ANSWER KEY: The Early Years: Mercury to Apollo-Soyuz Math

Directions:

Using *The Early Years: Mercury to Apollo-Soyuz Information Summaries* (pages 8 & 9), fill out the tables and complete the graphs below.

Project Mercury

1. Complete the table below.

Manned Spacecraft	Height (meters)	Max Diameter (meters)	Weight (kilograms)	Habitable Volume (cubic meters)
Mercury	2.9	1.9	1,451	1.02
Gemini	5.5	3.0	3,402	1.56
Apollo	18.0		3,4280	10.45

2. Reference the data provided in the *Information Summaries* to build a graph for each of the specifications. Each graph needs to have an appropriate heading. Use the numbers you entered in the above table to label the y-coordinates. Use the name of the vehicle to label the x-coordinates.

3. Complete the table below. Round Height to the nearest whole number and round Weight and Thrust to the nearest thousand.

Manned Spacecraft	Height (meters)	Weight (kilograms)	Thrust (Newtons)
Mercury-Redstone	25	28,000	347,000
Mercury-Atlas	29	118,000	1,601,000
Gemini-Titan II	33	136,000	1,913,000
Apollo-Saturn IB	68	544,000	7,117,000
Apollo-Saturn V	110	2,812,000	38,698,000

A *ratio* is a comparison between numbers and it is often written as a fraction.
Example: The height of the Mercury-Redstone vehicle is about 33 meters if we round to the nearest whole number. The height of the Apollo-Saturn IB is 68 meters. The ratio of height between the Apollo-Saturn IB and the Mercury-Redstone is 68 to 33, or $^{68}/_{33}$. This ratio, which equals a little more than 2, tells us the Apollo-Saturn IB is a little more than twice the height of the Mercury-Redstone.

A *proportion* is a mathematical statement expressing that two ratios are equivalent.
Example: The ratio 10/5 is proportional to the ratio 6/3 because they are equivalent to each other. If we simplify both ratios, we find they are both equal to 2.

4. Using the table you completed in Item 3, complete the table below with ratios in decimal form that compare each space launch vehicle with the Mercury-Redstone.
Example: The Mercury-Atlas is 29 meters tall and the Mercury-Redstone is 25. The ratio of the height of the Mercury-Atlas to the Mercury-Redstone is 29/25, or 1.15 as a decimal number. This means the Mercury-Atlas is 1.15 the height of the Mercury-Redstone.

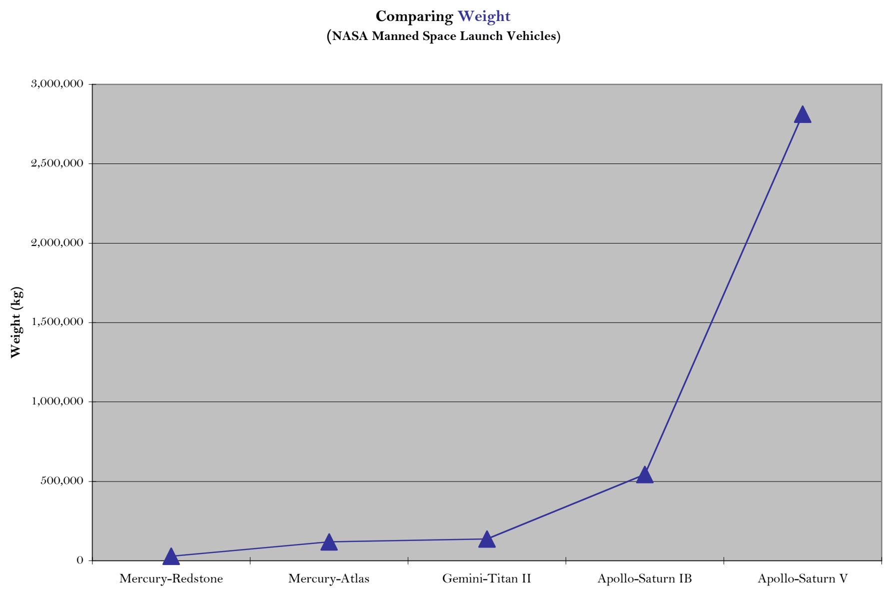
Manned Space Launch Vehicle	Height	Weight	Thrust
Mercury-Redstone	1.00	1.00	1.00
Mercury-Atlas	1.16	4.21	4.61
Gemini-Titan II	1.14	1.15	1.19
Apollo-Saturn IB	2.06	4.00	3.72
Apollo-Saturn V	1.62	5.17	5.44

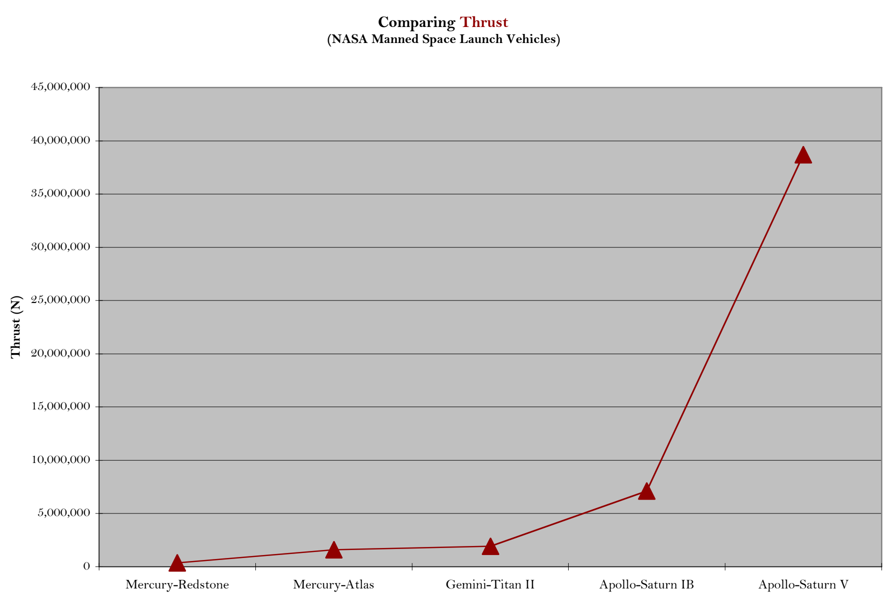
Look at the table you created and examine the relationship between Height, Weight, and Thrust. Is the proportion of Height or Weight equivalent to the proportion of Thrust?
There is no "equivalency" in the strict sense between any of these ratios.

Were there any proportions that were close to being equivalent?
The proportions of Weight and Thrust for any given vehicle seem to be close to an equivalency. This might suggest that there's a close relationship between them. Height, on the other hand, does not seem to have any relation to Thrust or Weight as clearly can be seen for the two Apollo spacecrafts.

Based on the data in the table, do you think you can predict how much thrust would be necessary for a new space vehicle if you were given its height and width? What if this new vehicle was 200 meters tall and weighed 224,000 kg.?
Since it seems that Weight and Thrust are both roughly equivalent proportionally, we can begin by determining a proportion between the weight of our new spacecraft (at 224,000kg) and the Mercury-Redstone, which gives us: 224,000/28,000 = 8. So, Thrust must be 8 times that of the Mercury-Redstone: 8 x 247,000 = 2,776,000 Newtons.

5. In the space below, create two line graphs using the information from the table in Item 3. One line graph should chart weight for all the space vehicles and the other should chart the thrust.





Comparing the shapes of these graphs, do they correspond with the ratios you calculated for each space vehicle?

Your turn to be a NASA Engineer!

6. If you wanted to build the next generation rocket for a manned flight vehicle, what specifications would it need to have? List them and draw a model.
Student answers will vary.