The Academy of Model Aeronautics' ALPHA: Potential Energy Background Information for the Teacher

When you wind the rubber motor of a model plane, you are storing **potential energy**. As the rubber motor of the plane unwinds, the potential energy is transformed into **kinetic energy**, the energy of motion. Kinetic energy is expressed in the following ways: the propeller spinning, the air being pushed backwards and the plane moving forward. As a plane flies upward, some of its kinetic energy is transformed into potential energy. When it descends, this potential energy is transformed back into kinetic.

In general, according to **Newton's 2nd law, F=MA**, planes with more turns on the rubber motor will generate more thrust and will have a greater time aloft. A plane with more turns on the rubber motor typically fly higher and farther than a plane with fewer turns. Planes with more turns on the rubber motor also will have longer flight times.

According to **Newton's 3rd law**, every force has an opposing force. As the propeller pushes air back, the air pushes the propeller and plane forward with equal force. As lift is generated, more than 70% of the force is derived as moving air is deflected down and away from the bottom of the wing. This action of pushing the air molecules down has an equal and opposite reaction of pushing the wing, and whatever is connected to it UP. This is another example of Newton's Third Law. The wing pushes air down and and the air pushes the wing up with equal force.

As thrust accelerates the plane forward, the wings of the plane generate lift. Drag, the resistance to forward motion, is a by-product of the plane's passage through the air. As the plane accelerates, drag increases until the drag equals thrust, causing the plane to fly at constant speed. At this point lift also equals weight.

Additional Background Information

Bernoulli's "scale of flow" theorem why the airplane is ALPHA light in structure or has a light "wing loading." For example, if a Piper Cub was reduced to the size of the ALPHA wingspan, it could not fly. As the airplane is reduced in size, its ***area of lift to mass*** also is reduced. However, the actual size of the air molecules do not shrink in scale. An exponential amount of lift is lost so to compensate, miniature aircraft designs must weigh significantly less to stay aloft.

Until recently, the flight of bees have been a bit of a mystery for scientists. We now know that they are able to fly well using small wings because they are able to move them rapidly to compensate for the smaller wing area. If bees were the size of man-carrying airplanes, the structures to move the wings would not be strong enough to compensate for the exponential increase in weight. This is the reason that most birds, as they become larger, rely more on gliding than flapping wings.

Student Data Sheet

Powering Up the AMA ALPHA with Potential Energy!

Background: When you wind the rubber motor of a model plane, you are storing potential energy. This energy is transformed into kinetic energy when you launch the plane. In general, according to Newton's 2nd law, F=MA, planes with more turns on the rubber motor will generate more thrust and accelerate faster than models with less thrust. As thrust accelerates the plane forward, the wings of the plane generate lift. Drag, the resistance to forward motion, is a by-product of the plane's passage through the air. As the plane accelerates, drag increases until the drag equals thrust, causing the plane to fly at constant speed. At this point lift also equals weight. Planes with more potential energy will generate more thrust and will have greater time aloft.

Directions: You will study how increasing the turns in a rubber motor will affect a plane's time aloft. Work with your partner or group and choose one plane to study.

1) Finish this hypothesis: If thrust increases, then…

2-4) List at least three variables you should keep the same every time you test your plane.

Flying the **AMA ALPHA** with **600** turns on the rubber motor:

Adjust your wing to establish the correct center of gravity (CG) . Mark the wing position with a pen. Use a winder to put **600** turns on your rubber motor.

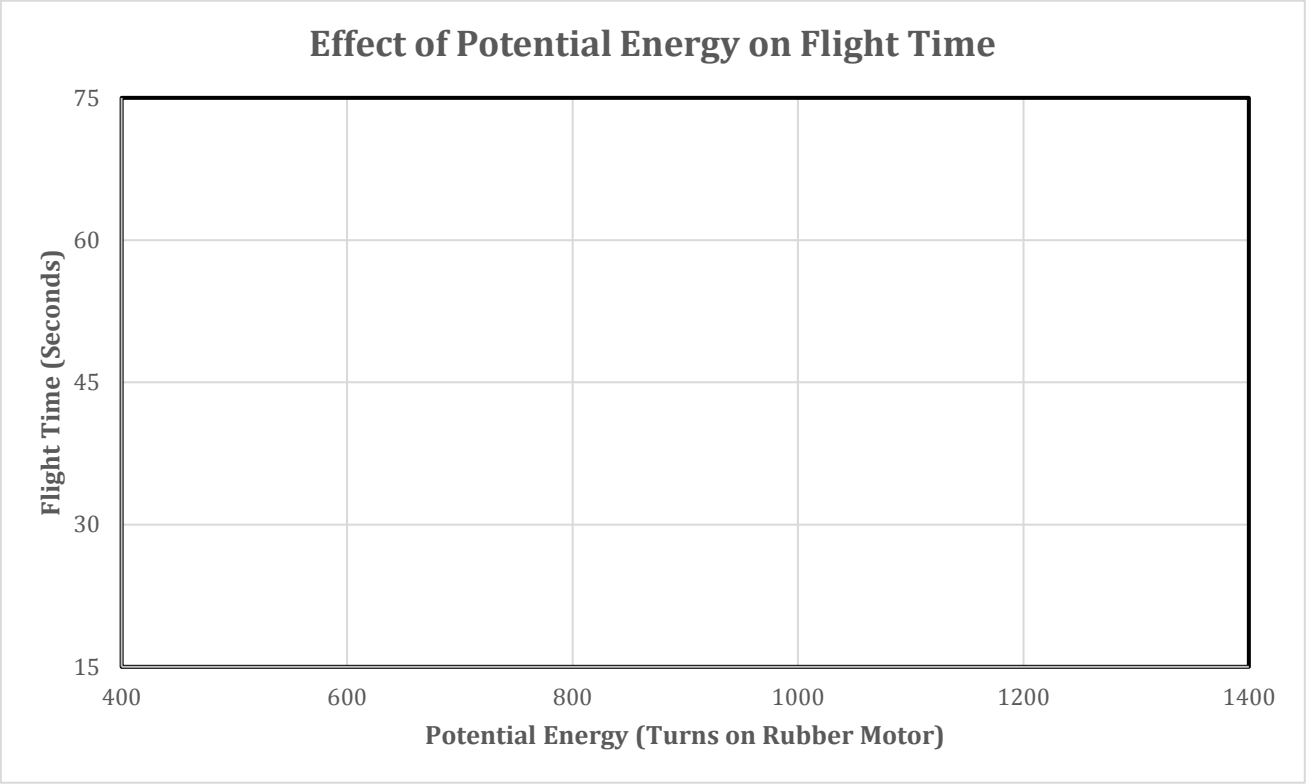
Flying the **ALPHA** with **800** turns on the rubber motor:

- Move your wing to the mark. Use a winder to put **800** turns on your rubber motor.
- Collect data using the same procedure as before.

ALPHA time aloft with 800 Turns _____

ALPHA time aloft with 1000 Turns

Graph your data for _____, _____, and _____turns:



How did changing the number of turns on the rubber motor affect time aloft?