3. **Altitude of a satellite:** A satellite is to be launched into a circular orbit around the Earth so that it orbits the planet once every T seconds.

(a) Show that the altitude h above the Earth's surface that the satellite must have is

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

where $G = 6.67 \times 10^{-11}\,\mathrm{m^3\,kg^{-1}\,s^{-2}}$ is Newton's gravitational constant, $M = 5.97 \times 10^{24}$ kg is the mass of the Earth, and $R = 6371$ km is its radius.

(b) Write a program that asks the user to enter the desired value of T and then calculates and prints out the correct altitude in meters.

(c) Use your program to calculate the altitudes of satellites that orbit the Earth once a day (so-called "geosynchronous" orbit), once every 90 minutes, and once every 45 minutes. What do you conclude from the last of these calculations?

Problem 3

(A) Show that altitude h above earth orbit is

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

Start with: $F_g = \frac{GMm}{R^2}$, $F_c = \frac{mv^2}{R}$

set equal for circular orbit

$$\frac{GM\cancel{m}}{R^2} = \frac{\cancel{m}v^2}{R} \quad \Bigg| \quad \frac{v^2}{R} = \frac{\left(\frac{2\pi R}{T}\right)^2}{R}$$

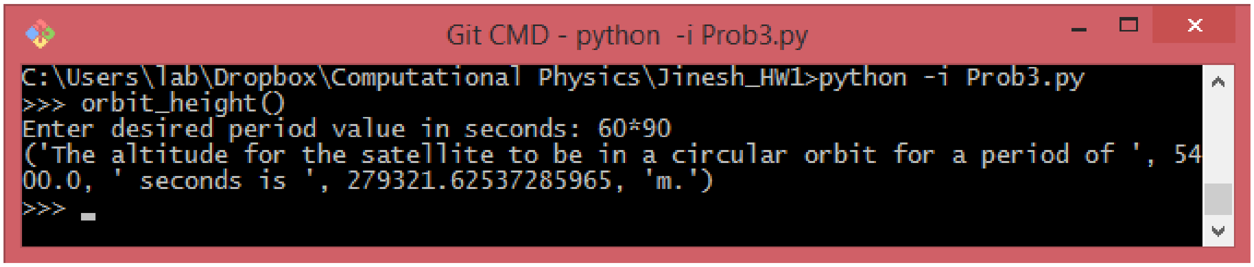
$$\frac{GM}{R^2} = \frac{4\pi^2 R^2}{T^2 R}$$

$$\frac{GMT^2}{4\pi^2} = R^3$$

$$\cancel{R = \sqrt[3]{\frac{GMT^2}{4\pi^2}}}$$

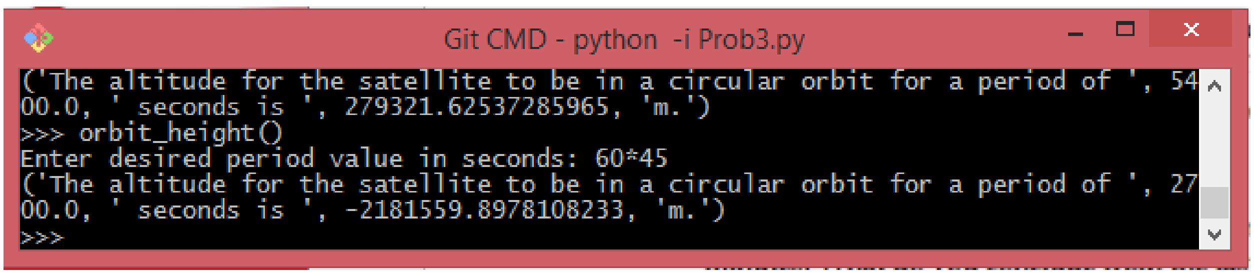
$$R = \left(\frac{GMT^2}{4\pi^2}\right)^{1/3}$$ * subtract earth's radius for h (height above earth).

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




```
C:\Users\lab\Dropbox\Computational Physics\Jinesh_HW1>python -i Prob3.py
>>> orbit_height()
Enter desired period value in seconds: 60*90
('The altitude for the satellite to be in a circular orbit for a period of ', 54
00.0, ' seconds is ', 279321.62537285965, 'm.')
>>>
```

1) Asked for user input on the period.
2) Calculated the value for the first result to be about 279 km.
3) When calculating the second part of problem c, the program returned a negative value displayed below. This means that the orbit is “inside” the earth. These calculations assume that the earth is a point mass and therefore would have this sort of result. Hence there are threshold values for T that must be reached for a realistic orbit.




```
('The altitude for the satellite to be in a circular orbit for a period of ', 54
00.0, ' seconds is ', 279321.62537285965, 'm.')
>>> orbit_height()
Enter desired period value in seconds: 60*45
('The altitude for the satellite to be in a circular orbit for a period of ', 27
00.0, ' seconds is ', -2181559.8978108233, 'm.')
>>>
```