ALKENES: REACTIONS WITH POTASSIUM MANGANATE(VII)

1. a) (i) purple solution becomes colourless

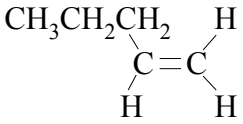
(ii) purple solution gives a very dark green solution followed by a dark brown precipitate.

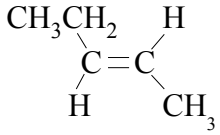
b) ethane-1,2-diol (or give the structural formula $HOCH_2CH_2OH$ – or a displayed version of this)

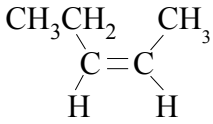
c) $CH_3CH{=}CH_2 + H_2O + [O] \longrightarrow CH_3CH(OH)\text{-}CH_2(OH)$

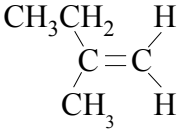
(The bond drawn between the two carbons in the product is just to spread the molecule enough so that the two OH groups don't overlap in the drawn structure. You could equally well draw the second OH group in line with the carbon chain.)

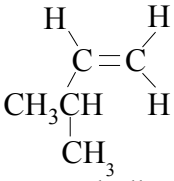
2. Potassium manganate(VII) is a powerful enough oxidising agent to oxidise any number of different organic compounds, and so the colour change wouldn't be specific to alkenes. It would be impossible to say that, because the solution changed colour, it must be an alkene.

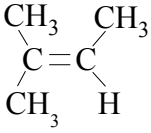
3. 
pent-1-ene


trans-pent-2-ene


cis-pent-2-ene


2-methylbut-1-ene


3-methylbut-1-ene

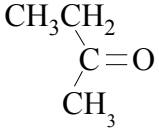

2-methylbut-2-ene

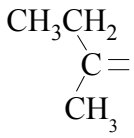
There are two ways you could work this out. You could start from the alkene, and work out what products would be formed and then match that against the results. Or you could start from the results and then work back to the formula of the alkene.

I am going to use the second method, because it is the way you would have to do it if you weren't given the possible formulae.

Result A: a ketone with the molecular formula C_4H_8O and the gas CO_2

CO_2 comes from a $=CH_2$ group.

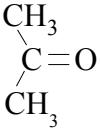
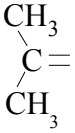
Ketones contain a C=O bond with two alkyl group attached. In this case, that must be 

That would have come from the group 

The original alkene must be 2-methylbut-1-ene. There are no other possibilities which would split in this way.

Result B: a carboxylic acid CH_3COOH and a ketone C_3H_6O.

The carboxylic acid comes from a carbon in the double bond with a single hydrogen on it and an alkyl group. In this case, it must be $CH_3CH=$.

The ketone comes from a carbon in the double bond with two alkyl groups attached. In this case that must be  coming from the group 

The original alkene must be 2-methylbut-2-ene. There are no other possibilities.

Result C: a carboxylic acid C_3H_7COOH and the gas CO_2.

The carboxylic acid comes from a carbon in the double bond with a single hydrogen on it and an alkyl group. In this case, it must be $C_3H_7CH=$, and the CO_2 comes from $=CH_2$.

The original alkene must be $C_3H_7CH=CH_2$. If you look back at the list, there are two alkenes which have this formula – pent-1-ene and 3-methylbut-1-ene.

Result D: two carboxylic acids C_2H_5COOH and CH_3COOH.

On the same logic as before, C_2H_5COOH came from $C_2H_5CH=$, and CH_3COOH came from $CH_3CH=$. The alkene was therefore $C_2H_5CH=CHCH_3$. There are two isomers which have that have that structure: cis- and trans-pent-2-ene.

(If you are near the beginning of an organic chemistry course, and have found this confusing because of the new types of compound that you have to deal with (ketones and carboxylic acids), I would suggest that you leave it for now, but make a note to come back to it after you have done some more organic chemistry. But don't forget! If it is on your syllabus, you will need to be able to solve problems of this sort.)