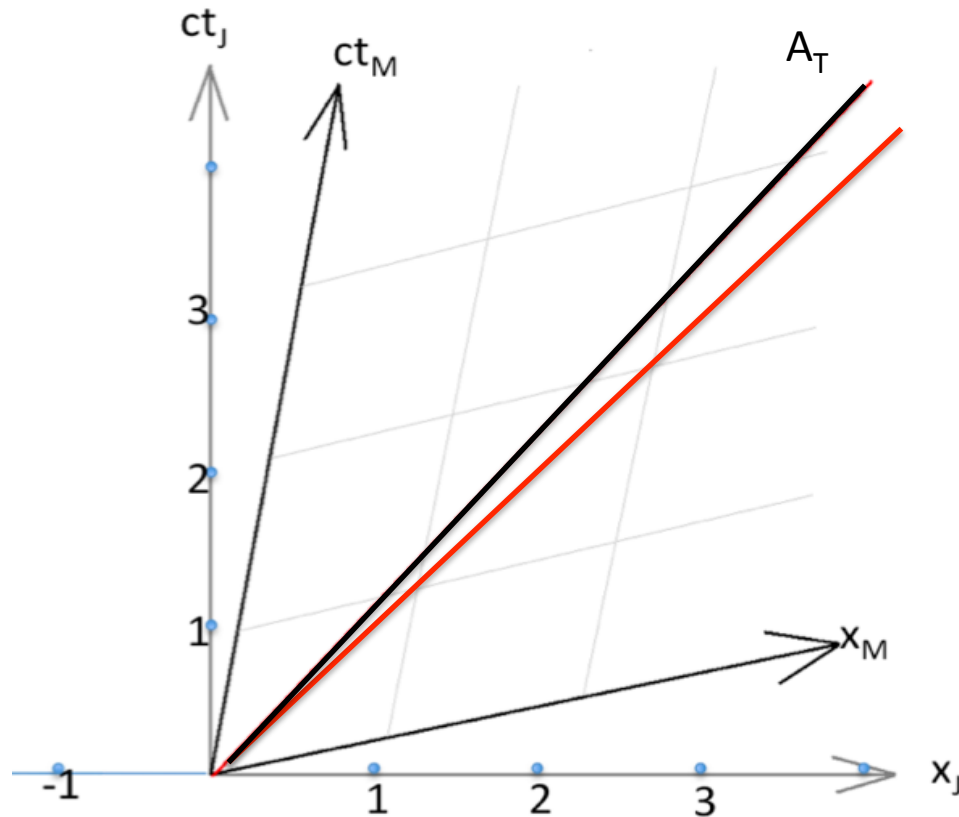


Problem 1

Figure 1 shows space-time diagrams for Jim and for Mary. Mary is moving away from Jim with constant velocity corresponding to a value of $\gamma=2$. The red line marks the light cone in Jim's frame and it is at an angle 45 degrees with respect to Jim's time axis.



Ignore the line from the origin to A. It was drawn by accident.

1. If Jim measures his time in units of seconds marked in the diagram at the ct_J locations as 1,2,3..., what are the units of distance in Jim's space axis? Explain your answer.
2. What is the angle θ that Mary's time axis makes with Jim's time axis and the angle ϕ that Jim's space axis makes with Mary's space axis? Explain your answer.
3. If we use a ruler the distance from zero to $ct_J=1$ and from zero to $x_J=1$ are approximately 2 cm. Using the same ruler how many cm from the origin you would place one on the ct_M axis? How many cm on the x_M axis? Explain.
4. Consider two events A and B with coordinates $(ct_J=3, x_J=1)$ and $(ct_J=3, x_J=3)$. Are the events simultaneous in Jim's frame? Are the events simultaneous in Mary's frame? If not what occurs first and what is the time difference between them? (use the invariance of Δs in answering this question)
5. Jim observes Mary to travel starting at time zero and reaching a location $(ct_J=3, x_J)$. What is the value of x_J and how long did it take as measured by Mary?
6. An experimentalist turns on a flash-light pulse at $t_J=0$ at a position $x_J=-1$. At what time would Jim and Mary would detect the pulse and what would be Mary's location?