Will Legg
1-26-2024
Once the document is complete, save it as a single pdf and upload this to the Week 3 Whiteboard item in gradescope: https://www.gradescope.com/

REFLECTION PROMPT:

Reflecting on this week in class, were you able to improve on what you said last week? Why or why not? Be specific and include supporting examples from this week's classes.

This week in class our group was able to quickly read and assess the problem of modeling the orbit of the satellite around Earth. After reading through the problem we identified what information was given, what information was relevant and what information we would have to identify through calculations. We asked questions of our LA and to try and identify what further information we could research using the internet, such as the mass and radius of the Earth, against what information might not be relevant, such as the mass of the satellite. This also helped us what assumptions we could make about the scenario, like ignoring air resistance and that gravity would be the only force acting on the satellite.

Given the fact that the satellite was in geostationary orbit relative to Earth, we knew the period it would take for the satellite to travel around Earth and we moved forward to set up a system of equations to solve for the velocity of the satellite. This week in class, my classmates let me lead in the equation writing and solving algebraically. I'm a little slower in solving for the solution when it's represented only in variables, so it helped to get me get involved in the decision making process and put me at the forefront to ask the relevant questions as we moved through the process to solve. I think this was a good way to get everyone involved as in the past weeks I'd mostly only been involved in organizing the work and not as much in the actual solving.

During Part D that involved coding, we let our groupmates with the least amount of experience in coding drive the programming while others who had Python experience helped them navigate. We followed our same process of identifying missing information in the program and tried to have a clear and concise plan of approach. Our LA helped us refine our code and use relevant functions to improve our likelihood of success and overall legibility. Moving forward I believe it'd be helpful to fully write out a flowchart and pseudocode for the program with integrated equations as we used in the previous parts of the process.

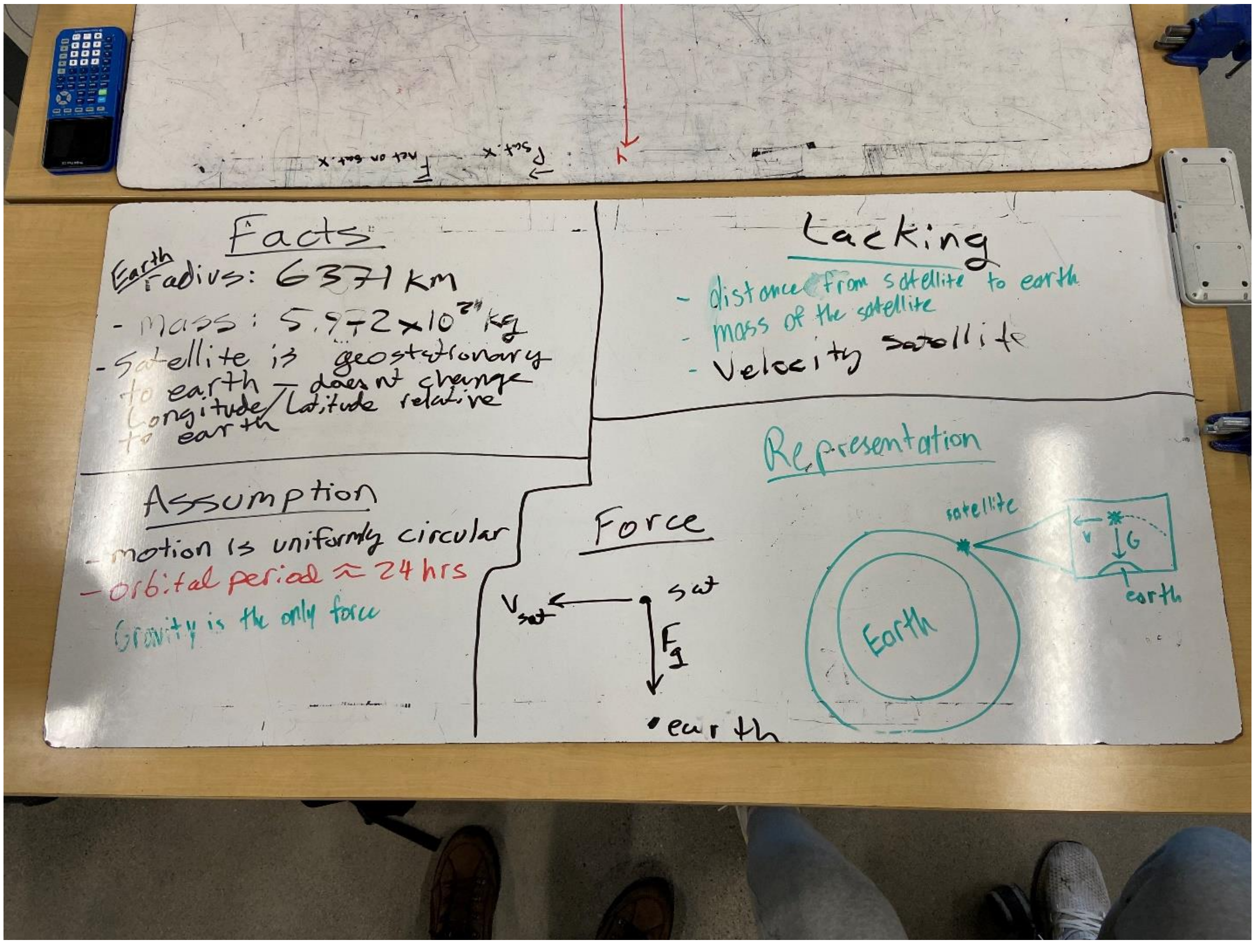
With the Group Project coming up next week, what do you want to contribute to your group next week?

I've already moved forward and made a general outline for the project as a Google doc which we'll all be able to edit simultaneously. I hope keep our legibility at 100%, translating out work clearly and concisely into our document so it's ready to be exported as a pdf. We will certainly have to divide all of our work with the given time constraints. I think my strengths are greatest with organization so hopefully I'll try to direct all work into our document and make sure all of our work is done orderly and we are on the same page in the solution process.

What strategies might you try? Be specific.

I think we can represent our usual white board process all on the same document and edit it all simultaneously. I think this will be quite a bit faster and more legible. We've also discussed writing out the steps of our solution process as a header with a short summary and then following that with our written out process using a tablet from others. I believe we will also have to split up our post-solution analysis so half the group could do model analysis where other half could do solution analysis and we both end with our suggested improvements. I think we can split up our duties for white board but we should all work together to define our goal, and then split work for solving and post-solution analysis.

PASTE IMAGES OF YOUR TUESDAY WHITEBOARDS HERE:



$$\left|\vec{F}_{grav}\right| = \frac{G\, M_{sat}\, M_{Earth}}{\left|\vec{r}_{sat}\right|^2}$$

$$\vec{F}_{net} = \frac{M_{sat}\, V_{sat}^2}{r_{sat}}$$

$$\left|\vec{F}_{grav}\right| = F_{net}$$

$$\frac{G\, M_{sat}\, M_{eart}}{\left|\vec{r}_{sat}\right|^2} = \frac{M_{sat}\, V_{sat}^2}{r_{sat}}$$

$$\frac{\sqrt{G\, M_{earth}}}{\sqrt{r_{sat}}} = V_{sat}$$

$$\vec{v} = \frac{\Delta x}{\Delta t}$$

$$\vec{v} = \frac{2\pi r}{T}$$

$$\frac{2\pi r}{T} = \sqrt{\frac{GM}{r}}$$

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

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

$r = 42231625.11\ m$

r from satalite to earth's core

$$\sqrt{\frac{G\, M_{earth}}{r_{sat}}} = V_{sat}$$

$V_{sat} = 3071\ m/s$

The velocity of the satellite to keep a geostationary orbit in relation to the earth is 3,071 m/s.

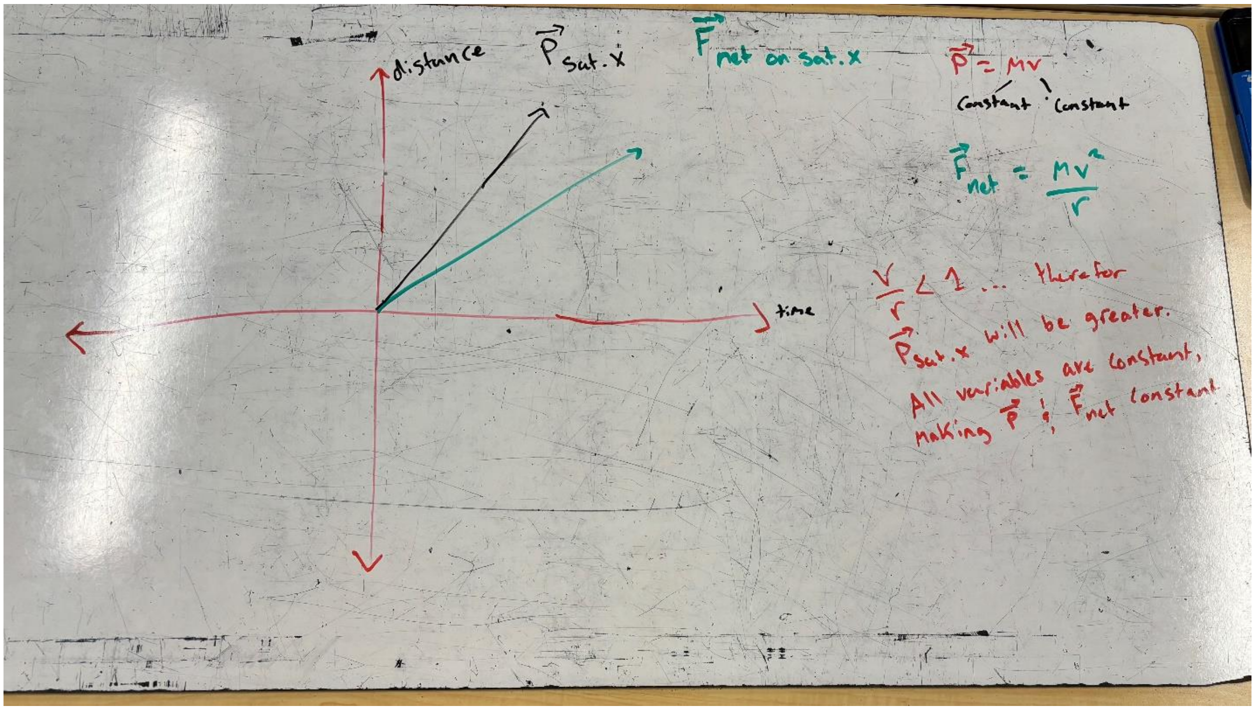
1. To be geostationary the satalite must be orbiting in a uniform circular motion.

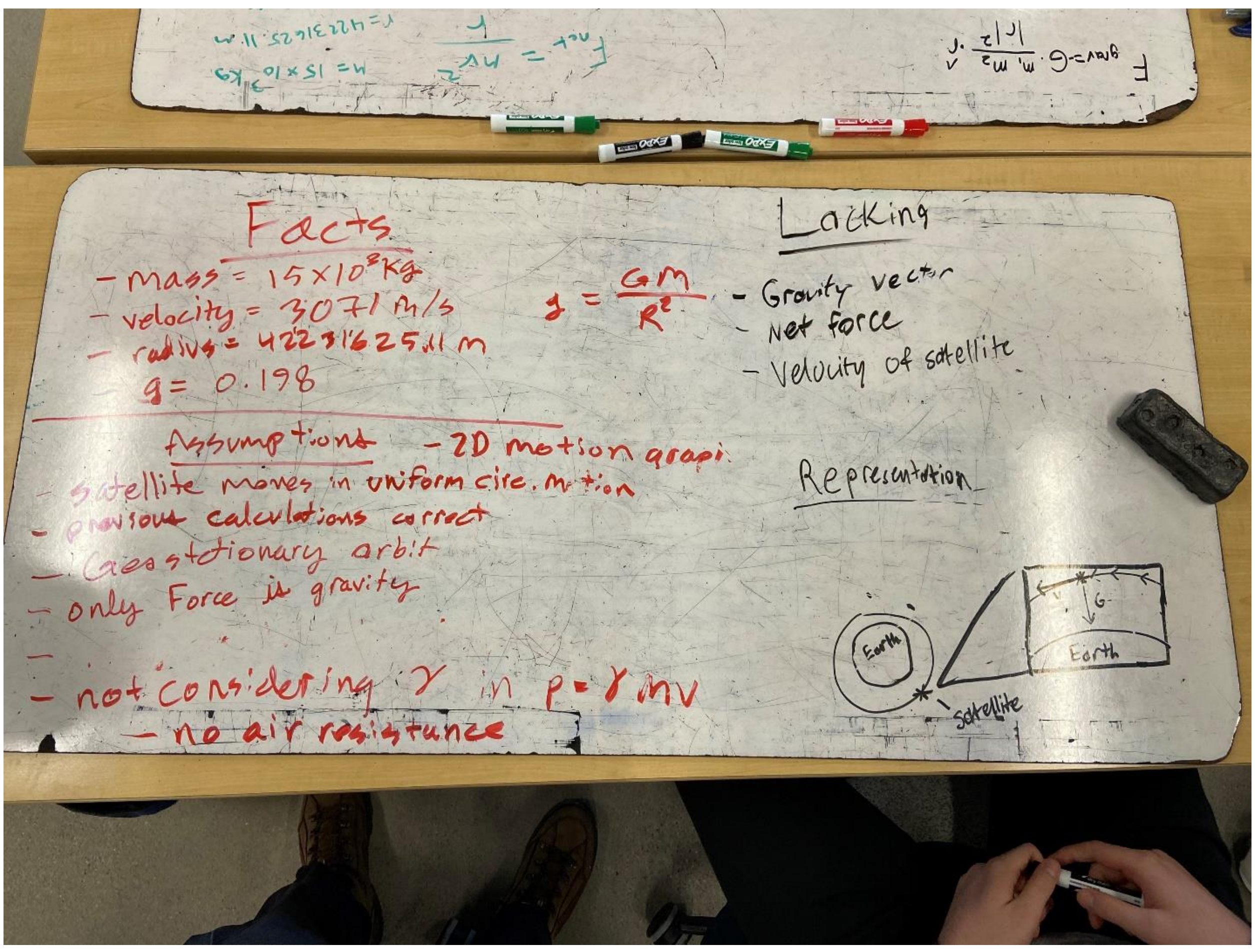
2. The velocity is perpendicular and proportional to the gravitational force inward.

3. The gravitational force is the force pulling the satalite to earth, The net force is the gravitational force <u>and</u> the velocity of the satalite, and the centripital force is the fake force that is felt between 2 objects in circular motion.

4. Yes, there is a force exerted on the Earth. However, due to the relative masses of the Earth and the satellite, it can be ignored.

5. Mass is the amount of matter that an object is made up of. Weight is the gravitational pull on an objected.


distance
$\vec{P}_{sat.x}$
$\vec{F}_{net\ on\ sat.x}$
time
$\vec{p} = mv$
constant constant
$\vec{F}_{net} = \frac{mv^2}{r}$
$\frac{v}{r} < 1$ ... therefor
$\vec{P}_{sat.x}$ will be greater.
All variables are constant,
making $\vec{p}$ & $\vec{F}_{net}$ constant


Facts
- mass = 15×10^2 kg
- velocity = 3071 m/s
- radius = 42231625.11 m
g = 0.198
$g = \frac{GM}{R^2}$
Lacking
- Gravity vector
- Net force
- Velocity of satellite
Assumptions
- 2D motion graph
- satellite moves in uniform circ. motion
- previous calculations correct
- Geostationary orbit
- only Force is gravity
- not considering γ in p = γmv
- no air resistance
Representation
Earth
v
G
Earth
Satellite

```
GlowScript 2.9 VPython

get_library('https://cdn.rawgit.com/PERLMSU/physutil/master/js/physutil.js')


#Window setup
scene.range=7e7
scene.width = 1024
scene.height = 760

#Objects
Earth = sphere(pos=vector(0,0,0), radius=6.4e6, color=color.blue)
Satellite = sphere(pos=vector(42231625, 0,0), radius=1e6, color=color.red, make_trail=True)
#SatOrbit = (pos=vector(0,0,0), length=
GCon = 6.67e-11
mEarth = 5.972e24
Gravity = (GCon*mEarth)/(Satellite.pos.x**2)



#Parameters and Initial Conditions
#Mass of Satellite
mSatellite = 15e3
vSatellite = vector(0,3073,0)
#Momentum of Satellite
pSatellite = mSatellite*vSatellite
DirVector = Earth.pos-Satellite.pos
Gvector = Gravity*DirVector
#Gobject = sphere(pos=DirVector, radius=1, color=color.blue)


#Time and time step
#Time Initial
t = 0
#Final Time
tf = 60*60*24
#Time Interval
dt = 1

#MotionMap/Graph
```

```


#Time and time step
#Time Initial
t = 0
#Final Time
tf = 60*60*24
#Time Interval
dt = 1

#MotionMap/Graph
SatelliteMotionMap = MotionMap(Satellite, tf, 20, markerScale=2000, labelMarkerOrder=False, markerColor=color.red)
#GvectorMotionMap = MotionMap(Gobject, tf, 20, markerScale=2000, labelMarkerOrder=False, markerColor=color.blue)
#Calculation Loop
while t < tf:
    rate(10000)
    #Net Force of the Satellite
    r_sep = Earth.pos-Satellite.pos
    r_hat = r_sep/mag(r_sep)
    Fgrav = (GCon*mEarth*mSatellite*r_hat)/mag(r_sep)**2
    Fnet = Fgrav

    pSatellite = pSatellite + Fnet*dt
    Satellite.pos = Satellite.pos + (pSatellite/mSatellite)*dt


    SatelliteMotionMap.update(t, pSatellite/mSatellite)

    #DirVector = Earth.pos-Satellite.pos
    #Gvector = Gravity*DirVector
    #GvectorMotionMap.update(t, Gvector)
    t = t + dt

    #Earth Rotation (IGNORE)
    theta = 7.29e-5*dt
    Earth.rotate(angle=theta, axis=vector(0,0,1), origin=Earth.pos)
```

$$F_{grav} = -G \cdot \frac{m_1 m_2}{|r|^2} \cdot \hat{r}$$

m_1 = mass earth

m_2 = mass satalite

r_{sep} = Earth.pos - Sat.pos

$$\hat{r} = \frac{\vec{r}}{|r|}$$

gives us r_{sep}

$$F_{net} = \frac{mv^2}{r}$$

$m = 15 \times 10^3$ kg

$r = 42231625.11$ m

$v = 3{,}071$ m/s

$$\vec{F}_{net} = 3349.76 \text{ N}$$

$$m_2 g = G \cdot \frac{m_1 m_2}{r^2}$$

The direction of gravity changes based on pos. of the satalite ∴ we will get the direction vector by pos.earth - pos. Satalite then multiplying by the force of gravity