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 HOCH₂CH₂OH – or a displayed version of this)

   c) \[ \text{CH}_3\text{CH}=\text{CH}_2 + \text{H}_2\text{O} + [\text{O}] \rightarrow \text{CH}_2\text{CH}-\text{CH}_2 \]

   (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. 

   \[ \begin{array}{c}
   \text{CH}_3\text{CH}=\text{CH}_2 \\
   \text{pent-1-ene} \\
   \text{CH}_3\text{CH}=\text{CH}_2 \\
   \text{2-methylbut-1-ene} \\
   \text{CH}_3\text{CH}=\text{CH}_2 \\
   \text{3-methylbut-1-ene} \\
   \text{CH}_3\text{CH}=\text{CH}_2 \\
   \text{2-methylbut-2-ene} \\
   \end{array} \]

   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 \( \text{C}_4\text{H}_8\text{O} \) and the gas \( \text{CO}_2 \)

   \( \text{CO}_2 \) comes from a \( =\text{CH}_2 \) group.

   Ketones contain a \( \text{C}=\text{O} \) bond with two alkyl group attached. In this case, that must be

   \[ \begin{array}{c}
   \text{CH}_3\text{CH}_2 \\
   \text{C}=\text{O} \\
   \text{CH}_3 \\
   \end{array} \]
Chemguide – answers

That would have come from the group

\[
\begin{array}{c}
\text{CH}_3 \\
\text{C} \\
\text{CH}_3
\end{array}
\]

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 \( \text{CH}_3\text{COOH} \) and a ketone \( \text{C}_3\text{H}_6\text{O} \).

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 \( \text{CH}_3\text{CH}=- \).

The ketone comes from a carbon in the double bond with two alkyl groups attached. In this case that must be \( \text{CH}_3 \)
\[
\begin{array}{c}
\text{C} \\
\text{CH}_3
\end{array}
\]

coming from the group
\[
\begin{array}{c}
\text{CH}_3 \\
\text{C} \\
\text{CH}_3
\end{array}
\]

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

Result C: a carboxylic acid \( \text{C}_3\text{H}_7\text{COOH} \) and the gas \( \text{CO}_2 \).

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 \( \text{C}_3\text{H}_7\text{CH}=- \)
\[
\begin{array}{c}
\text{C} \\
\text{CH}_3
\end{array}
\]

and the \( \text{CO}_2 \) comes from \( \!=\text{CH}_2 \).

The original alkene must be \( \text{C}_3\text{H}_7\text{CH}==\text{CH}_2 \). 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 \( \text{C}_2\text{H}_5\text{COOH} \) and \( \text{CH}_3\text{COOH} \).

On the same logic as before, \( \text{C}_2\text{H}_5\text{COOH} \) came from \( \text{C}_2\text{H}_5\text{CH}=- \), and \( \text{CH}_3\text{COOH} \) came from \( \text{CH}_3\text{CH}=- \). The alkene was therefore \( \text{C}_2\text{H}_5\text{CH}==\text{CHCH}_3 \). 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.)