

## An Extended Revision Exercise that tests a variety of Y12 skills **ANSWERS**

In all answers, show your working!

1. 10.0g of washing soda (sodium carbonate **decahydrate**) were heated strongly to constant mass.

Calculate the mass of **anhydrous crystals** produced.

Mr of  $\text{Na}_2\text{CO}_3 \cdot 10 \text{H}_2\text{O} = 286$  (no UNITS!)

Moles of  $\text{Na}_2\text{CO}_3 \cdot 10 \text{H}_2\text{O} = 0.0350 \text{ mol}$  so moles of  $\text{H}_2\text{O} = 10 \times 0.0350 = 0.350 \text{ mol}$

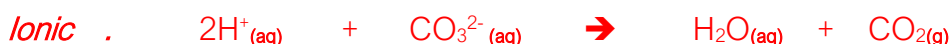
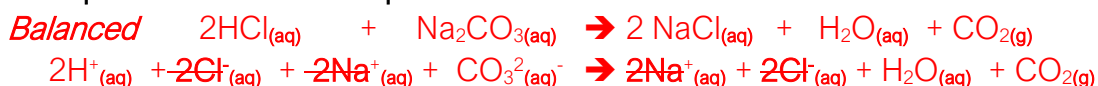
Mass of water in  $\text{Na}_2\text{CO}_3 \cdot 10 \text{H}_2\text{O}$  is  $0.0350 \times 18.0 = 6.29 \text{ g}$

Therefore, mass that is anhydrous  $\text{Na}_2\text{CO}_3 = 10.0 \text{ g} - 6.29 \text{ g} = 3.71 \text{ g}$

2. This dehydrated sample was dissolved in de-ionised water and made up accurately to  $250 \text{ cm}^3$  in a volumetric (or graduated) flask.

$25.0 \text{ cm}^3$  aliquots (portions) of the solution were titrated against hydrochloric acid. The mean titre was found to be  $21.80 \text{ cm}^3$

Write a **balanced equation** and an **ionic equation** for this reaction.



3. Determine the concentration of this hydrochloric acid. Name 2 indicators that could be used.

Moles of  $\text{CO}_3^{2-}$  per aliquot ( $25.0 \text{ cm}^3$ ) =  $25.0/250 \times 0.0350 = 3.5 \times 10^{-3} \text{ mol}$

Moles of  $\text{H}^+$  per titration must be  $3.5 \times 10^{-3} \text{ mol} \times 2 = 7.0 \times 10^{-3} \text{ mol}$

Concentration of  $\text{H}^+ = 7.0 \times 10^{-3} / (21.8/1000) = 0.321 \text{ mol dm}^{-3}$

Indicators **methyl orange** and **phenolphthalein**

4. The carbon dioxide that was produced was collected in a gas syringe. Calculate the volume of the gas which was collected at  $24.0^\circ\text{C}$  and at an atmospheric pressure of  $99.5 \text{ kPa}$ . Express your answer in **cubic centimetres** and to **3 sig fig**.

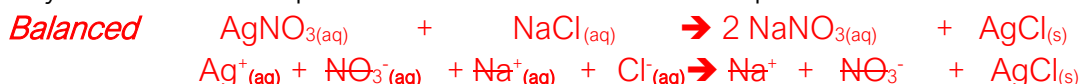
$pV=nRT$  so  $V=nRT/p$

$n=3.5 \times 10^{-3} \text{ mol}$      $R=8.314 \text{ J mol}^{-1}\text{K}^{-1}$      $T=273+24.0=297\text{K}$      $p=99500\text{Pa}$

$V= \frac{3.5 \times 10^{-3} \times 8.314 \times 297}{99500} = 8.69 \times 10^{-5} \text{ m}^3 = 8.69 \times 10^{-5} / 1000000 = 86.9 \text{ cm}^3$

5. To the resulting solution from the experiment was added an excess of silver nitrate solution. The precipitate that formed was collected by filtration and allowed to dry.

Write balanced symbol and ionic equations for the reaction that took place.



6. Calculate the **theoretical mass** of precipitate obtained.

Moles of Cl<sup>-</sup> **per titration** must be same as moles of H<sup>+</sup> from HCl<sub>(aq)</sub>

Moles of Cl<sup>-</sup> **per titration** was calculated as 7.0 x 10<sup>-3</sup> mol (see question 3!)

So mass of AgCl must be 7.0 x 10<sup>-3</sup> mol x molar mass of AgCl

$$7.0 \times 10^{-3} \text{ mol} \times (108 + 35.5) = \underline{1.00 \text{ g}}$$

7. The mass of crystals collected was greater than expected. What extra step should have been taken to reduce this error?

**Dry to constant mass**

8. Calculate the **atom economy** for the process if it is the precipitate that is the desired product.

AgCl is the desired product (the other product in solution will be NaNO<sub>3</sub>)

$$(108 + 35.5) / [(108 + 35.5) + (23 + (14 + 48))]$$

$$143.5 / 228.5 = \underline{62.8\%}$$

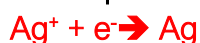
9. Calculate the **percentage by mass** of silver in the precipitate.

$$108 / (108 + 35.5) \times 100\% = \underline{75.3\%}$$

10. If the sample is left in UV light (or heat), a chemical reaction takes place where the white crystals turn black. The black crystals are pure silver. Calculate the maximum mass of silver produced. (This process is at the heart of the original black and white photography)

$$7.0 \times 10^{-3} \text{ mol} \times 108 \text{ g mol}^{-1} = \underline{0.756 \text{ g}}$$

11. Write a **half equation** for the process that produces the black solid.



12. What is the name of the chemical process taking place?

**Reduction**

13. For the process in question 12 to occur, there must be another process taking place simultaneously.

Write an equation for the other process?

There must **oxidation** also happening at the same time because you can't have one without the other! It must be the Cl<sup>-</sup> that gets oxidised as it's **the only other species present**.

