Chem 353
Take-Home Assignment 2

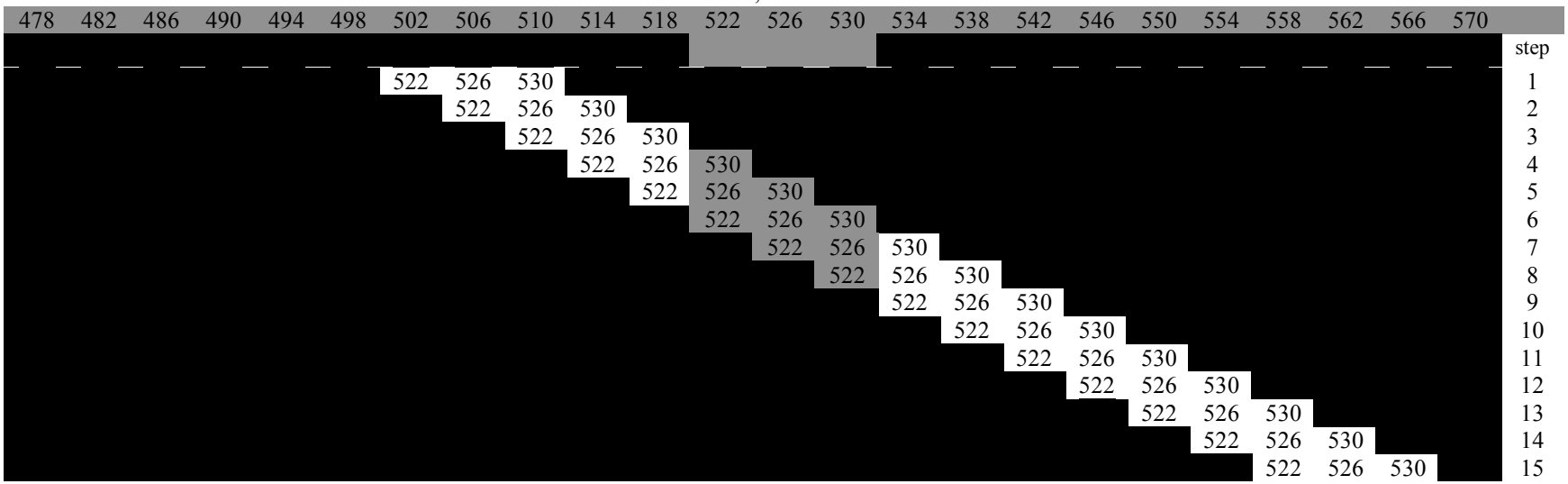
Exploring the Importance of Slit Widths

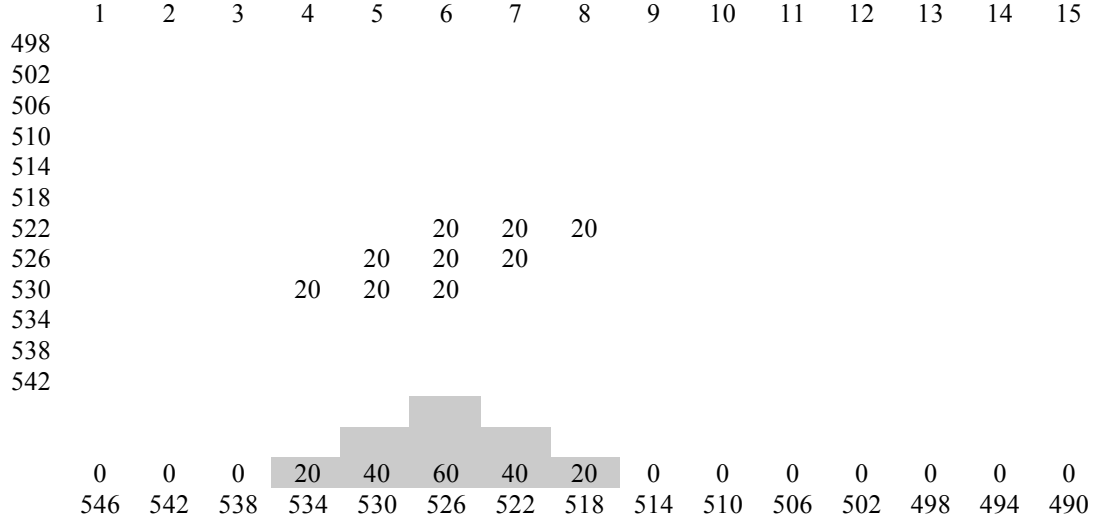
On the back of this page is a simulation demonstrating how the width of a monochromator's entrance and exit slits affects the resulting output of a spectral scan. This simulation uses a monochromatic source of radiation at $\lambda = 526$ nm with both the entrance and exit slit widths set to 12 nm. The numbers along the top show the wavelength scale when the entrance and exit slits are mutually centered. The numbers give the wavelength in the center of a cell; thus, when the slits are mutually centered, the entrance slit is passing radiation from 520 nm to 532 nm and the exit slit is passing radiation from 520 nm to 532 nm. In this example the exit slit and the entrance slit are of equal width, each being 12 nm. Cells with a gray shading show radiation from the source with each gray cell representing a power of 20 units.

Scanning the monochromator occurs in steps. In the first step, the monochromator's exit slit is set to pass radiation from 540 nm – 552 nm, with the radiant power recorded at 546 nm. Because the entrance slit always passes radiation from 520 nm – 532 nm, no radiation exits the monochromator. In the second step the monochromator's exit slit passes radiation from 536 nm – 548 nm with the radiant power recorded at 542 nm (note that we are scanning to shorter wavelengths); again, the radiant power is 0. Continuing in this fashion, in the fourth step the exit slit passes radiation from 528 nm – 540 nm and for the first time the slits overlap with 20 units of radiant power exiting the monochromator. At step 6 the two slits are perfectly aligned and 60 units of radiant power reach the detector. At step 8 the exit slits allows radiation from 512 nm – 524 nm and 20 units of radiant exit the monochromator. At step 9 the exit slit, which passes radiation from 508 nm – 520 nm, no longer overlaps the entrance slit and no radiant power reaches the detector. The resulting spectral scan shows a triangular output of power vs. wavelength, with the power rising from 0 at $\lambda = 538$ nm, reaching a maximum value of 60 at $\lambda = 526$ and then falling to 0 at $\lambda = 514$ nm. The effective bandwidth, λ_{eff}, is 12 nm and the width at the baseline is 24 nm.

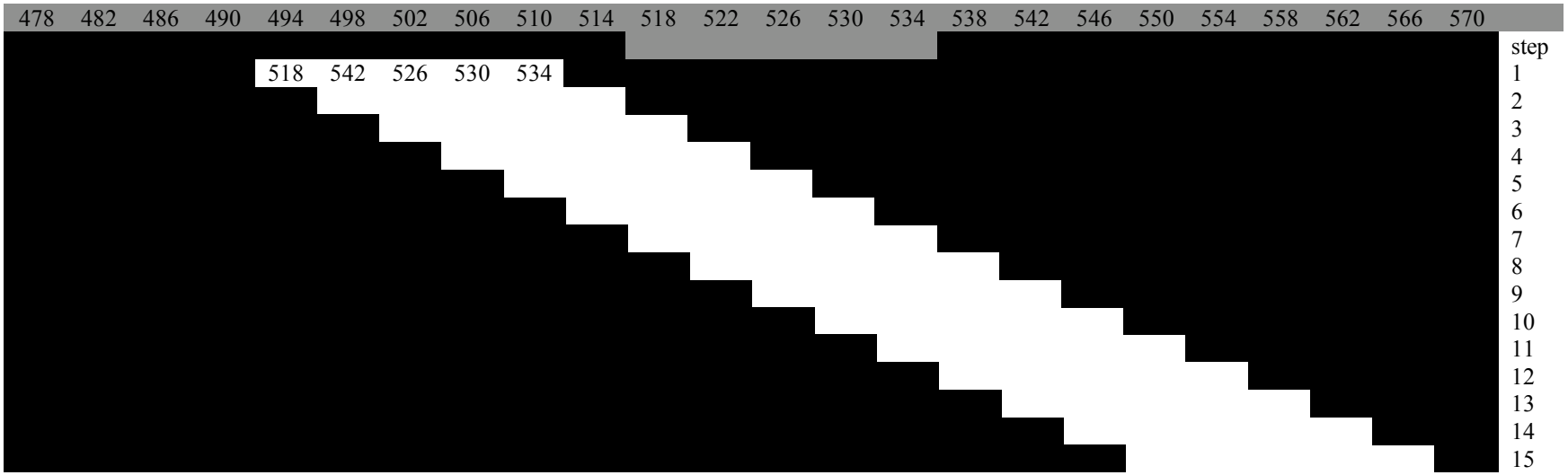
For this assignment, analyze the scenarios on the remaining pages and then write a short essay (no more than one typed page not including figures) in which you discuss the effect of slit width on the amount of radiant power reaching the detector and on the ability to resolve closely spaced wavelengths, and as to whether there is any benefit in using entrance and exit slits with different widths. In addition, discuss what situations might favor smaller or larger slit widths. Your essay, which should be well-written, is due in class on Monday, February 18th. Be sure to support your answers with appropriate plots of radiant power vs. wavelength.

Source radiation at λ = 526 nm; width of entrance and exit slit = 12 nm

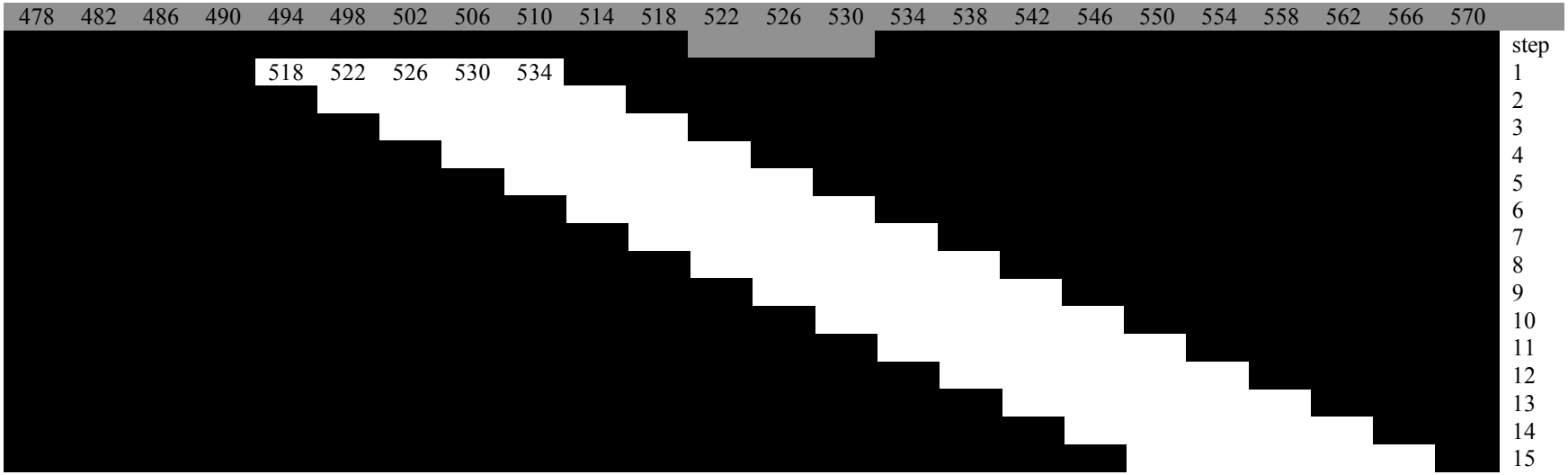




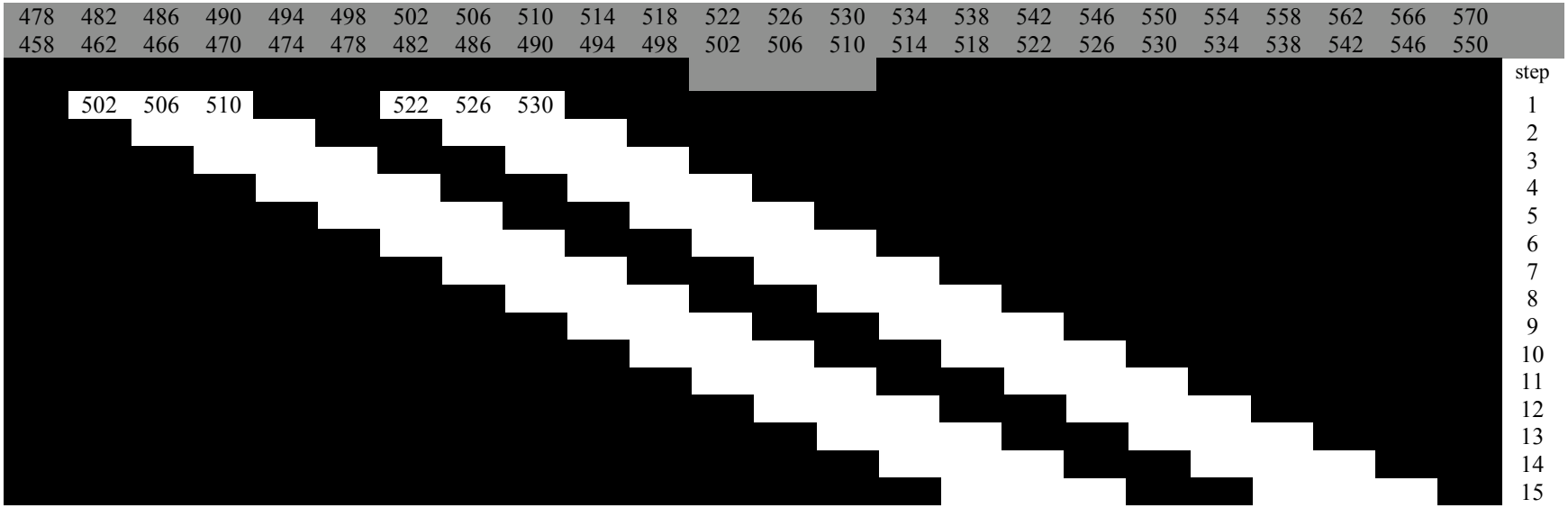
Scenario 1: Source radiation at λ = 526 nm; width of entrance and exit slit = 20 nm



Scenario 2: Source radiation at λ = 526 nm; width of entrance slit = 12 nm; width of exit slit = 20 nm



Scenario 3: Source radiation at λ = 506 nm and 526 nm; width of entrance slit = 12 nm; width of exit slit = 12 nm



Scenario 4: Source radiation at λ = 502 nm and 530 nm; width of entrance slit = 12 nm; width of exit slit = 12 nm