4.13   Skills and Techniques 2 - Errors Answers

1. a)i) $\dfrac{0.02}{10} \times 100 = \underline{0.2\%}$

    ii) $\dfrac{0.04}{10} \times 100 = \underline{0.4\%}$

  b) The $10cm^3$ class A pipette has less of a percentage uncertainty because of the way it is manufactured. It will be a more expensive piece of apparatus than the $10cm^3$ class B pipette.

2. a) $\dfrac{0.25}{500} \times 100 = \underline{0.05\%}$

  b) $\dfrac{0.50}{500} \times 100 = \underline{0.10\%}$

3. $\dfrac{0.1}{18.5} \times 100 = \underline{0.54\%}$

4. a) $C_1V_1 = C_2V_2$

     $1.45 \times 0.01 = C_2 \times 0.25$

     $C_2 = 0.058$ mol l^{-1}

  b) Error $10cm^3$ class B pipette

     $\dfrac{0.04}{10} \times 100 = 0.4\%$

     Error in $250cm^3$ volumetric flask

     $\dfrac{0.30}{250} \times 100 = 0.12\%$

     Combine both errors: $0.40\% + 0.12\% = \underline{0.52\%}$

     Apply this percentage uncertainty to the concentration.

     $\dfrac{0.52 \times 0.058}{100} = 3.016^{-4}$ mol l^{-1}

     $\underline{0.058 \pm 3 \times 10^{-4}\text{ mol }l^{-1}}$

5. a) 10cm^3 of the 1.0 mol l^{-1} sodium carbonate solution should be pipetted into a 100cm^3 volumetric flask and made up to the mark with distilled water. The flask should be inverted several times.

(This can obviously be prepared by using 25cm^3 and diluting to 250cm^3).

b) First procedure (percentage error)

$$\frac{0.10}{1.35} \times 100 = \underline{7.4\%}$$

Second procedure (percentage error)

$$\frac{0.10}{14.05} \times 100 = \underline{0.71\%}$$

THERE IS A CLEAR REDUCTION IN THE PERCENTAGE ERROR.

6. Number of moles of HCl = c x v

Number of moles of HCl = 0.98 x 0.0265

Number of moles of HCl = 0.02597 moles

HCl : KOH

1 : 1

0.02597 moles : 0.02597 moles

Concentration of KOH = n /v

Concentration of KOH = (0.02597 / 0.02)

Concentration of KOH = 1.2985 mol l^{-1} (1.3 mol l^{-1})

Percentage uncertainty in pipette

$$\frac{0.06}{} \times 100 = 0.30\%$$

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Percentage uncertainty in burette

$$\frac{0.10 \times 100}{26.5} = 0.37735\% \ (0.38\%)$$

Total uncertainty = 0.30% + 0.38%

Total uncertainty = 0.68%

Overall uncertainty = $\frac{0.68 \times 1.2985}{100}$ = 0.00889298 mol l^{-1} (0.009 mol l^{-1})

Concentration of KOH = 1.3 ± 0.009 mol l^{-1}