

Essential Tool for Chemistry Concepts, Variables & Equations, Including Sample Problems, Common Pitfalls & Helpful Hints

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Your success in chemistry depends on your ability to solve numerical problems.

## BASIC SKILLS

### CALCULATOR SURVIVAL

- Become familiar with your calculator.
- Before the exam, make sure you can multiply, divide, add, subtract and use all needed functions.
- Calculators never make mistakes; they take your input (rounded & accidentally) and give an answer.
- Look at the answer; does it make sense?
- Do a quick estimate to check your work.
- Sample:**  $4.34 \times 7.68(1.65 \times 9.8)$  is roughly  $4 \times 8(1 \times 10)$  or 32; the actual answer 3.24.

### HOW TO DO WORD PROBLEMS

- Read and evaluate the question before you start plugging numbers into the calculations.
- Identify the variables, constants and equations.
- Write out units of the variables and constants.
- Work out the unit before the number.
- You may have extra information, or you may need to obtain constants from your text.

### HOW TO WORK WITH UNITS

All numerical data has units. In chemistry, we use metric "SI" units.

- Pitfall:** If the unit is wrong, the answer is wrong!
- Unit problem: Convert pascals of "10"
- 1 atm =  $10^5$  pascals =  $10^5$  pascals
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- 2. Fundamental Units**
  - Mass: kilogram (kg)
  - Length: meter (m)
  - Temperature: Kelvin (K)
  - Time: second (s)
  - Amount of a substance: mole
  - Electric charge: coulomb, (C)

- 3. Derived Units**
  - Area: length squared,  $m^2$
  - Volume: length cubed,  $m^3$ ; 1 liter (L) =  $1 dm^3$
  - Density: mass/volume; common unit  $kg/m^3$
  - Speed: distance/time; common unit  $m/s$
  - Electric current: ampere (A) =  $1 C/s$
  - Force: Newton (N) =  $1 kg \cdot m/s^2$
  - Energy: Joule (J) =  $1 kg \cdot m^2/s^2$
  - Pressure: Pascal (Pa) =  $1 kg/m \cdot s^2$

### 4. Fundamental Constants

Mass	in units (g/mole)	in kg
electron	$9.109 \times 10^{-31}$	$9.109 \times 10^{-31}$
proton	$1.6726 \times 10^{-27}$	$1.6726 \times 10^{-27}$
neutron	$1.6749 \times 10^{-27}$	$1.6749 \times 10^{-27}$
Electronic charge	$1.6022 \times 10^{-19} C$	
Avogadro's number, $N_A$	$6.02214 \times 10^{23}$	
Ideal gas constant, R		
R, for gas calculations	$8.314 J/(K \cdot mol)$	
R, for energy calculations	$8.314 J/(K \cdot mol)$	
Faraday Constant, $F$	$96,485 C/mol$	
Planck's Constant, $h$	$6.626 \times 10^{-34} J \cdot s$	
Speed of light, $c$	$2.9979 \times 10^8 m/s$	

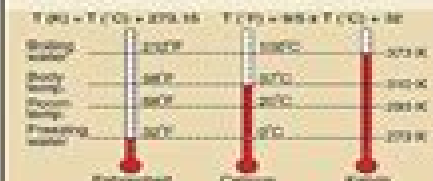
## BASIC SKILLS cont.

### HOW TO CONVERT DATA

The unit & numerical value are changed using a conversion factor or equation.

### HOW TO USE EQUATIONS FOR DATA CONVERSION

- Sample:** Convert temperature of  $40^\circ C$  to  $^\circ F$  and Kelvin.
- Given:  $K = ^\circ C + 273.15$
- Calculate: Temperature in  $K = 40^\circ C + 273.15 = 313.15 K$
- Given:  $^\circ F = 9/5 ^\circ C + 32$
- Calculate: Temperature in  $^\circ F = 9/5 \times 40^\circ C + 32 = 104^\circ F$



### HOW TO USE A CONVERSION FACTOR

- Sample:** "1 hour = 60 minutes" gives two conversion factors.
- 1. Multiply by "1 hour/60 minutes" to convert minutes to hours.
- 2. Multiply by "60 minutes/1 hour" to convert hours to minutes.
- Sample:** Determine the number of hours in 45 minutes.
- Given: Conversion factor is "1 hour/60 minutes"
- Calculate: Time = 45 minutes  $\times$  (1 hour/60 minutes) = 0.75 hour (minutes cancel).

### Common conversions:

1 calorie	= 4.184 J	1 kg	= 2.2 lb	1 m	= 1.1 yd
1 g	= 0.001 kg	1 atmosphere (atm)	= $1 \times 10^5$ Pa		
1 atm	= $1.01325 \times 10^5$ Pa	1 atm	= 760 mm Hg		

**Pitfall:** Equations and conversion factors have units. Review of inserting conversion factors.

## MATH REVIEW

### HOW TO WORK WITH ALGEBRAIC EQUATIONS

Give equal treatment to each side.

- Add or subtract:**
  - Sample:** Given,  $x + 3$ , then,  $x + 3 = 4 + 3$ .
- Multiply or divide:**
  - Sample:** Given,  $x = y$ , then,  $4x = 4y$  and  $x/2 = y/2$ .
  - Given:  $x = 3 + 4$ , then  $4x = 4(3 + 4) = 4(7) = 28$ ,  $x \neq 2$ .
  - Pitfall:** Dividing by zero is not allowed.

### HOW TO WORK WITH SCIENTIFIC NOTATION

The exponent gives the power of 10.

- Sample:**  $0.00045 = 4.5 \times 10^{-4}$ ;  $0.45 = 4.5 \times 10^{-1}$
- Sample chemical applications:** Molar masses are  $10^{-3}$  mol; 1 liter of water contains about  $1 \times 10^{24}$  atoms.

## MATH REVIEW cont.

### HOW TO USE LOGARITHMS & EXPONENTS

- Common logarithm,  $\log_{10}$ , base "10":**
  - Denotes number or function in powers of 10.
  - Sample:** Given,  $y = 10^5$ , then  $\log_{10} y = 5$ .
- Natural logarithm,  $\ln$ , base "e":**  $\ln(x) = 2.718281828$ 
  - Denotes number or function in powers of "e."
  - Sample:** Given,  $x = e^5$ , then  $\ln x = 5$ .
- Products:**  $\log(xy) = \log x + \log y$
- Powers:**  $\log(x^y) = y \log(x)$
- Multiplication:** Add exponents from each term.
  - Sample:**  $10^2 \times 10^3 = 10^{2+3} = 10^5$ .
- Division:** Subtract denominator exponents from numerator exponents.
  - Sample:**  $10^2/10^3 = 10^{2-3} = 10^{-1}$ .
- Square root:**  $\sqrt{x} = x^{1/2}$
- Reciprocal:**  $1/x = x^{-1}$

**Pitfall:** Your calculator has separate keys for  $\ln$  (base  $e$ ),  $\log$  (base 10),  $10^x$  and  $e^x$ .  
Sample chemical applications: pH of acid and base.

### HOW TO CALCULATE ROOTS OF A POLYNOMIAL

An equation of the form,  $ax^2 + bx + c = 0$  has 2 solutions or roots, given by the quadratic formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

- Sample:** Determine the roots for the equation:  $3x^2 - 4x + 1 = 0$
- Given:  $a = 3$ ,  $b = -4$ ,  $c = 1$
- Calculate: Root 1 =  $\frac{-(-4) + \sqrt{(-4)^2 - 4(3)(1)}}{2(3)} = \frac{4 + \sqrt{16 - 12}}{6} = \frac{4 + 2}{6} = 1$
- Calculate: Root 2 =  $\frac{-(-4) - \sqrt{(-4)^2 - 4(3)(1)}}{2(3)} = \frac{4 - 2}{6} = \frac{2}{6} = \frac{1}{3}$

**Pitfall:** Reround round off error. Substitute the roots into the equation to verify results.  
Sample chemical applications: Weak acids, weak bases, buffers, chemical equilibria.

### HOW TO DETERMINE THE EQUATION OF A LINE

LINEAR EQUATION:  $y = mx + b$

- $m$ , slope of the line;  $m = \Delta y/\Delta x$
- $b$ , y-intercept; the line crosses the y-axis at  $(0, b) = y_0$ ,  $x = 0$ .
- Sample:** Determine the equation of a line using  $(x, y)$  data.
- Given:  $(1, 2)$ ,  $(2, 4)$ ,  $(3, 6)$
- Calculate: Slope =  $m = \Delta y/\Delta x = (3 - 1)/(3 - 1) = 2/2 = 1$
- Calculate: y-intercept =  $b = y_0 - mx_0 = (2) - (1)(1) = 2 - 1 = 1$
- The equation of the line is  $y = 1x + 1$ .
- Sample chemical applications:** Gas calculations, Beer's Law; studying reaction-rate data.



# Chemistry Equations Answers Quickstudy Academic

**Huangqi Zhang**



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