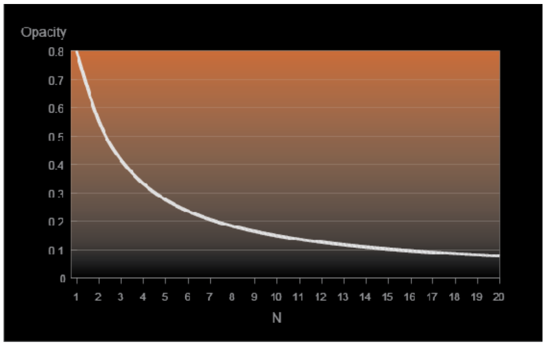

This curve shows how much light is transmitted through a stack of 20 filters if each filter reduces the transmitted light by 20%.

After the first filter, N=1, the light intensity has been reduced from 100% to 80%.

After passing through the second filter, N=2, the light intensity is reduced to

$100\% \times 0.8 \times 0.8 = 100\% \times (0.8)^2 = 64\%$.

The reduction of light brightness as it passes through an aerosol cloud is not an additive process, but a multiplicative one. The figure to the left shows how light brightness changes as it passes through stacks of filters of varying lengths from 1 to 20. Note that the curve is not a straight line as it would be if the dimming were additive.

Scientists measure the dimming of light by the distance at which the light brightness is reduced by exactly 2.718 times or from 100% to 36.8%. Because aerosols are very dilute, the distance to which the light intensity falls to 36.8% is typically measured in kilometers. A basic mathematical function that describes light attenuation is given by

$$I(x) = 1.0\, e^{-x/L}$$

where L is the attenuation distance in kilometers and X is the length of the path through the aerosols.

Problem 1 – Suppose that for a particular cloud of aerosols the attenuation distance is 2 kilometers and the actual thickness of the cloud is 0.5 kilometers. What will be the light intensity to the nearest percent for a light ray passing through this cloud?

Problem 2 – For convenience, the attenuation distance L is usually reported as the extinction coefficient C = 1/L in units of km^{-1}. A) What is the equation for I(x) in terms of C? B) What is the value for I(x) in percent for a cloud with C = 0.20 km^{-1} and a cloud thickness of x=20 km?

Problem 3 – The SAGE-III instrument will measure the stratospheric aerosols, which have an average extinction of 1.2×10^{-4} km^{-1}. Light from the rising and setting sun will be measured along a path through the stratosphere that is about 3,000 km in length. What is the intensity of sunlight reaching the SAGE-III instrument?

Problem 1 – Suppose that for a particular cloud of aerosols the attenuation distance is 2 kilometers and the actual thickness of the cloud is 0.5 kilometers. What will be the light intensity to the nearest percent for a light ray passing through this cloud?

Answer: L = 2 km and x = 0.5 km so I = 100% x e(-0.5/2) = **78%**

Problem 2 – For convenience, the attenuation distance L is usually reported as the extinction coefficient C = 1/L in units of km^{-1}. A) What is the equation for I(x) in terms of C? B) What is the value for I(x) in percent for a cloud with C = 0.20 km^{-1} and a cloud thickness of x=20 km?

Answer: A) **$I(x) = 1.0\ e^{-Cx}$** B) $I(20) = 100\%\ e^{(-0.2x20)}$ = **1.8%**

Problem 3 – The SAGE-III instrument will measure the stratospheric aerosols, which have an average extinction of 1.2×10^{-4} km^{-1}. Light from the rising and setting sun will be measured along a path through the stratosphere that is about 3,000 km in length. What is the intensity of sunlight reaching the SAGE-III instrument?

Answer: $I(3000km) = 100\%\ e^{(-0.00012)(3000)}$ = **69.7%**.