Algebra IV

Fractions and percentages

5

Answers to additional problems

5.1 Using eqn. (5.7), the percentage yield $= \dfrac{0.069\ \text{mol}}{0.105\ \text{mol}} \times 100 = 66\%$.

5.2 We calculate the overall yield of ligand using a form of eqn. (5.1),
overall yield of ligand = (yield of step **1**) × (yield of step **2**) × (yield of step **3**)

$$\text{so overall yield} = \frac{2}{3} \times \frac{22}{23} \times \frac{4}{10} = \frac{2 \times 22 \times 4}{3 \times 23 \times 10} = \frac{176}{690} \text{ or } 0.255.$$

You could also cancel by a factor of 2 in the first expression

$$\text{overall yield} = \frac{1}{3} \times \frac{22}{23} \times \frac{4}{5} = \frac{1 \times 22 \times 4}{3 \times 23 \times 5} = \frac{88}{345} = 0.255$$

It's more conventional to write this result as a percentage: the overall yield is 25.5%.

5.3 The majority of the second term is a constant, so we write $\dfrac{2\, z_+ z_- e^2}{\frac{1}{2} d\varepsilon} = \dfrac{k}{\frac{1}{2}}$. Inserting terms in template eqn. (5.5) yields, $k \times \dfrac{2}{1} = 2k$.

Therefore, the second term is $2 \times \dfrac{2\, z_+ z_- e^2}{d\varepsilon} = \dfrac{4\, z_+ z_- e^2}{d\varepsilon}$

In solid-state chemistry, it is usual *not* to rearrange this equation in order to emphasize the factor of ½.

5.4 Inserting numbers into eqn. (5.4) yields, $\dfrac{3}{4} - \dfrac{1}{17} = \dfrac{(3 \times 17) - (1 \times 4)}{4 \times 17} = \dfrac{51 - 4}{68} = \dfrac{47}{68}$ mol.
It might be more usual to then express this amount as a decimal, writing 0.691 mol.

5.5 The empirical formula of vitamin C is $C_6H_8O_6$.
The mass of carbon is 6 × 12 g = 72 g.
The mass of hydrogen is 8 × 1 g = 8 g.
The mass of oxygen is 6 × 16 g = 96 g.
The molar mass is therefore (72 + 8 + 96) g = 176 g.
Inserting numbers in eqn. (5.10),

$$\%\ \text{carbon} = \frac{72}{176} \times 100 = 41\%$$

$$\%\ \text{hydrogen} = \frac{8}{176} \times 100 = 4.6\%$$

$$\%\ \text{oxygen} = \frac{96}{176} \times 100 = 54.4\%$$

The elemental composition of Vitamin C is 41% carbon, 4.6% hydrogen, and 54.4% oxygen. The sum of these three percentages is 100%.

5.6 As a fraction, we express the yield as $\left(\frac{0.85}{1.25}\right)$. As a decimal, the yield is 0.68. To express this number as a percentage, we multiply this decimal by 100,

$$\% = 0.68 \times 100 = 68\%.$$

5.7 If the cost increases by ⅓, then the cost will be (1 + ⅓) times that initially. If the sum cannot be obtained intuitively, it may be quantified using eqn. (5.3),

$$\frac{1}{1}+\frac{1}{3}=\frac{(1\times 3)+1}{1\times 3}=\frac{4}{3}.$$

The new price is then 4/3 × £12.50 per kg = £16.67 per kg. Perhaps the users need to find another supplier.

5.8 Inserting numbers into eqn. (5.6), $x_B = \frac{3.2\text{ mol}}{(4.5+3.2+11.6)\text{ mol}} = \frac{3.2}{19.3} = 0.166$.

Expressed as a percentage, $x_B = 16.6\%$.

5.9 If the concentration is 30%, then every 100 ml of solution contains 30 ml of H_2O_2. By simple proportions, 150 ml of solution requires 45 ml of H_2O_2,

$$\text{Amount of } H_2O_2 = \frac{30\%}{100}\times 150\text{ ml} = 45\text{ ml}$$

The remainder (150 – 45) ml = 105 ml will be deionized water.

5.10 Using a variant of eqn. (5.3),

$$\frac{1}{40}+\frac{2}{55}+\frac{3}{80}=\frac{1\times(55\times 80)+2\times(40\times 80)+3\times(40\times 55)}{40\times 55\times 80}\text{ mol}$$

Notice how the denominator comprises each of the three denominators from the three source fractions. Each of the three terms in the numerator follows a pattern. The number outside the bracket is the numerator from the original fraction. The two numbers inside the bracket are the denominators from the two other fractions.

After multiplying the terms, we have $\frac{4400+6400+6600}{176\,000}=\frac{17\,400}{176\,000}$

This last result can be simplified by cancelling to 87/880 mol, which equates to 9.89×10^{-2} mol of *Abacavir*.