Candidate evidence

Question 4(d)

Candidate 1

Water has a pH of 7 and shows up as green on pH paper.

uric acid would would be acidic so push the pH down and turn pH paper towards red.

the pH would vary depending on what food and drink you have consumed recently and what affects this had on your body. Carboxylic acids would shift your urine to be more acidic. carbohydrates are not acidic so would be more alkali.

Candidate 2

- ~~Urine~~ Urine is most likely slightly acidic
- Due to the presence of acidic compounds such as creatinine and uric acid the Urine should be acidic
- there is a ~~no~~ large majority percentage of water (91% to 96%) therefore the acidic compounds will have been diluted therefore the urine will only be slightly acid, almost neutral

Candidate 3

The pH range of human urine is vast as it can contain salts.
Since the strength of the salt is dependent on the acid & based that makes it up.
E.g. a strong acid and weak base would make an acidic salt, and so if urine has a lot of acidic salt in it then it is going to be more acidic in pH.
The same goes for a weak acid & a strong base, making an alkaline salt. Meaning that if these were high amounts in urine then the urine is going to be more alkali in pH.

Candidate 4

The pH range of human are urine is most likely to be above pH or 7 or equal to 7 as urine contains organic solutes which are amines and amides, which are weak bases. Bases have a pH above 7:
Weak bases are bases that only dissociate partially in aqueous solutions.

Candidate 5

The amine groups in these compounds suggests it could be slightly acidic, considering if the ^-NH group were removed and a couple more H^+ groups were added to make it more acidic, you would end up with ammonia. (NH_4^+)

Although, it wouldn't be strong in its acidity as 91% – 96% is water, a neutral substance (pH 7.00), so even if there are a lot of acids present, they'll be greatly diluted.

The human diet will also affect this pH range, more acidic / basic foods will likely have that effect on urine. ← fruits / fizzy juice etc.

However, it is a range and as I have pointed out the possibility of ammonia, an ammonium ion is more likely considering not a lot of the NH groups are next to any double bonds, therefore with a K_a of 5.6×10^{-10} I would expect it to be somewhat basic.

The pH range could also be tested if this is correct with an an indicator like phenol red or azolitmin

(6.8 – 8.4) (4.5 – 8.3)

acid base acid base

Candidate 6

It is likely ~~a~~mine will be alkaline as the compounds shown above each have nitrogens with lone pairs of electrons. so will act as bases.

For example in urea:

$-\ddot{N}H_2$ will accept a proton due to the lone pair of electrons. This removes H^+ from the water equilibrium ~~2H2O~~

$$H_2O \rightleftharpoons H^+ + OH^-$$

so the equilibrium is pushed to the right causing an increase in the OH^- conc. ∴ ~~less~~ increasing pH

Carboxylic acids will lower the pH as they will partially dissociate in water.

$$R-COOH \rightleftharpoons RCOO^- + H^+$$

Candidate 7

The pH can vary depending on the amount of acid & base in your urine. It can also vary depending on the strength of the acid / base present

Strong acids & bases can fully dissociate into ~~solution~~ ions in an aqueous solution

Weak acids & bases can partially dissociate into ions in an aqueous solution i.e. carboxylic acids are weak acids (methanoic acid $H-C(=O)-OH$)

Salts can also vary the pH of urine - these pHs determined by the parent acid & base that make it during the neutralisation reaction. ($NaCl$ has a pH of 7 because its made from a strong acid & alkali)

$$NaCl + H_2O \rightleftharpoons \underset{\text{strong base}}{NaOH} + \underset{\text{strong acid}}{HCl}$$

The pH of urine could be determined by use of indicators These are weak acids that change colour depending on a solutions pH.

Care must be taken when deciding which to use as each indicator has a specific pH range it works in (methyl orange works within a pH range of 3.1-4.4)

The presence of carboxylic acids & salts allows them to be a buffer

An acidic buffer is made of a weak acid & one of its salts buffers keep the pH of a solution approximately constant despite any addition of acid or base

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

$$CH_3COO^-Na^+ \rightleftharpoons CH_3COO^- + Na^+$$

Candidate 8

Urine contains both salt and carboxylic acids. Carboxylic acids are a weak acid and therefore do not fully dissociate in water. Urea, creatinine and uric acid all contain the ammonia functional group. Ammonia and amides are weak bases. When a weak base and a weak acid react together they undergo a neutralisation reaction and form a salt of approximately pH 7. However, most of urine is water which forms an equilibrium.

$$2H_2O \rightleftharpoons H_3O^+ + OH^-$$

Due to this forming an equilibrium, changes in the solution cause the position of the equilibrium to shift for example temperature. The ~~position of the~~ equilibrium ~~constant~~ constant can be worked out from the equation $K_w = [H_3O^+][OH^-]$ and this should give us a value of 1.01×10^{-14} at 25°C. However if the body temperature changes so does the position of the equilibrium therefore it may produce more H_3O^+ ions or OH^- ions depending on the circumstance this can then affect the overall pH of the water therefore the pH of the urine. Hence a change in temperature can alter the pH of the water slightly. However it won't alter it greatly therefore the range of pH of human urine is likely to be approximately pH 6-8 (depending on its conditions)

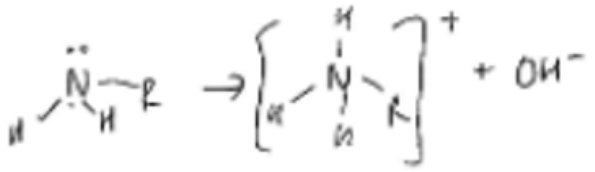
Candidate 9

Urine will contain more weak acids than strong, such as carboxylic acids.

These will have a higher acidic pH, as they only partially dissolve in water:

e.g. $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$.

Urine will also contain substances with amine groups, which are basic, because the lone pair of electrons on the nitrogen can accept a H^+, causing a greater concentration of OH^- ions, making them basic.

e.g. 

Urine is likely close to neutral as the basic and acidic substances cancel out.

It's likely close to neutral, as water is the largest component of water, and it has a dissociation of 1×10^{-14} at 25°C, with the concentration of H^+ and OH^- being the same.

Depending on the salts in the urine, it may be more acidic or basic, because when:

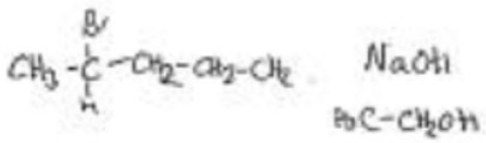
- a salt of a weak acid and strong base dissolves, a basic solution is formed.
- a salt of strong acid and weak base dissolves, an acidic solution is formed.
- a salt of strong acid and strong base is formed, a neutral solution is formed.

Question 9

Candidate 1

To identify any metals present you could use atomic emmission spectroscopy and the flame colour test as depending on the colour of the flame, you could identify the metal.

Candidate 2



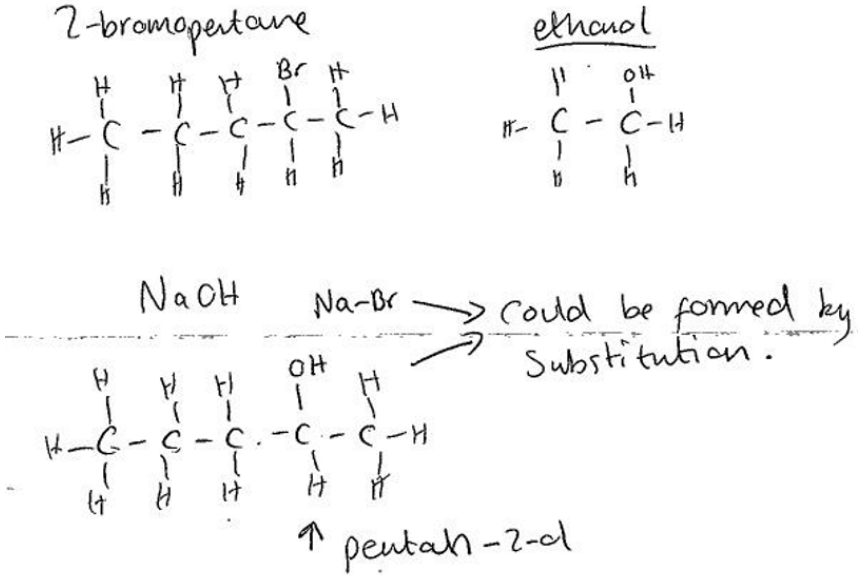
- one of the products could be an ether as ethand could take part in an electrophilic substitution to create ethoxide ions and then take part in a nucleophilic substitution to create 1-ethoxy-2pentane
- but Sodium hydroxide doesnt react with alcohols so Sodium hydroxide would need to be split into Sodium & hydroxide ions first

Candidate 3

could be identified using

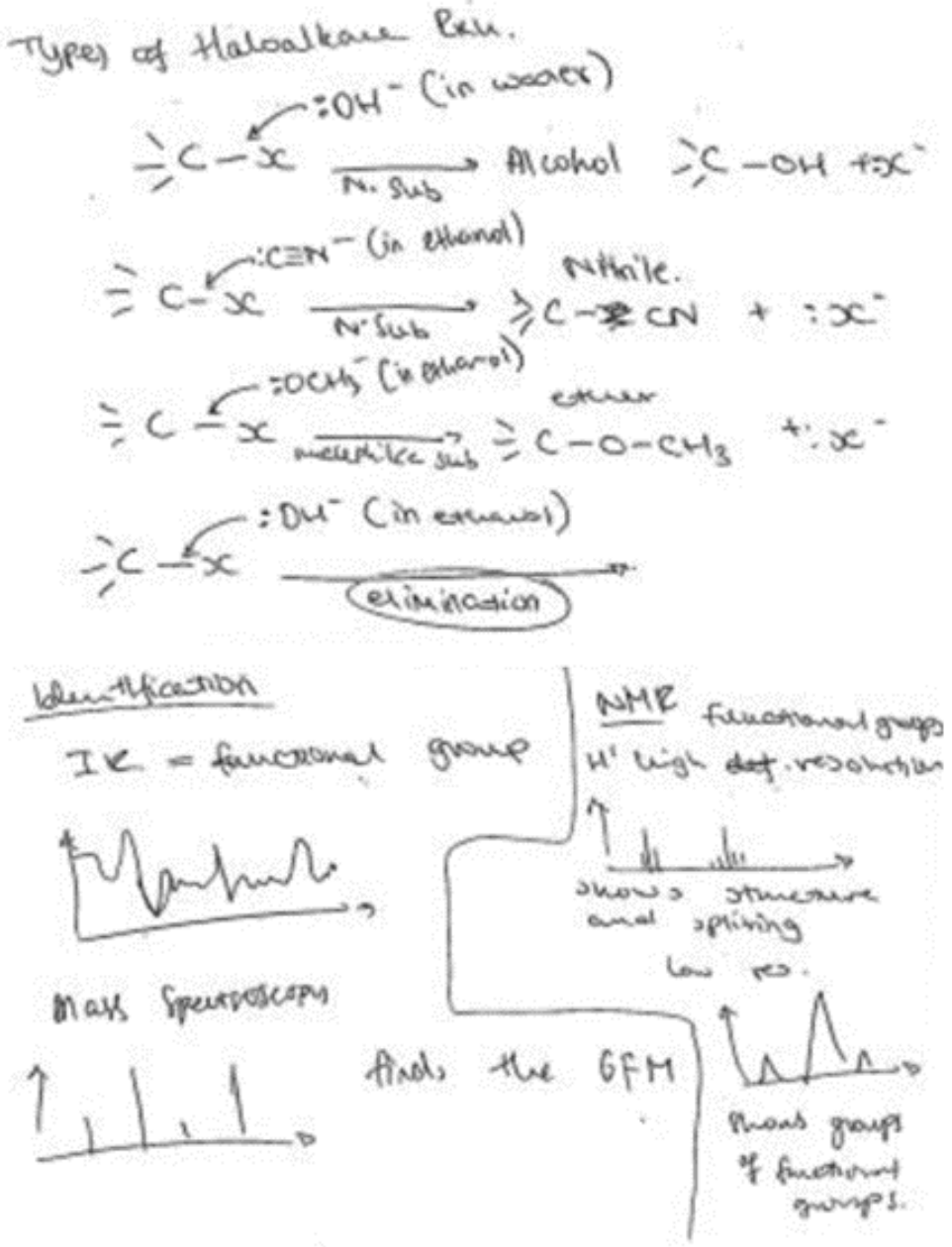
infa red radiation

Candidate 4



Candidate 5

Candidate 6


Types of Haloalkane Rxn.
:OH⁻ (in water)
Alcohol
N. Sub
:C≡N⁻ (in ethanol)
Nitrile.
N. Sub
:OCH₃⁻ (in ethanol)
ether
nucleophilic sub
:OH⁻ (in ethanol)
elimination
Identification
IR = functional group
NMR functional groups
H¹ high def. resolution
shows structure and splitting
low res.
Mass Spectroscopy
Finds the GFM
Shows groups of functional groups.

Candidate 7

There are 3 reactants, so that already gives a bunch of opportunities for a range of products, if the student wishes to control this, it would be a better idea to do them in two steps.

To identify these, you have a range of options; colorimetry, infrared radiation, NMR spectroscopy, absorption, mass spectroscopy.

By identifying the hydrogen environments, you can better guess possible structures

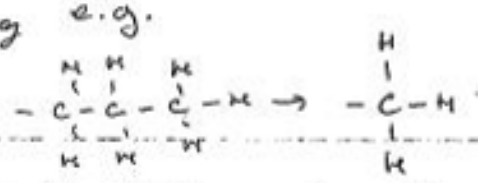
Infrared is good to identify any functional groups as it will peak at different wavenumbers, e.g

- O-H alcohols
- C-H alkane
- C-H benzene ring

It can also help identify the type of molecule if it has the same bond.

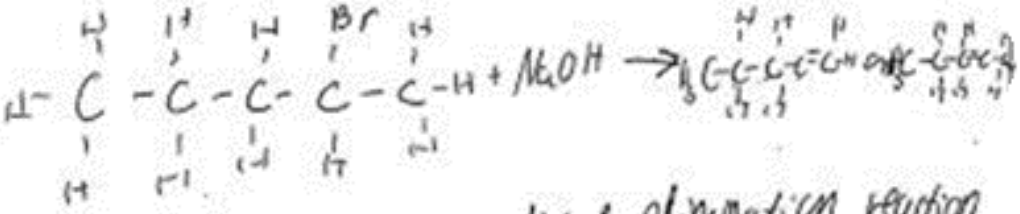
With mass spec, you can identify the full gfm of the molecules in the sample and also work out possible structures by using other peaks to see where the molecule has split.

e.g.



gfm = 44g gfm = 15g

Candidate 8



This is a base induced elimination reaction that must occur in hot ethanol to produce pent-1-ene and pent-2-ene. Haloalkanes can also react with Sodium hydroxide in water to produce alcohols.

To identify the products ^1H NMR could be carried out as the two alkenes produced have a different number of H environments. Elemental microanalysis would show they have the empirical formular of CH_2 as they are structural isomers. They could also be identified using boiling point in distillation. To check the purity of the products, TLC could be used and if there are multiple spots, impurities or other products are present.