HW1

February 14, 2017

1 Homework 1

1.1 Problem 1

1.1.1 Part (a)

Using equation (1) we have:

```
In [1]: import math

        #Defining pi constant.
        Pi=3.14159
        #Gravitational constant in m3kg-1s-2.
        G=6.67*10**(-11)
        #Mass of earth in kilos.
        M=5.97*10**(24)
        #Radius of earth in meters.
        R=6371.0*10**(3)
        #Inputing orbital period in seconds.
        T=float(input("Enter the desired orbital period in seconds: "))
        #Altitude corresponding to the desired period.
        h=(G*M*T**2.0/(4.0*Pi**2.0))**(1.0/3.0)-R
        #Answer output.
        if h<=0:
            print "Such an orbit is impossible to exist."
        else:
            print"The altitude corresponding to the given orbital period\
            is %.0f meters" % (h)
```

```
Enter the desired orbital period in seconds: 10000000
The altitude corresponding to the given orbital period is 996504575 meters
```

1.1.2 Part (b)

Using the same equation and logic we have:

```
In [2]: import math
```

```
#Defining pi constant.
Pi=3.14159
#Gravitational constant in m3kg-1s-2.
G=6.67*10**(-11)
#Mass of earth in kilos.
M=5.97*10**(24)
#Radius of earth in meters.
R=6371.0*10**(3)
#Defining orbital periods of interest in seconds.
T1,T2,T3=24.*60.*60,90.*60.,45.*60.
#Calculation of the corresponding altitudes.
h1=(G*M*T1**2.0/(4.0*Pi**2.0))**(1.0/3.0)-R
h2=(G*M*T2**2.0/(4.0*Pi**2.0))**(1.0/3.0)-R
h3=(G*M*T3**2.0/(4.0*Pi**2.0))**(1.0/3.0)-R
#Answer output.
print"The altitude corresponding to an orbital period of 24\
hours is %.0f meters" % (h1)
print"The altitude corresponding to an orbital period of 90\
minutes is %.0f meters" % (h2)
print"The altitude corresponding to an orbital period of 45\
minutes is %.0f meters" % (h3)
```

```
The altitude corresponding to an orbital period of 24 hours is 35855934 meters
The altitude corresponding to an orbital period of 90 minutes is 279325 meters
The altitude corresponding to an orbital period of 45 minutes is -2181558 meters
```

It seems that there can not exist an orbit with an orbital period of 45 minutes.

1.1.3 Part (c)

Using again the same equation and logic we have:

```
In [3]: import math

        #Defining pi constant.
        Pi=3.14159
        #Gravitational constant in m3kg-1s-2.
        G=6.67*10**(-11)
        #Mass of earth in kilos.
        M=5.97*10**(24)
        #Radius of earth in meters.
        R=6371.0*10**(3)
        #Defining orbital periods of interest in seconds.
        TD,TG=24.*60.*60., 23.93*60.*60.
        #Calculation of the corresponding altitudes.
        hD=((G*M*TD**2.0/(4.0*Pi**2.0))**(1.0/3.0)-R)
        hG=((G*M*TG**2.0/(4.0*Pi**2.0))**(1.0/3.0)-R)
        #Calculation of the difference between the two altidutes.
```

```
Dh=hD-hG
#Answer output.
print"The altitude corresponding to an orbital period of\
24 hours is %.0f meters" % (hD)
print"The altitude corresponding to the geosyncronous orbit\
is %.0f meters" % (hG)
print"The difference between the two altidutes of interest\
is %.0f meters" % (Dh)
```

```
The altitude corresponding to an orbital period of 24 hours is 35855934 meters
The altitude corresponding to the geosyncronous orbit is 35773786 meters
The difference between the two altidutes of interest is 82148 meters
```

1.2 Problem 2

1.2.1 Part (a)

If x is the distance between the two planets and v the magnitude of the velocity of the spaceship then the duration of the trip as measured by an observer on earth is given by: $t = v/x$. To calculate the duration of the trip as measured by an observer on the spaceship we need to use formula (2). So we have:

```
In [4]: import math

        #Speed of light in meters per second
        c=3.*10.**8.
        #Inputing the distance between planets.
        xin=float(input("Enter the distance between planets in light years: "))
        #Transformation of distance into light years
        x=xin*(9.461*10.**15.)
        #Inputing the spaceship velocity.
        vin=float(input("Enter the spaceship velocity as a fraction of the\
        speed of light (0<v<1): "))
        #Transformation of velocity into meters per second.
        v=vin*c
        #Calculation of trip duration as measured by an observer on earth.
        tP=x/v
        tPout=tP/(3.154e+7)
        #Calculation of trip duration as measured by an observer on the spaceship.
        t=tP/((1.-(v**2./c**2.))**(-1./2.))
        tout=t/(3.154e+7)
        print "Trip duration as measured by an observer on earth %f years" %(tPout)
        print "Trip duration as measured by an observer on the spaceship %f years" %(tout)
```

```
Enter the distance between planets in light years: 10
Enter the spaceship velocity as a fraction of the speed of light (0<v<1): 0.99
Trip duration as measured by an observer on earth 10.099943 years
Trip duration as measured by an observer on the spaceship 1.424772 years
```

1.2.2 Part (b)

Using the program above for a distance of 10 light years and a velocity magnitude of 0.99 of the speed of light we get t′ = 1.42 years.

1.3 Problem 3

1.3.1 Part (a,b)

```
In [5]: import math

        #Inputing the mass number.
        A=float(input("Enter the mass number: "))
        #Inputing the atomic number.
        Z=float(input("Enter the atomic number: "))
        #Liquid drop model constants.
        a1,a2,a3,a4=15.67,17.23,.75,93.2
        if A%2!=0:
            a5=0.
        elif A%2==0 and Z%2==0:
            a5=12.
        elif A%2==0 and Z%2!=0:
            a5=-12.
        #Calculation of binding energy.
        B=(a1*A)-(a2*A**(2./3.))-(a3*(Z**2.)/(A**(1./3.)))-((a4*(A-2.*Z)**2.)/A)+\
        (a5/(A**(1./2.)))
        print "Binding energy: %f MeV" %(B)
        print "Binding energy per nucleon is: %f MeV" %(B/A)
```

```
Enter the mass number: 58
Enter the atomic number: 28
Binding energy: 493.935607 MeV
Binding energy per nucleon is: 8.516131 MeV
```