Answer all question on the back of this page (or on a separate sheet). Please be as neat as you can. Show all work, including units. Circle your final answer clearly.

Launch location and free ΔV

In the second homework we calculated that you need a ΔV of about 8 km/s to orbit the Earth. But that calculation ignored the fact that the Earth rotates (it ignored a lot of other thing like air resistance as well). The rotation of the Earth an can be a source of free ΔV if you launch in the correct direction (eastward). How much ΔV you get depends on your location on the Earth.

More specifically, it depends on your latitude. The best place to get free ΔV is at the equator.

To calculated how fast the Earth is rotating at the equator you need two pieces of data: the total distance around the equator, and the time it takes the Earth rotate 360°.

The distance around the equator is $2\pi R_E$, where R_E is the radius of the Earth (R_E = 6,371 km).

The time it takes the Earth to rotate 360° is 23.93 hours

1 (5 pts) Calculate the distance around the Earth's equator.

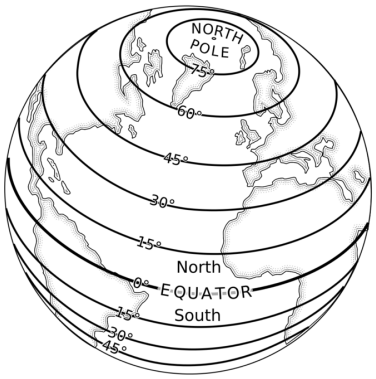
2 (5 pts) Calculate the time it takes the Earth to rotate in seconds.

3 (10 pts) Calculate the speed of an object on the Earth's equator. This is the free ΔV that the Earth's rotation gives you.

The speed of an object at any latitude can be found by:

$$V_{eq} \cos(\theta)$$

where V_{eq} is your speed at the equator, and θ is your latitude.



4 (5 pts) The main US launch site is *Cape Canaveral* located at a latitude of $\theta = 28.5°$. Calculate the free ΔV at Cape Canaveral.

5 (5 pts) The Russians main launch site is the *Baikonur Cosmodrome* located at a latitude of $\theta = 46°$. Calculate the free ΔV at the Baikonur Cosmodrome.

Make sure your calculator is set to degree mode. If you are using Google be sure to enter `cos(28.5 deg)`.

Astronomy 105 Homework #3 Name:_____