This equation can be used in a few practical ways when thinking about physics problems. We'll do a couple and, as we do, remember that physics breaks down to critically thinking about what forces are present—and when—and then plugging the numbers into the equation. Let's do a basic one first. You are working with an electric motor company developing a new electric motor. This motor turns a shaft designed to move a load of 3,000kg with a maximal force of 800N. What is the acceleration the motor needs to apply to the 3,000kg mass?

Going to our equation of a = F/m, we know both F, 800N, and m, 3,000kg. So, plugging them into the formula:

$$a = 800N/3{,}000kg$$

$$a = 0.27m/s^2$$

So, the 3,000kg object will be accelerated at a rate of $0.27m/s^2$ when the motor exerts a force of 800N to the object. Physics problems where you are given F and m and need to calculate acceleration are very straightforward since you plug the numbers into the equation and then just do the calculation.

With some other problems, you must do a little more figuring and strategic thinking about how to get the answer. For example, if you and a couple of your physics-nerd friends were sitting around watching Ryan Crouser win the 2016 Olympic shot put with a distance of 22.52m, you might have wondered how much force he exerted to make a 7.26kg shotput travel that far. Further, let's say you wanted to compare the force generated to put the shot that far versus the force generated to throw the venerated 95 mile-per-hour fastball in baseball.

Before we get into it, let me say that for these calculations, I made some estimations based upon analyzing the shot-putting and baseball-throwing motions. I believe these are reasonable, but there is some minor error introduced since I wasn't using high speed film captures; however, the same error would be present for both the shot put and baseball throwing motions, so I think everything kind of evens out and this is a fair comparison.

We'll start with the shotput. Keep in mind the primary formula is a = F/m and we are trying to figure out F. So solving for F, we get F = ma. We already know m, the mass of the shotput, is 7.26 kg, but I need to do some figuring to get "a." I analyzed Ryan Crouser's throwing motion and believe that the reasonable acceleration he applied to the shotput on his winning throw was $7.21m/s^2$. We have m = 7.26kg and a = $7.21m/s^2$, so all we need to do is substitute them into the equation to solve for F:

$$a = F/m$$

$$(m)(a) = F$$

$$(7.26kg)\ (7.21m/s^2) = F$$

$$F = 52.34N$$

So, the force he imparted to the shotput to make it fly 22.52m through the air was 52.34N.

Now, let's compare that to the force needed to generate a 95 mile per hour fastball in baseball.

95 mph is 42.47m/s, which we will say is the velocity when the ball leaves the pitcher's hand. I figured the acceleration achieved to make that velocity is 55.89m/s^2. Recall the shotput acceleration of 7.21m/s^2, so the baseball pitcher generates about 7 times the acceleration as the shot putter. That is quite a big difference between the two throwing movements, but if you are thinking that the baseball pitcher must therefore exert more force, we will see that mass is a big equalizer when it comes to acceleration. The mass of the baseball is 145g, which is 0.145kg. Now we know acceleration and mass, so we just need to complete the equation and get the answer.

$$a = F/m$$

$$(m)(a) = F$$

$$(0.145\text{kg})(55.89\text{m/s}^2) = F$$

$$8.1\text{N} = F$$

So, the pitcher gives 8.1N of force to the baseball to accelerate it from 0 to 95 mph (42.47m/s), while the shot putter generates 52.34N on the shotput to make it travel 22.52m. Although the acceleration to the baseball is about 7 times greater than that to the shot put, the shot put has 50 times the mass of the baseball, which is why so much more force is imparted to the shotput compared to the baseball.

Let's do one more and calculate acceleration directly. How much acceleration is produced by a dragster with a mass of 1,200kg that produces a force of 31,000N? Here, we just plug the numbers into the equation:

$$a = F/m$$

$$a = 31{,}000\text{N}/1200\text{kg}$$

$$a = 25.83\text{m/s}^2$$

Figure 7.8.1

Acceleration Data of Space Shuttle Discovery

NASA compiled this data following the Space Shuttle Discovery mission STS-121. This table shows time, altitude, velocity and acceleration for the Shuttle from take off until it enters orbit, which takes about 8 minutes. Note how often its acceleration changes during the ascent due to the timed nature of the rockets firing.

Time (s)	Altitude (m)	Velocity (m/s)	Acceleration (m/s^2)
0	-8	0	2.45
20	1244	139	18.62
40	5377	298	16.37
60	11,617	433	19.40
80	19,872	685	24.50
100	31,412	1026	24.01
120	44,726	1279	8.72
140	57,396	1373	9.70
160	67,893	1490	10.19
180	77,485	1634	10.68
200	85,662	1800	11.17
220	92,481	1986	11.86
240	98,004	2191	12.45
260	102,301	2417	13.23
280	105,321	2651	13.92
300	107,449	2915	14.90
320	108,619	3203	15.97
340	108,942	3516	17.15
360	108,543	3860	18.62
380	107,690	4216	20.29
400	106,539	4630	22.34
420	105,142	5092	24.89
440	103,775	5612	28.03
460	102,807	6184	29.01
480	102,552	6760	29.30
500	103,297	7327	29.01
520	105,069	7581 (16,958 miles/hr)	0.10