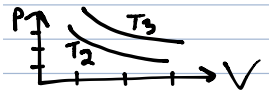
ch 03 so.html 1. T increase
2. P increase (isovolumetric)
3. isothermal expansion
4. phase change

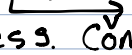
PV diagrams



Isotherms: T = constant PV = constant $T_3 > T_2$

curves look like $y = \frac{1}{x}$ which makes sense since

$p \propto \frac{1}{V}$

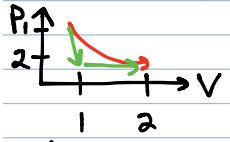
if V = constant, then a PV diagram looks like 

An automobile is also a thermodynamic process. Consider a piston

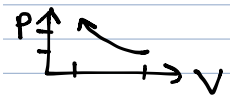
combustion raises T, P V↑ gases do work on piston

$dW = F \cdot dx = pA \cdot dx = p\,dV$

$W = \int dW = \int_{V_1}^{V_2} p\,dV$

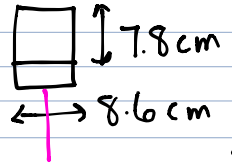


Work depends on path! The two areas under the curves differ



gas does "negative" work on the piston (piston does positive work on the gas)

example A Porsche Boxster has a 6-cylinder engine with a stroke length of 7.8 cm, a bore (cylinder diameter) of 8.6 cm, a total volume of 2687 cm^3, and a compression ratio of 11.3:1. Find the horsepower @ 7200 rpm



$W = \int p\,dV = \int \frac{NkT}{V} dV \approx NkT_1 \int \frac{dV}{V} = NkT_1 \ln V_2/V_1$

$= P_1 V_1 \ln V_2/V_1$

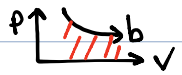
Suppose $P_1 = 1.01 \cdot 10^5$ Pa, $T_1 = 300$ k, $V_1 = 2687 cm^3$

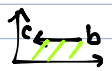
$\rightarrow W = 660 \frac{J}{\text{Stroke}} \cdot \frac{7200 \text{ rev/min}}{60 \text{ sec/min}} = 7.8 \cdot 10^4$ J/s

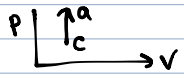
$= 106$ hp 1 hp = 746 w

(reality 245 hp)

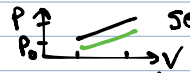
a

Gas expands  work done is positive (area under curve)

Gas contracts  Work done to compress gas (negative of area under curve is gas' work)

P increased w/out changing V  no work done by (or on) gas

Total work done by the gas is positive, since $W_{ab} + W_{bc} + W_{ca} > 0$

S3.html  sea level more work at sea level

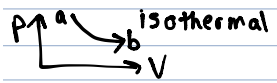
S2.html rankings high to low 1B, L, 1T, A, 1V

1st Law of Thermo

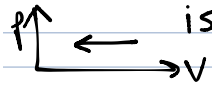
$\Delta U = Q - W$ where ΔU is the internal energy (KE + PE) of a system

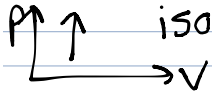
adding heat Q increases U

doing work W decreases U

 isothermal T = constant $\Delta U = 0$ since $U \sim \frac{3}{2} NKT$

$\rightarrow Q = W$ (and since $W > 0$ then $Q > 0$)

 isobaric Volume decreases $\rightarrow$ W by gas is < 0 e.g. cool a balloon w/LN_2

 isochoric no change in V $\Rightarrow W = 0 \Rightarrow \Delta U = Q$

e.g. heat a sealed box

S3.html Why does the propane canister get frosted?

escaping liquid propane phase transitions to a gas, which requires energy (from the canister)

S4.html  $|W_{top\ part}| > |W_{bottom\ part}|$ and $W_{top} > 0$

1 (A)

2 (B)

3 (A)

4 (A)

5. (C) $\Delta U = Q - W$

$U \sim \frac{3}{2} NkT \qquad \Delta U \sim \Delta T$

For a complete loop,

$P_i V_i = P_f V_f \Rightarrow T_i = T_f$

6. (A) $\Delta U = 0$ for the same reason as for #5

$\rightarrow \Delta U = Q - W = 0$

$\rightarrow Q = W$

7 (B) same kind of reasoning...

8 (A) $|Q|_I > |Q|_{II}$ and $Q_I > 0$