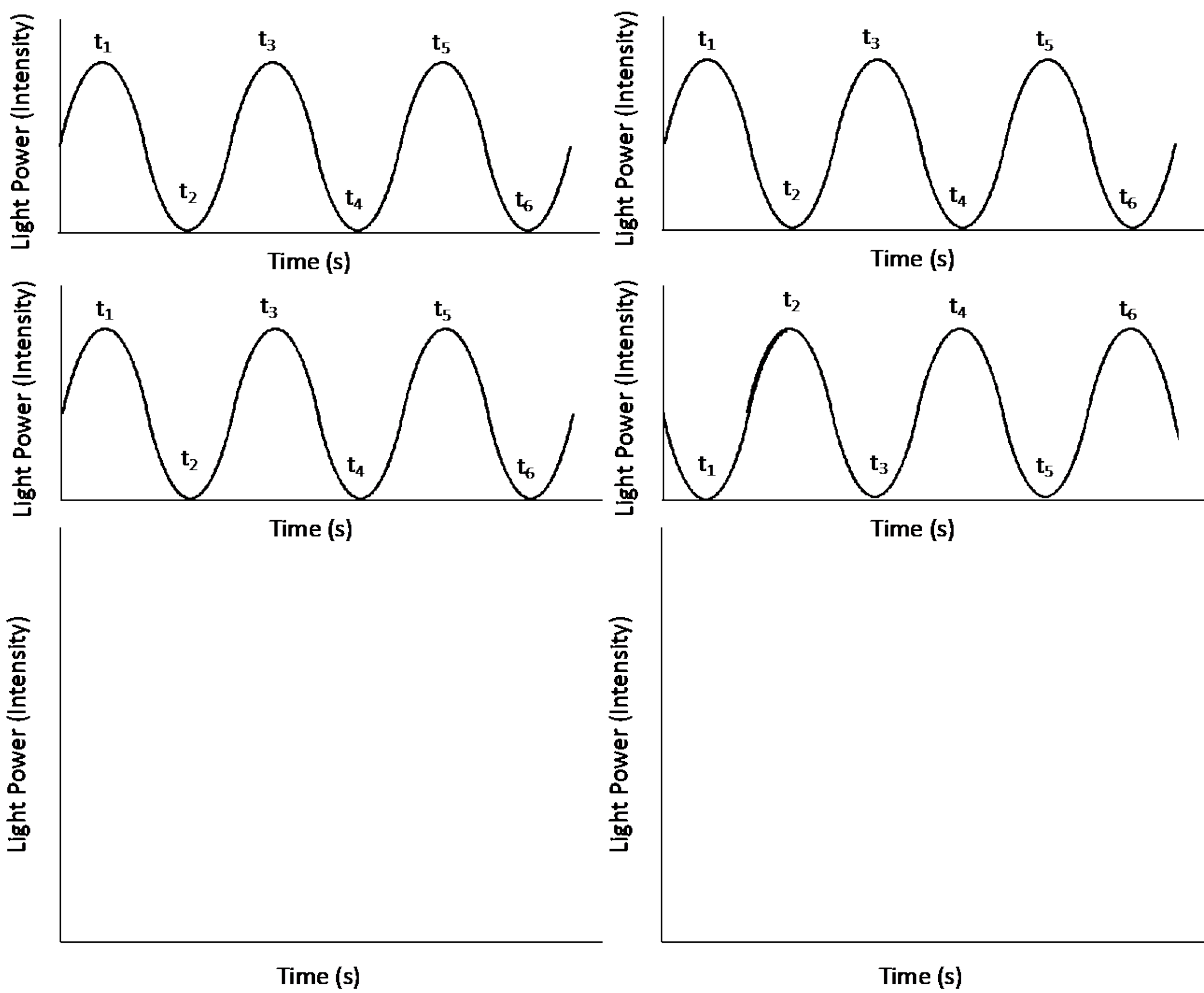
Appendix - Module 2
Michelson Interferometer
Small Group Worksheet
Student Learning Objectives:

- Distinguish between constructive and destructive interference.
- Identify the parts and light path within a Michelson Interferometer.
- Describe how changing the location of the moveable mirror affects the waveform striking the sample for monochromatic light and polychromatic light.
- Recognize the relationship between wavelength and frequency.

1. Consider the monochromatic radiation shown below.
    a. Look at the two waveforms on the left. What happens to the intensity as a function of time at each of the indicated points when you combine the two radiation waves on the left side?
    b. Sketch the new waveform. This represents perfectly constructive interference.
    c. What is the difference between the two radiation waves on the right side?
    d. What happens to the intensity as a function of time at each of the indicated points when you combine the two radiation waves on the right side?
    e. Sketch the new waveform. This represents perfectly destructive interference.



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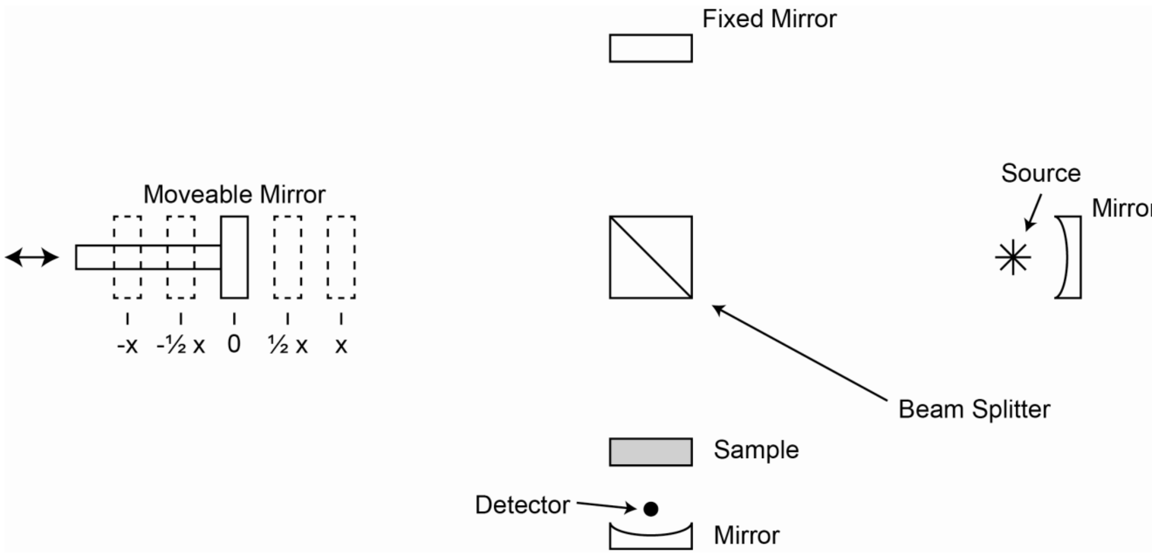
2. Consider the Michelson Interferometer shown below.




(Image from Molecular and Atomic Spectroscopy by T. Wenzel, https://community.asdlib.org/activelearningmaterials/molecular-and-atomic-spectroscopy/)

a. Trace the light path from the source to the detector.
    i. What is the purpose of the mirror next to the source and the mirror next to the detector?

    ii. What is the purpose of the beam splitter?

b. The “0” mark of the moveable mirror represents the *zero path difference (ZPD).* This is the location where the moveable mirror is the same distance from the beam splitter as the distance from the fixed mirror to the beam splitter. What kind of interference occurs when the moveable mirror is in this position? Why does this interference occur?

3. Consider monochromatic radiation with a wavelength equal to x. The moveable mirror is positioned at the distance equal to ½x. What kind of interference occurs when the moveable mirror is in this position?

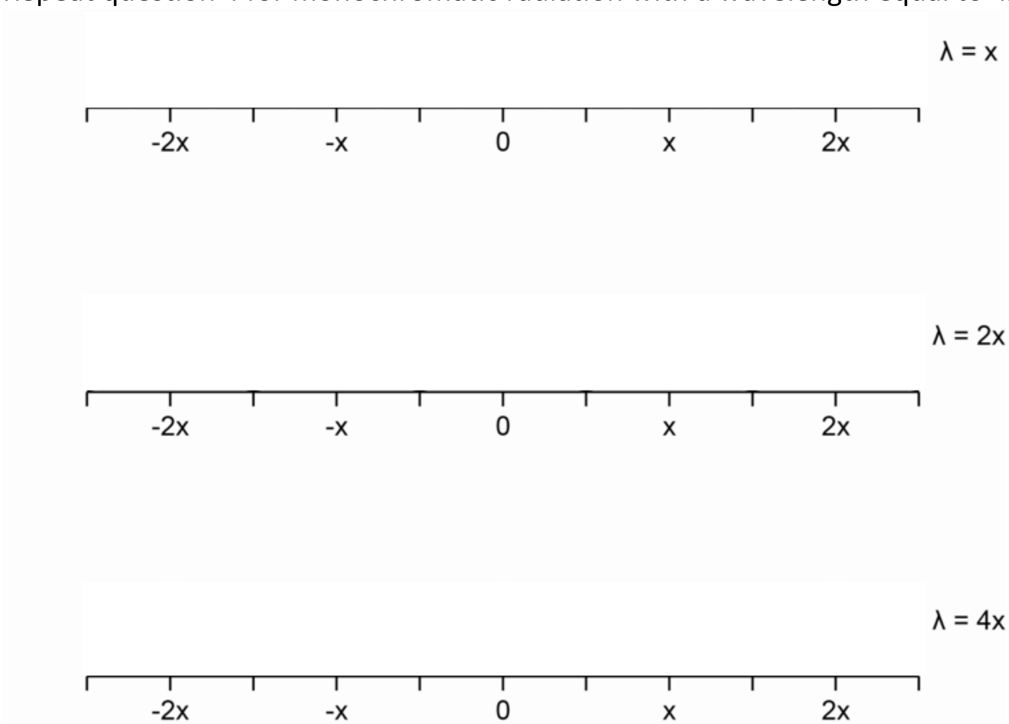
4. Consider monochromatic radiation with a wavelength equal to x. The moveable mirror is moved to each of the 5 positions shown above (-x, -½x, 0, ½x, x)
    a. What kind of interference occurs at each of these points?

    b. Is your answer to 4a true for all mirror positions?

    c. Plot the intensity of radiation at the sample versus the position of the moveable mirror for this wavelength. (Use the graph on the next page.)

5. Repeat question 4 for monochromatic radiation with a wavelength equal to 2x.

6. Repeat question 4 for monochromatic radiation with a wavelength equal to 4x.




7. If all three waves of monochromatic radiation shown above (wavelengths x, 2x, and 4x) were to be present at the same time, what would that waveform look like? Use your group white board to sketch the intensity of radiation as a function of the moveable mirror's location.

8. What is the frequency of each of the three waves of monochromatic radiation shown above (wavelengths x, 2x, and 4x)? Use your group white board to make a scatter plot of the frequency of each radiation wave (x-axis) to the intensity of each radiation wave (y-axis).

Food for thought (extra questions for discussion):

- If the moveable mirror is slowly moving from one position to the next at a controlled, constant speed, could you replace the location labels on the x-axes with time labels? Why or why not?
- If one of the 3 waves of monochromatic radiation above were absorbed by a sample, how would the combined waveform in question 6 change? Why or why not?
- If you added another wave of monochromatic radiation to the plot in 6 (say, wavelength of 3x), how would the combined waveform change?