PHYSICS 20323: Scientific Analysis & Modeling - Fall 2021
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1. The following formula was used to calculate the orbiting altitude of a satellite. Where T = the orbital period in (s), G = 6.67E-11 $\frac{m^3}{kgs^2}$, M = mass of the planet in (kg), and R = the radius in (km).

$$h = \left(\frac{GMT^2}{4\pi^2}\right)^{1/3} - R$$

This table contains the planet's information:

Mass	Radius	Day	Sidereal Day	T = 5 h	T = 1.5 h	T = 0.5 h
6.417E^{23}kg	3.39E^{6}m	88761.6 s	88642.8 s	18000 s	5400 s	1800 s

2. These are the Python programs used to calculate the altitudes given different orbital periods.

```
In [8]:
#Geosynchronous
import numpy as np
X=float(input("T value is: "))
T=X
G=6.67E-11 #(m^3)/kgs^2
M=6.417E23 #kg
R=3.39E6 #m

eq1=G*M*(T**2)
eq2=4*(np.pi**2)
eq3=(eq1/eq2)**(1/3)
h=eq3-R
print ("Altitude is: ",f"{h:.2E}","m")
```

```
T value is: 88761.6
Altitude is:  1.71E+07 m
```

```
In [12]:
#Siderial
import numpy as np
X=float(input("T value is: "))
T=X
G=6.67E-11 #(m^3)/kgs^2
M=6.417E23 #kg
R=3.39E6 #m

eq1=G*M*(T**2)
eq2=4*(np.pi**2)
eq3=(eq1/eq2)**(1/3)
h=eq3-R
print ("Altitude is: ",f"{h:.2E}","m")
```

```
T value is: 88642.8
Altitude is:  1.70E+07 m
```

```
In [9]:
#T = 18000 sec
import numpy as np
X=float(input("T value is: "))
T=X
G=6.67E-11 #(m^3)/kgs^2
M=6.417E23 #kg
R=3.39E6 #m

eq1=G*M*(T**2)
eq2=4*(np.pi**2)
eq3=(eq1/eq2)**(1/3)
h=eq3-R
print ("Altitude is: ",f"{h:.2E}","m")
```

```
T value is: 18000
Altitude is:  3.67E+06 m
```

```
In [10]:
#T = 5400 sec
import numpy as np
X=float(input("T value is: "))
T=X
G=6.67E-11 #(m^3)/kgs^2
M=6.417E23 #kg
R=3.39E6 #m

eq1=G*M*(T**2)
eq2=4*(np.pi**2)
eq3=(eq1/eq2)**(1/3)
h=eq3-R
print ("Altitude is: ",f"{h:.2E}","m")
```

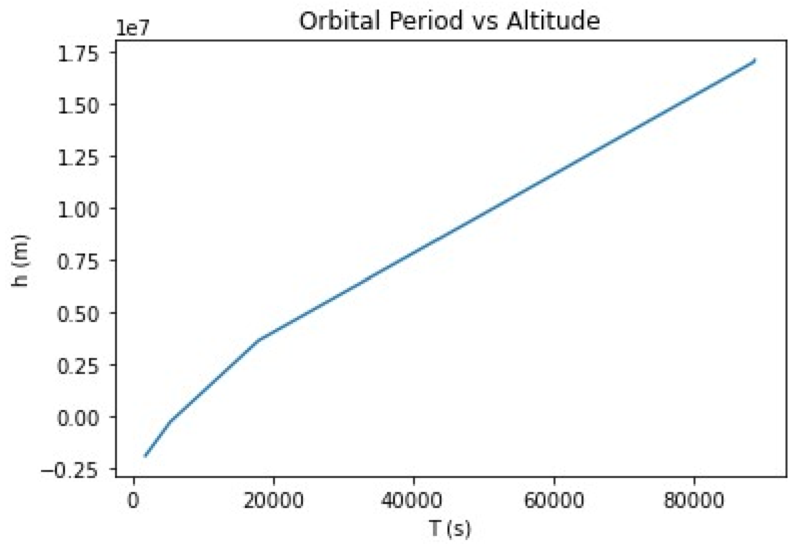
```
T value is: 5400
Altitude is:  -2.28E+05 m
```

```
In [11]:
#T = 1800 sec
import numpy as np
X=float(input("T value is: "))
T=X
G=6.67E-11 #(m^3)/kgs^2
M=6.417E23 #kg
R=3.39E6 #m

eq1=G*M*(T**2)
eq2=4*(np.pi**2)
eq3=(eq1/eq2)**(1/3)
h=eq3-R
print ("Altitude is: ",f"{h:.2E}","m")
```

```
T value is: 1800
Altitude is:  -1.87E+06 m
```

3. The results of the program show how a larger period will yield a larger orbital altitude. This is consistent with the formula since the orbital period (T) is on the top part of the fraction. This phenomenon is also known as Kepler's 3rd law of planetary motion. As the period gets shorter the altitude begins to get smaller and even becomes negative. This would mean it is not possible for the satellite to orbit that fast. The graph below shows how an increasing period correlates to an increasing altitude.



4. A sidereal day takes into account the rotation of the planet and the orbit around it's star. This makes the sidereal day slightly shorter than the complete rotation around itself. With the sidereal day considering the orbit around the sun, it means that the observer on earth will see the object in the sky in a sidereal day. The altitude is lower for the sidereal day compared to the complete rotation around its axis. Since the sidereal day is shorter, altitude is smaller. This is confirmed through the data we see in the chart and graph.