Year 12 Science: Titration: how much acid is really in the vinegar?

Name: _____ Date: _____

Try these without your notes first, then check the answer key.

Practice

1. 2.650 g of anhydrous sodium carbonate (M = 105.99 g mol^{-1}) is made up to 250.0 mL. Find its concentration.

2. A student's titres are 22.60 (rough), 22.15, 22.40, 22.20 and 22.10 mL. Which are concordant, and what is the mean titre?

3. $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$. 20.00 mL of 0.1000 mol L^{-1} Na_2CO_3 needs 22.15 mL of HCl. Find c(HCl).

4. A cleaner is diluted 25.00 mL to 250.0 mL, and the diluted solution is 0.0850 mol L^{-1}. What is the concentration in the bottle?

5. Explain why the student standardised the sodium hydroxide instead of weighing out the pellets.

Fix the mistake

6. Correct this statement: "I averaged all four titres, including the rough one."

7. Correct this statement: "n(NaOH) = n($H_2C_2O_4$), so c(NaOH) = 0.04870 mol L^{-1}."

8. Correct this statement: "The vinegar's concentration is 0.07013 mol L^{-1}."

9. Correct this statement: "I rinsed the burette with distilled water before filling it with NaOH."

Answer key (for parents and tutors)

1. 2.650 g of anhydrous sodium carbonate (M = 105.99 g mol^{-1}) is made up to 250.0 mL. Find its concentration.
   n = 2.650 ÷ 105.99 = 0.02500 mol; c = 0.02500 ÷ 0.2500 = 0.1000 mol L^{-1}.

2. A student's titres are 22.60 (rough), 22.15, 22.40, 22.20 and 22.10 mL. Which are concordant, and what is the mean titre?
   22.15, 22.20 and 22.10 mL agree within 0.10 mL; mean = (22.15 + 22.20 + 22.10) ÷ 3 = 22.15 mL. 22.40 mL is left out.

3. $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$. 20.00 mL of 0.1000 mol L^{-1} Na_2CO_3 needs 22.15 mL of HCl. Find c(HCl).
   n(Na_2CO_3) = 0.1000 × 0.02000 = 2.000 × 10^{-3} mol; n(HCl) = 2 × 2.000 × 10^{-3} = 4.000 × 10^{-3} mol; c = 4.000 × 10^{-3} ÷ 0.02215 = 0.1806 mol L^{-1}.

4. A cleaner is diluted 25.00 mL to 250.0 mL, and the diluted solution is 0.0850 mol L^{-1}. What is the concentration in the bottle?
   Dilution factor 10, so 10 × 0.0850 = 0.850 mol L^{-1}.

5. Explain why the student standardised the sodium hydroxide instead of weighing out the pellets.
   NaOH absorbs water and carbon dioxide from the air, so a weighed mass is not all NaOH and its concentration would be wrong; titrating it against a primary standard gives its true concentration.

6. Correct this statement: "I averaged all four titres, including the rough one."
   Only the concordant titres go in the mean; the rough titre only shows roughly where the end point is.

7. Correct this statement: "n(NaOH) = n($H_2C_2O_4$), so c(NaOH) = 0.04870 mol L^{-1}."
   Oxalic acid needs two NaOH per molecule, so n(NaOH) = 2 × n($H_2C_2O_4$), giving 0.09740 mol L^{-1}.

8. Correct this statement: "The vinegar's concentration is 0.07013 mol L^{-1}."
   That is the diluted solution; multiply by the dilution factor of 10 to get 0.7013 mol L^{-1} in the bottle.

9. Correct this statement: "I rinsed the burette with distilled water before filling it with NaOH."
   Rinse it with the NaOH; leftover water dilutes it, which makes the titres too large and the answer too high.