

Question 4

Candidate 1

To determine if the compound does contain copper, and not another metal, A sample can be ignited, if the flames turn a distinctive blue-green the sample is likely a copper compound to determine if the compound is $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

Not ~~not~~ precisely weigh a sample in a dish, while also ~~weighting~~ obtaining the dish weight. Then heat the compound for several minutes, before allowing to cool in a desiccator. Once cooled reweigh the sample + dish. Repeat until mass is constant. The difference in mass, allows you to calculate the mass of water in the sample. By then comparing the moles of pure CuSO_4 and water you can find the ratio in this case 1:5

Candidate 2

~~copper is a transition metal so it has a incomplete d-subshell~~

copper is a transition metal so it has a incomplete d-subshell

this means that when copper becomes a ion or releases electrons
~~are moved to a higher energy shell or level~~

$\text{CuSO}_4 \cdot \text{H}_2\text{O}$ firstly estimate the

1 : 2.5 ~~by using the relative atomic masses of the elements~~

firstly copper has a mp of 1085°C

recrystallisation is done by getting a hot solvent & hot filtering
~~the~~ to remove impurities then cooled to just have crystals

firstly heat up the crystals then add water

because H_2O melts at 0°C then use filtration to separate
the CuSO_4 from the H_2O

find out the mass of ~~the~~ by weighing by difference then divide the mass
by GFM to find number
of moles

GFM H_2O : 18

GFM CuSO_4 : 159.6g

for water find the volume &
the concentration then find number of
moles

so the blue crystals are $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ the moles
should have a ratio of $\text{CuSO}_4 \quad \text{H}_2\text{O}$
1 : 5

Candidate 3

titration, mass spectroscopy, colorimetry,
measuring mp and bp of crystal.

Candidate 4

The sample could be heated to a constant mass
and the moles of water present could be
calculated and the ratio of CuSO_4 to H_2O
could be found. If it is 1:5 then the
sample could be determined to be $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.

First crucible ~~and for the~~^{is} weighed
then crucible + sample is weighed.

Heated ~~then~~ on a bunsen flame, then cooled in
a dessicator to prevent reabsorption of water. This
is then reweighed and process repeated until a
constant mass is found.

The mass of water is found by subtracting the original
mass of sample with the mass of anhydrous (no water) sample.

It could be added to a solvent ^{heated} and then cooled
to allow crystals to form, if the crystals
match the bright blue description then it could be
determined to be $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

Candidate 5

$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is a hydrated form of CuSO_4 . To identify ~~the~~ the ratio between the CuSO_4 molecules and the H_2O molecules within the compound, the compound is heated to constant mass.

This is done in a desiccator. The mass of $\text{CuSO}_4 \cdot n\text{H}_2\text{O}$ is weighed by difference in a weighing boat (n = number of moles of H_2O). The compound is then heated and placed into the desiccator until it has cooled. Once it has, ~~the~~ the compound ~~is weighed~~ + weighing boat's mass is measured again. This cycle of heating & cooling is repeated until constant mass is achieved. The mass of water (which has evaporated) can be determined by: ~~subtracting the~~

$$m(\text{H}_2\text{O}) = m(\text{CuSO}_4 \cdot n\text{H}_2\text{O} + \text{weighing boat}) - m(\text{CuSO}_4 + \text{weighing boat})$$

The mass of CuSO_4 can be determined by:

$$m(\text{CuSO}_4) = m(\text{CuSO}_4 + \text{weighing boat}) - m(\text{weighing boat})$$

Since we know the GFM of H_2O and CuSO_4 , the number of moles of each substance can be calculated using the equation:

$$n = \frac{m}{\text{GFM}}$$

The ratio of $\text{H}_2\text{O} : \text{CuSO}_4$ should be 5:1, which would identify the sample as $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.

This doesn't necessarily prove that the compound contains copper, but instead proves that the compound is hydrated in a 5:1 ratio.

To prove the presence of copper, the dehydrated CuSO_4 can be heated in a flame test. If copper is present, then the flame will be blue-green.

~~Another~~

~~Eq~~ CuSO_4 is also very soluble in water ($>10\text{gL}^{-1}$), so by dissolving the ~~compound~~ compound in water, you could determine that it was not ~~the~~ copper carbonate, copper phosphate, copper ~~oxide~~ oxide or copper hydroxide.

Candidate 6

A flame test could be performed to determine that the compound contained copper. Copper burns with a blue-green light (522nm), which is very distinctive.

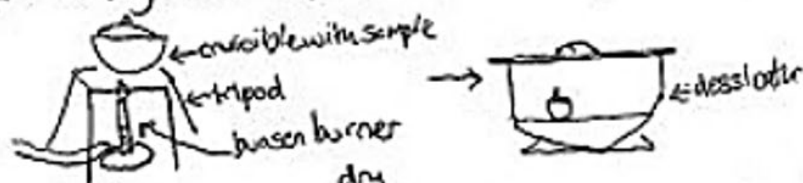
This could also be determined by taking an atomic emission spectrum of the compound, as each element has a unique emission spectrum that is produced by electrons falling from an excited state back to their ground state, emitting photons of specific wavelengths corresponding to the energy gap between the shells.

Copper sulfate (CuSO_4) is soluble in water. This could be used to ~~identify~~ narrow down the range of copper compounds it could be.

Gravimetric analysis could be used to identify the number of moles of water that were present in the compound.

The compound would be added to a crucible (the mass of the empty crucible is recorded) and weighed. The compound would then be heated over a Bunsen burner and cooled in a desiccator (to prevent absorption of water from the atmosphere) before being reweighed. This process would be repeated until a constant mass was obtained.

The mass of water lost can be obtained ~~from~~ by subtracting the dry mass from the original mass, and the number of moles of water lost calculated.



The composition of the ^{dry} crystals ~~can~~ may also be able to be determined from their melting point and melting point range. This could be found using a melting point apparatus and compared to literature values for different copper compounds to identify the crystals.

Candidate 7

Colour arises from the energy gaps between HOMO and LUMO. The size of the energy gap correlates to the wavelength of light emitted and absorbed. The colour complementary to the one that is absorbed is the one seen observed. This compound must absorb yellow light. An emission spectrum could be produced, which would allow for the elements within the sample to be identified. As an electron falls to a lower energy level, light is emitted. The wavelength of light emitted is particular to the element ~~and the state size of energy~~ that the electron belongs to. This would allow each element in the sample to be identified.

Mass spectrometry could also be used to identify the elements and in the sample, as well as the molecules used to make it up. If for example, a peak 18 units below the parent peak is observed, it is possible to deduce that water is present.

Candidate 8

The crystals can be analysed using mass spectroscopy
: to determine what ion fragments are present

An infrared spectrum of the crystals can be made
to determine what bonds are present in the crystals

Using this information it is possible to determine the structure
of an unknown sample

Question 9

Candidate 1

In acid-base indicators, changes in concentration of H^+ or OH^- ions will shift equilibrium thus causing a colour change when the pH changes. For example, if an alkali solution is added to bromothymol blue, the OH^- ions will react with the H^+ ions on the right, and so equilibrium will shift right to produce more, resulting in a ~~colour change~~ blue colour. If an acidic solution is added, this will increase the concentration of H^+ ions on the right, and so equilibrium will shift left to counteract the change, resulting in a yellow colour. ~~Thus~~ Therefore, in bromothymol blue, a colour change from yellow to blue indicates an increase in pH (in the range of 6.0-7.6) and a colour change from blue to yellow indicates a decrease in pH in this range.

small amount
of

In an acid buffer solution, the weak acid provides H^+ ions when these are removed by the addition of a base. This means equilibrium will shift left. The conjugate base provided by the salt will remove excess H^+ ions from the addition of a small amount of an acid. This means the equilibrium will shift right. When a small amount of water is added, equilibrium does not move because the ~~ratio~~ ratio of OH^- ions to H^+ ions remains the same.

Candidate 2

→ Brønsted-Lowry defines acids as proton donors and bases as proton acceptors. Weak acids and bases are totally dissociated in solution, but strong acids and bases are only partially dissociated.
→ A buffer solution does not change pH even with small volumes of acid or base added.

The equilibrium constant K_a , for example the acidic buffer formed from the dissociation of ethanoic acid is as follows:

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{CH}_3\text{COO}^-]}{[\text{CH}_3\text{COOH}]}$$

Candidate 3

In an acidic buffer like the one above, the equilibrium balances the pH when small amounts of acid or base are added.

When a small amount of base is added, the equilibrium shifts to the product side to provide more hydronium ions and absorb excess hydroxide ions, keeping the pH stable.

When a small amount of acid is added, the equilibrium shifts to the reactant side as the CH_3COO^- ion absorbs excess hydronium ions, causing an increase in the concentration of CH_3COOH , shifting the equilibrium and keeping the pH stable.

Candidate 4

In acid-base indicators the indicator exists in equilibrium, the indicator in its $[In^-]$ form is a distinctly different colour to the $[HIn]$ form. $[In^-]$ = yellow, $[HIn]$ = blue. When the pH of the solution changes the K_{in} changes which leads to an increase in the $[HIn]$ form of the indicator, when this differs by ~ 10 the colour change is seen.

~~Acidic~~ buffers control pH by keeping it at one pH. In acidic buffers the pH is maintained even when small volumes of water, acid or alkali are added. This happens because the weak acid is in good reserve so if an alkali is added and the OH^- ions react with the H_3O^+ ions causing a decrease in concentration, the weak acid can replace the H_3O^+ ions and return pH to what it was originally.

If an acid is added the conjugate base of the ~~weak~~ salt is in good reserve, ~~the~~ addition of H_3O^+ ions can be reduced by reacting with OH^- ions provided by the conjugate base, this keeps the pH at ~~its~~ original levels.

Candidate 5

when the negative ions reacts with the positive ions ~~from water~~ H_3O^+ the equilibrium shifts to the right in order to replace those ions ~~in~~ this therefore produces more H_3O^+ ions in the buffer producing an acidic buffer.

Water can act as an acid and a base sometimes. A base ~~is~~ is a H^+ acceptor and an acid is a H^+ ~~or~~ donor. A basic buffer is produced by a strong acid and a weak base. acid-base indicators are chosen based on how their pH responds to the buffer. You can find the pH of different indicators on page 14

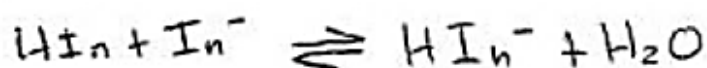
Candidate 6

Buffers - Prevent pH change when acid/base added
acid buffers = weak acid and its salt

~~base buffers~~

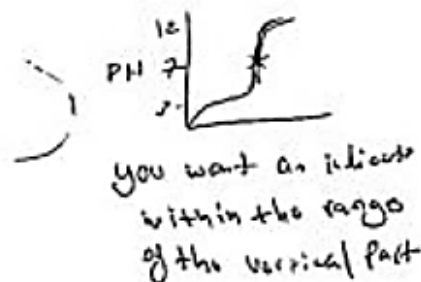
weak acid partially dissociates in water
acid donates protons to become a conjugate base
base accepts protons and becomes conjugate acid

Indicators



$$\text{pH} = \text{pK}_{\text{in}} \pm 1$$

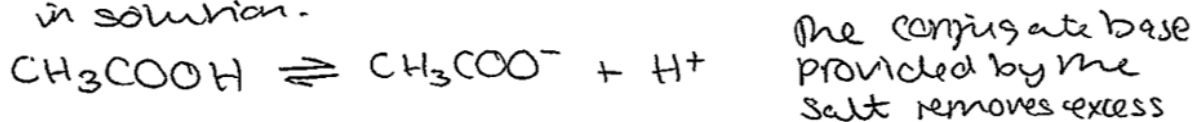
$$K_{\text{in}} = \frac{[\text{H}_2\text{O}^+][\text{In}^-]}{[\text{HIn}]}$$



Candidate 7

Indicators are weak acids where the acid has a distinctly different colour from its conjugate base. The equilibrium constant for indicators is $K_{in} = \frac{[H_3O^+][In^-]}{[HIn]}$. The colour is determined by the ratio of $[In^-]$ to $[HIn]$ and the colour change of the indicator occurs theoretically when $K_{in} = [H_3O^+]$. The colour change is said to be distinguishable when $[HIn]$ and $[In^-]$ differ by a factor of 10.

Equilibria is important in buffers. An example of an acid buffer is ethanoic acid and sodium ethanoate in solution.



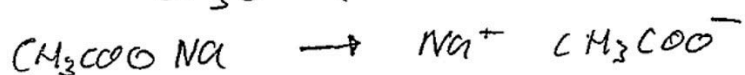
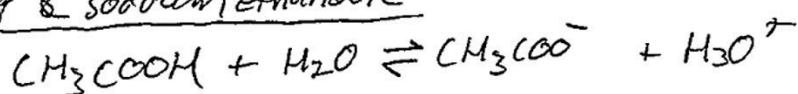
$CH_3COONa \rightarrow Na^+ + CH_3COO^-$ H^+ . The weak acid provides H^+ ions that remove excess OH^- . The equilibrium then shifts to the right to replace H^+ ions lost. This means addition of small amounts of acid and alkali [Turn over] do not change pH of buffer.

Candidate 8

Indicators are weak acids where the conjugate base is a different color to the acid. The addition of H_3O^+ or OH^- ions will drive the equilibrium to one side or the other by creating a color change as it does, so as the conjugate base or acid color is favored.

Buffers are solutions of weak acid or base and a salt of the acid/base.

ethanoic acid & sodium ethanoate



addition of H_3O^+ will react with excess CH_3COO^- ions to form ethanoic acid.

addition of OH^- will react with H_3O^+ to form water. Hence buffer resists small changes to pH.

acids are proton donors

bases are proton acceptors

weak acids and bases do not fully dissociate in solution.