Clocks 1 and 2 are synchronized and separated by a distance \( L = 2 \) light seconds. Two other clocks (synchronized in their rest frame) fly through the lab at speed \( v \). The clocks read seconds. The picture below represents one view of reality:

![Diagram of clocks and their readings](image)

a. What can you say about the proper separation of the moving clocks? (the best you can do is an algebraic expression, in terms of the variables & numbers given so far)

b. Find the speed \( v \)

c. Redraw the picture(s) showing these events from the other point of view.

A picture drawn later shows

![Diagram of clocks and their readings](image)

d. What does clock 1 read?

e. What does the unmarked moving clock read?

f. What do clocks 3 and 4 read?

g. What is the proper distance between 3 and 4?

h. What is the distance between clocks 1 and 3?

i. Redraw the above event (leading clock meets clock 4) as seen from the rest frame of the leading clock. Determine as many clock readings and distances as you can.
9. A 20 meter pole is carried so fast in the direction of its length that it appears to be only 10 m long in the "laboratory" frame of reference. Therefore, at some instant the pole can be entirely enclosed in a barn 10 m long. However, look at the same situation from the runner's reference frame: to her the barn appears to be contracted to half its (proper) length. How can a 20 m pole fit into a 5 m barn? Explain. Draw some pictures to show what everyone sees and when.

![Diagram](image)

10. An observer reports that two missiles are moving parallel to one another on a straight line path, one with speed \(0.9c\) and the other with speed \(0.7c\). Find the speed of one missile with respect to the other.

Consider two cases - both missiles moving in the same direction and the two missiles approaching each other.

11. Some practice with the Lorentz transformation equations - using your answers to problem 5: Use the answers you obtained for parts a and c (rocket times) and the Lorentz equations to get the answers to parts b and d (earth times). You should get the same answers you did before.

13. The frequency of green light is about \(\sqrt{2}\) times that of red light.

Find the speed of the alleged traffic violator, who in good conscience tells the judge that the top light on the signal was green. Is he guilty?

14. Observers on a train see a photon traveling vertically (in the \(y'\) direction). Find \(u_x\) and \(u_y\) as measured by station observers who see the train going by at speed \(v\) in the \(x\) direction.

Draw a vector indicating the direction of the photon's travel (its velocity).

Verify that \(u_x^2 + u_y^2 = c^2\) - that the photon travels at speed \(c\) in the station frame.