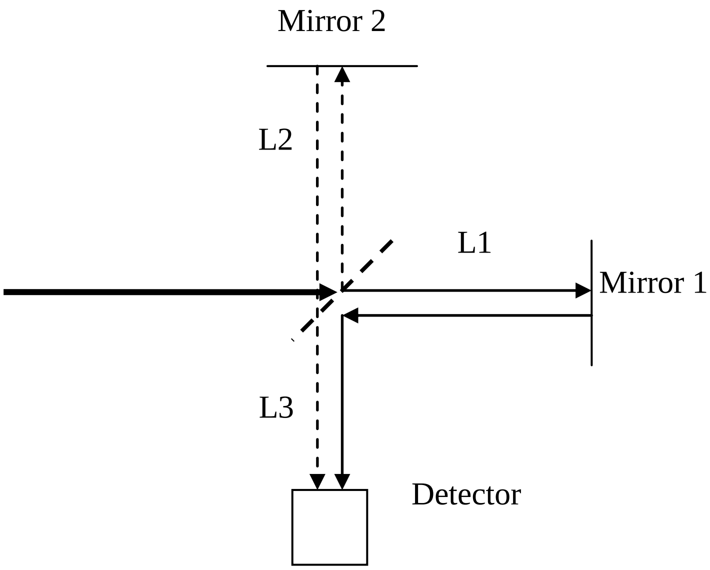
WS 27
Physics 322
Interference

Consider the Michelson Interferometer diagramed below. The light incident on the device is monochromatic.



What is the relative phase of the two beams (one going to mirror 1 and one going to mirror 2) at the beam splitter?

Assume that we have a wavelength of light that is 2 cm long, that L2=L1=3 cm and that L3 is 4 cm long.
For the light traveling to Mirror 1, what is the total path length that the light travels from the beam splitter to the detector?

For light traveling to Mirror 2 and then to the detector what is the total path length that the light travels from the beam splitter to the detector?

The optical path difference (OPD)is determined by the difference in path lengths of the two possible paths reaching the detector. What is the OPD in this case?

How could we determine the relative phase, δ, in radians of the two beams and what is it in this case?

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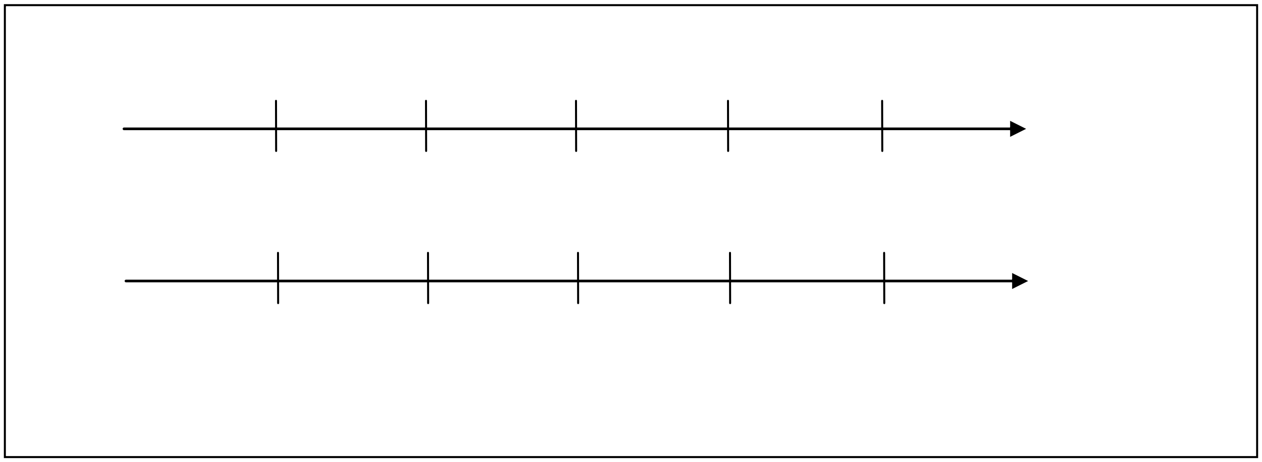
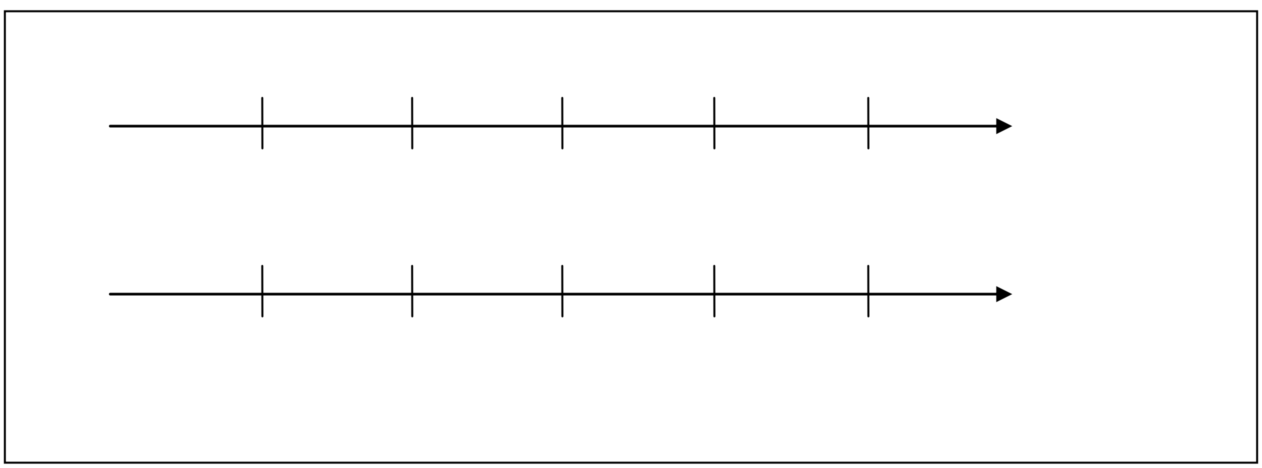
In the area below, starting we will consider the detector to be on the right hand side of the page. Draw lines that are the length of each path for the light to travel from the beam splitter to each mirror. Now draw in the waves on each line for a single moment in time. Determine whether at the detector constructive or destructive interference is occurring.



Suppose that mirror 2 is moved a distance of 1/2 cm further away (L2 is now 3.5 cm). Sketch this situation in the area below. Determine the OPD between the two waves.

Determine δ.

Determine whether constructive or destructive interference is observed at the detector.



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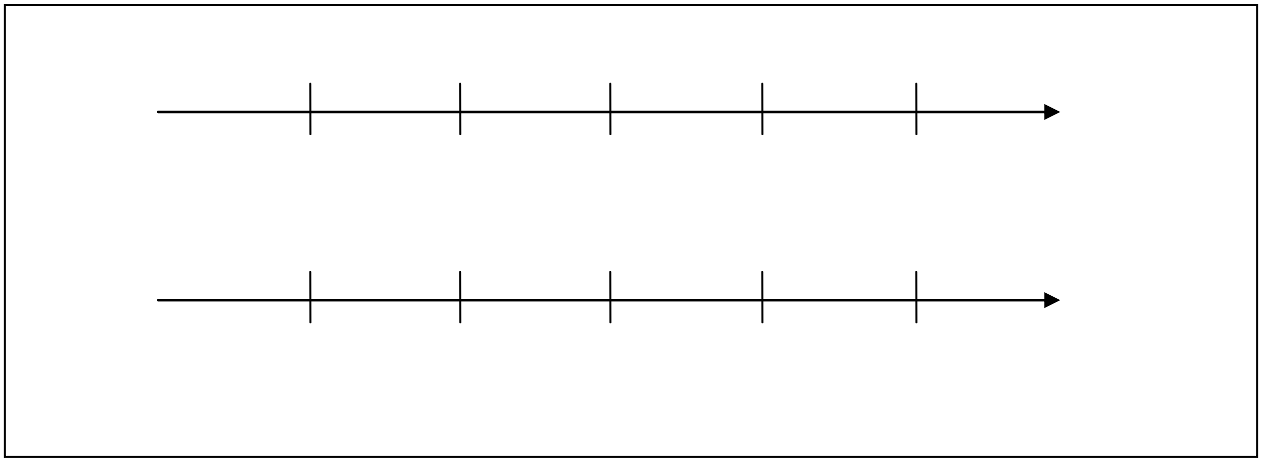
Suppose mirror 2 is moved a distance of 1cm further away (L2 is now 4 cm). Sketch the waveforms, determine the OPD, δ, and determine whether at the detector constructive or destructive interference is occurring.



Suppose that we were to write the electric field of the incident wave as $E = E_o e^{i(kz-\omega t)}$. If the beam splits 50/50 on each path, write an expression for the overlapping beams (note: as a simplification you can "unwrap/unfold" the beam and consider it to have traveled in a straight line as in the diagrams). Identify δ in this expression.

Write an expression for the irradiance as a function of position.

Imagine that mirror 2 were moving with a speed **v**. Write an expression of the irradiance as a function of time. Graph this irradiance as a function of time. What does your graph mean? Does this make sense?.

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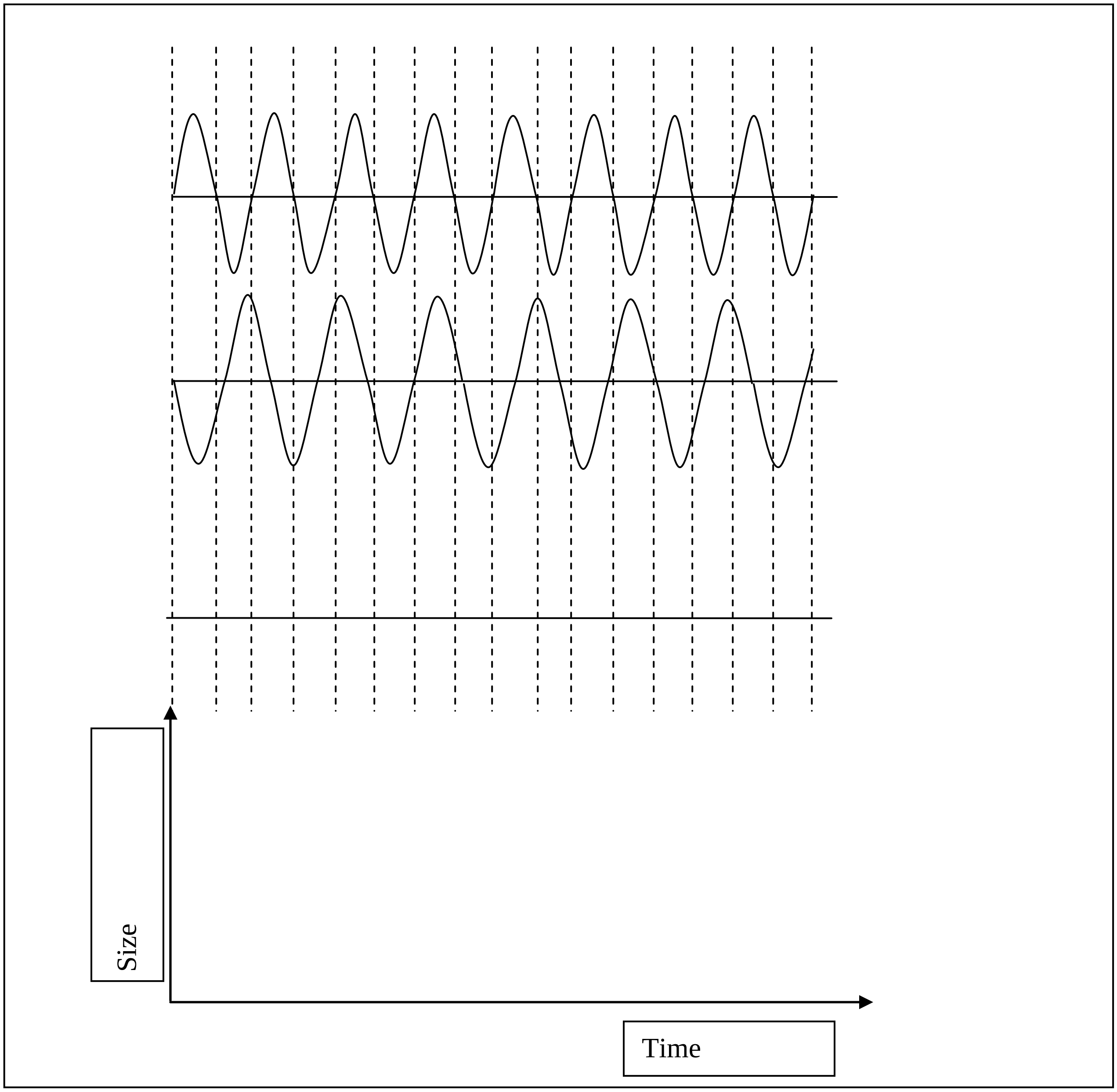
<u>Interference between different wavelengths</u>

Suppose that I have two sources of different wavelengths (1 cm and 2 cm). The waves emitted by these sources travel a distance of 1/2 cm in a second. Given the following diagram, make a plot of the size of the resultant wave as a function of time (20 sec).



If the two wavelengths were closer together, what would you expect to happen to the signal at the screen as a function of time?

Write a mathematical expression for this situation and determine what you would see on the screen as a function of time.

Does this differ from that observed for waves of the same wavelength? Explain.