**</u>:- Therefore diameter (size) of hole also increases.
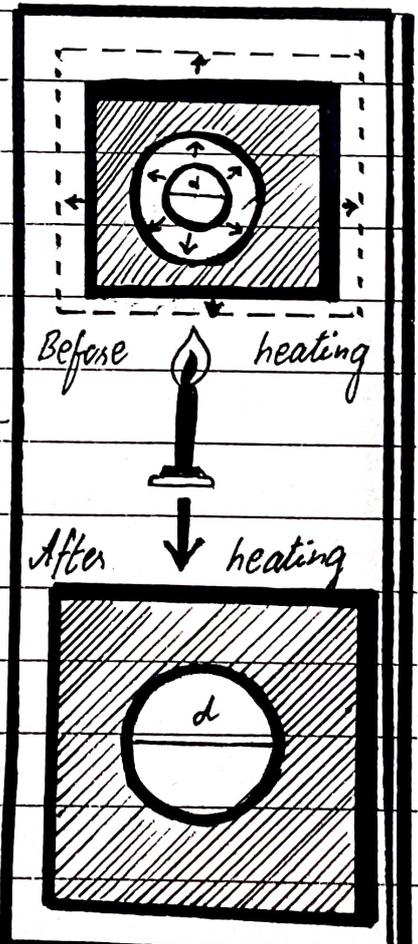
Q. No. 2 (iii) <u>Thermometer will measure the temperature of the air surrounding the thermometer bulb.</u>

<u>Explanation:</u> When thermometer is in contact with an object then thermal equilibrium is reached between thermometer and object.
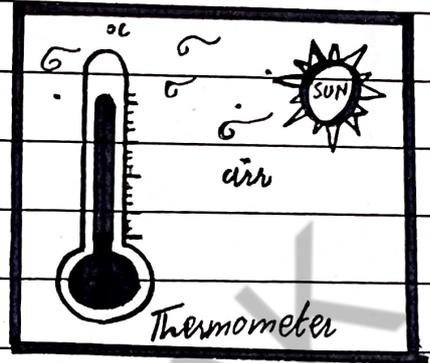
★ At that point, we say that thermometer is showing temperature of the object.

★ In this case, thermometer comes in equilibrium with air surrounding the thermometer bulb, so thermometer measures the temperature of air.

<u>Conclusion:</u> So, thermometer shows temperature of air.

Q. No. 2(iv) <u>The pressure in a gas containing hydrogen will leak more quickly than the gas cylinder containing oxygen.</u>

<u>Reasons:</u> ★ According to Graham's law of diffusion.

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

▶ The smaller the molecular mass of gas greater will be rate of diffusion and vice versa.

▶ As the hydrogen is lighter than oxygen therefore rate of diffusion of hydrogen gas is greater than oxygen.

$$\frac{r_{H_2}}{r_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{H_2}}}$$

$$\frac{r_{H_2}}{r_{O_2}} = \sqrt{\frac{32}{2}}$$

$$\frac{r_{H_2}}{r_{O_2}} = \sqrt{16}$$

$$\frac{r_{H_2}}{r_{O_2}} = 4$$

<u>Conclusion:</u>

$$r_{H_2} = 4 \, r_{O_2}$$

Q. No. 2 Part (v) *The temperature of the room will not decrease but increase slightly.*

Reasons:- ★ Air conditioner absorbs heat from the room as well as rejects heat in the same room at the same rate.

★ During compression of gas some heat is produced due to friction in the compressor. This heat is also expelled in the same room.

Conclusions:- Because of which temperature of room will increase slightly.

Q. No. 2 Part (vi) When the automobile is driven for a while then heat produce due to friction between road and tyre i.e the work done against friction appears as heat energy.

As some work will be done against friction

Explanation:- * This heat is absorbed by the gas molecules.

* It increases the temperature and average Kinetic energy of gas molecules.

$$P \propto K.E_{av}$$

* When average kinetic energy of gas molecules increases the number of collision of gas molecules with walls of tyres increases per unit time therefore pressure of gas inside tyre also increases.

Q. No. 2 Part (vii) On removing the valve, the air escaping from a cycle tube cools (due to adiabatic expansion of air)

As valve open gas moves out ward

Resulting in adiabatic expansion

Explanation:- * When the valve is removed the air rushes out from the tube towards low atmospheric pressure forming an adiabatic expansion.

$$W = -\Delta U$$

* The above equations shows that during expansion, internal energy decreases of a gas and hence decreasing the temperature of gas i.e (causes cooling)

Mathematically:-

$$T \propto \Delta U$$
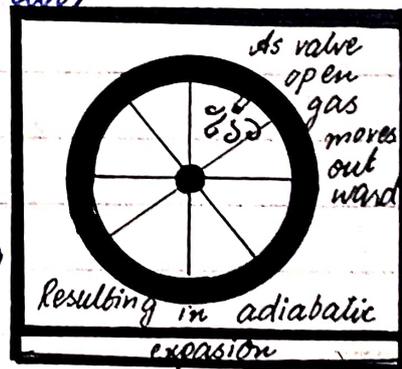
Q. No. 2 Part (xiii) <u>**Limitations of 1st law of thermo-dynamics**</u>

★ First law of thermodynamics doesn't provide a clear idea about the direction of flow of heat.

★ It does not tells that under what condition transformation of heat and work takes place.

★ It does not tells about change in entropy of a system as 2nd law states that :-

"<u>All natural process takes place when entropy of the system plus surrounding increases.</u>"

Q. No. 2 Part (ix) No, it is not possible to construct a heat engine that will not expel heat into the atmosphere.

<u>Reason</u>:- •- According to 2nd law of thermodynamics Lord Kelvin's statement ("It is impossible to construct a heat engine operating in cycle which absorbs heat from a hot reservoir and it converts it completely into work without rejecting any heat to sink.")

•- Every engine expels heat energy to the surrounding & produce thermal pollution.

<u>Conclusion</u>:- If it is possible, then it will be violation of Second law of thermodynamics.

Q. No. 2 Part (x)

"Zero"	"Infinity"	"Negative"
Molar specific heat can be zero in adiabatic process.	Molar specific heat can be infinity in isothermal process.	Molar specific heat of a gas is always (POSITIVE).
$\Delta Q = Cn\Delta T$	$\Delta Q = Cn\Delta T$	
(for C)	(for C)	* It can never be negative.
$C = \dfrac{\Delta Q}{n\Delta T}$	$C = \dfrac{\Delta Q}{n\Delta T}$	
As for adiabatic process $\Delta Q = 0$	As for isothermal process $\Delta T = 0$	
$C = \dfrac{(0)}{n\Delta T}$	$C = \dfrac{\Delta Q}{n(0)}$	
$\boxed{C = 0}$	$\boxed{C = \infty}$	

Q. No. 2 Part (xi) **Given data:-** Temperature of heat source $= T_1 = 227°C = 227 + 273 = 500K$

Temperature of sink $= T_2 = 27°C = 27 + 273 = 300K$

Given $\eta = 45\%$ (Prove it is true or not)

To find:- Efficiency $= \eta = ?$

Solution:-

$\eta = 1 - \dfrac{T_2}{T_1}$

$\eta = 1 - \dfrac{300}{500}$

$\eta = 1 - 0.6 = 0.4$

$\eta\% = 0.4 \times 100$

$\eta\% = 40\%$

Conclusion:- The inventor of engine claimed is efficiency 45% but in actual its 40%. So his claim is not valid.

Give a short response to the following questions

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

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?

3. A thermometer is placed in direct sunlight. Will it read the temperature of the air, or of the sun, or of some thing else?

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

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

6. Why does the pressure of the air in automobile tyre increases if the automobile is driven for a while?

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

8. Write the limitations of first law of thermodynamics.

9. Is it possible, according to the second law of thermodynamics, to construct an heat engine that is free from thermal pollution?

10. Can specific heat of a gas be zero or infinity? Can specific heat be negative?

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