Year 13 Science: A quantitative chemistry investigation: titration analysis

Name: _____ Date: _____

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

Practice

1. 1.325 g of anhydrous sodium carbonate (M = 106.0 g mol^{-1}) is made up to 250.0 mL. What is its concentration?

2. 20.00 mL of that solution needs 21.60 mL of hydrochloric acid: $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$. What is the acid's concentration?

3. Titres of 18.35, 18.70, 18.40 and 18.30 mL were recorded. What mean titre should be used?

4. A 2.00 g sample of impure ascorbic acid contains 1.76 g of $C_6H_8O_6$. What is its percentage purity?

5. A student forgot to rinse the burette with iodine solution, leaving it wet with water. Would the vitamin C results come out too high or too low?

Fix the mistake

6. Correct this statement: "I rinsed the conical flask with the juice so it would not be diluted."

7. Correct this statement: "My titres were 13.25, 13.15 and 13.80 mL, so the mean titre is 13.40 mL."

8. Correct this statement: "The 10.00 mL portion contained 2.809×10^{-4} mol, so the tablet contained 0.0494 g."

9. Correct this statement: "My results were very precise, so they must be accurate."

Answer key (for parents and tutors)

1. 1.325 g of anhydrous sodium carbonate ($M = 106.0$ g mol^{-1}) is made up to 250.0 mL. What is its concentration?
   $n = 1.325 \div 106.0 = 0.01250$ mol; $c = 0.01250 \div 0.2500 = 0.0500$ mol L^{-1}.
2. 20.00 mL of that solution needs 21.60 mL of hydrochloric acid: $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$. What is the acid's concentration?
   $n(Na_2CO_3) = 0.0500 \times 0.02000 = 1.000 \times 10^{-3}$ mol, so $n(HCl) = 2 \times 1.000 \times 10^{-3} = 2.000 \times 10^{-3}$ mol; $c = 2.000 \times 10^{-3} \div 0.02160 = 0.0926$ mol L^{-1}.
3. Titres of 18.35, 18.70, 18.40 and 18.30 mL were recorded. What mean titre should be used?
   18.70 mL is not concordant; the mean of 18.35, 18.40 and 18.30 is 18.35 mL.
4. A 2.00 g sample of impure ascorbic acid contains 1.76 g of $C_6H_8O_6$. What is its percentage purity?
   $1.76 \div 2.00 \times 100 = 88.0\%$.
5. A student forgot to rinse the burette with iodine solution, leaving it wet with water. Would the vitamin C results come out too high or too low?
   Too high: the water dilutes the iodine, so a bigger titre is needed, and the calculation (using the standardised concentration) gives more moles of vitamin C than were really there.
6. Correct this statement: "I rinsed the conical flask with the juice so it would not be diluted."
   Rinse the flask with distilled water only; extra juice clinging to it would add moles beyond the 25.00 mL pipetted.
7. Correct this statement: "My titres were 13.25, 13.15 and 13.80 mL, so the mean titre is 13.40 mL."
   Average only concordant titres: 13.80 mL is not within 0.20 mL, so the mean is 13.20 mL.
8. Correct this statement: "The 10.00 mL portion contained 2.809×10^{-4} mol, so the tablet contained 0.0494 g."
   Scale up by the dilution: the 100.0 mL flask held ten times as much, 2.809×10^{-3} mol, which is 0.494 g.
9. Correct this statement: "My results were very precise, so they must be accurate."
   Precise means repeatable; a systematic error such as an unstandardised titrant shifts every titre the same way and leaves them inaccurate.