

# Flight Pattern of a Model Rocket Launch

## Learning Objective

In this lesson we will look at the flight path of a model rocket. By the end of the lesson the student should understand the various stages of a model rocket flight.

## Grade Level

9 – 11

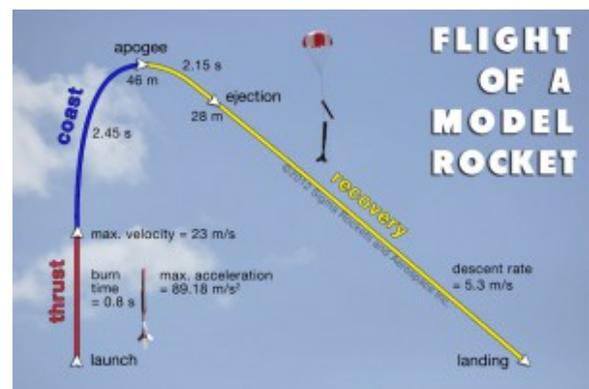


Figure 1 - Flight Path of a Model Rocket

## – Introduction –

In the diagram on the right we can see a graphic of a typical model rocket flight. As you may see in the diagram the four main stages of a model rocket flight are thrust, coast, apogee and recovery. We used our electronic altimeter to record data for each of these stages. We have included the data collected from our test flight with our rocket flight path graphic.

Our test rocket was launched using an Estes B6-4 rocket motor.

## Thrust Phase

The Thrust Phase is the first phase of the flight and begins right after ignition. It is during the Thrust Phase where the model rocket gets all its upward acceleration. The length of the Thrust Phase is determined by the burn time of the motor. For our test flight the burn time was measured at 0.8 seconds.

The acceleration and maximum velocity the rocket reaches is determined by the total impulse of the motor and the weight of the rocket. And it occurs during the thrust phase. For our test flight the maximum acceleration was recorded as  $89.18 \text{ m/s}^2$ . The maximum velocity that our test rocket reached was 23 m/s.

Total impulse simply means the product of the average force of the motor and the burn time. In other words:

$$\text{Total Impulse} = \text{Force}_{\text{average}} \times \text{Time}_{\text{burn}}$$

Since force is measured in Newtons and time in seconds, Total Impulse would be measured in Newton-seconds. We will not determine Total Impulse in this article. In future articles we will go into more detail with regards to this parameter.

## Coast Phase

After the burn time of the Thrust Phase the delay or Coast Phase begins. It is during this phase where there is no thrust coming from the motor. It is here where the rocket begins to decelerate. It may reach its apogee during this stage. The Coast Phase gives way to the ejection of the recovery device. For our test flight the Coast Phase was broken up into two values. The first one was the time taken from the end of the Thrust Phase to the apogee of the flight. This was recorded as 2.45 seconds. The second time was the time taken for the rocket to go from apogee to ejection. It was recorded as 2.15 seconds. Thus the total time the model rocket coasted for before ejection was 4.6

seconds. This time is known as the delay time.

You may find the delay time in the model rocket classification as well. It is the last number shown. For example a B6-4 motor has a delay of 4 seconds which is pretty close to the actual time we recorded.

## **Apogee and Ejection**

On our graphic in figure 1 we show the ejection charge coming after apogee or the highest altitude in the flight. This is the case for most rocket flights. This is also the most desirable flight pattern. However, in some situations the ejection of the parachute comes before the apogee of the flight. This is caused by a delay that is too short.

It may be dangerous for ejection to happen before apogee as the rocket is traveling at a high speed when the parachute is deployed. This may damage the parachute and the rocket. As well, the opposite is true. A delay that is too long may make for a deployment too close to the ground. Or in some cases so late that the rocket crashes.

For our test flight the apogee was recorded at 46 meters. Our ejection altitude was recorded at 28 meters above the ground. Apogee occurred 2.45 seconds after the end of the trust phase or 3.25 seconds after the rocket lift off. The ejection happened at 4.6 seconds after the burn phase or 5.4 seconds after the rocket left the ground.

## **Recovery Phase**

Nothing brings more relief when launching model rockets than to see the parachute glide the rocket to a soft landing. The speed at which the rocket returns to the ground depends on the size and efficiency of the recovery device. Generally it is good to bring a model rocket down gently so that it will not be damaged.

The recovery phase starts once the ejection charge is fired and the parachute is pushed out. For our test flight the rocket descended at 5.3 m/s.

## Our Test Model Rocket

The test rocket we built was done using [OpenRocket](#). The rocket has 3 fins, is 63 cm long with a 34 mm diameter. A B6-4 motor was loaded into the rocket as well as an electronic device to take measurements for our flight analysis. We used an electronic altimeter to record flight data.

## Flight Analysis

Our model rocket was launched on a calm day. The flight was smooth and the nylon parachute deployed as expected. We have included a table of our flight measurements below to correspond with our graphic in figure 1 above.

Table 1 – Rocket Flight Analysis

Parameter	Actual Measurement
Apogee	46 m
Maximum Velocity	23 m/s
Maximum Acceleration	89.18 m/s <sup>2</sup>
Time to Apogee from End of Thrust Phase	2.45 s
Time from Apogee to Ejection	2.15 s

<b>Ejection Altitude</b>	28 m
<b>Flight Duration</b>	9.9 s
<b>Descent Rate</b>	5.3 m/s

In the video of our flight analysis the model rocket is stopped and held in place at its various points in the flight path. As mentioned above, the measurements were taken using an electronic altimeter.

## Test your knowledge

0%

**What are the four main stages of a model rocket flight?**

thrust, recovery, land, altitude  
takeoff, recovery, loiter, stabilize  
thrust, coast, apogee, recovery  
takeoff, coast, altitude, recovery

Correct! Wrong!

The four main stages of a model rocket flight are thrust, coast, apogee and recovery.

Continue >>

**What is the name of the parameter used to measure the recovery phase of a rocket flight?**

burn time  
maximum acceleration  
descent rate  
minimum velocity

Correct! Wrong!

The recovery phase starts once the ejection charge is fired and

the parachute is pushed out. The rocket descends at the decent rate and is usually measured in metres per second.

Continue >>

**The Thrust Phase of the rocket flight is determined by the burn time of the rocket motor?**

True

False

Correct! Wrong!

The Thrust Phase is the first phase of the flight and begins right after ignition. It is during the Thrust Phase where the model rocket gets all its upward acceleration. The length of the Thrust Phase is determined by the burn time of the motor.

Continue >>

**Apogee is the term given to the highest point of the rocket flight?**

True

False

Correct! Wrong!

Continue >>

Flight Pattern Quiz

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