Applications to Exponential and Logarithmic Functions[1]

1. In curing concrete the strength after t days of curing is given by the equation,

   $$f = f_c(1 - e^{-kt}).$$

   Where f_c is the ultimate strength.

   a. If it takes 6 days for the concrete to get 65% of its ultimate strength, find k.

   b. How long will it take for the concrete to get 92% of its ultimate strength.

2. Newton's Law of Cooling (Warming)[2]: The temperature T of an object at time t is given by the formula

   $$T(t) = T_a + (T_0 - T_a)e^{-kt}$$

   where $T(0) = T_a$ is the initial temperature of the object, T_a is the ambient temperature and $k > 0$ is the constant of proportionality.

   A 20° object is cooked in a 200°C oven. After 3 hours the temperature of the object is 40°C.

   a. Assuming the temperature of the object follows Newton's Law of Warming, find a formula for the temperature of the object T as a function of its time in the oven, t, in hours.

   b. The object is done cooking when the internal temperature reaches 175°C. After how many hours will the object be cooked?

[1] by Yann Lamontagne `http://obeymath.org`, compiled on September 24, 2015

[2] from Precalculus, version 3, Carl Stitz and Jeff Zeage, 2011

3. Sound pressure level (SPL) or sound level L_p is a logarithmic measure of the effective sound pressure of a sound relative to a reference value. It is measured in decibels (dB) above a standard reference level.

$$L_p = 10\log_{10}\left(\frac{{p_{\text{rms}}}^2}{{p_{\text{ref}}}^2}\right) \text{ dB}$$

where $p_{\text{ref}} = 20\mu\text{P}$ is the reference sound pressure and p_{rms} is the rms sound pressure being measured.[3]

According to the article *Traffic Induced Noise Pollution in Dhaka City* "the average noise level in the road side in Dhaka city is about 78dB(A) which far exceeds the acceptable limit of 60 dB(A) set by the Department of Environment".

Assuming dB = dB(A) in the above equation find p_{rms} when the sound pressure level is measured at 78dB(A).

4. The moment magnitude scale (M_{w}) is used by seismologists to measure the size of earthquakes in terms of the energy released. M_{w} is a dimensionless number defined by

$$M_{\text{w}} = \frac{2}{3}\log_{10} M_0 - 10.7,$$

where M_0 is the magnitude of the seismic moment in dyne centimeters.[4]

The 2010 Central Canada earthquake was a magnitude 5.0 M_{w} earthquake that occurred in Central Canada on June 23, 2010.[5]. Compute M_0 the magnitude of the seismic moment.

[3] Wikipedia.org: Sound pressure
[4] Wikipedia.org: Moment magnitude scale
[5] Wikipedia.org: 2010 Central Canada earthquake