Math Without a Calculator for AP Chemistry

Number Sense

6.02 × 1000 = _____ 6.02 × 0.01 = _____ 0.1 × 1000 = _____

0.02 × 1000 = _____ 0.3 × 1000 = _____ 0.5 × 1000 = _____

Let fractions be your friends!

Fraction	Decimal	Percent
3/5		
	0.80	
		33%
	0.167	
	1.20	
4/3		
		40%
	0.25	

Example: $\frac{3.00}{1.2}=\frac{3.00}{\frac{6}{5}}=3.00\times\frac{5}{6}=\frac{15}{6}=\frac{5}{2}=2.50$

9. $\frac{600}{0.25}$ = _____

10. $\frac{600}{0.4}$ = _____

11. $\frac{600}{0.03}$ = _____

12. 80% of 1200 = _____

13. 60% of 80 = _____

14. 125% of 1200 = _____

Fermi Estimation Rules

1. Round all values to one significant digit
2. Divide numerator and denominator by any obvious common factor, especially power of ten
3. Combine factors in the denominator and factors in the numerator, by multiplying, except for 100.

Apply the Fermi estimation rules to approximate the following: **No calculator!**

1. $\frac{444}{125} \Big| \frac{746}{738} \Big| \frac{246}{757} =$

2. $\frac{3.65}{676} \Big| \frac{1000}{1.00} \Big| \frac{4.15}{706} \Big| \frac{323}{11.0} =$

3. $\frac{60.0}{3.00} \Big| \frac{17.0}{214} \Big| \frac{666}{37.0} \Big| \frac{44.0}{18.0} =$

4. $\frac{6.47}{2.55} \Big| \frac{0.88}{65.3} \Big| \frac{7.48}{12.2} \Big| \frac{28.9}{5.52} =$

5. $\frac{8.85}{\quad} \Big| \frac{0.70}{6.65} \Big| \frac{72.00}{86.00} \Big| \frac{3.0}{\quad} =$

6. $\frac{48.0}{\quad} \Big| \frac{303}{298} \Big| \frac{102}{205} \Big| \frac{1.0}{1000} =$

7. $\frac{4.00}{\quad} \Big| \frac{1.00}{5.05} \Big| \frac{7.00}{6.00} \Big| \frac{30.0}{\quad} =$

8. $\frac{71.8}{2.77} \Big| \frac{1.62}{189} \Big| \frac{851}{38.6} \Big| \frac{21.2}{19.59} =$

Writing large or small numbers in scientific notation can vastly simplify operations.

$6.02 \times 10^{1} =$ _____ $6.02 \times 10^{-3} =$ _____ $6.02 \times 10^{4} =$ _____

$3.2 \times 10^{-4} = 0.32 \times 10^{?} = 32 \times 10^{?}$ $1.6 \times 10^{8} = 16 \times 10^{?} = 0.16 \times 10^{?}$

Remember these exponent rules:

$a^m \times a^n = a^{m+n}$ $\quad$ $a^m \div a^n = a^{m-n}$ $\quad$ $\left(a^m\right)^n = a^{m \times n}$

$(5 \times 10^{-2})\ (5 \times 10^{-5})$ = _____ $\quad$ $(2.0 \times 10^{-6})^2\ (1.0 \times 10^{-6})$ = _____

$\frac{2.5 \times 10^{-4}}{5.0 \times 10^{-4}}$ = $\quad$ $\frac{8.0 \times 10^{-3}}{5.0 \times 10^{-4}}$ = $\quad$ $\frac{1}{2.0 \times 10^{5}}$ =

(0.00042) (200 000 000) = _____ $\quad$ (0.00042) ÷ (200 000 000) = _____

$(0.0050)^2$ = _____ $\quad$ $(1.0 \times 10^{-5})^2\ (0.5 \times 10^{-5})$ = _____

$\frac{x^2}{1.0 \times 10^{-2}} = 4.0 \times 10^{-12}$ _____ $\quad$ $\frac{x^2}{5.0 \times 10^{-2} - x} = 5.0 \times 10^{-10}$ _____

Sample Multiple Choice questions

1. What is the maximum mass of copper that could be plated out by electrolyzing aqueous $CuCl_2$ for 16.0 hours at a constant current of 3.00 amperes?
   A) 28 grams
   B) 57 grams
   C) 64 grams
   D) 114 grams
   E) 128 grams

2. How many grams of Na_2CO_3 (molar mass = 106.0 g/mol) are required for complete reaction with 25.0 mL of 0.155 M HNO_3?

   $Na_2CO_{3\,(aq)} + 2HNO_{3\,(aq)} \rightarrow 2NaNO_{3\,(aq)} + CO_{2\,(g)} + H_2O_{(l)}$

   a) 0.410 g
   b) 205 g
   c) 0.205 g
   d) 0.122 g

3. Enough water is added to 11.5 grams of ethanol, C_2H_5OH, to make 2.00 liters of solution. What is the molarity of the ethanol?
   a) 0.125
   b) 0.250
   c) 0.500
   d) 5.75
   e) 0.333

4. We have the following equilibrium: $2A \leftrightarrow B$. At equilibrium we measure [A] = 0.056 M and [B] = 0.21 M. Calculate the equilibrium constant for the reaction as written.
   a) 67
   b) 0.015
   c) 3.8
   d) 14

5. Calculate the volume, in milliliters, of 0.200M H_3PO_4 required to completely neutralize 25.0 mL of 0.500M KOH.
   a) 20.8 mL
   b) 25.0 mL
   c) 50.0 mL
   d) 62.4 mL
   e) 75.0 mL

6. A compound containing only carbon and hydrogen is 80.0% by weight carbon. Which of the following represents the empirical formula for the hydrocarbon?
   a) CH
   b) CH_2
   c) C_2H_3
   d) CH_3

7. Approximately what mass of $CuSO_4 – 5H_2O$ (250 g mol^{-1}) is required to prepare 250 mL of 0.10M copper(II) sulfate solution?
    a) 4.0 g
    b) 6.2 g
    c) 34 g
    d) 85 g

8. A 14.0 L cylinder contains 5.60 g N_2, 40.0 g Ar, and 6.40 g O_2. What is the total pressure in atm at 27°C?
    A) 26 x 0.0821
    B) 30 x 0.0821
    C) 60 x 0.0821
    D) 120 x 0.0821

9. In the figure there are three gases present, Gas A, B, and C the number of spheres represents the number of moles of each gas present. If the total pressure within the vessel is 5.0 atm, what is the partial pressure of Gas B?
    A) 1.00 atm
    B) 1.33 atm
    C) 1.50 atm
    D) 1.67 atm

10. Each of the following salts has a solubility of 1.0×10^{-5} M. Rank the salts in order of lowest to highest Ksp.

    AX B_2X C_2X_3 D_3X

    A) $C_2X_3 < D_3X < B_2X < AX$
    B) $C_2X_3 < D_3X < AX < B_2X$
    C) $D_3X < C_2X_3 < B_2X < AX$
    D) $D_3X < B_2X < AX < C_2X_3$

11. In a saturated solution of $Zn(OH)_2$ at 25°C, the value of $[OH^-]$ is 2.0×10^{-6}M. What is the value of the solubility product constant, Ksp, for $Zn(OH)_2$ at 25°C?
    A) 4.0×10^{-18}
    B) 8.0×10^{-18}
    C) 4.0×10^{-12}
    D) 2.0×10^{-6}

12. Consider N_2 *(g)* + O_2 *(g)* ↔ 2 NO *(g)*. The reaction was initiated by adding 15.0 moles of NO to a 1.0-L flask. At equilibrium, 3.0 moles of oxygen are present in the 1.0-L flask. Calculate the value of K*eq*.
    A) 0.33
    B) 3.0
    C) 5.0
    D) 9.0

13. 0.10 mol $NaC_2H_3O_2$ and 0.050 mol HCl was added to 1.0 L of 0.075 M $HC_2H_3O_2$. List the species in order of decreasing equilibrium concentration.

A) $[HC_2H_3O_2] > [C_2H_3O_2^-] > [Cl^-] > [H_3O^+]$
B) $[H_3O^+] > [Cl^-] > [C_2H_3O_2^-] > [HC_2H_3O_2]$
C) $[HC_2H_3O_2] = [C_2H_3O_2^-] > [Cl^-] = [H_3O^+]$
D) $[Cl^-] = [H_3O^+] > [HC_2H_3O_2] = [C_2H_3O_2^-]$

14. Consider the equilibrium

$$H_2\,(g) + I_2(g) \leftrightarrow 2\,HI\,(g)$$

In a closed system, the initial partial pressure of hydrogen is 1.25 atm and the initial partial pressure of iodine is 1.75 atm. At equilibrium, the partial pressure of hydrogen is 1.00 atm. Which expression gives the value of K*p* for this system?

A) $\dfrac{(0.50)^2}{(1.00)\,(1.75)}$

B) $\dfrac{(0.25)^2}{(1.25)\,(1.75)}$

C) $\dfrac{(0.50)^2}{(1.00)\,(1.50)}$

D) $\dfrac{(0.25)^2}{(1.00)\,(1.50)}$

15. What is the enthalpy change for the following reaction under standard conditions?

$$CS_2\,(l) + 2\,O_2\,(g) \rightarrow CO_2\,(g) + 2\,SO_2\,(g)$$

ΔH^o_f CS *(l)* = +88 kJ/mol
$\Delta H^o_f\,CO_2$ *(g)* = −394 kJ/mol
$\Delta H^o_f\,SO_2$ *(g)* = −297 kJ/mol

A) −1076 kJ/mol
B) −900 kJ/mol
C) −779 kJ/mol
D) −603 kJ/mol

16. Consider the reaction $C_2H_5OH(l) + 3\,O_2(g) \rightarrow 2\,CO_2(g) + 3\,H_2O(l)$ $\Delta H = -1.37 \times 10^3$ kJ/mol

When a 15.1 g sample of ethyl alcohol (molar mass = 46.1 g/mol) is burned, how much energy is released as heat?

A) 0.449 kJ
B) 2.25×10^3 kJ
C) 4.49×10^2 kJ
D) 1.02×10^3 kJ