describe its motion relative to the accelerating frame of reference.

1.3 With the help of outside reading, compare the astronomical frames of reference adopted by Ptolemy and Copernicus. Which was more nearly an inertial reference frame?

1.4 Recall that $F_c = mr\omega^2$, $\omega = 2\pi/T$, and $w = mg$. Calculate the ratio of centripetal force to weight at latitude θ on the earth to show that the earth is approximately an inertial reference frame.

1.5 Suppose that S_1 is an inertial reference frame and that the Galilean coordinate transformations hold true. How do you know that S_2 is also an inertial reference frame?

1.6 If Eq. (1.1) is true, does this mean that S_1 and S_2 are necessarily inertial reference frames?

1.7 An event occurs at $x_1 = 3.0$ m, $y_1 = 1.0$ m, and $z_1 = -0.5$ m; $t_1 = 2.0$ s when $v = 4.0$ m/s. Calculate x_2, y_2, z_2, and t_2 and indicate the event on a sketch of the frames of reference.

1.8 A series of events occurs at the origin of S_2. How are their positions and times related to one another in S_1?

1.9 Repeat Example 1.2 with a 20 m/s wind to the south.

1.10 Repeat Example 1.2 with a 20 m/s wind to the east.

1.11 To measure a length in S_2, positions x_2 and x_2' are both measured at the same time, t_2 (that is, simultaneously). Then $L_2 = x_2' - x_2$. Use a Galilean coordinate transformation to find L_1, the length measured in S_1.

1.12 To measure T_2, a time interval in S_2, times t_2 and t_2' are measured at the same position, x_2. Then $T_2 = t_2' - t_2$. What then is T_1, the time interval measured in S_1?

1.13 Show that conservation of linear momentum is invariant under a Galilean transformation for a completely inelastic collision of two objects (they hit and stick together).

1.14 Show that the conservation of kinetic energy is invariant under a Galilean transformation for an elastic collision of two objects.

1.15 Does the statement that "the laws of conservation of energy and of momentum are invariant under a Galilean transformation" mean that all inertial observers will measure the same values for energy and momentum?

1.16 An airplane travels at a constant velocity 200 km southwest with respect to the ground in 1/2 hour in a constant wind of 60 km/hr to the west at a constant elevation. What are the components of the airplane's position and velocity with respect to the ground and the air? What are the accelerations?

1.17 A river is flowing south at 15 ft/s. A canoist aims northeast and paddles at 5 ft/s with respect to the water. With respect to the water and with respect to the earth, what are the components of the canoe's position and velocity after 20 s? What are the accelerations?

1.18 The *jerk* is defined as the time rate of change of acceleration. Derive the Galilean jerk transformation.

1.19 An ultralight aircraft can fly at 30 m/s in still air. The pilot wishes to fly at this airspeed in a straight line between two points, the second point being 8.0 km northeast of the first. If there is a constant 10 m/s wind blowing to the west: a) In what direction must he aim the aircraft to fly between the two points? b) How long will the trip take him?

1.20 The canoist in Example 1.4 aims the canoe directly across the river and paddles to the other side, then reverses directly back to return to the original side, then finally aims the canoe upstream and paddles back to the start. Ignoring turnaround times, what is the round-trip time?

1.21 Johnny Jones is jogging at a constant velocity of 3.0 m/s west when he sees his Aunt Susie running at a constant velocity of 7.0 m/s 30° north of east. (Both velocities are measured with respect to the earth.) What is Aunt Susie's velocity with respect to Johnny? What is Johnny's velocity with respect to Aunt Susie? (This is a relative's velocity problem, in case you hadn't noticed.)

1.22 For those who know about matrixes, suppose that position and time are represented by the column matrix

$$\begin{bmatrix} x \\ y \\ z \\ ict \end{bmatrix},$$