Logarithms

Logarithms

Logarithms are useful

- when quantities vary on many orders of magnitude
  - $[H^+]$ → pH = -log $[H^+]$
- Solving some problems involving exponents

Logarithms

Logarithms and exponentiation are inverse functions

- one will undo the other

If $y = b^x$

Then the logarithm of y to base b is x

$\log_b(y) = x$

The logarithm of y is the number, x, to which the base, b, must be raised to equal y

Logarithms

In chemistry, the only bases used are base 10 and base e

- Base 10 logarithms
  - common logarithm
  - written as log, the b is omitted
  - "log" key on your calculator
- Base e logarithms
  - natural logarithms
  - e = 2.718 …
  - written as ln
  - "ln" key on your calculator

Logarithms

Try these

	log	ln
734		
0.0150		
4.47×10^{-5}		

Then use the exponential function to get the original number back.

Logarithms

Try these

	log	ln
734	2.866	6.599
0.0150	-1.824	-4.200
4.47×10^{-5}	-4.350	-10.016

Logarithms

Useful relationships valid for either log on ln

- $\log(xy) = \log(x) + \log(y)$

  $x = 10^{\log(x)}$ and $y = 10^{\log(y)}$

  $xy = 10^{\log(x)} \times 10^{\log(y)} = 10^{\log(x) + \log(y)}$

  $\therefore \log(xy) = \log(x) + \log(y)$

- $\log(x/y) = \log(x) - \log(y)$
- $\log(x^a) = a \log(x)$

  $\log(x^2) = \log(x\,x) = \log(x) + \log(x) = 2\log(x)$

Logarithms

To convert between log and ln

- $\ln(x) = \ln(10) \log(x) = 2.303 \log(x)$

  $$x = e^{\ln(x)} = 10^{\log(x)} = \left(e^{\ln(10)}\right)^{\log(x)} = e^{\ln(10)\log(x)}$$

  $\therefore \ln(x) = \ln(10) \log(x)$

Logarithms

In lab 2 logarithms will be used to find the order of a reaction

The rate of reaction will be measured for different reactant concentrations.

Will have to solve equations such as

$0.464 = 0.500^x$

Take log of both sides

$\log(0.464) = \log(0.500^x) = x \log(0.500)$

$$x = \frac{\log(0.464)}{\log(0.500)} = 1.11$$

Try solving the following equation for x

$2.3 = (1.5)^x$