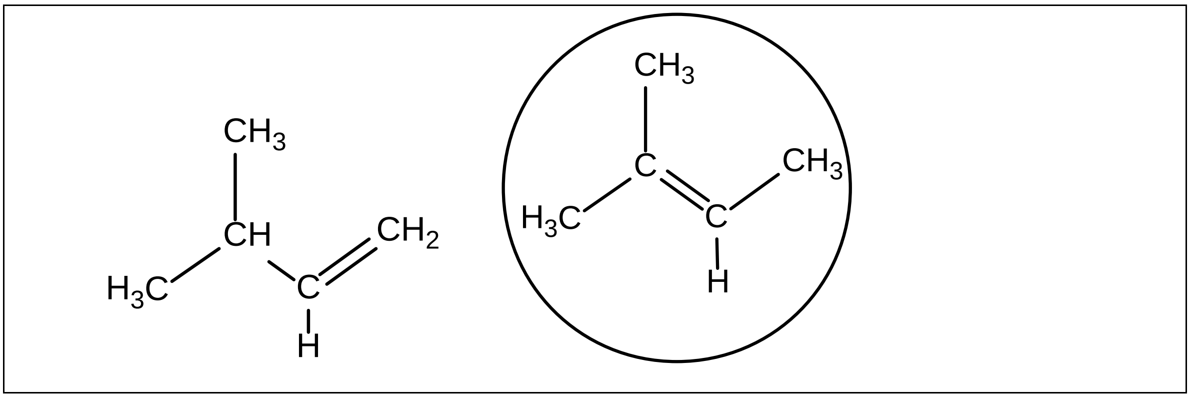
(ii) Draw the structures of alkenes produced when the secondary chloroalkane from part (i) reacts with KOH in ethanol.



2 marks

(iii) Circle the alkene from part (ii) above that is formed in the greatest amount. Justify your answer.

The H is removed from the C atom (adjacent to the C carrying the OH) with the least number of H atoms attached

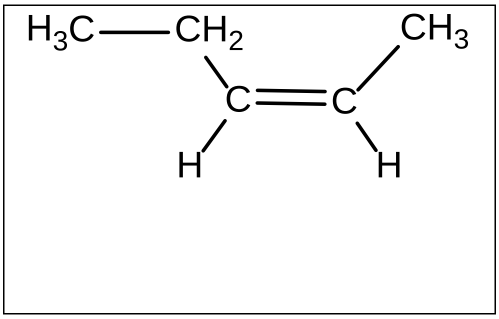
1 mark for selecting correct isomer

1 mark for explanation BUT second mark only possible if correct isomer circled

QUESTION TWO (4 marks)

There are five C_5H_{10} constitutional (structural) isomers that are alkenes.

(a) One of the five alkenes exists as cis-trans stereoisomers. Draw the structure of the cis isomer of this alkene.



1 mark

(b) Explain why the alkene in part (a) exists as cis-trans isomers whereas the isomeric alkene that has the same carbon skeleton does not.

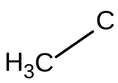
Both alkenes have a double bond which limits the rotation around the bond. ½ mark

The alkene above has 2 different groups attached the C atom at each end of the double bond whereas the pent-1-ene isomer has 2 H atoms on the atom at one end of the double bond

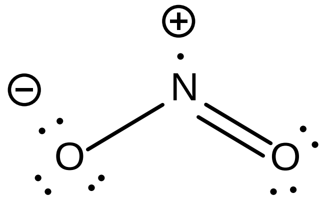
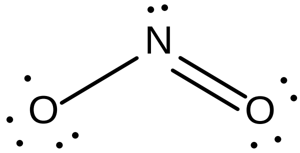
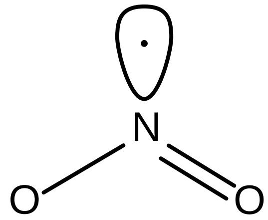
1/2 mark

(c) Two C_5H_{10} alkenes have the same carbon skeleton, but neither exists as cis-trans isomers. One of these reacts with HCl to form a tertiary chloroalkane as the major product.

(i) Draw the structure of this alkene;



(c) (i) Draw TWO Lewis structures for nitrogen dioxide (NO_2) and the 3-dimensional molecular shape for one of these.

 1 mark – any shape	 1 mark any shape	V-shape  1 mark – does not need to show single electron on N

(ii) The "formal charge" is the number of valence electrons in the atom, minus the number of lone pair electrons at that atom in the Lewis structure, minus the number of bonds to the atom in the Lewis structure. Formal charge can be used to help explain where electrons are likely to be found on atoms in a molecule. Identify your structure in part (i) that formal charge suggests is most likely.

The <u>second structure</u> (with zero formal charges is most likely on this basis)

1 mark -correct structure identified (does not need to justify)

(iii) The O-N-O bond angle is actually 134.3°. Does this value support your proposed Lewis structure? Justify your answer.

<u>No.</u> The <u>second structure should have a bond angle less than 120°</u> whereas the <u>first structure should have a bond angle much greater than 120°</u> because of the <u>lower electron-electron repulsion between the unpaired electron and the N–O bonding electrons</u>.

1 mark for No,

1 mark for comparing bond angles

1 mark for linking to lower repulsion between unpaired e and bonded pairs (compared to non-bonding pair and bonded pairs)

QUESTION SIX (10 marks)
Silver nitrate is used in volumetric analysis to determine the concentration of chloride ions in an aqueous solution. Because of the high cost of $AgNO_3$, a student uses an available supply of 0.0500 mol L^{-1} $AgNO_3$ solution and some solid $AgNO_3$ to prepare 100.0 mL of 0.0750 mol L^{-1} $AgNO_3$. She prepares the solution by:

(i) pipetting exactly 50.00 mL of the 0.0500 mol L^{-1} $AgNO_3$ solution into a 100.0 mL volumetric flask;
(ii) adding an appropriate mass of $AgNO_3$;
(iii) diluting the solution to exactly 100.0 mL.

(a) What mass of $AgNO_3$ should be added in step (ii)? [$M(AgNO_3)$ = 169.9 g mol^{-1}]

$n(Ag^+)$ in final solution = 0.100 L x 0.075 mol L^{-1} = 0.00750 mol ***1 mark***

$n(Ag^+)$ pipetted = 0.0500 L x 0.0500 mol L^{-1} = 0.00250 mol ***1 mark***

$n(AgNO_3)$ needing to be added = 0.00750 mol – 0.00250 mol = 0.00500 mol ***1 mark***

$m(AgNO_3)$ = 0.00500 mol x 169.9 g mol^{-1} = 0.8495 g ***1 mark***

(b) Solid $MgCl_2$ (0.100 g) was then added to the solution. Assuming no change in the total volume, what i

QUESTION SEVEN (7 marks)

The Kjeldahl method can be used to determine the percentage of nitrogen in meat and other organic products. A 0.0986 g sample was heated with concentrated sulfuric acid for two hours to oxidise organic matter and convert all nitrogen to ammonium ions. The solution was then made strongly basic by adding excess sodium hydroxide solution producing ammonia. The ammonia was then distilled into 50.00 mL of 0.1010 mol L^{-1} HNO_3. Exactly 23.45 mL of 0.1500 mol L^{-1} NaOH was required to neutralise the excess acid.

Calculate the amount (moles) of NH_3 that was distilled into the HNO_3 and hence determine the percentage of N in the original sample.

n(HNO_3) added = 0.0500 L x 0.10Tm (t4dol)-2( )

QUESTION ELEVEN (13 marks) ***Change to 11 marks***

When aqueous ammonia is added drop-wise to a copper sulfate solution, a blue solid of copper hydroxide forms. As further ammonia is added, the solid redissolves and a dark blue solution forms.

The following equilibria explain these observations:

A: $Cu(OH)_{2(s)}$ ¡ $Cu^{2+}_{(aq)} + 2OH^{-}_{(aq)}$

B: $Cu^{2+}_{(aq)} + 4NH_{3(aq)}$ ¡ $[Cu(NH_3)_4]^{2+}_{(aq)}$

(a) Give the equilibrium expression for each of these processes.

$K_A = [OH^-]^2[Cu^{2+}]$ *1 mark*

$K_B = [Cu(NH_3)_4{}^{2+}]/[Cu^{2+}][NH_3]^4$ *1 mark*

(b) Explain why copper hydroxide can form when ammonia is added.

Ammonia is a weak base and, in aqueous solutions, reacts with water to form a low concentration of OH^- (and $NH_4{}^+$). The OH^- reacts with Cu^{2+}

QUESTION TWELVE (6 marks) ***Change to 7 marks***

The average chemical formula for common diesel fuel is $C_{12}H_{26}$. Dodecane ($C_{12}H_{26}$) has an enthalpy of combustion of –8072 kJ mol^{-1} and a density of 0.745 g mL^{-1}

PERIODIC TABLE OF THE ELEMENTS