Assume that S' frame is moving wrt S frame with speed V along the common x-x' axis and $t = t' = 0$ when their origins match.

1. Determine constants A, C and D from following equations:

$$A^2 - c^2C^2 = 1; \quad vA^2 + c^2CD = 0; \quad c^2D^2 - v^2A^2 = c^2 \tag{1}$$

2. At what speed v will the Galilean and Lorentz expressions for x differ by 0.10 percent? By 1 percent? By 10 percent?

3. Assume that $v = 0.6c$. Find the coordinates of following events in S'.

   a. $x = 4$ m, $t = 0$ s   b. $x = 4$ m, $t = 1$ s
   c. $x = 1.8 \times 10^8$ m, $t = 1$ s   d. $x = 10^9$ m, $t = 2$ s

4. An event occurs in S at $x = 6 \times 10^8$ m, and in S' at $x' = 6 \times 10^8$ m at $t' = 4$ s. Find the relative velocity of the systems.

5. An observer sees two spaceships flying apart with speed $0.99c$. What is the speed of one spaceship as seen by the other?

6. One of the most prominent spectral lines of hydrogen is the H_α line, a bright red line with a wavelength of 656.1 nm.

   (a) What is the wavelength of the H_α line from a star receding with a speed of 3000 km/s?

   (b) The H_α line measured on earth from opposite ends of the sun's equator differ in wavelength by 9×10^{-12} m. Assuming that this effect is caused by rotation of the sun, find the period of rotation. The diameter of the sun is 1.4×10^6 km.

7. A slab of glass moves to the right with speed v. A flash of light emitted from A and passes through the glass to arrive at B, a distance L away. The glass has thickness D in rest frame. The speed of light in glass is c/n. How long does it take the light to go from A to B?

8. What is the proper interval between the occurrence of two events: (a) if in some inertial frame the events separated by 10^9 m and occur 5 sec apart? (b) If ... 7.5×10^8 m and occur 2.5 sec apart? (c) If ... 5×10^8 m and occurs 1.5 sec apart?

9. Suppose that a pole vaulter holding a 16 ft long pole parallel to his direction of motion, runs through an 8 ft long shed which is open at both ends. Is it possible to close the sliding doors at each end of the shed such that the pole is completely inside the shed before it strikes the exit door? Discuss the situation from the point of view of both pole vaulter and the farmer on the shed roof?

10. Show that, with $u'^2 = u_x'^2 + u_y'^2$ and $u^2 = u_x^2 + u_y^2$, we can write

$$c^2 - u^2 = \frac{c^2(c^2 - u'^2)(c^2 - v^2)}{(c^2 + u_x'v)^2}$$

   (b) From this result show that if $u' < c$ and $v < c$, then u must be less than c.
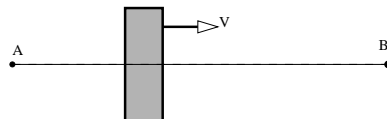

Figure for problem 7