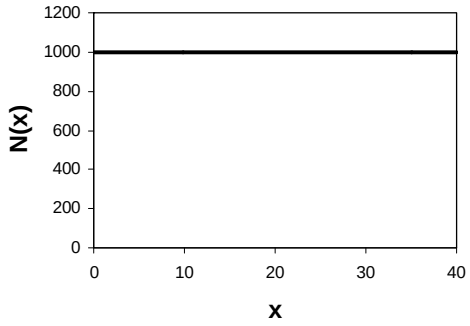
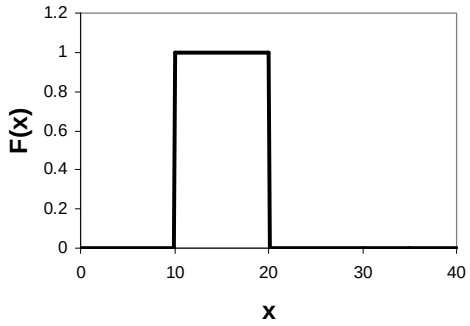
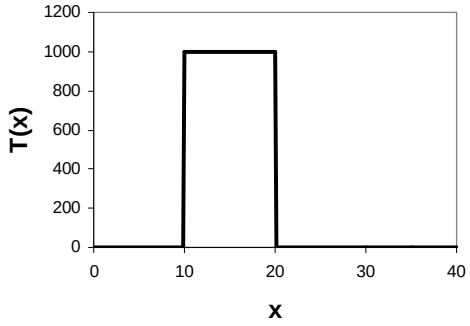
Graph of photon emission N(x)



Graph of filter transmission F(x)



Graph of photon transmission T(x)



Sunglasses are one of the most common, every-day filters that we use. They work in much the same way as the far more sophisticated filters used in professional and scientific photography and digital imaging.

A light source creates huge numbers of photons all across the electromagnetic spectrum. A filter blocks out all of the photons and passes only a narrow range of photons with the desired wavelengths. This process can be described mathematically.

Suppose a light source emits N photons according to the function N(x)=1000 photons shown in the graph to the left (Top). Suppose a filter can be defined according to the piecewise function F(x) = 1.0 for $10 < x < 20$, and F(x)=0 for all other values of x (middle graph). The number of photons passed by this filter is given by T(x) = N(x)F(x). It is easy to see in the bottom graph for T(x) that only photons between $10 < x < 20$ will be passed. The number of photons passed is just P = T(x)x(dx) where the base length is defined by the dx=20-10 = 10-unit width of the filter between x=10 and x=20, and the height is just 1000, so P = 1000x10 = 10,000 photons.

Problem 1 – Suppose that N(x)=1000 and the filter is designed to match the table below:

x	F(x)
0 to 20	0
21 to 25	0.5
26 to 30	1.0
31 to 40	0.5
41 to infinity	0

A) Graph N(x) and F(x). B) What is the total number of photons passed? (Hint: create a table for each wavelength interval) and list N(x), F(x),T(x) and P)

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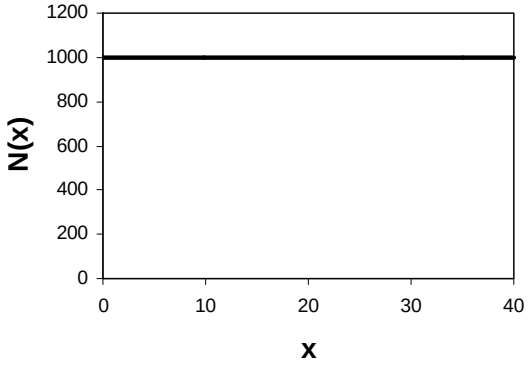
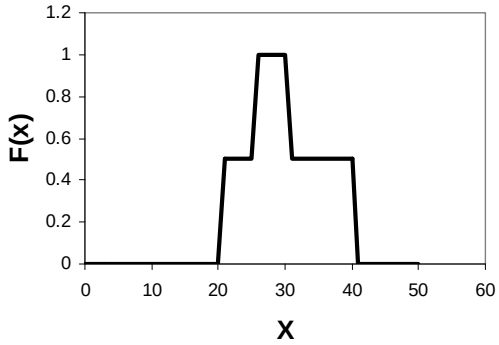
Answer:

A) See below:





B) For each wavelength interval defined by the filter function, compute the product of NxFx(dx) and the wavelength interval, dx, and then sum the results as shown in the table below:

x	dx	N(x)	F(x)	P=NxFx(dx)
0 to 20	20	1000	0	0
21 to 25	4	1000	0.5	2000
26 to 30	4	1000	1.0	4000
31 to 40	9	1000	0.5	4500
41 to infinity	infinity	1000	0	0

The total number of photons passed is
P = 2000+4000+4500 so
P=10,500 photons