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Space Comm

HW1

Note: I realized I forgot units after running all of my simulations: r is in km, θ is in degrees, V_r and V_{θ} are in km/s, e is unitless, and T is hours:minutes:seconds

Problem 1)

Python code also attached as a separate document. This is the code after problem 3 was finished.

```
#!/usr/bin/python3
import numpy as np
import matplotlib.pyplot as plt
import math
import pdb
# r = np.arange(0, 2, 0.01)
# theta = 2 * np.pi * r

r = 4436.82e6 # km MUST BE A FLOAT
theta = 0.0 # degrees
Vr = 0.0 # km/s
Vtheta = 6.10 # km/s

G = 6.672e-20 # km^3 / kg*s^2
Mp = 1.989e30 # earth 5.974e24 #kg

deltaTSec = 10000

rn = [r] # km
thetaN = [theta] # degrees
deltaRn = [Vr * deltaTSec] # km
deltaThetaN = [Vtheta * deltaTSec / r] # degrees / km

def deltaRnPlus1(deltaRn, rn, deltaThetaN, G, Mp, deltaTSec):
    term1 = deltaRn
    term2 = (rn + 1/2 * deltaRn) * (deltaThetaN ** 2)
    term3 = (G * Mp * (deltaTSec ** 2)) / ((rn + 1/2 * deltaRn)
** 2)
```

```

# pdb.set_trace()
return term1 + term2 - term3

def deltaThetaNPlus1(deltaThetaN, deltaRn, rn):
    term1 = deltaThetaN
    term2 = (2 * deltaRn * deltaThetaN) / (rn + 1/2 * deltaRn)
    return term1 - term2

for x in list(np.arange(0, 864000 * 90560 , deltaTSec)):#3.154e7
    rn.append(rn[-1] + deltaRn[-1])
    thetaN.append(thetaN[-1] + deltaThetaN[-1])
    tempDeltaRn = deltaRnPlus1(deltaRn[-1], rn[-1],
deltaThetaN[-1], G, Mp, deltaTSec)
    tempThetaN = deltaThetaNPlus1(deltaThetaN[-1], deltaRn[-1],
rn[-1])
    deltaRn.append(tempDeltaRn)
    deltaThetaN.append(tempThetaN)

ax = plt.subplot(111, projection='polar')
ax.plot(thetaN, rn)
ax.grid(True)
u = G * Mp

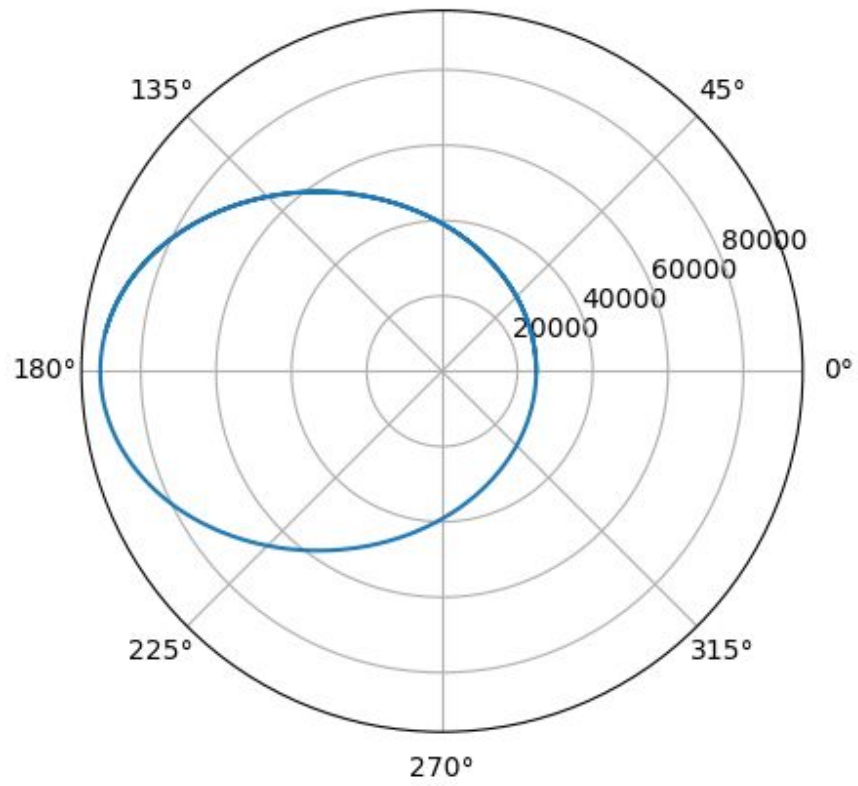
Ra = max(rn) # approx
Rp = min(rn) # approx
e = (Ra - Rp) / (Ra + Rp)

a = Ra / (1 + e)
T = math.sqrt(4 * np.pi**2 * a**3 / u)
m,s = divmod(T, 60)
h,m = divmod(m, 60)
print("e = %f and T = %f seconds" % (e, T))
ax.set_title("Orbit r=%d theta=%d Vr=%d Vtheta=%.4f e=%.4f
T=%d:%02d:%02d" % (r,theta,Vr,Vtheta,e,h,m,s), va='bottom')
ax.set_rmax(Ra + 5000)
plt.show()

```

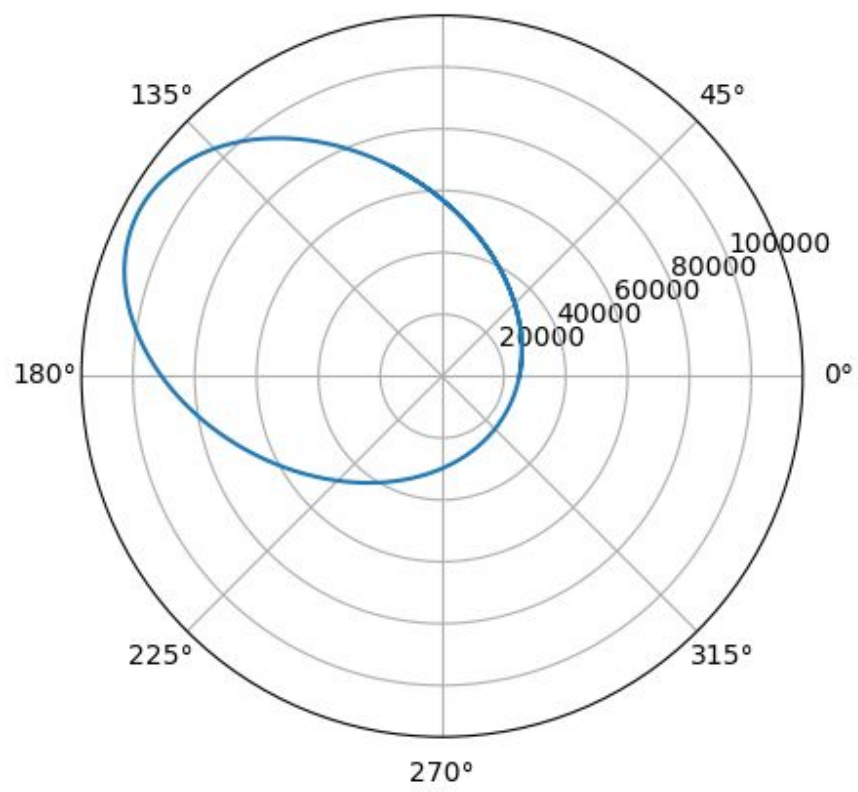
2)
a)

Orbit $r=25000$ $\theta=0$ $V_r=0$ $V_\theta=5$ $e=0.568098$ $T=38:29:44$



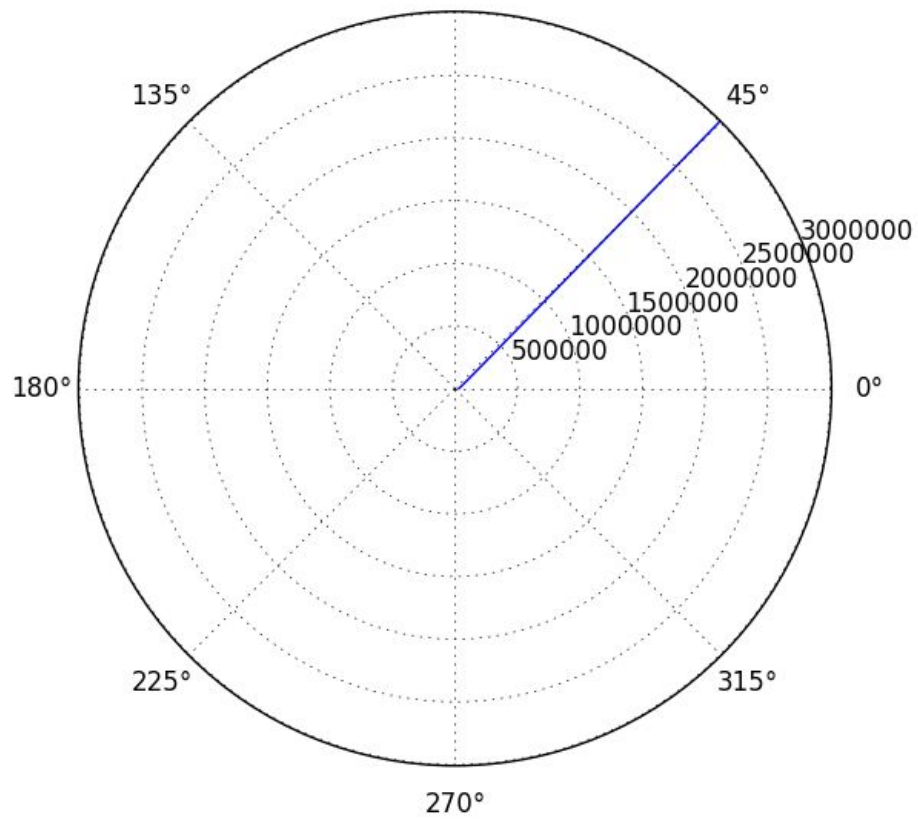
b)

Orbit $r=25000$ $\theta=0$ $V_r=1$ $V_\theta=5$ $e=0.648918$ $T=48:42:44$



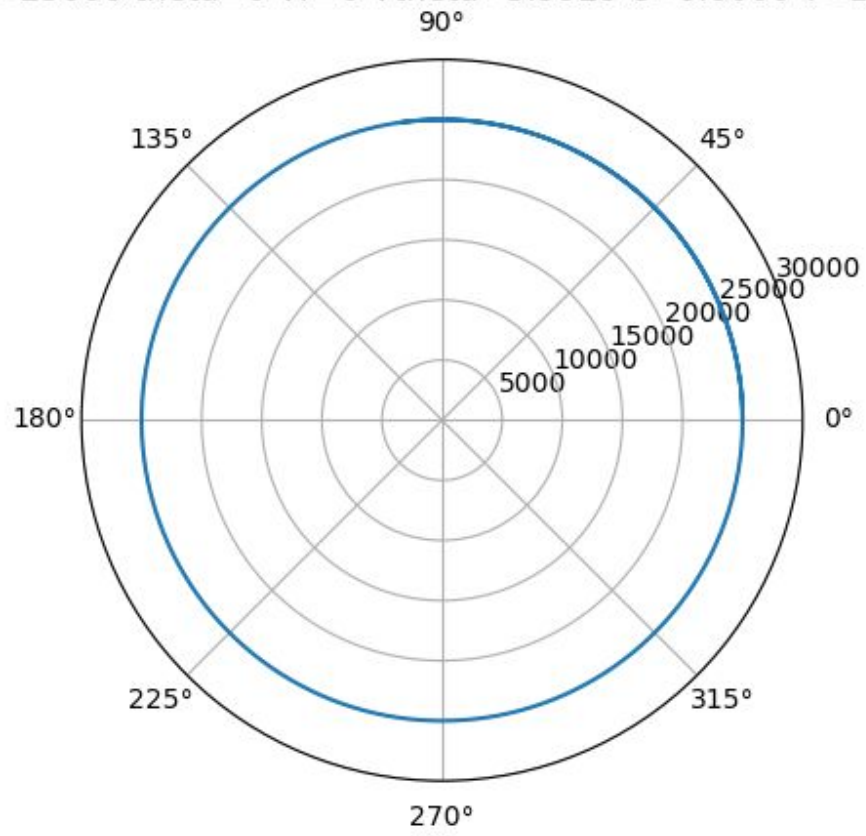
c)

Orbit $r=30000$ $\theta=0$ $V_r=6$ $V_\theta=5$ $e=0.980228$ $T=5166:41:32$



d)

Orbit $r=25000$ $\theta=0$ $V_r=0$ $V_\theta=3.9929$ $e=0.0000$ $T=10:55:39$



3)

Orbit $r=4436820000$ $\theta=0$ $V_r=0$ $V_\theta=6.1000$ $e=0.2444$ $T=2154890:48:53$

