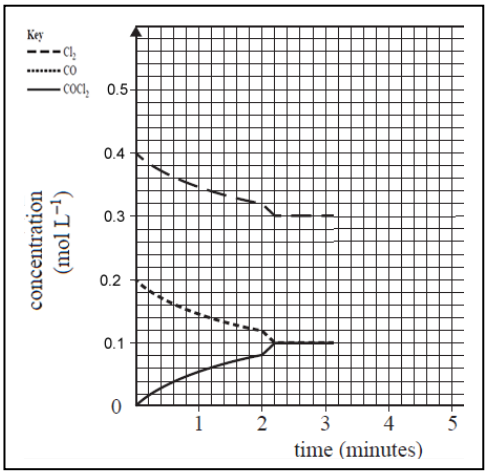
Revision lesson 2 –Equilibrium, enthalpy and organic chemistry

1) A chemist injected 0.20 mol carbon monoxide gas, CO, and 0.40 mol chlorine gas, Cl2, into a previously evacuated and sealed 1.0 L flask. At that instant, the following reaction began to occur.

$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$ $\Delta H = -108$ kJ mol^{-1}



The concentrations of the three species present in the flask were monitored over time. The flask was held at a constant temperature. The concentration–time graph shown on the right was obtained.

a) A sudden change to the system was made at the 2 minute mark. Consider the following possibilities and discuss which of the following would have caused the change. Give an explanation for each.

1. a catalyst was injected into the flask.
It is possible that a catalyst caused the acceleration of the reaction as it accelerated the reaction towards equilibrium.
2. the volume of the flask was increased.
increasing the volume of the flask would have resulted in all concentrations spontaneously decreasing. This is not shown.
3. helium, an inert gas was injected into the flask.
adding helium gas does not change the rate of the reaction.
4. some of the gas mixture was removed from the flask.
removing gas should decrease the concentration of all species.

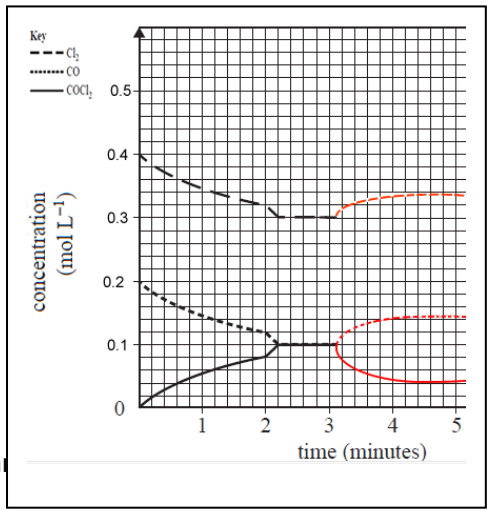
b) Calculate the magnitude of the equilibrium constant for the reaction at this particular temperature.

$[COCl_2] / [CO][Cl_2] = [0.1] / [0.1][0.3] = 3.33M^{-}=3M^{-}$ (1 sig fig)

c) The equilibrium system was suddenly heated, at constant volume, at the three-minute mark. Draw the changes that would occur on the graph above.

A net backward reaction would occur. $[COCl_2]$ would decrease while $[Cl_2]$ and [CO] would increase.

d) Describe the changes to the magnitude of the equilibrium constant that would take place after the system was heated and kept at this new temperature. *The magnitude would decrease as the reaction would drive in the backward direction to reach a new equilibrium position.*



2) Oxygen gas can be regenerated from carbon dioxide a
the equation below.

$$12CO_2(g) + 14H_2O(g) \rightarrow 2C_6H_{14}(g) + 19O_2(g) \quad \Delta H = ?$$

Given the following information answer the questions listed.

$$C_6H_{14}(g) + \frac{19}{2}O_2(g) \rightarrow 6CO_2(g) + 7H_2O(g) \quad \Delta H = -4158 \text{ kJ mol}^{-1}$$

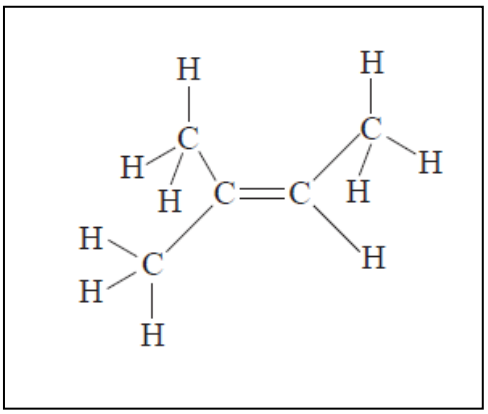
a) Calculate the *ΔH* for the equation above.
Don't forget. When the equation is reversed the ΔH changes sign. If the equation is doubled so does the ΔH double.
ΔH = +4158 X 2 = +8316 kJ/mol

b) How much energy, in kJ, is used or released if a mass of 50.00 kg of oxygen gas is to be supplied to the station? Give the answer to the right number of significant figures.
Step 1 calculate the mol of oxygen gas
=> 5.0000 X 10^4 / 32.0 = 1563
Step 2 calculate the energy needed to produce 1563 mol of oxygen gas.
=> 19/8316 = 1563 / x kJ/mol
=> x kJ/mol = 1563 X 8316 / 19 = 6.84 X 10^5 kJ/mol

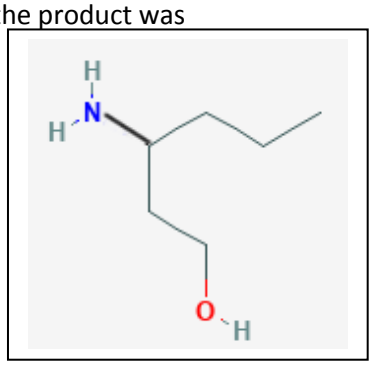
3) Consider the molecules shown on the right.
a) Name the molecule *2-methylbut-2-ene*

b) Draw the structural isomers of this molecule and name each one.

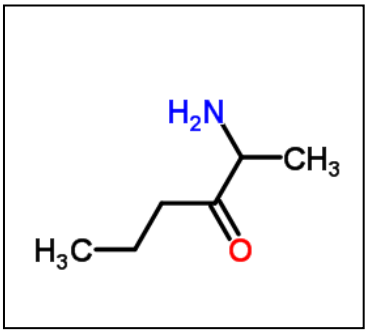
pent-2-ene, pent-1-ene,
2-methylbut-1-ene, 3-methylbut-1-ene



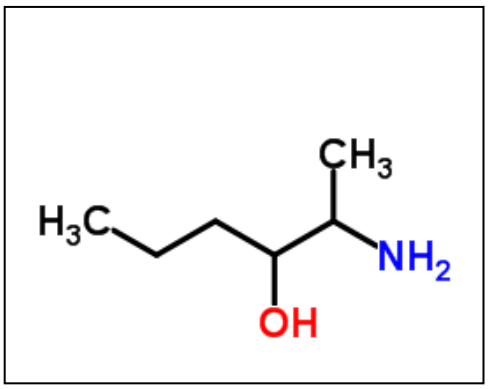
4) An unknown alcohol was placed in an acidified solution of $K_2Cr_2O_7$.
a) Draw the structure of the alcohol and name it if the product was 3-aminohexanoic acid
3-aminohexan-1-ol



b) Another unknown alcohol was also placed in an acidified solution of $K_2Cr_2O_7$ and the molecule shown on the right was produced.
Name the alcohol used and give its semi-structural formula.



2-aminohexan-3-ol



5) Ethanol is produced by yeast according to the equation below.

$C_6H_{12}O_6(aq) \rightarrow 2C_2H_6O(aq) + 2CO_2(g)$.

a) Calculate the percentage atom economy for this reaction.

% atom economy = (mass of desired product / mass of reactants) X 100
=> (2 X 46 / 180) X 100 = 51%

b) 36.00 grams of glucose was placed in a 1.0 L reaction vessel with yeast. After three days the production of carbon dioxide gas had ceased, at which point the concentration of ethanol in the vessel 0.300 M.
Calculate the percentage yield for this reaction.
Step 1 find the mol of glucose
=> 36.0 / 180 = 0.20
Step 2 find the theoretical yield, in mol of ethanol
=> 2 X 0.20 = 0.40
Step 3 find the % yield.
=> (Actual amount of product / theoretical amount of product) X 100
=> 0.300 / 0.40 = 75% yield.