According to **Newton's Second Law, F=MA**, a heavier plane with the same thrust will experience a smaller acceleration. Therefore, a heavier plane will travel a greater distance around the pylon, while its speed increases to the point at which it can lift off the ground. Conversely, Newton's 2nd law predicts that lighter planes with the same thrust will have a greater acceleration and will takeoff sooner. Planes with more weight require more lift to fly. When a plane flies level and at constant speed, lift equals its weight.

A heavier plane usually will fly at a lower altitude around the pylon. A heavier plane will have more kinetic energy (but less potential energy) than a plane with less weight. The flight time and travel distance of a heavier plane will be shorter than that of a lighter plane.

The pylon string applies **centripetal force** that counteracts the inertia and velocity of the plane. According to **Newton's 3rd Law**, the string and the plane pull with equal and opposite force. If the pylon string were to break, the inertia of the plane would cause it to fly off in a straight line.

Consider a *JETSTREAM* that has an average speed of 4.6 m/s and a mass of 15 grams. More energy is required to take off and achieve altitude. If the energy is held constant (at 1000 turns on the rubber motor) the plane cannot climb as high, the distance flown is less and the flight time is also less.

Sample Data: The following table shows some likely results for a pylon plane with a radius of 2.1 meters:

1000 Turns on the Rubber Motor	**Liftoff Around Pylon**	**Average Altitude**	**Average Laps**	**Average Total Distance**	**Average Speed** (meters/second)
No Extra Weight	25 %	~ 0.8 meters	5.8 laps	77 meters	4.6
With 1 penny	38 %	~ 0.5 meters	4.9 laps	61.2 meters	~4.6
With 2 pennies	50 %	~ 0.35 meters	2.2 laps	27.2 meters	~4.6

Two important notes:

1) The average speed of the plane should remain constant regardless of weight. This is because the *JETSTREAM* has no movable control surfaces (rudder, ailerons, elevators); the trim never changes and, in general, the plane flies at the same angle of attack. Keeping the number of turns on the rubber motor constant also ensures that the average speed remains constant for each flight.

2) Be sure to place the penny over the center of gravity, about 1/4 of the way back from the leading edge of the wing. If the penny is placed too far back on the wing, the plane will be tail-heavy, increasing drag and decreasing the average speed of the plane.