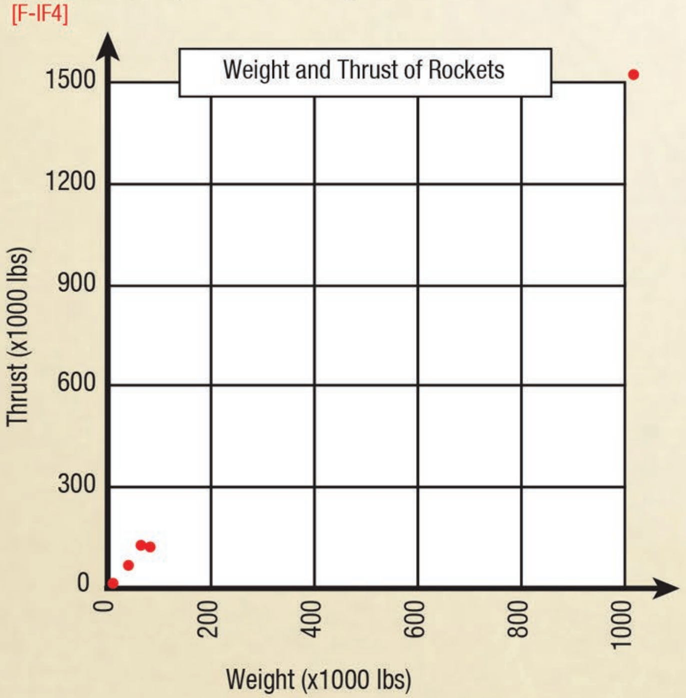
ROCKET PARK

	Weight (x1000 lbs)	Thrust (x1000 lbs)
Jupiter C	66	83
Juno II	110	171
Jupiter	108	150
German V-I	4	1
Saturn I	1,124	1,589

Make a scatterplot of the weight and thrust below. [F-IF4]



Find the rate of change in weight/thrust between the Jupiter C and Saturn I [F-IF6, S-ID7]

$\frac{83 - 1589}{66 - 1124} = \frac{-1506}{-1058}$ 1.42

Approximate the y-intercept of the line of best fit. What does it mean in this context? [F-IF4, F-IF7]

Because the data plot consists of data from different rockets, the y-int = 6.2. This does not make sense logically (having negative thrust) but illstrates that this data does not make a perfect function. Line of best fit.

Write an equation for the relationship between thrust and weight using function notation. Then use this function to find the range (weight) when the domain (thrust) is 500,000 lbs. [F-IF2, F-IF1]

$f(x) = 1.4x - 6.2$

$500{,}000 = 1.4x - 6.2$

$500{,}006.2 = 1.4x$

$x = 357{,}147$ lbs.

Find the slope of the line between the Jupiter C and the Saturn I. Explain what the slope means in this context. [S-ID7]

slope = $\frac{y_2 - y_1}{x_2 - x_1} = \frac{1589 - 83}{1124 - 66} = \frac{1506}{1058} = 1.4$

The slope demonstrates how the relationship between weight/thrust differs between the two rockets

Describe the correlation between the weight and thrust. [S-ID8]

The heavier the weight, the greater the thrust

Use the slope from above and the point for the Jupiter C to find the equation of the line. [A-CED2]

$y = mx+b$

$83 = (1.4)(66)+b$

$b= -9.4$

$y = 1.4x - 9.4$

Use your equation to predict the approximate weight of a rocket to the nearest unit with a thrust of 500,000 lbs. [A-REI3, A-CED1, F-LE1]

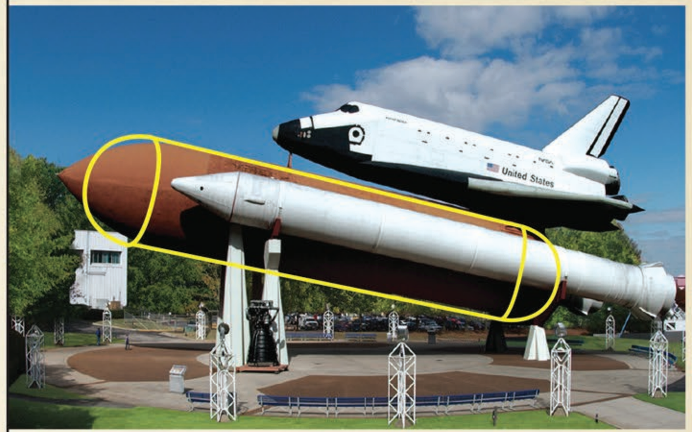
$500{,}000 = 1.4x - 9.4$

$500{,}009.4 = 1.4x$

$x = 357{,}150$ lbs.

SHUTTLE PARK

The External Tank is 154 ft long and 28 ft in diameter. It has a lift-off weight of 1,667,677 lbs. The Pathfinder orbiter is 120 ft long, 47 ft high, and has a wing span of 78 ft. It weighs 153,000 lbs. [N-Q1]



The External Tank is approximately two half spheres at the top and bottom of a cylinder. Find the surface area of the external tank using these formulas.

For a cylinder, the area of the sides is $2\pi rh$.
For a sphere, the surface area is $4\pi r^2$. [A-REI3]

$[1/2\,(4\pi r^2)] + [1/2\,(4\pi r^2)] + (2\pi rh)$

$(1/2 \bullet 4 \bullet 14^2) + (1/2 \bullet 4 \bullet 14^2) + (2 \bullet \pi \bullet 14 \bullet 154)$

$392\pi + 392\pi + 4312\pi = 5096\pi$ ft^2

If the budget for the metal that encases the external tank is $60,000, what is the most the metal should cost per square foot? [N-Q2]

$\frac{60{,}000}{5{,}096}$ = $11.77/sq. ft.

Math Exploration Algebra 1

your journey starts here

U.S. Space & Rocket Center

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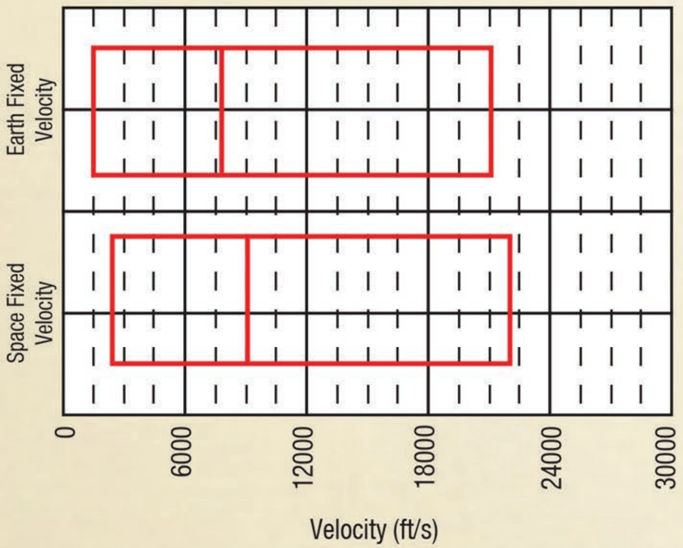
These skill-based activities correlate to nationally-accepted mathematics standards and are aligned with Common Core Standards as well as the Alabama College and Career Ready Standards.

SATURN V HALL

Did you know there are different kinds of velocity? Earth Fixed Velocity is velocity as observed from Earth. Space Fixed Velocity is velocity as observed from Space.

Apollo 11 Ascent Phase	Earth Fixed Velocity (ft/s)	Space Fixed Velocity (ft/s)
Liftoff	1.5	1341
Mach 1 achieved	1054	2024
Max dynamic pressure	1653	2627
S-IC center engine cutoff	5321	6493
S-IC outboard engine cutoff	7852	9069
S-IC/S-II separation	7883	9101
S-II center engine cutoff	17405	18726
S-II outboard engine cutoff	21638	22691
S-II/S-IV B separation	21377	22700
S-IV B 1st burn cutoff	24238	25562
Earth orbit insertion	24244	25568

Create two parallel box plots on the graph below. [S-ID1]

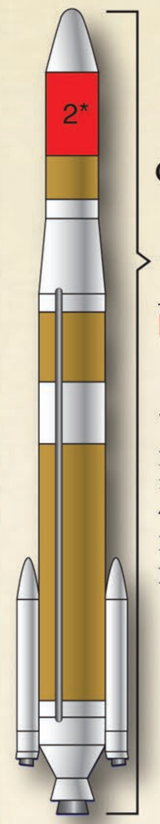


Compare the two medians. What is the difference between them? [S-ID2]

901 - 7883 = 1218

Marshall Space Flight Center rotates about Earth's axis at approximately 1300 ft/s. How is this represented in the data and plot? [S-ID3]

The Marshall Space Flight Center would be in the first quarter of the data above for Earth fixed velocity



The ULA Delta IV Med+ (4.2) is currently a launch provider for the U.S. Air Force, Global Positioning System (GPS) and other payloads.

1. The length of the ULA Delta IV Med+ (4.2) is __206__ ft __8.3__ in. Convert this to inches. [A-CED4]

(206 x 12) + 8.3 = 2480.3 in.

*2. If the payload portion - the top cylindrical portion excluding the nose cone - is approximately 37 feet tall and the payload volume is 4911 ft^3, what is the diameter of the payload portion? [A-CED4]

Recall: The volume of a cylinder is $V = \pi r^2 h$

$V = \pi r^2 h$
$4911 = \pi r^2 (37)$
$132.43 = \pi r^2$
$42.15 = r^2$
r 6.49ft.

Diameter = 2r
D = 2 (6.49)
D 12.98ft.

MOON MODEL

The area around a moon base is mapped out in a grid of one mile squares with the base at (0,0). A moon buggy leaves the moon base to map out gravitational anomolies and follows a path of $y = x^2 + 2x + 9$.
In order to extend its mission, the buggy commander requests more fuel. A fuel truck leaves the moon base in a linear direction of $y = 8x$.

At what coordinates will the fuel truck intersect the path of the moon buggy? [A-REI7]

They intersect at (3,24)

How far will the fuel truck need to travel to reach the moon buggy? Recall: $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ [A-REI11]

$\sqrt{(3-0)^2 + (24-0)^2} = \sqrt{3^2+24^2} = \sqrt{585} = 3\sqrt{65}$ mi

If the fuel truck travels at 5 miles per hour, how long will it take the fuel truck to reach the moon buggy? [F-IF5]

$3\sqrt{65}$ / 5 4.8 hours

THE FORCE [F-BF2]

The countdown at "The Force" begins at T-minus 42 hours.
42 hours = __151,200__ seconds.

42 x 60 x 60 = 151,200

Close to lift off we hear the announcer saying "10, 9, 8, 7, 6,..." Then the rocket lifts off at a 0.
What if the count down were different? Really different.
What if instead of 10, 9, 8 , ...,
it was 8000, 4000, 2000, ...
. 1/2 . 1/2
What would the next 4 counts be?

1,000, 500, 250, 125

Is the new countdown geometric or arithmetic?

geometric

If it is arithmetic, what is the common difference?

n/a

If it is geometric, what is the common ratio?

1/2

With the new countdown, will the rocket ever lift off? Explain why or why not.

No. Because each term is half the previous term, the countdown numbers would get infinitely smaller but woul dnever reach zero.

This graph comes from the biomedical results of Apollo 11 at the NASA Life Sciences Divison Archives.

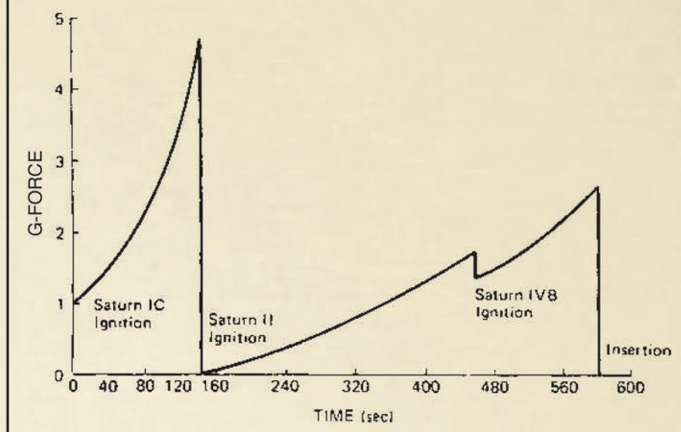


Figure 2. Typical Apollo launch profile – Saturn V launch vehicle.

During what interval(s) is S-IC ascent acceleration increasing?

(4.6 - 1) G
150 sec
~ (0, 150)

During what interval(s) is the S-II ascent acceleration increasing?

~ (150, 460)

During what interval(s) is the S-IVB ascent acceleration increasing?

~ (460, 580)

How many minutes after liftoff is the Saturn V at maximum acceleration?
What is the maximum acceleration?

150 seconds
~ 4.6 G's

What is the average rate of change of the acceleration per second for the interval from 0 to 2.5 minutes?

$\frac{(4.6 - 1)\ G}{150\ sec}$ = .024 G/sec