A Carnot heat pump is a Carnot engine operated in the opposite sense. A Carnot heat pump is operated between two temperatures T1 and T2 where T1>T2. For a given temperature T1, as the difference between T1 and T2 increases, the COP of a Carnot heat pump:

Increases.

Decreases.

does not change.

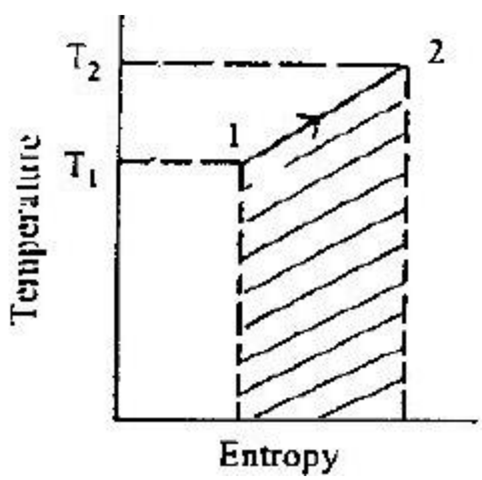
at first increases, then decreases.

none of the others mentioned.

Answer: decreases. Explanation: COP(heat pump) = T1/(T1 – T2)

As the value of T1 – T2 increases, value of COP decreases.

In the TS-diagram given the area under the curve in the process 1->2 is best represented by which of the following?



Work done during the process

Heat absorbed during the process

Heat rejected during the process

Increase of internal energy during the process

Increase of entropy during the process

Answer: B , Heat absorbed during the process

Change of entropy when an ideal gas is heated under constant pressure (with initial temperature and pressure T_i and V_i and final temperature and pressure T_f and V_f) is:

$\Delta S = nR \ln(V_f/V_i)$

$\Delta S = n C_P \ln(T_f/T_i)$

$\Delta S = n C_V \ln(T_f/T_i)$

$\Delta S = nR \ln(T_f/T_i)$

$\Delta S = n C_P \ln(V_f/V_i)$

Answer: $\Delta S = n C_P \ln(T_f/T_i)$ (= \Delta S = nR ln(V_f/V_i) + n C_V ln(T_f/T_i) , at constant P)

An ideal gas is in a volume V1 at pressure P1. It undergoes ***adiabatic free expansion*** into thrice its original volume i.e. V2=3V1. The change of entropy is:

0

nR ln(4)

2 nR

nR ln(3)

sqrt(3) nR

Answer: nR ln(4) because V_f = V1+V2 = 4V1 and the change of entropy = nR ln(V_f/V_i)

A Carnot engine operates between the absolute temperatures T1 and T2 (T1>T2) where T1=900K. Another Carnot engine operates between the temperatures T2 and T3 (T2>T3) with T3=400 K. For both heat engines to be equally efficient, T2 would be:

600 K

720 K

500 K

650 K

750 K

Answer: 600 K; Solution: For equal efficiency : eta = 1 - (T2/T1) = 1 - (T3/T2) => T2/T1 = T3/T2

=> T2 = sqrt(T1 T3) => T2 = sqrt(900*400) = 600 K

How are the efficiencies of any heat engine (η) and that of a reversible heat engine (ηR) compared, when both are operating between same heat source and same heat sink?

$\eta = \eta R > 0$

$\eta > \eta R > 0$

$0 < \eta < \eta R$

$\eta > 0, \eta R < 0$

$\eta > 0, \eta R = 0$

(cannot be determined in general)

Answer: $0 < \eta < \eta R$

What type of thermodynamic function entropy is?

an extensive and path function

an extensive and state function A

an intensive and path function

an intensive and state function

none of the mentioned.

Answer: an extensive and state function

At the equilibrium state of any system the entropy of the system:

becomes a maximum.

becomes a minimum.

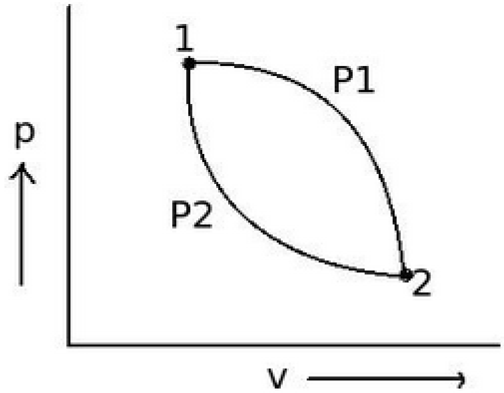
becomes equal to entropy of the surroundings.

increases.

Is none of the mentioned.

Answer: entropy of the system becomes a maximum.

Two reversible paths P1 and P2 are represented in the figure and the process represented is a cyclic process. Which will be the correct relation for the cyclic process shown?



$$\oint_{1\to 2;P1+\ 2\to 1;P2} \frac{dQ}{T} = 0$$

$$\int_{1\to 2;P1} \frac{dQ}{T} = \int_{1\to 2;P2} \frac{dQ}{T}$$

$$\int_{2\to 1;P1} \frac{dQ}{T} = \int_{2\to 1;P2} \frac{dQ}{T}$$

All of three mathematical relations.

None of the given mathematical relations.

Answer: All of three mathematical relations

A non-cyclic reversible process is one that:

occurs without any outside interventions i.e. is spontaneous in both directions.

can be reversed with no net change of the system and the surroundings. A

must be carried out at low temperature.

can be reversed with no net change of entropy of the system.

must be carried out very slowly.

Answer: Can be reversed with no net change of the system and the surroundings. This is because, the net energy of the system + surroundings always remain constant and the net entropy remains constant as well in a reversible process. Hence **every NET thermodynamic variable** remains constant.

Which one of the following is true?

For a quasi-static process $\Delta S=0$.

Entropy increases when a liquid freezes at its melting point.

For a spontaneous process $\Delta S=0$.

The number of microstates available to a system is a measure of its entropy. A

Entropy of the pure crystalline solid is zero at 0 degrees Celsius.

Answer: The number of microstates available to a system is a measure of its entropy.