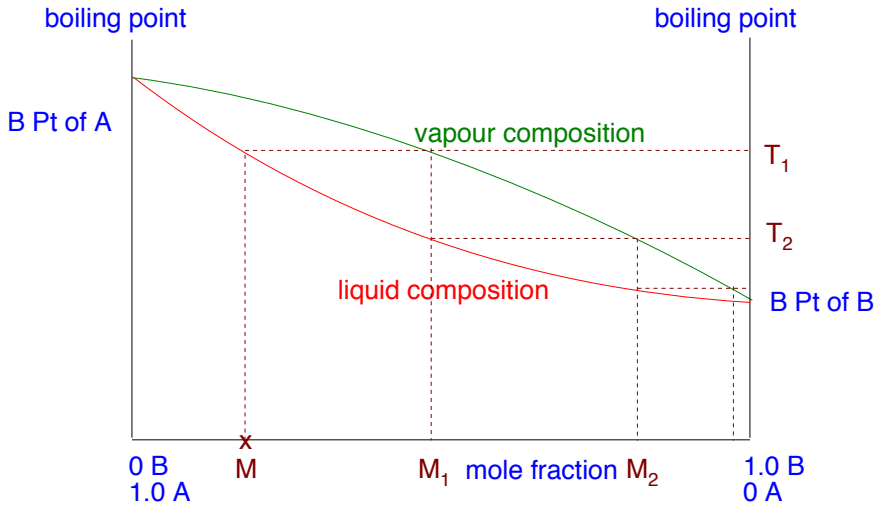
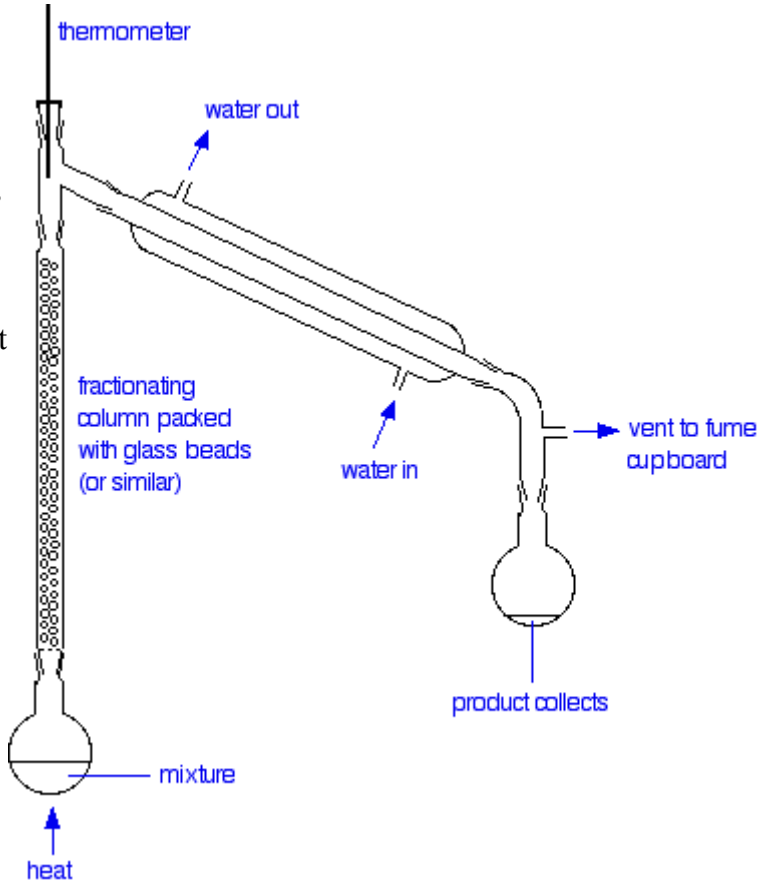
FRACTIONAL DISTILLATION OF IDEAL MIXTURES OF LIQUIDS

1. If you boil the mixture M, it will boil at a temperature T_1. The vapour above the liquid at this temperature will be richer in the more volatile substance B. If you condense that vapour, it will give a liquid of the composition M_1.



If you reboil that, it will boil at a temperature T_2. The vapour over that liquid will have a composition M_2, still richer in B. If you go on doing that, reboiling and recondensing, then the vapour becomes richer and richer in B until it eventually becomes pure B. When you finally get to that point and condense the vapour, then you will have pure B liquid.

2. a)



Make sure that you have drawn a proper cross-section. There should be a free path through the entire apparatus with no barriers.

Make sure that your apparatus isn't totally sealed. There has to be a vent at the right-hand side

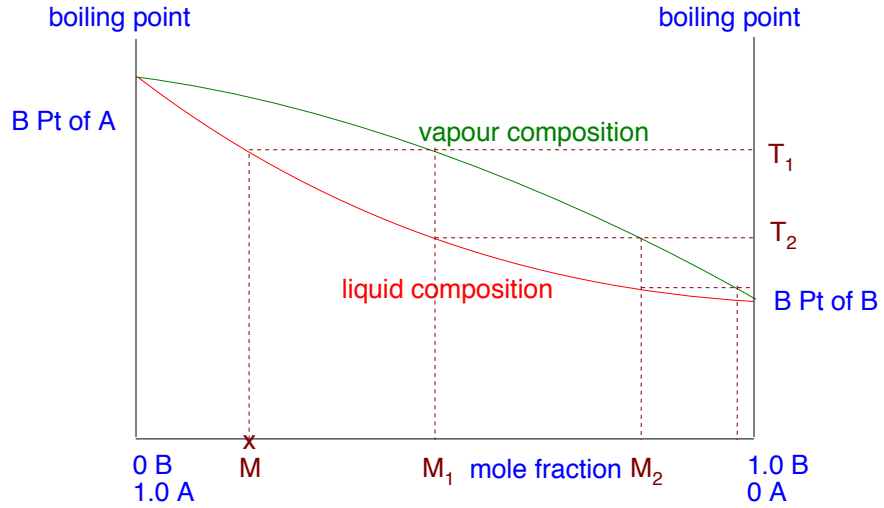
Make sure that your thermometer bulb is exactly level with the top outlet of the column.

If you have used a column with some other sort of packing, then that's fine, as long as you have shown it.

b) You have to be sure that only the vapour of the more volatile of the two liquids passes into the condenser. That means that the thermometer has to read exactly the boiling point of the more volatile liquid.

If it is below that, then nothing is going to pass out into the condenser. If it is above that, then your distillate will still contain some of the less volatile component.

c) Re-using the diagram from Q1:



B is the more volatile liquid; A is the less volatile one.

The vapour over the boiling liquid in the flask will be richer in B than the original liquid is. That vapour will pass up the column until the temperature falls enough for it to condense to give a liquid richer in B than the one in the flask (equivalent to M_1 in the diagram). This will start to trickle down the column.

Hot vapour coming up from the flask will reboil the condensed liquid, giving a vapour which will be even richer in B (M_2 on the diagram). This will condense to a liquid, trickle down the column and then be reboiled .

This continuous process will go on until the vapour is entirely B. The column is heated so that this is finally complete right at the top of the column.

Meanwhile, the liquids trickling down the column get richer and richer in A as the B is removed and carried up the column. Eventually, the liquid in the flask will end up as pure A.

(You could do this perfectly well without a diagram. I am re-using it partly to just reinforce your learning!)

3. Just as with a lab fractionating column, the temperature falls as you go higher. Some of the vapour at each height will condense on the trays. The hot vapour rising through the bubble caps will reboil this, and the new vapour will be richer in the more volatile component than before.

The liquid left on the tray is richer in the less volatile component, and this will overflow back down to the tray underneath, where it will be reboiled by new hot vapour.

So, by repeated condensing and reboiling, the more volatile component will rise to the top of the column, and the less volatile one will flow to the bottom.

Alternatively, for a larger mixture of components, like crude oil, you can tap off the contents of trays at various heights in the column. This allows you to collect mixtures of compounds with similar boiling points, such as gasoline, kerosine, and so on, rather than doing a complete separation.