Significant Digits

The examples below illustrate the proper use of significant digits for the Chemistry 30 Diploma Examination in a response.

Example 1

A 10.0 mL sample of a Fe^{2+}(aq) solution of unknown concentration is titrated with a standardized 0.120 mol/L $KMnO_4$(aq) solution. The following data are recorded.

2 decimal places (10.10–1.00) according to the addition/subtraction rules leaves 3 significant digits

Trial	I	II	III
Final burette reading (mL)	10.10	19.22	28.33
Initial burette reading (mL)	1.00	10.10	19.22
Titrant added (mL)	**9.10***	9.12	9.11

The concentration of the Fe^{2+}(aq) is __________.

Reaction Equation

$MnO_4^-(aq) + 8\,H^+(aq) + 5\,Fe^{2+}(aq) \rightarrow Mn^{2+}(aq) + 4\,H_2O(l) + 5\,Fe^{3+}(aq)$

Exact number, therefore does **not** change the final number of significant digits

Average volume of titrant added is 9.11 mL

$$[Fe^{2+}(aq)] = 9.11 \text{ mL } MnO_4^-(aq) \times 0.120 \text{ mol/L } MnO_4^-(aq) \times \frac{5 \text{ mol } Fe^{2+}(aq)}{1 \text{ mol } MnO_4^-(aq)} \times \frac{1}{10.0 \text{ mL } Fe^{2+}(aq)}$$

$[Fe^{2+}(aq)] =$ **0.547** mol/L

* Final answer has 3 significant digits (least number present according to the multiplication/division rule)

Example 2

K_a value has 2 significant digits

The pH of a 0.100 mol/L solution of ethanoic acid is __________.

$$K_a = \mathbf{1.8 \times 10^{-5}} = \frac{x^2}{(0.100 \text{ mol/L} - x)}$$

The value of x can be ignored when compared to 0.100 mol/L in the case of such a weak acid.

K_a is approximately $\dfrac{x^2}{0.100 \text{ mol/L}}$

$x = [H_3O^+(aq)] =$ **0.001342**

Additional digits carried through on an interim basis

pH = –log(0.001342 mol/L)

= **2.87**

Final answer has 2 significant digits

Example 3

A student conducts a calorimetry experiment to determine the energy transferred when Solution A is mixed with Solution B. The data collected are shown below. Assume the specific heat capacity for each solution is the same as that of water.

Mass of Solution A (g)	100.0
Mass of Solution B (g)	100.0
Mass of final solution mixture (g)	200.0
Initial temperature of solutions A and B (°C)	20.0
Final temperature of the solution mixture (°C)	23.0

The original data are limited to 3 significant digits.

$\Delta H = mc\Delta t$

$\Delta H = (200.0 \text{ g})\ (4.19 \text{ J/g}\cdot°\text{C})\ (\mathbf{3.0}\ °\text{C})$

The resulting temperature has 2 significant digits.

$\Delta H = \mathbf{2.5}$ kJ

The final answer should be rounded to the same number of significant digits contained in the input data for the calculation $\Delta H = mc\Delta t$ that has the fewest number of significant digits.

The final answer has 2 significant digits because the input data for the $\Delta H = mc\Delta t$ calculation is limited by the temperature difference of 3.0 °C, which has 2 significant digits.