Thermodynamics - The 4 Gas Processes A Phys...

✡ Can you do Qs 1 + 2 from memory? keep trying till you can

$R = 8.3\ J\ mole^{-1}$

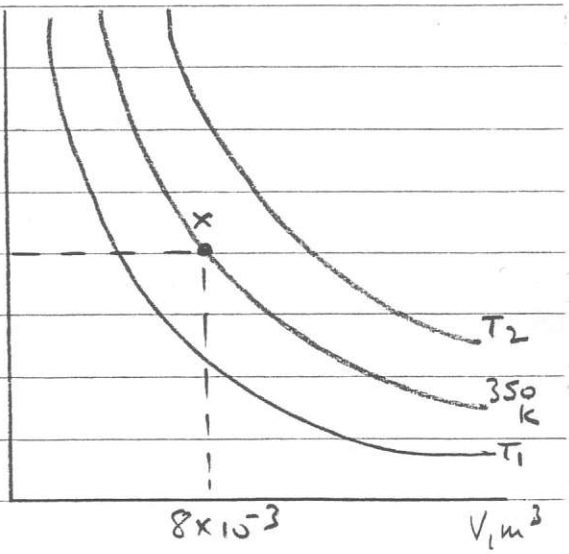
1. Write the 1st Law of Thermodynamics and explain the symbols (4)

2. Can you copy + fill in the table?

Gas process	P, V, T		Gas Law formula	1st Law of Thermodynamics
	constant	changing		
There's 4 of 'em!			eg... $P_1V_1 = P_2V_2$	eg $\Delta U = 0$ so....

(lots)

3. A fixed mass of gas is at X on the pV graph. This question is about the 4 gas processes, starting from X.



a) Isothermal expansion to $12 \times 10^{-3}\ m^3$
- State the final values of P, V, T (4)
- change in internal energy? (1)
- estimate work done by gas? (harder) (2)

b) Isovolumetric heating to 450 K
- final values of P, V, T ? (4)
- work done by / on gas ? (1)

c) Adiabatic cooling to $12 \times 10^{-3}\ m^3$ and 300 K
- final values of P, V, T ? (2)

d) Isobaric compression to $5 \times 10^{-3}\ m^3$
- final values of P, V, T ? (4)
- work done a gas ? (2)

e) Copy the graph - draw + label processes (a) - (d) (4) [24]

Thermodynamics – 4 gas processes

Answers

A Phys 1.1

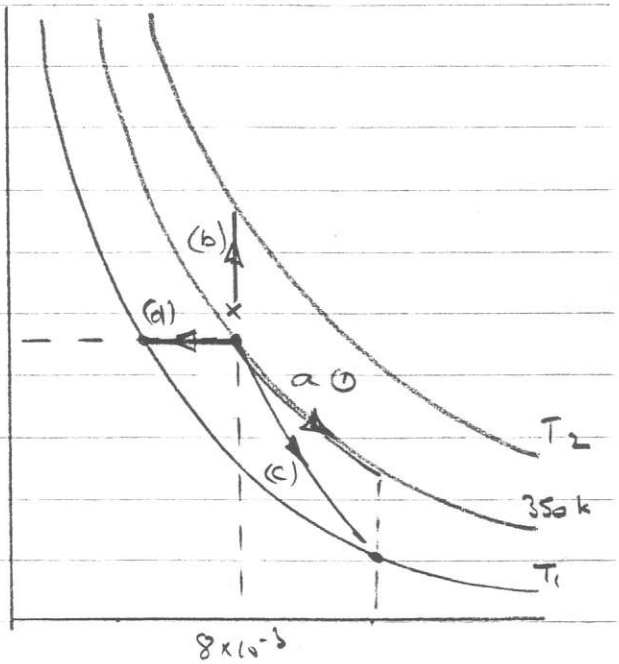
1. Um... er... $\Delta U = Q + W$ ①
   - ΔU: change in ① internal energy, J (≈ av. mol. speed)
   - Q: heat energy... ① given to gas (>0); taken from gas (<0) (4
   - W: ① work done on gas, J (on gas > 0; by gas < 0)

2.

	process	const.	changes	formula (or $PV = k$)	1st Law...
1.	Isothermal	T	P, V	$P_1V_1 = P_2V_2$	$\Delta U = 0$, so $Q = -W$ ②
2.	Isovolumetric	V	P, T	$P_1/T_1 = P_2/T_2$	$W = 0 = P\Delta V$; so $\Delta U = Q$ ②
3	Isobaric	P	V, T	$V_1/T_1 = V_2/T_2$	$\Delta U = Q + W$. ②
4	Adiabatic	none	all	$P_1V_1/T_1 = P_2V_2/T_2$	$\Delta U = Q + W$. ②

each line complete for 2 : each error −1 [8]

3. Here's the graph, part (e) at the start, to show how things fit.



a) Isothermal – along 350 k line

$V \to \frac{3}{2}V$ so $P \to \frac{2}{3}P$ = 200 kPa ①

$V_2 = 12 \times 10^{-3}\ m^3$ ① $T_2 = 350$ k !! ① /4

$\Delta U = 0$ J – same temp ! ①

ΔW = area ① under $\approx 250 \times 10^3 \times 4 \times 10^{-3} = 1000$ J ① [7]

b) Isovolumetric....

$T_2 \to \frac{450}{350}T_1$ so $P_2 \to \frac{450}{350}P_1$ = 386 kPa

$V_2 = 8 \times 10^{-3}\ m^3$ ① and $T_2 = 450$ k ① /4

$\Delta V = 0$ so $W = P\Delta V = 0$ J ① [5]

c) Adiabatic.... $P_1V_1/T_1 = P_2V_2/T_2$ ① $\to P_2 = P_1 \times V_1/V_2 \times T_2/T_1$ = 171 kPa ①

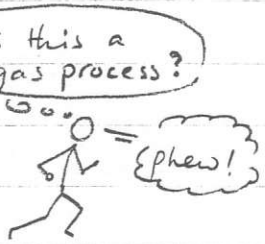
$V_2 = 12 \times 10^{-3}\ m^3$ $T_2 = 300$ k /2 [2]

d) Isobaric.... $V \to \frac{5}{8}V_1$ so $T \to \frac{5}{8}T_1$ = 219 k ①

$P_2 = 300$ kPa ① and $V_2 = 5 \times 10^{-3}\ m^3$ ① /4

work done = area ① under (d) = $P\Delta V = 300 \times 10^3 \times 3 \times 10^{-3} = 900$ J ① /2 [6]

e) ① each for (a) – (d) [4]



TN 4.99

Q... 1 2 3

out of /4 /8 /24