A multi-staged rocket is a vehicle having two or more rocket motors, each firing after the one preceding has exhausted its propellant. This is done to allow the upper portion of the rocket to fly to high altitudes.

Staging with Apogee High Performance Model Rocket Motors is slightly different from the techniques used by other motor manufacturers. The methods described in this publication are valid only for the black powder rocket motors produced by Apogee Components. Composite motors and rocket engines from other manufacturers are not covered in this report.

In the traditional staged rocket, when the propellant burns out in the booster stage of the motor, hot gases burst forward out of the engine and are directed into the nozzle of the upper stage motor. Hopefully ignition of the upper stage occurs.

This method is not reliable with the high performance motors from Apogee Components for two reasons. First, the nozzle of the motors are very small, drastically decreasing the likelihood of hot gases ever entering the nozzle. Second, Apogee rocket motors operate at significantly higher internal chamber pressures than other rocket motors. So when burn-through occurs in the booster motor, there is a larger internal pressure trying to separate the two motors. Because of this, the separation time is quicker, decreasing the time available for hot gases to ignite the upper stage. When separation occurs, the hot gases are quickly cooled by mixing with the surrounding air. If the hot gases don't enter the upper stage's nozzle, successful upper stage ignition will not occur.

To solve these problems, a special igniter needs to be inserted into the nozzle of the upper stage motor. This igniter greatly increases the odds of successful ignition of the upper stage, because the hot gases from the booster stage can easily ignite the portion of the igniter which sticks out the back of the nozzle. Once lit, the igniter burns up into the nozzle of the upper stage, igniting the propellant inside the motor.

Another special modification is to vent some of the pressure above the booster motor, so that separation is slow slightly to give the hot gases some time to ignite the special staging igniter. Figure 3 shows that the motors must be separated by a short distance to allow room for the vent hole.

Preparation of the motor is the key to successful staging. The special staging igniter must be inserted fully into the nozzle so that it touches the propellant. This is done to allow the upper portion of the rocket to fly to high altitudes.

Insert staging igniter into nozzle of upper stage motor(s) until it touches the propellant

1/8 inch (3 mm)

Cut off one tip of toothpick

3/8 inch (9.5 mm)

Make holder by cutting the toothpick to length as shown

Push toothpick firmly into nozzle to hold igniter in place

Figure 2: Installation of the staging igniter and its wooden holder (made from a toothpick).
but it is very durable and it is able to withstand the installation procedure. With the igniter installed, gently bend the exposed portion of the igniter so that it stands away from the wooden holder. This will increase the odds of the hot gases touching the exposed portion of the igniter and lighting the pyrogen material.

The motor can then be inserted into the motor mount tube in preparation for flight. Two methods for attaching booster motors are shown on this page. Both methods show vent holes that are needed to allow the internal pressure to be reduced. Figure 3 shows that the motors close together should be separated by at least 5 mm to allow room for the vent hole. If no vent hole exists, the upper stage will be pushed off, and there won’t be sufficient time for the special staging igniter to lite.

When the two motors are separated by some distance (up to 15 cm), the tube joining the two motors should have some holes in it near the nozzle of the upper stage. These holes not only reduce the pressure inside the transfer tube, but they also allow the cooler air in front of the booster stage motor to be pushed out of the tube by the hot exhaust gases. The holes should be at least 6.3 mm (1/4 inch) in diameter, or of a similar area (see figure 4). If your model has a transfer tube inside a larger body tube, you must have holes in the larger tube too, to allow the air to escape completely out of the rocket.

You may notice a slight hesitation after booster burnout before the upper stage ignites. This is caused by the short time it takes for the pyrogen material to burn up inside the nozzle of the upper stage. This delay is less than 1/2 second.