Solutions: Chapter 3 Problems

1\. a. 1.9030 five

b. 0.03910 four

c. $1.40 \cdot 10^4$ three

2\. a. 1.237

b. 1.238

c. 0.135

d. 2.1

e. 2.00

7\. a. 12.3

b. 75.5

c. $5.520 \cdot 10^3$

d. 3.04

e. $3.04 \cdot 10^{-10}$

f. 11.9

g. 4.600

h. $4.9 \cdot 10^{-7}$

16\. note: the number of decimal places in the error and the result must be consistent.

a. $\sqrt{0.03^2 + 0.02^2 + 0.06^2} = 0.07$ = ± 0.07absolute error

$9.23 + 4.21 - 3.26 = 10.18$ CV, number of sig. figs limited by the one with the minimum

$\frac{0.07}{10.18} \cdot 100 = 0.688$ = 0.7% ans: 10.18 ± 0.07 (0.7%)

b. $\frac{91.3 \cdot 40.3}{21.1} = 174.379$ =174 value

$\sqrt{\left(\frac{1.0}{91.3}\right)^2 + \left(\frac{0.2}{40.3}\right)^2 + \left(\frac{0.2}{21.1}\right)^2} \cdot 174 = 2.664$ = ± 3 absolute error

$\frac{3}{174} \cdot 100 = 1.724$ = 2% CV ans: 174 ± 3 (2%)

c. $\frac{4.97 - 1.86}{21.1} = 0.147$ $4.97 - 1.86 = 3.11$ numerator

$\frac{3.11}{21.1} = 0.147$ value

$\sqrt{0.05^2 + 0.01^2} = 0.051$ error of numerator

$$\sqrt{\left(\frac{0.051}{3.11}\right)^2 + \left(\frac{0.2}{21.1}\right)^2}\cdot 0.147 = 2.784 \times 10^{-3}$$ = ± 0.003absolute error

$$\frac{2.784\cdot 10^{-3}}{0.147}\cdot 100 = 1.894$$ = 1.8% CV   ans: 0.147 ± 0.002 (2%)

d.

$$\sqrt{0.0008^2 + 0.002^2 + 0.01^2} = 0.01$$ = ± 0.01absolute error

$$2.0164 + 1.233 + 4.61 = 7.859$$ ans: 7.86 ± 0.01 (0.1%)

$$\frac{0.01}{7.86}\cdot 100 = 0.127$$ 0.1% CV

e. $$\sqrt{0.8^2 + 0.2^2 + 0.1^2} = 0.831$$ = ± 0.8 absolute error

$$2016.4 + 123.3 + 46.1 = 2185.8$$

$$\frac{0.8}{2185.8}\cdot 100 = 0.037$$ = 0.04% CV   ans: 2185.8 ± 0.8 (0.04%)

f. For $y = x^{a}$, $\%e_y = a\ \%e_x$

$$3.14^{\frac{1}{3}} = 1.464$$ value, note: significant figures similar to logarithms

$$\frac{0.05}{3.14}\cdot 100 = 1.592$$ = 1.592% CV of x, i.e. $\%e_x$; intermediate stages, keep all

$$\frac{1}{3}\cdot 1.592 = 0.531$$ = 0.531% CV of y, i.e. $\%e_y$

$$\frac{0.531}{100}\cdot(1.464) = 7.774 \times 10^{-3}$$ = ± 0.008 error in y, final stage the number of decimal places 3

ans: 1.464 ± 0.008 (0.5%)

g. For y = log x, error in y = (0.43429 * e_x)/x

$$\log(3.14) = 0.497$$ value

$$0.43429\cdot\frac{0.05}{3.14} = 6.915 \times 10^{-3}$$ = ± 0.007 i.e. e_y ans: 0.497 ± 0.007 (1%)

20. moles of H^+ reacted = twice the moles of CO_3^{-2} used

moles of CO_3^{-2} = $\frac{0.9674 \cdot gm}{105.989 \cdot \frac{gm}{mole}} = 9.1273623 \times 10^{-3}\,mole$ (note for later: 4 sig. figs.)

it's associated error = $\sqrt{\left(\frac{0.0009}{0.9674}\right)^2 + \left(\frac{0.001}{105.989}\right)^2} \cdot 0.0091274 = 8.492 \times 10^{-6}$

moles of H^+ = 2 x 0.0091274 +- 8.492 x 10^{-6} note: 2 is an integer no error involved

molarity of HCl = $2 \cdot \frac{0.0091274 \cdot mole}{0.02735 \cdot liter} = 0.6675 \frac{mole}{liter}$ (4 sig. figs. will not change here)

it's error = $\sqrt{\left(\frac{8.492 \cdot 10^{-6}}{0.0091274}\right)^2 + \left(\frac{0.00004}{0.02735}\right)^2} = 0.001733$

ans: 0.667 $\pm$ 0.002 mol/L