Another challenging Extended Revision Exercise that tests a variety of Y12 skills.

In all answers, show your working!

1. Iron (II) sulfate can be found in several named minerals which differ by the level of hydration.
   Write a general formula for these compounds, using x to represent the number of waters of crystallisation.

   ……

   8.71g of one of the minerals was dehydrated to constant mass
   The mass of anhydrous crystals produced was found to be 5.91g
   Show that the mineral form of the hydrate was *Rozenite* (the tetra hydrate)

2. This dehydrated sample was dissolved in de-ionised water and made up accurately to 100cm^3 in a graduated flask. This solution was used to determine the concentration of a sodium chlorate(I) solution.
   20.0 cm^{3}aliquots (samples) of the iron (II) solution were titrated (in conical flask) against the chlorate(I) solution (in burette). The mean volume of chlorate (I) solution (the titre) was found to be 26.70 cm^3.
   a) Write the chemical formula of chlorate (I) ion ……

   b) What is the oxidation number (state) of chlorine in this chlorate (I) ion ……

   c) chlorate (I) ion is a good oxidising agent and the chlorine becomes reduced to the chloride ion

      Write the chemical formula of the chloride ion ……

   d) What is the oxidation number (state) of chlorine in this chloride ion ……

   e) Using these oxidation numbers, complete the half-equation showing the reduction of the chlorate (I) ion to chloride

      …… + …… + $2H^+$ ➔ …….. + H_2O

   f) The iron (II) ions are oxidised to iron (III) ions by chlorate in the titration.
      Using the oxidation numbers, complete the half-equation showing the oxidation of the iron (II)

      …… ➔ …….. + ……

g) Write a full balanced **redox equation** for this reaction. **Remember**, you need to combine the two equations in such a way the **number of electrons on both sides cancel out.** Hint, multiply one of the equations before adding together

……

h) Now you have found the ratio of reactants from the redox equation above, determine the concentration of this chlorate(I) solution.

3. The **aqueous chloride** that is produced in part 2 could be oxidised back to chlorine gas by reacting it with a powerful oxidising agent.
Write the **half-equation** showing the oxidation of chloride to chlorine

……

The chlorine that was produced was collected in a gas syringe. Calculate the volume of the gas which was collected at 299K and at an atmospheric pressure of 101 000Pa. Express your answer in **cubic decimeters**, to **1 decimal place** and in **standard form.**

The volume of chlorine collected was significantly lower than expected. Give one possible reason, other than human error or leaks in the apparatus. (Clue: the reaction tool place in water)

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4. The chlorine in the gas syringe was then repeatedly passed through an aqueous solution of sodium bromide to produce bromine (this is how bromine is extracted industrially from sea water).

a) What would be the main observation during the reaction?

……..

b) What is the name of this **specific** redox reaction? ……..

c) Write an ionic equation for the reaction.

……

d) What mass of sodium bromide would be necessary to consume all the chlorine **BUT** not be in excess?

e) Calculate the **atom economy** for the process if the bromine is the desired product.
Care! You can't use the ionic equation! Think why.

f) Calculate the **percentage by mass** of bromine in sodium bromide.

5. The bromine can be extracted carefully from the water to produce pure bromine liquid. This can be used to produce bromomethane by reaction with natural gas (methane)

For the reaction to occur between these two chemicals, the reaction must be started by applying which condition?

…….

What is the name of this process that 'kick-starts' the reaction?

…….

Write a chemical equation for this process

……

Now complete the propagation steps for the process.

Draw the displayed formulae for 1 unwanted product formed in the reaction and explain how it got there!

Reason……

6. 26.4g of bromine produced 9.23g of bromomethane.
   a) Calculate the **percentage yield.**

   b) Calculate the **atom economy**.

7. The bromomethane can be converted into methanol in one step.
   a) What is the name of this **type** of reaction?.....
   b) What are the reagents and conditions?

      Reagents ..... Conditions .....

   c) What is the name of the **mechanism**?

      ……

   d) Draw the mechanism for the reaction.

8. The methan**ol** can be oxidised readily to methan**al** (old name, formaldehyde). In the lab this can be done using which common oxidising agent?

   ……

What other chemical is needed in the reaction?

……

Would you select a **reflux** or a **distillation** set up for the reaction? ……

Write an equation for this reaction using [O] to represent the oxidising agent.

……

What colour change would you observe during the course of the reaction which would indicate the reaction was taking place?

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