

PROBLEMS

1.2 The Principle of Newtonian Relativity and the Galilean Transformation

1. In a lab frame of reference, an observer finds Newton's second law is valid in the form $\sum F = ma$. Show that
$$\sum_{\substack{\text{actual} \\ \text{physical} \\ \text{forces}}} F = ma$$

Newton's second law is not valid in a reference frame moving past the laboratory frame of Problem 1 with a constant acceleration a_1 . Assume that mass is an invariant quantity and is constant in time.

2. A 2000-kg car moving with a speed of 20 m/s collides with and sticks to a 1500-kg car at rest at a stop sign. Show that because momentum is conserved in the rest frame, momentum is also conserved in a reference frame moving with a speed of 10 m/s in the direction of the moving car.
3. A billiard ball of mass 0.3 kg moves with a speed of 5 m/s and collides elastically with a ball of mass 0.2 kg moving in the opposite direction with a speed of 3 m/s. Show that because momentum is conserved in the rest frame, it is also conserved in a frame of reference moving with a speed of 2 m/s in the direction of the second ball.