Algebra V

Rearranging simple equations

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Answers to additional problems

6.1 **1.** Cancelling the k_1 terms yields $\text{rate} = \frac{\cancel{k_1} k_2^2}{\cancel{k_1} k_2 k_3} \rightarrow \text{rate} = \frac{k_2^2}{k_2 k_3}$

2. We then cancel one of the k_2 terms $\text{rate} = \frac{k_2^{\cancel{2}}}{\cancel{k_2} k_3} \rightarrow \text{rate} = \frac{k_2}{k_3}$

3. We MULTIPLY both sides by k_3 $k_3 \times \text{rate} = k_2$

4. We DIVIDE both sides by 'rate' $k_3 = \frac{k_2}{\text{rate}}$

6.2 Rewriting the data in the form of an equation yields,

$$m_{\text{sample}} + 0.250\text{ g} = 12.443\text{ g}$$

A mass of 0.250 g has been ADDED to m_{sample} so we reverse this operation and SUBTRACT this mass from both sides of the equation,

$$m_{\text{sample}} + \cancel{0.250\text{ g}} - \cancel{0.250\text{ g}} = 12.443\text{ g} - 0.250\text{ g}$$

so $m_{\text{sample}} = 12.443\text{ g} - 0.250\text{ g} = 12.193\text{ g}$.

6.3 **1.** We MULTIPLY both sides by [ethane], $K\,[\text{ethane}] = [H_2]\,[\text{ethene}]$

2. We then DIVIDE both sides by [ethene], $[H_2] = \frac{K[\text{ethane}]}{[\text{ethene}]}$

6.4 The top line is effectively a bracket and can be written as $(v - u)$. We cannot do anything to the v term without doing the same to the u term.

1. We first MULTIPLY both sides by t, $at = v - u$

2. We then ADD u to both sides, $v = u + at$

Notice how we swapped the two sides of the equation in this last line, to ensure v is the subject.

6.5 We first divide both sides by the proton concentration term, $\frac{K_a}{[H^+]^2} = \frac{[SO_4^{2-}]}{[H_2SO_4]}$

We then multiply both sides of the equation by the concentration of undissociated acid,

$$[SO_4^{2-}] = \frac{K_a[H_2SO_4]}{[H^+]^2}$$

6.6 The concentration c has been MULTIPLIED by ε and by ℓ. We must therefore reverse the operation and DIVIDE by them. Unlike Worked Example 6.6, we will DIVIDE by the compound term $\varepsilon\,\ell$,

$$A = \varepsilon c\,\ell \rightarrow \frac{A}{\varepsilon\ell} = \frac{\cancel{\varepsilon} c \cancel{\ell}}{\cancel{\varepsilon}\cancel{\ell}}$$

so $c = \frac{A}{\varepsilon\ell}$

6.7 273.15 has been ADDED to t to yield T so we reverse this operation and SUBTRACT 273.15 from both sides,

$$T - 273.15 = t + \cancel{273.15} - \cancel{273.15}$$

so $t = T - 273.15$

6.8 k_2 has been MULTIPLIED by the two concentration terms, [acid] [alcohol], so we reverse the operation by DIVIDING both sides of the equation by [acid] × [alcohol],

$$\frac{\text{rate}}{[\text{acid}][\text{alcohol}]} = \frac{k_2 \cancel{[\text{acid}]}\,\cancel{[\text{alcohol}]}}{\cancel{[\text{acid}]}\,\cancel{[\text{alcohol}]}}$$

so $k_2 = \dfrac{\text{rate}}{[\text{acid}][\text{alcohol}]}$

6.9 We start by rewriting the data in a more manageable way.

- In words: 1 dm^3 of solution of concentration 0.2 mol dm^{-3} contains 0.2 mol.
- As an equation: $1\ \text{dm}^3 \times 0.2\ \text{mol dm}^{-3} = 0.2\ \text{mol}$

Note how we retain the units here to help prove the equation is valid.

Next, as one litre contains 1000 cm^3, we divide by 1000 to determine how much thiosulphate is contained in only one cm^3,

$$\frac{1\,\text{dm}^3 \times 0.2\,\text{mol}\,\text{dm}^{-3}}{1000} = \frac{0.2\,\text{mol}}{1000}$$

But we don't want 1 cm^3. We want 25 so we multiply both sides by 25,

$$25 \times \frac{1\,\text{dm}^3 \times 0.2\,\text{mol}\,\text{dm}^{-3}}{1000} = 25 \times \frac{0.2\,\text{mol}}{1000}$$

We see 25 cm^3 of solution contains (25 × 0.2)/1000 mol = 0.005 mol, or 5 mmol.

6.10 The compound term $T\Delta S^{\ominus}$ has been SUBTRACTED from $\Delta H^{\ominus}$, so we must reverse the operation and ADD $T\Delta S^{\ominus}$ to both sides of the equation,

$$\Delta G^{\ominus} + T\Delta S^{\ominus} = \Delta H^{\ominus} - \cancel{T\Delta S^{\ominus}} + \cancel{T\Delta S^{\ominus}}$$

so $\Delta H^{\ominus} = \Delta G^{\ominus} + T\Delta S^{\ominus}$