Chemguide – answers

ALDEHYDES AND KETONES: INTRODUCION

1. a) A: ketone butanone (You could call this butan-2-one (and lots of people do!), but the "2" is actually unnecessary. There is no other isomer of butanone which is also a ketone.)

   B: aldehyde propanal

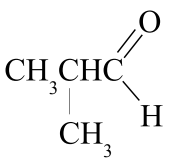
   C: ketone: pentan-3-one

   D: aldehyde: pentanal

   E: aldehyde: 2-methylpentanal

   b) (i) $CH_3CH_2CH_2CHO$ (or show the aldehyde group in full as in B in part (a))

   (ii) $CH_3COCH_2CH_2CH_3$ (You could equally well have flipped this over end-to-end so that the CO group is next to the right-hand CH_3 group. Or you could have drawn it as in A in part (a), with a CH_3 and a $CH_3CH_2CH_2$ group attached to the CO group.)

   (iii) 

   (or you could just show the aldehyde group as CHO)

2. a) There is a high degree of separation of charge on the C=O bond with the carbon atom being quite positive and the oxygen quite negative. This is because oxygen is more electronegative than carbon and so draws bonding electrons towards itself.

   b) (i) A nucleophile is a negatively charged ion or a molecule with a fairly negatively charged part such as the lone pair of electrons on a nitrogen atom in ammonia.

   (ii) Nucleophiles are attracted to positively (or slightly positively) charged parts of other species (molecules or ions). In this case, they would be attracted to the fairly positively charged carbon atom in the C=O bond.

3. Oxidising agents oxidise a hydrogen attached to the carbon-oxygen double bond. So, for example, the hydrogen in ethanal, CH_3CHO, is oxidised to an OH group to give ethanoic acid, CH_3COOH. Ketones don't have a hydrogen attached to the C=O bond and so this can't happen.

4. a) They have similar lengths and numbers of electrons and so the dispersion forces between the molecules will be similar.

   b) The alkane only has dispersion forces between its molecules, but the aldehyde has permanent dipole-dipole attractions as well.

c) The alcohol has dispersion forces and dipole-dipole attractions, but also has hydrogen bonds between its molecules.

d) Aldehydes and ketones can't hydrogen bond with themselves, because they don't have a hydrogen atom attached directly to a very electronegative atom. But they can hydrogen bond with water molecules, forming a hydrogen bond between a lone pair on the oxygen and the fairly positively charged hydrogen on a water molecule. So when you mix a small aldehyde or ketone with water, you have to break hydrogen bonds between the water molecules, but they are replaced by similar bonds involving the aldehyde or ketone.

In the case of an alkane, you don't get hydrogen bonds between it and water, and so the hydrogen bonds in the water can only be replaced by much weaker dispersion forces. It isn't energetically profitable to do this.

e) As the chains get bigger, you have to break more hydrogen bonds in the water to fit the aldehyde or ketone between the water molecules, but you only get one hydrogen formed in exchange. Mixing becomes less energetically profitable.