L6 – 6.5 – Applications of Logarithms in Physical Sciences

MHF4U

Part 1: Review of Solving Logarithmic Equations

Example 1: Solve for x in the following equation

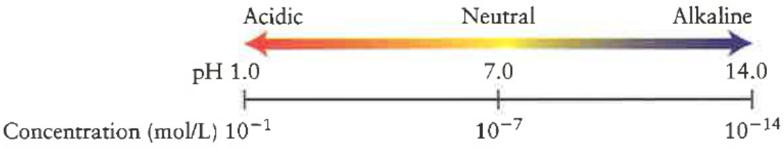
$$\log_2(x-6) = 4 - \log_2 x$$

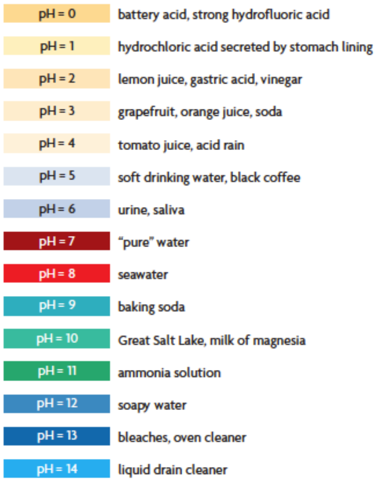
Part 2: pH Scale

The pH scale is used to measure the acidity or alkalinity of a chemical solution. It is defined as:

$$pH = -\log[H^+]$$

where $[H^+]$ is the concentration of hydronium ions, measured in moles per liter.





pH = 0	battery acid, strong hydrofluoric acid
pH = 1	hydrochloric acid secreted by stomach lining
pH = 2	lemon juice, gastric acid, vinegar
pH = 3	grapefruit, orange juice, soda
pH = 4	tomato juice, acid rain
pH = 5	soft drinking water, black coffee
pH = 6	urine, saliva
pH = 7	"pure" water
pH = 8	seawater
pH = 9	baking soda
pH = 10	Great Salt Lake, milk of magnesia
pH = 11	ammonia solution
pH = 12	soapy water
pH = 13	bleaches, oven cleaner
pH = 14	liquid drain cleaner

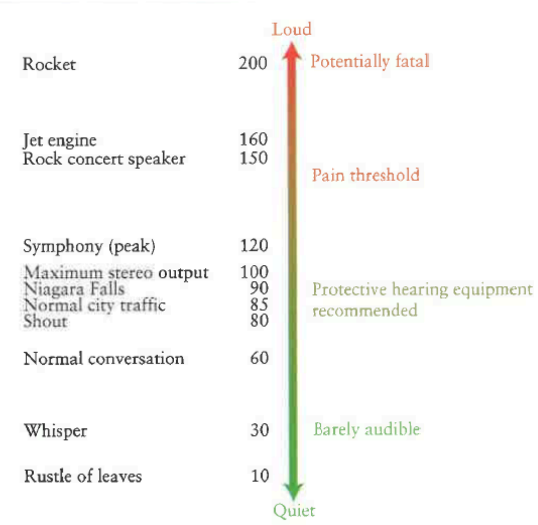
Example 2: Answer the following pH scale questions

a) Tomato juice has a hydronium ion concentration of approximately 0.0001 mol/L. What is its pH?

b) Blood has a hydronium ion concentration of approximately 4×10^{-7} mol/L. Is blood acidic or alkaline?

c) Orange juice has a pH of approximately 3. What is the concentration of hydronium ions in orange juice?

Part 3: Decibel Scale


Loud
Rocket 200
Potentially fatal
Jet engine 160
Rock concert speaker 150
Pain threshold
Symphony (peak) 120
Maximum stereo output 100
Niagara Falls 90
Normal city traffic 85
Shout 80
Protective hearing equipment recommended
Normal conversation 60
Whisper 30
Barely audible
Rustle of leaves 10
Quiet

Some common sound levels are indicated on the decibel scale shown. The difference in sound levels, in decibels, can be found using the equation:

$$\boldsymbol{\beta_2 - \beta_1 = 10\log\left(\frac{I_2}{I_1}\right)}$$

where, $\beta_2 - \beta_1$ is the difference in sound levels, in decibels, and $\frac{I_2}{I_1}$ is the ratio of their sound intensities, where I is measured in watts per square meter (W/m^2)

Example 3: Answer the following questions about decibels

a) How many times as intense as a whisper is the sound of a normal conversation

b) The sound level in normal city traffic is approximately 85 dB. The sound level while riding a snowmobile is about 32 times as intense. What is the sound level while riding a snowmobile, in decibels?

Part 4: Richter Scale

The magnitude, M, of an earthquake is measured using the Richter scale, which is defined as:

$$\boldsymbol{M = \log\left(\frac{I}{I_0}\right)}$$

where I is the intensity of the earthquake being measured and I_0 is the intensity of a standard, low-level earthquake.

Example 4: Answer the following questions about the Richter Scale

a) How many times as intense as a standard earthquake is an earthquake measuring 2.4 on the Richter scale?

b) What is the magnitude of an earthquake 1000 times as intense as a standard earthquake?