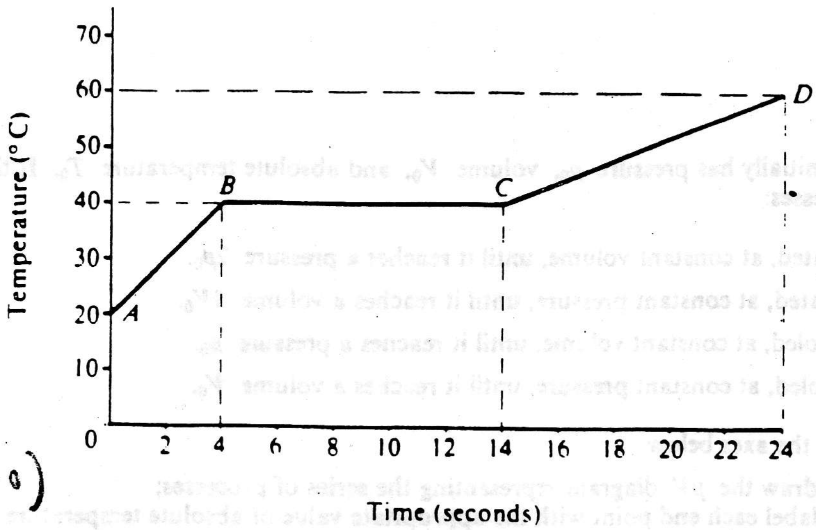
AP Thermal Questions.

Do these on this Paper. (unless you really don't want to)



#1

• A 0.020-kilogram sample of a material is initially a solid at a temperature of 20° C. Heat is added to the sample at a constant rate of 100 joules per second until the temperature increases to 60° C. The graph above represents the temperature of the sample as a function of time.

$1000\ J/kg°C$ (a) Calculate the specific heat of the solid sample in units of joules per kilogram °C.

$5 \times 10^4\ J/kg$ (b) Calculate the latent heat of fusion of the sample at its melting point in units of joules per kilogram.

(c) Referring to the three intervals AB, BC, and CD shown on the graph, select the interval or intervals on the graph during which:

AB CD i. the average kinetic energy of the molecules of the sample is increasing

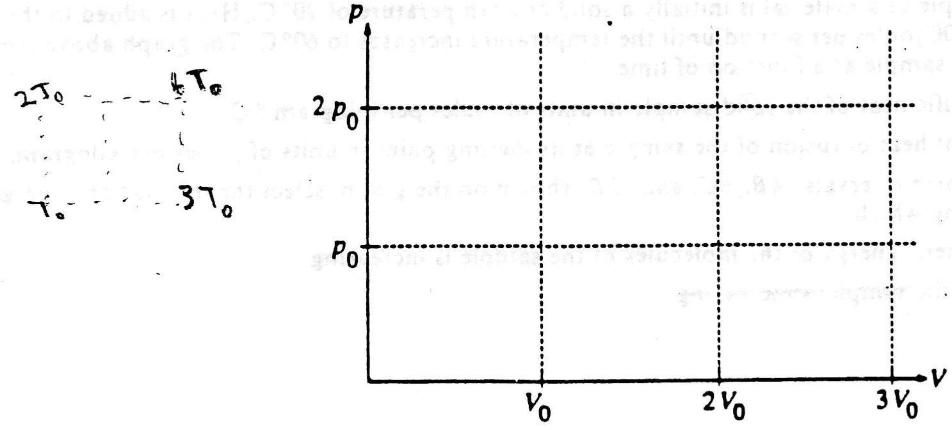
AB BC CD ~~ii. the entropy of the sample is increasing~~

#2 An ideal gas initially has pressure p_0, volume V_0, and absolute temperature T_0. It then undergoes the following series of processes:

I. It is heated, at constant volume, until it reaches a pressure $2p_0$.
II. It is heated, at constant pressure, until it reaches a volume $3V_0$.
III. It is cooled, at constant volume, until it reaches a pressure p_0.
IV. It is cooled, at constant pressure, until it reaches a volume V_0.

(a) On the axes below

i. draw the pV diagram representing the series of processes;
ii. label each end point with the appropriate value of absolute temperature in terms of T_0.

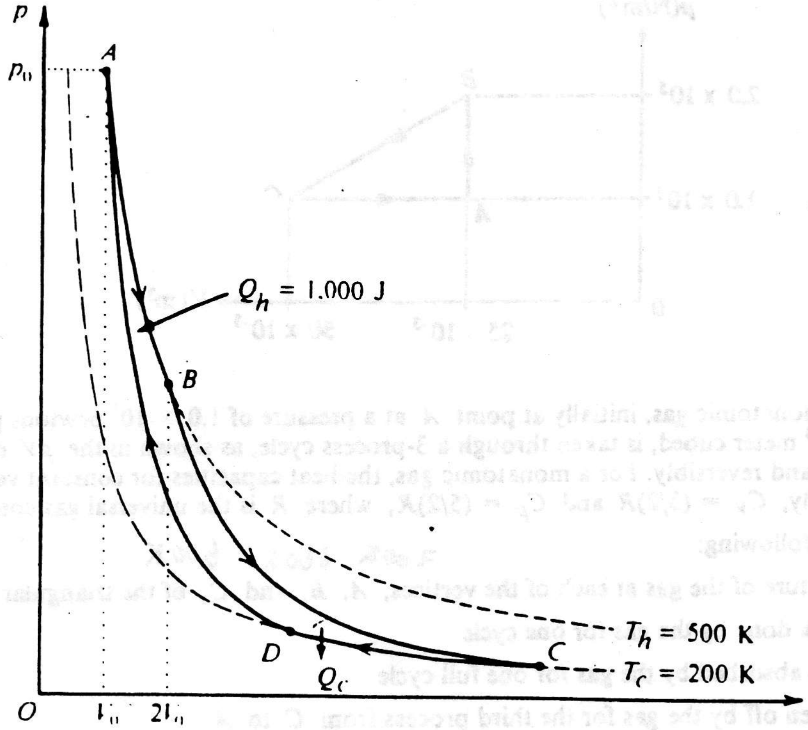


(b) For this series of processes, determine the following in terms of p_0 and V_0.

i. The net work done by the gas → $2p_0V_0$
ii. The net change in internal energy → 0
iii. The net heat absorbed → $2p_0V_0$

Optional (c) Given that $C_p = \frac{5}{2}R$ and $C_V = \frac{3}{2}R$, determine the heat transferred during process 2 in terms of p_0 and V_0.

$\Delta Q = nC_p\Delta T = n\frac{5}{2}R(4T_0) = 10nRT_0 = 10p_0V_0$



#3 3. The pV-diagram above represents the states of an ideal gas during one cycle of operation of a reversible heat engine. The cycle consists of the following four processes.

Process	Nature of Process
AB	Constant temperature (T_h = 500 K)
BC	Adiabatic
CD	Constant temperature (T_c = 200 K)
DA	Adiabatic

$P_B = P_0/2$ During process AB, the volume of the gas increases from V_0 to $2V_0$ and the gas absorbs 1,000 joules of heat.

(a) The pressure at A is p_0. Determine the pressure at B.

1000J (b) Using the first law of thermodynamics, determine the work performed by or on the gas during the process AB.

increase (c) During the process AB, does the entropy of the gas increase, decrease, or remain unchanged? Justify your answer. Optional

400J (d) Calculate the heat Q_c given off by the gas in the process CD.

+ work (e) During the full cycle $ABCDA$, is the total work the gas performs on its surroundings positive, negative, or zero? Justify your answer.

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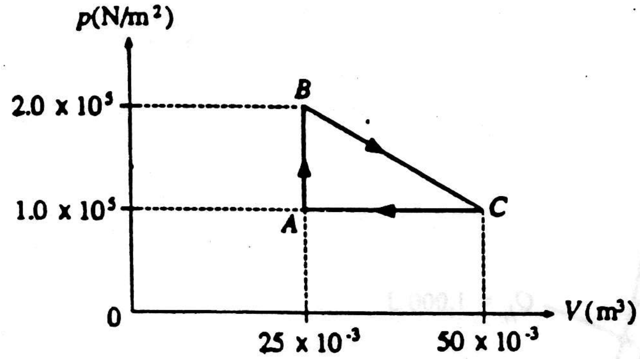

#4 4. One mole of an ideal monatomic gas, initially at point A at a pressure of 1.0×10^5 newtons per meter squared and a volume of 25×10^{-3} meter cubed, is taken through a 3-process cycle, as shown in the pV diagram above. Each process is done slowly and reversibly. For a monatomic gas, the heat capacities for constant volume and constant pressure are, respectively, $C_V = (3/2)R$ and $C_p = (5/2)R$, where R is the universal gas constant, 8.32 J/mole · K.

Determine each of the following:

300K 600K 600K

(a) the temperature of the gas at each of the vertices, A, B, and C, of the triangular cycle

1250J (b) the net work done by the gas for one cycle

1250J (c) the net heat absorbed by the gas for one full cycle

6240J (d) the heat given off by the gas for the third process from C to A

.17 (e) the efficiency of the cycle

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#5 6. A freezer contains 20 kilograms of food with a specific heat of $2 \times 10^3 \frac{J}{kg\ {}^\circ C}$. The temperature inside the freezer is initially -5° C. The freezer motor then operates for 10 minutes, reducing the temperature to -8° C.

1.2×10^5 J (a) How much heat is removed from the food during this time?

The freezer motor operates at 400 watts.

2.4×10^5 J (b) How much energy is delivered to the freezer motor during the 10-minute period?

3.6×10^5 J (c) During this time, how much total heat is ejected into the room in which the freezer is located?

6.4°C (d) Determine the temperature change in the room if the specific heat of air is $700 \frac{J}{kg\ {}^\circ C}$. Assume there are 80 kilograms of air in the room, the volume of the air is constant, and there is no heat loss from the room.

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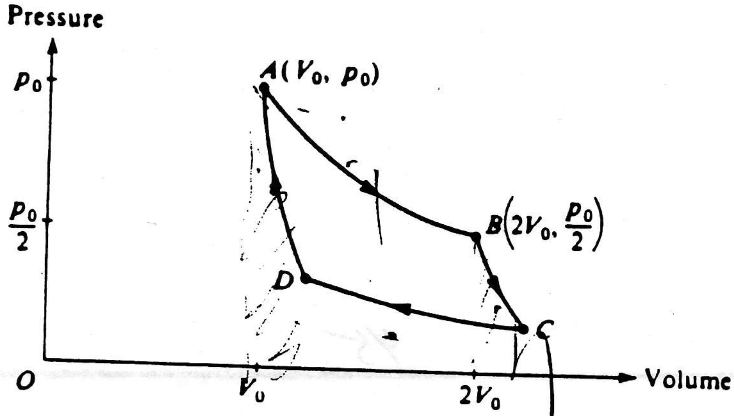
#6 A proposed ocean power plant will utilize the temperature difference between surface seawater and seawater at a depth of 100 meters. Assume the surface temperature is 25° Celsius and the temperature at the 100-meter depth is 3° Celsius.

.074 (a) What is the ideal (Carnot) efficiency of the plant?

1250MW (b) If the plant generates useful energy at the rate of 100 megawatts while operating with the efficiency found in part (a), at what rate is heat given off to the surroundings?

2.77×10^{-9} kg/s (c) A nuclear power plant operates with an overall efficiency of 40 percent. At what rate must mass be converted into energy to give the same 100-megawatt output as the ocean power plant above? Express your answer in kilograms per second.

The diagram below represents the Carnot cycle for a simple reversible (Carnot) engine in which a fixed amount of gas, originally at pressure p_0 and volume V_0, follows the path *ABCDA*.



(d) In the chart below, for each part of the cycle indicate with +, −, or 0 whether the heat transferred Q and temperature change ΔT are positive, negative, or zero, respectively. (Q is positive when heat is added to the gas, and ΔT is positive when the temperature of the gas increases.)

+ 0
0 −
− 0
0 +

	Q	ΔT
AB		
BC		
CD		
DA		

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