- the internal energy of the ideal gas can't change.

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

- adiabatic processes → no heat is allowed to flow in or out of the system, but the gas can be expanded or be compressed.

$\Delta U = -W$

↳ work done by the system

↳ internal energy of a closed system

▷ 2nd Law of Thermodynamics

Heat will spontaneously flow from something hotter to something colder, but it won't flow from something colder to something hotter.

↳ because of entropy → which is the ~~[illegible]~~ inherent disorder of a system. The more disordered the system, the higher its entropy.

- If the entropy in a system decreasses, that means ~~that~~ the entropy of the environment around the system must increase enough to compensate

↳ there's an overall increase in entropy of the universe.

- when the molecules are different temperatures → orderly arrangement
- when their temperatures become equal → the neat organization is gone hence the increase of entropy.

Homework 1

1 (a), (e) & (g) are in equilibrium.

(a) There is no mass or heat transfer through the piston; hence each part is in equilibrium within their respective subsystem.

(e) The pressure & temperature of the system are the same.

(g) There is no change in the rate of dissolution.

2 Yes, as the conservation of energy (a.k.a. 1st Law of thermodynamics) does not allow systems to produce work without any energy.

3 $E_{in} = 100\,kW$; $E_{lost} = 3\,kW$

$$E_{stored} = E_{in} - E_{lost}$$
$$= 97\,kW$$

where: $kW = \frac{kJ}{s}$

$t = 6\,hr = 21\,600\,s$

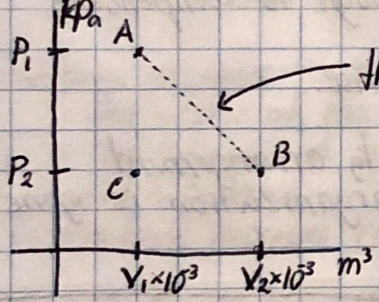
$$e_{stored} = E_{stored} \cdot t$$
$$= 2\,095\,200\,kJ$$

After 6hr of operation, 2 095 200 kJ of energy have been stored.

4 $P_1V_1 = P_2V_2$, @constant temperature

$$200\,kPa\,(10\,L) = P_2\,(25\,L)$$
$$P_2 = 80\,kPa$$

(a) The pressure in the balloon is 80 kPa when its volume is 25 L.



the process.

work done = area under ABCD

$1m^3 = 0.001\,L$

$$Work = \left[\frac{1}{2}(P_1 - P_2\,kPa)(V_2 - V_1\,m^3) + (P_2\,kPa)(V_2 - V_1\,m^3)\right]\times10^{-3}$$
$$= \left[\frac{1}{2}(120\,kPa)(15\,m^3) + (80\,kPa)(15\,m^3)\right]\times10^{-3}$$
$$= \left[2100\,kPa\,m^3\right]\times10^{-3}$$
$$= 2.1\,kJ$$

$Pa = \frac{kg}{m\,s^2}$ & $J = \frac{kg\,m^2}{s^2}$

(b) The work done by the balloon envelope is 2.1 kJ.

$\boxed{5}$

(a) True. The gas volume decreases with an increase in gas compression.

(b) False. When the gas expands (higher pressure to a lower pressure) the system's energy decreases.

(c) Sometimes True. the work is zero for reversible adiabatic cycles. Irreversible adiabatic cycles will produce some kind of work

(d) Sometimes True. the work is zero for reversible adiabatic cycles. For any other form of cycle, it will not be zero.

(e) True. The change in pressure depends on the work; and the change in energy depends on the change in pressure.

(f) False. Same explanation as (e). The container's shape is not germane.

$\boxed{6}$ $U = A + BPV$; where U = specific energy
$A = 60\ kJ/kg$
$B = 8$
$P = kPa$
$V = m^3/kg$ $\longrightarrow$ also...

78 kJ/kg

$P_1 = 1.5\ MPa$
$V_1 = 60\ L$
$V_2 = 150\ L$

For adiabatic processes, $\Delta U = -W$; also from $U = A + BPV$ we can determine:

$\Delta U = B(P_2V_2 - P_1V_1)$; and

$$W = \frac{P_2V_2 - P_1V_1}{\gamma - 1}$$, where: W = work done & γ = heat capacity ratio.

$$\text{So: } +B(P_2V_2 - P_1V_1) = \frac{P_2V_2 - P_1V_1}{\gamma - 1}$$

$$\gamma = 1.125$$

For adiabatic processes,

$$W = \int_{V_1}^{V_2} P\,dV = \int_{V_1}^{V_2} \frac{k}{V^{\gamma}}\,dV = k\left[\frac{V^{(1-\gamma)}}{1-\gamma}\right]_{V_1}^{V_2}$$

$$W = P_1 V_1^{\gamma}\left[\frac{V^{(1-\gamma)}}{1-\gamma}\right]_{V_1}^{V_2}$$

$$W = \frac{P_1 V_1^{\gamma}}{1-\gamma}\left[V_2^{(1-\gamma)} - V_1^{(1-\gamma)}\right]$$

$$W = \frac{(1.5\times10^{6})(60\times10^{-3})^{1.125}}{1-1.125}\left[150\times10^{-3\,(1-1.125)} - 60\times10^{-3\,(1-1.125)}\right] \text{ Pa m}^3$$

$W = 77\,918.739$ J
is the work done by the system

$Pa = \frac{Kg}{ms^2}$ & $J = \frac{Kg\,m^2}{s^2}$