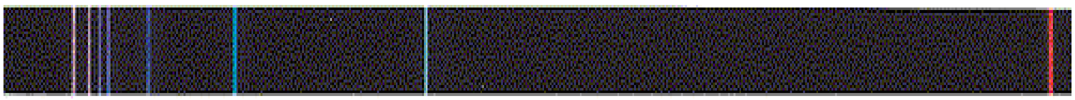
Dry Lab 3 – Atomic Structure and Molecular Geometry

Part A

Heated atoms (and molecules, like [NO_2]) release photons when excited e^{-1}'s drop from a higher energy level to a lower energy level. This creates a visible atomic emission spectrum that is unique for each element. Below is the visible spectrum for hydrogen. Observe the blue-green line at 486 nm, which is where the H atom's e^{-1} drops from n = 4 to n = 2. In the chapter 7 class notes, we saw how to calculate the photons' wavelength. Also, observe the red line at 656 nm. We calculated the energy, frequency, and wavelength of its photons in the chapter 7 homework.

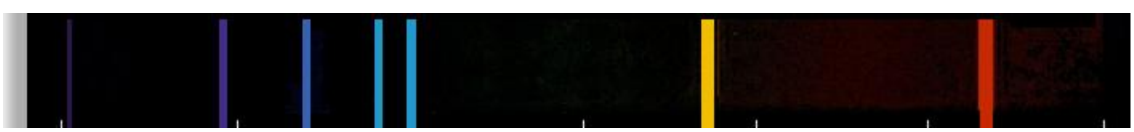


Wavelength (nm)

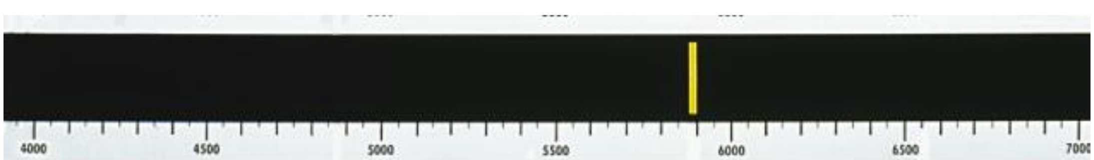
Use Table D3.5 to identify the elements in the following three spectra.
Then, identify the wavelengths listed on the table that are visible in these elements' spectra.
Spectrum 1 contains seven of the wavelengths that are listed on the table for its element.

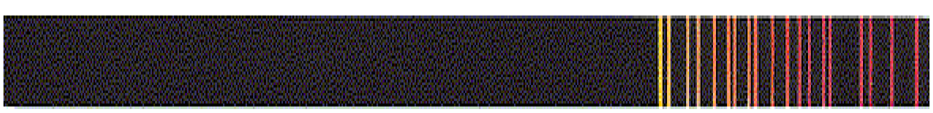
The element in spectrum 2 contains wavelengths with both very high and very low relative intensities. However, only the wavelengths with high intensities are observed. The wavelengths with low intensities are not observed because they are masked by those with high intensities. Also, the two wavelengths observed are so close together that they appear to be only one line.

Spectrum 3 has a band of many lines in a small region.
As you identify the element, count the number of lines and note their overall range.
Then, state the wavelength for each of those lines.



400 450 500 550 600 650 700
Wavelength (nm)





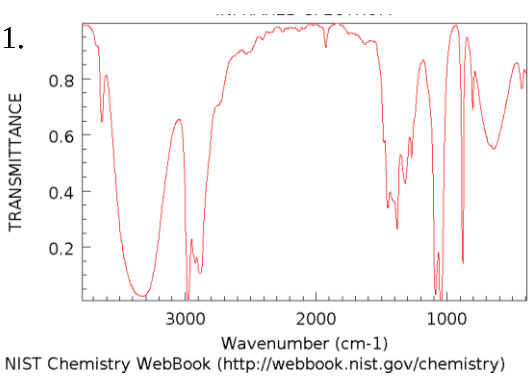
400 450 500 550 600 650 700
Wavelength (nm)

Part B

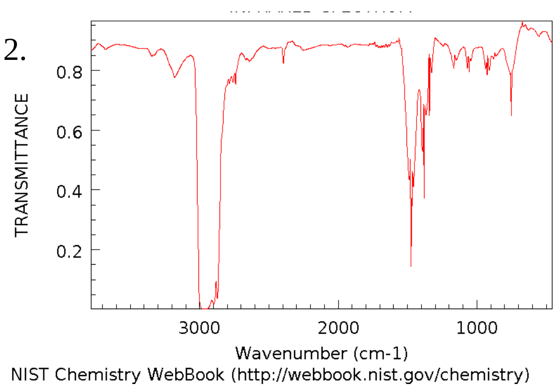
Chemical bonds are like springs, and they vibrate when they absorb infrared radiation ([like CO_2]). Bonds absorb infrared at the same characteristic wavenumbers (cm^{-1}) almost regardless of the rest of the molecule. So, a particular wavenumber will generally tell us that a particular chemical bond is present on a molecule. Where the bond absorbs infrared, the transmittance (what is not absorbed) drops to a low value (near bottom of spectrum plot). Below is a table of chemical bonds and their characteristic wavenumbers. Use this table to determine which wavenumbers (cm^{-1}) and bonds are present in the four infrared spectra below. Then, match each spectrum with its compound from the list below the spectra.

C−H	2850-2960 (strong - medium)
	1500 (medium) and 750 (weak) may be present as well
O−H	3200 – 3500 (strong and very broad)
C−O	1050 – 1150 (strong)
C=O	1670 – 1780 (very strong)
C=C	1640 – 1680 (medium – weak)

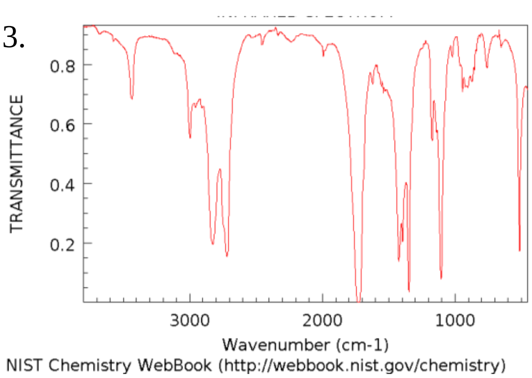
1.



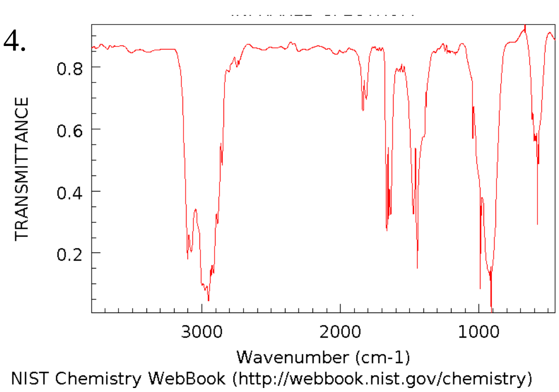
2.



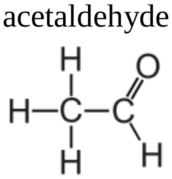
3.



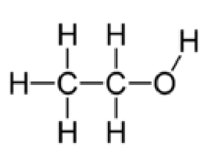
4.



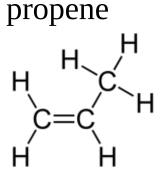
Compounds: acetaldehyde



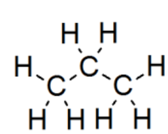
ethanol



propene



propane



Part C

Refer to Examples 9.07, 9.11, 9.12, 10.01, and 10.05,
as well as to the molecular geometry charts.
Complete the molecular geometry table for the following substances and ions.
The central atom is boldfaced and italicized.
COBr_2 , Cl***C***N, ***P***F_3, H_2***N***$^{-1}$ (Each has a central atom that follows the octet rule.)
PF_5, ***I***F_3, ***Xe***Cl_2, ***S***O_4^{-2} (Each has a central atom with more than eight valence e^{-1}'s)

Lab Questions

1. Beta-carotene absorbs primarily blue and violet light in the visible spectrum. Explain why it appears orange. Do you see the light that is absorbed? What do you see instead?

2. Molecular vibrational transitions absorb infrared radiation, while electronic transitions of double bonds absorb ultraviolet radiation. Use Figure 6.3, along with the equations $E = hc/\lambda$ and $E = h\nu$, to explain how the energies of infrared and ultraviolet compare with visible light transitions. That is, do they have higher or lower energies than visible light?

3. Suppose that an excited electron emits a photon, and the photon's wavelength is then measured. Explain the type of change that has occurred to the electron to allow it to emit a photon. Explain how you would mathematically determine the energy and frequency of the photon using its wavelength.