The Juno spacecraft was launched on August 5, 2011 on a 5 year journey to Jupiter. This image was taken 120 seconds after launch and shows one of the solid rocket boosters being jettisoned. The camera is on the Atlas booster and looks down on the engines and the distant arc of a cloudy Earth. Scenes from the launch can be found on *YouTube*, and show a dazzling launch from multiple viewing locations on Earth and in space.

During the launch, and the boost to orbit, the altitude of the rocket changes continuously as the engines provide thrust, eventually lifting the entire payload into orbit at a planned altitude of 420 kilometers (261 miles). A short table of the rocket's altitude and times is provided below.

Elapsed Time (seconds)	Altitude (miles)	Altitude (kilometers)
160	46	
192	60	
268	81	
274	83	
315	95	
319	97	
339	112	

Problem 1 - American engineers use English units for all measurements including the details of the rocket launch where 1 mile = 1.6 kilometers. Use this information to complete the table above in metric units rounded to the nearest kilometer.

Problem 2 - From the tabular data, graph the altitude of the rocket in time.

Problem 3 - From the data, find the function A(t) that predicts the altitude of the rocket at future times. The function will be of the form

$$A(t) = a + b\ln(t)$$

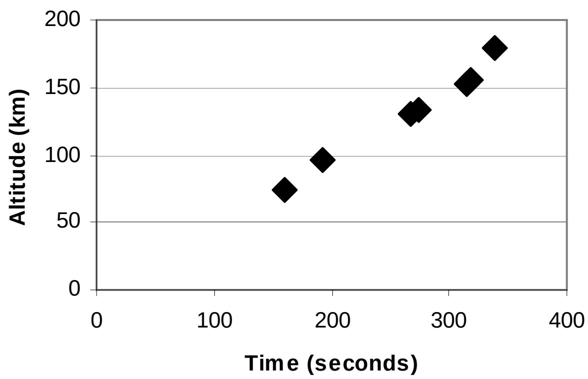
Find the constants a and b for A(t) in kilometers and A(t) in miles.

Problem 4 - How many seconds after launch will it take for the rocket to reach orbit altitude at 420 kilometers?

Problem 1 - American engineers use English units for all measurements including the details of the rocket launch where 1 mile =1.6 kilometers. Use this information to complete the table above in metric units rounded to the nearest kilometer.

Elapsed Time (seconds)	Altitude (miles)	**Altitude (kilometers)**
160	46	**74**
192	60	**96**
268	81	**130**
274	83	**133**
315	95	**152**
319	97	**155**
339	112	**179**

Problem 2 - From the tabular data, graph the altitude of the rocket in time.



Problem 3 - From the data, find the function A(t) that predicts the altitude of the rocket at future times. The function will be of the form

$$A(t) = a + b\ln(t)$$ Find the constants a and b.

Answer: Choose (160,74) and (319,155) then
74 = a + 5.1b and 155 = a + 5.8b
Solve by substitution: a = 74 - 5.1b then 155 =(74-5.1b) + 5.8b
So 81 = 0.7b and b = 116. Then a = -518
So with A(t) in kilometers, and t in seconds, we have:

$$A(t) = -518 + 116\ln(t)$$

In miles this becomes $$A(t) = -324 + 73\ln(t)$$

Problem 4 - How many seconds after launch will it take for the rocket to reach orbit altitude at 420 kilometers?

Answer: $420 = -518 + 116\ln(t)$ so t = **3,248 seconds or about 54 minutes**.

Note: The actual time is about 3,229 seconds.