Physics 109: Homework #4 Solutions

4.1 Inertial motion: (a) and (d). Accelerated motion: (b), (c), and (e). In cases (b) and (e) the unbalanced force is the same: gravity. In case (c) the situation is somewhat more complex although the simple answer is that gravity is the unbalanced force. The bob moves along an arc of a circle so there is a centripetal acceleration in the direction of the rod that holds the bob. Because of the centripetal acceleration, the tension in the rod is not completely balanced by the component of gravity that acts along the direction of the rod. Furthermore, the component of gravity that acts along the direction of motion (i.e., along the arc) is also unbalanced. So a pendulum bob is continually accelerated in both directions: along the arc of motion and along the rod that holds it.

4.2 Mass is a measure of a body's inertia, or resistance to motion. Weight is the force of gravity acting on mass. Your weight would change if you were on the surface of the Moon, or on a spacecraft in orbit about the Earth, but your mass would not change. Acceleration is the rate of change of velocity with time, while velocity is the rate of change of position with time. In addition to numerical values both of these quantities are characterized by their direction.

4.3 1st law (inertia): puck sliding on an air table at constant velocity; 2nd law ($F = ma$): gravity accelerating a falling object; 3rd law (action-reaction): jet engine, rocket engine.

4.4 If the masses of each were doubled and the distance halved, then the force would increase by $2 \times 2/(0.5^2) = 16$. If the mass of only one were doubled as well as the distance, then the gravitational force would change by $2/2^2 = 0.5$.

4.5 If the Moon's mass were halved, then the tidal acceleration of the Sun and Moon on the Earth would have the same numerical value. Neap tides would be nearly eliminated when the Moon was at first or third quarter, but would be strong during full or new Moon when the tidal accelerations of the Sun and Moon would add.