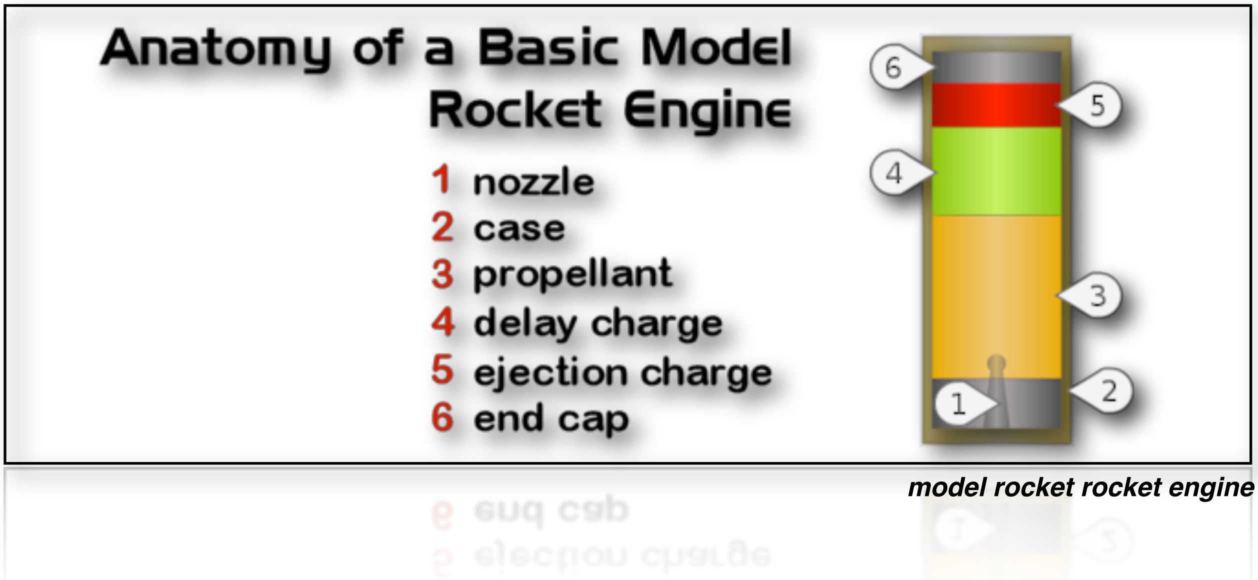
The numbers (and letters) behind model rocket engines

My first model rocket was a Canaroc Challenger. It came in a complete kit with some C6-3 engines. Little did I know at the time that a rocket as small as the Challenger would soar out of view using this engine. It took about 2 hours to find the rocket. Returning home happy to have retrieved it but exhausted by the search effort I began to wonder what C6-3 actually meant.



model rocket rocket engine

Above is a cut out of a typical model rocket engine. The nozzle (1) is the end where the hot gases from the engine eject giving the rocket its thrust. The casing (2) which holds the engine together is made usually from layers of paper or may be plastic. The propellant (3) is what actually creates the thrust for the rocket. The delay charge (4) produces very little or no thrust for the rocket and serves as the gap between the thrust and the ejection charge (5) of the flight. The end cap (6) together with the nozzle (1) keeps the contents of the model rocket engine together.

What does the first letter mean?

The code on the model rocket engine typically starts with a letter such as A, B, C etc. For some engines a fraction may precede the letter such as 1/4 or 1/2. This letter indicates the engine's total impulse range (commonly measured in newton-seconds). Each letter in successive alphabetical order doubles the impulse of the letter preceding it. This does not mean, however that a given "C" engine has twice the total impulse of a given "B" engine, only that C engines are in the 5.01-10.0 N-s range while "B" engines are in the 2.51-5.0 N-S range. For instance, a B6-4 engine from Estes-Cox Corporation has a total impulse rating of 5.0 N-s. A C6-3 engine from Quest Aerospace has a total impulse of 8.5 N-s.
Below is a chart showing the impulse ranges for the letter designation for model rocket engines.

CLASS	Total Impulse (metric)	Total Impulse (Imperial)
A	1.26-2.50 N·s	0.29-0.56 lbf·s
B	2.51-5.00 N·s	0.57-1.12 lbf·s
C	5.01-10.00 N·s	1.13-2.24 lbf·s
D	10.01-20.00 N·s	2.25-4.48 lbf·s
E	20.01-40.00 N·s	4.49-8.96 lbf·s
F	40.01-80.00 N·s	8.97-17.92 lbf·s
G	80.01-160.00 N·s	17.93-35.96 lbf·s
H	160.01-320.00 N·s	35.97-71.92 lbf·s
I	320.01-640.00 N·s	71.93-143.83 lbf·s
J	640.01-1280.00 N·s	143.84-287.65 lbf·s
K	1,280.01-2,560.00 N·s	287.66-575.30 lbf·s
L	2,560.01-5,120.00 N·s	575.31-1150.60 lbf·s
M	5,120.01-10,240.00 N·s	1150.61-2301.20 lbf·s
N	10,240.01-20,480.00 N·s	2301.21-4602.40 lbf·s
O	20,480.01-40,960.00 N·s	4602.41-9204.80 lbf·s
		model rocket impulse chart

What does the first number after the letter mean?

The number that follows the letter indicates the average thrust of the engine measured in newtons. A lower number represents a lower average thrust and usually a longer thrust burn (assuming comparable engines have the same total impulse). So a B4 engine with go slower and burn longer than a B6 engine (assuming that they have the same total impulse).

Clustering engines increases both the average and total impulse and thus the velocity of the rocket. For example if you put two B6-4 engines together in a cluster the average thrust would rise to 12 newtons and the total impulse would be classified as a C engine.

Staging engines increases the total impulse but does not change the average thrust. For example, if you have a two stage rocket with a B6-0 for the first stage and a B6-6 for the upper stage the average thrust stays at 6. The two engines together would be equivalent of C6 engine.

What does the last number mean?

The delay component from the picture (4) controls when the ejection charge is ignited and the recovery device is ejected. This is the last number in the model rocket engine classification and simply represents a time in seconds. Thus a B6-4 engine will have a delay after the initial thrust of 4 seconds before the ejection charge is fired. A B6-6 will have 6 seconds of delay.

Picking the right delay is pivotal in having a successful flight. Too short a delay and the rocket is still traveling at a high rate of speed when the recovery device is ejected. This may cause damage to the recovery device and/or rocket. A delay that is too long may result in a late recovery device ejection. This can be disastrous for obvious reasons. Usually a longer delay time will be used on a lighter rocket or the top stage of a staged rocket. A shorter delay is good for heavier rockets.

Which engine do I choose?

Choosing the right engine comes from experience. But the best advice, especially if you are just starting out, is to follow the engine recommendations on the package that comes with the model rocket. As well, software that allows you to design rockets can be used to simulate a flight and thus choose an appropriate engine before you actually launch.

Lessons from my Canaroc Challenger

I was so impressed with my first rocket flight that I continued to push my rockets higher and higher. Eventually I lost my Canaroc Challenger after it drifted into the sky. Lesson learned, choose the right engine for the rocket and the weather conditions.