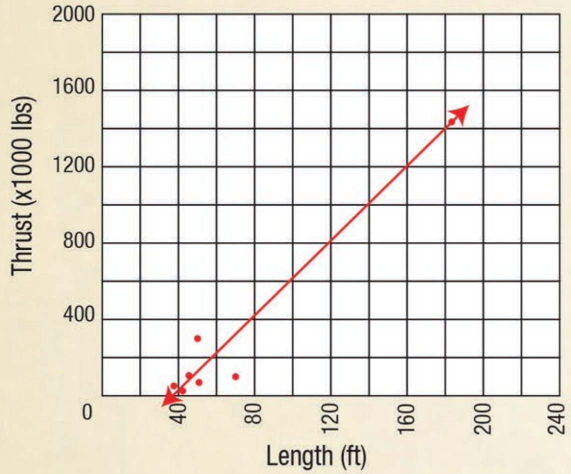
ROCKET PARK

Name	Length (ft)	Thrust (lbs)
Saturn I	189.9	1,589,285
Jupiter	60	150,000
Juno II	77.1	150,000
Redstone	69.3	78,000
Jupiter-C	71.3	83,000
Mercury-Redstone	83.38	78,000
Atlas	71.2	387,000

Create a scatter plot from the lengths and thrusts of the rockets in Rocket Park. [8-SP1, 8-SP4]



Draw a best fit line for the scatter plot.
The line should be straight and pass as close as possible to most data points. [8-SP2, 8-SP3]

Why does this data describe a function? [8-F1]
Because for every input (length) there is exactly one output (thrust). However, this won't necessarily be true for all rockets.

Determine the slope of the left side and the right side of the best fit line and compare these two values. [8-EE6]
m = 11805.8 for both sides

Looking at the slope of the line of best fit, describe the thrust of a very tall rocket and a very short rocket. [8-F2]
The taller the rocket, the greater the thrust

Determine the y-intercept of the best fit line.
b = -690007.5

Determine an appropriate linear equation that models the data. Use the form: y = mx + b. [8-F3]
y = 11805.8x - 690007.5

SHUTTLE PARK

The External Tank is 154 ft long and 27.6 ft in diameter. It has a lift-off weight of 1,667,677 lbs. The Orbiter is 122 ft long, 57ft 11in ft high, and has a wing span of 78 ft.

The Solid Rocket Boosters are 149.2 ft long and 12.2 ft in diameter, and the sides of the nose cones are 18.3 ft long.

Assume the Solid Rocket Boosters and External Tank can be approximated as cylinders, with constant height and diameter.

Prove that one Solid Rocket Booster and the External Tank are a) congruent, b) similar, or c) neither. [8-G5]
SRB = 149.2/12.2 = 12.2
ET = 154/27.6 = 5.5
Because their ratios between height and diameter are different they are neither.

Find the approximate volume of the external tank. [8-G9]
Recall: $V_{cyl} = \pi r^2 h$

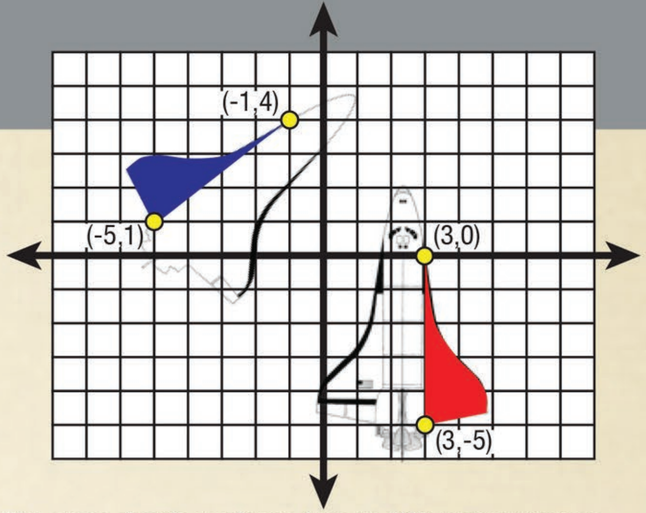
$\pi(13.8^2)(154)$
Volume 29327.76 π ft^3

The nose of the solid rocket boosters is a cone, whose sides and base form a triangle. Using the Pythagorean theorem, prove that this cannot be a right triangle. [8-G6]

Because there is no hypotenuse (no longest side) this data does not apply to the phythagorean theorem so it is not right.

Two students are standing on opposite sides of Pathfinder and measuring the angle from the ground up to cockpit with their phones. If one student measures the angle as 35° and the other measures it as 45°, then what is the angle between the two students as measured from the cockpit. [8-G5]

180 - (35+45) = 100°



The space shuttle performed many different maneuvers during launch and orbit, including flipping upside-down, rolling and turning around backwards.

Use the Pythagorean theorem to find the distance traveled by the leading edge of the wing during this maneuver. [8-G8]

$4^2 + 4^2 = C^2$
$16 + 16 = C^2$

$\sqrt{32} = \sqrt{C^2}$
$C = \sqrt{32} = 4\sqrt{2}$

Prove that the length of the inner edge of the wing is the same in the red and blue wings. [8-G7]

Blue:
$3^2 + 4^2 = C^2$
$9 + 16 = C^2$
$\sqrt{25} = \sqrt{C^2}$
C = 5

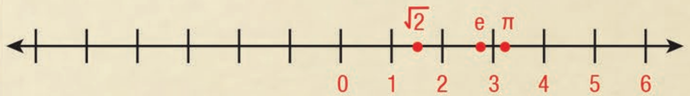
Red:
C = 5

Describe a series of rotations, reflections, translations and dilations to transform the starboard wing from the red position to the blue position. [8-G1, 8-G2, 8-G3, 8-G4]

- reflected across y-axis
- rotate 90° clockwise
- translate 2 units down

There are three irrational numbers that are commonly used in science and engineering: π (˜3.14), e (˜2.72), and √2 (˜1.41). They are often used when working with circles, limits and distances. [8-NS1, 8-NS2]
Graph these numbers on a number line.

Bonus points if you can also use their negative values.



Math Exploration Grade 8

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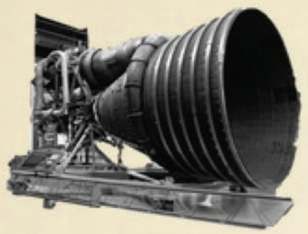
These skill-based activities correlate to nationally-accepted mathematics standards and are aligned with Common Core Standards as well as the Alabama College and Career Ready Standards.

Which engines increased the Saturn V's speed the most?

Five F-1 Engines

or



The F-1s produce a much greater thrust

One F-1 engine produces 1,500,000 lbs of thrust.
Five F-1 engines produce 7,500,000 lbs of thrust.
In scientific notation, five F-1 engines produce 7.5 x 10 6 lbs of thrust.

The F-1 engines burn for 135 seconds (1.35 x10^2 s).

The first stage of the Saturn V (S-IC) weighs 4,972,000 lbs fully loaded.

The total weight of all three stages of the Saturn V is 6,200,000 pounds (6.2 x106 lbs).

The five F-1 engines in the first stage of the Saturn V increased the acceleration of the rocket from 39 ft/s2 to 118 ft/g2.

Five J-2 Engines

The J-2s burn longer when the rocket is much lighter

One J-2 engine produces up to 200,000 - 230,000 lbs of thrust.
Five J-2 engines produce up to 1,000,000 lbs of thrust.
In scientific notation, five J-2 engines produce _____ x 10— lbs of thrust.

The J-2 engines burn for 301 seconds (3.01 x10^2 s) beginning 160 seconds into flight and ending at 461 s.

The second stage of the Saturn V (S-II) weighs 1,037,000 lbs fully loaded.

The total weight of the second and third stages of the Saturn V is 1,400,000 pounds (1.4 x10^6 lbs).

The five J-2 engines in the second stage of the Saturn V increased the acceleration of the rocket from 26 ft/s^2 to 59 ft/s^2.

$\Delta v = \bar{a} \bullet t$

change in velocity = average acceleration • time

Five F-1 Engines

What is the final acceleration? a_f = 118 ft/s^2

What is the initial acceleration? a_i = 39 ft/s^2

What is the average acceleration? $\bar{a}$ = 78.5 ft/s^2

$\bar{a} = \frac{(a_i + a_f)}{2} = \frac{(118 + 37)}{2} = 78.5$

What is the time? t = 135 s

What is the change in velocity? Δv = 10,597.5 ft/s

$\Delta v = \bar{a} \bullet t$

10,597.5 = 78.5 • 135

Five J-2 Engines

What is the final acceleration? a_f = 59 ft/s^2

What is the initial acceleration? a_i = 26 ft/s^2

What is the average acceleration? $\bar{a}$ = 42.5 ft/s^2

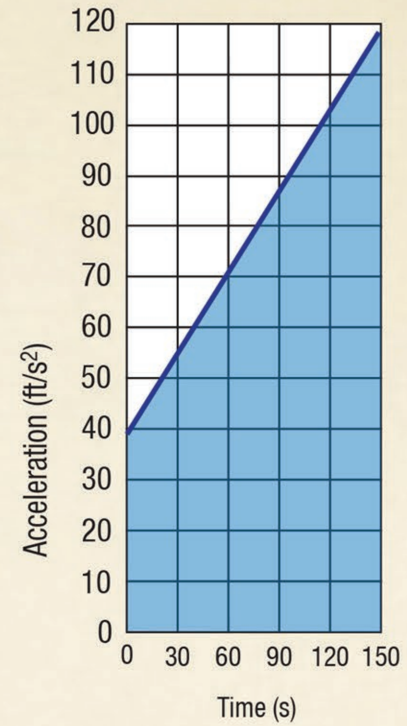
$\bar{a} = \frac{(a_i + a_f)}{2} = \frac{(59 + 26)}{2} = 42.5$

What is the time? t = 301 s

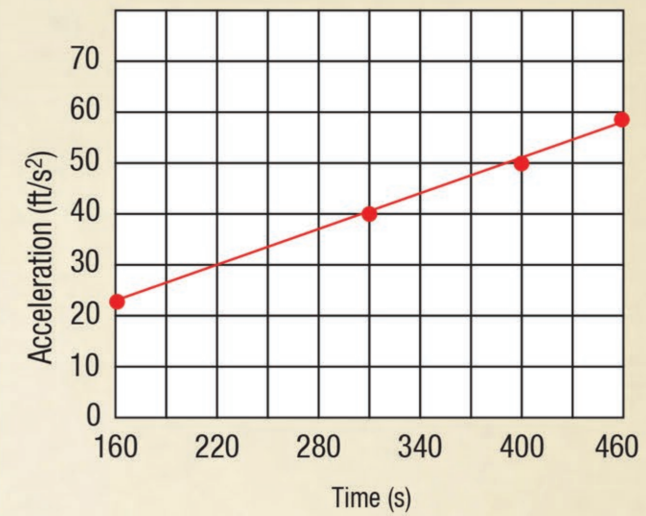
What is the change in velocity? Δv = 12,792.5 ft/s

$\Delta v = \bar{a} \bullet t$

= (42.5) (301) = 12,792.5



Assuming a constant rate of change of the acceleration, graph the acceleration of the five J-2 engines by plotting the initial and final accelerations.



Five F-1 Engines or Five J-2 Engines

Which engines increased the Saturn V's speed the most?

Using the two graphs, determine which engines had the greatest rate of change in acceleration.

The F-1 engines experience a greater ratge of change

Find two times when the acceleration of the two different engine configurations will be the same?

- They both have an acceleration of 40 when the F-1 first takes off and the J-2 is 310 seconds in flight
- They both have an acceleration of 50 ft/s² when the F-1 is at 20 seconds and the J-2 is at 400 seconds

The formula used to calculate change in velocity (average acceleration multiplied by the time) is the same formula used to find the area of a trapezoid.

Another way of looking at this is to find the area under the curve on an acceleration-time graph.

You now may want to look up the term integrals.