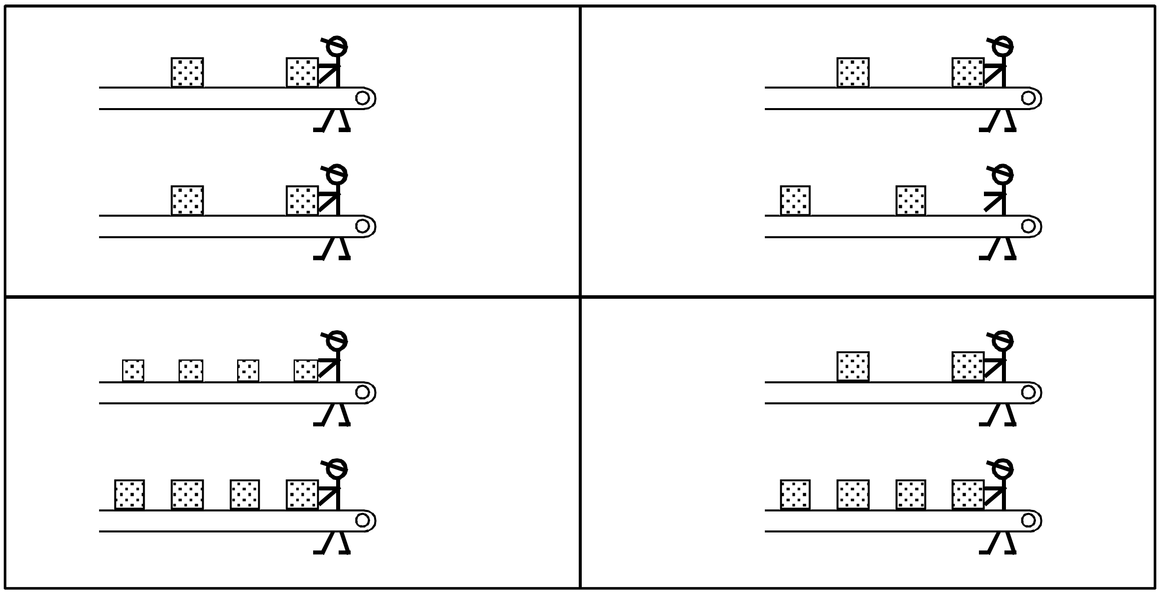
PhyzSpringboard: Interference in 1-D

Felix

1. 'NPHASE

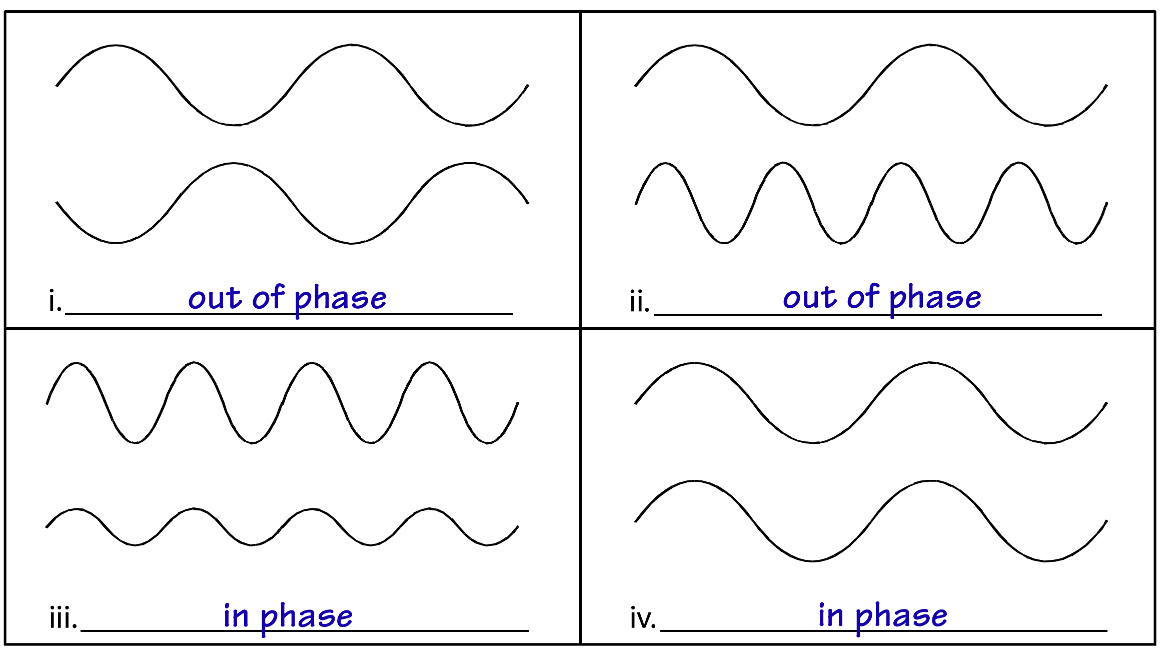
Consider boxes being taken off two conveyor belts as shown in the four diagrams below. The two diagrams on the left depict situations in which the unloading is occuring in phase; the two diagrams on the right depict situations in which the unloading is occuring out of phase.

IN PHASE | **OUT OF PHASE**



a. How is "in phase" different from "out of phase"?

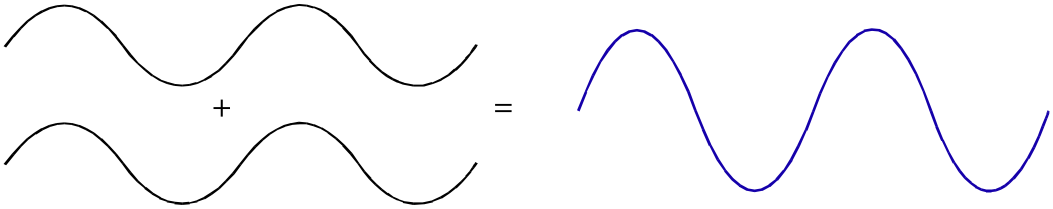
b. Consider the waves shown below. Identify each pair of waves as either "in phase" or "out of phase".



2.’NTERFERENCE

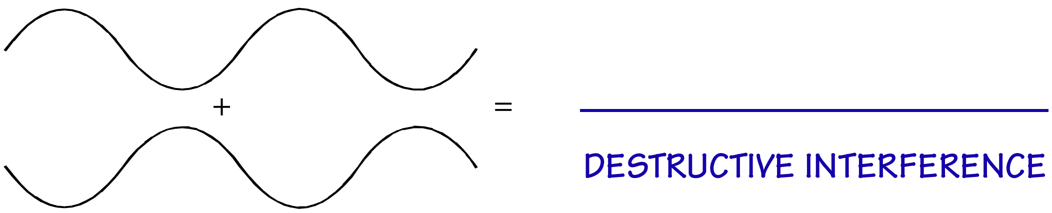
When two waves reach a point in phase, they add to each other. When two waves reach a point out of phase, they cancel each other. Show what the combining of each pair of waves will look like.

a.



CONSTRUCTIVE INTERFERENCE

b.



DESTRUCTIVE INTERFERENCE

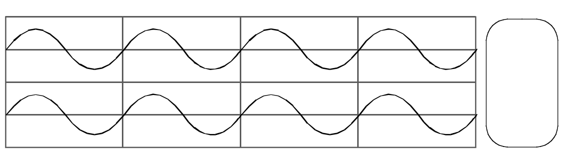
One of the diagrams above (a. or b.) represents CONSTRUCTIVE INTERFERENCE, the other represents DESTRUCTIVE INTERFERENCE.

c. Label each one correctly.

3. MOV’N ’N

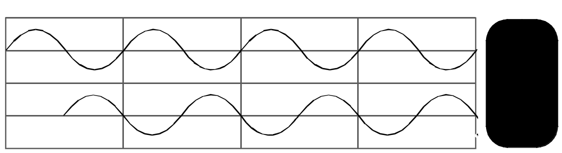
In each case below, two wave sources are oscillating with the same frequency and emitting waves with the same wavelength. The upper source remains fixed, the lower source moves to the right. The waves from the two sources strike a wave observer (perhaps a screen if the waves are light waves). If the waves hit the screen in phase, the screen lights up brightly due to the constructive interference of the light. If the waves hit the screen out of phase, the screen is dark due to the destructive interference of the light. Cases a and b have been completed; finish the set by completing c, d, e, and f.

a.



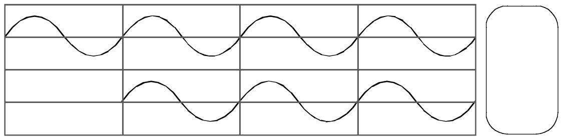
Top: 4λ
Bottom: 4λ
$\Delta L = 0$

b.



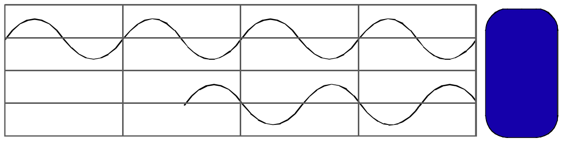
Top: 4λ
Bottom: 3.5λ
$\Delta L = 0.5\lambda$

c.



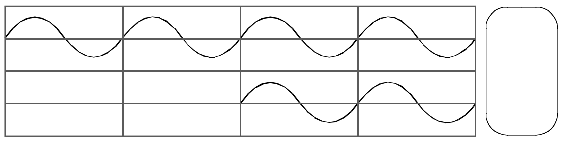
Top: 4λ
Bottom: 3λ
ΔL = 1λ

d.



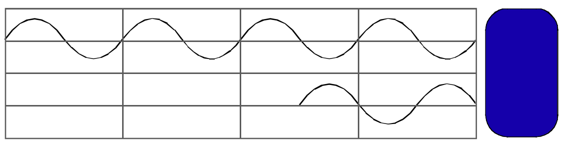
Top: 4λ
Bottom: 2.5λ
ΔL = 1.5λ

e.



Top: 4λ
Bottom: 2λ
ΔL = 2λ

f.



Top: 4λ
Bottom: 1.5λ
ΔL = 2.5λ

4. 'N CONCLUSION

Examine the length of the wave path in each case above. This distance is called the **pathlength**, and can be measured in wavelengths. For example, in 3.a. above, both the upper and lower paths were 4.0λ. That is, the distance from the source to the observer was 4 wavelengths.

a. Determine the pathlengths for the upper and lower wave paths in each of the other cases (3.b. through 3.f.). Record your results in the space to the right of each case above.

b. The **pathlength difference** is simply the difference in the pathlengths of the two waves. For example, the pathlength difference for the waves in case 3.a. above is 4.0λ. – 4.0λ. = 0. Determine the pathlength difference in each of the other cases (3.b. through 3.f.). Record your results in the space to the right of each case above. (The difference is always 0 or a positive value.)

c. Earlier, we determined the nature of the interference (constructive or destructive) based on the phase of the two waves relative to each other. Now, write a pair of statements relating the nature of the interference to the pathlength difference.

i. The interference is constructive when the pathlength difference is
an integer number of wavelengths (0, 1λ, 2λ, ...)

ii. The interference is destructive when the pathlength difference is
an odd number of half wavelengths (0.5λ, 1.5λ, 2.5λ, ...)