import math

sig=[0,3600]

m=[0,3600]

p=[0,3600]

mm=[0,40]

dp=[0,40]

r=[0,40]

kk=2

ak=2

p0=1

p0=400

m0=0.2

patm=1

bet=0.78

bc=2.5\*0.0001

tau=1

hh=20

rk=1000

rc=0.1

N=10

ak=0

kk=0.05\*0.000000000001

q=1000000

qq=q\*(1/(2\*3.14\*hh))

taum=tau

taut=0.001

print(mm)

def zx(x):

zx=1-0.1162\*0.01\*x+0.3744\*0.00001\*x\*x-0.2965\*0.000000001\*x\*x\*x-0.1975\*0.00000000001\*x\*x\*x\*x

def zpp(x):

zpp=-0.1162\*0.01+2\*0.3744\*0.00001\*x-3\*0.2965\*0.000000001\*x\*x-4\*0.1975\*0.00000000001\*x\*x\*x

def kp(x):

kp=kk\*ak\*\*(x-p0)

def sp(x):

sp=0.814286\*x

def spp(x):

spp=0.814286

def ap(x):

ap=1.116+0.1157\*0.01\*x+0.23674\*0.000001\*x\*x

def app(x):

app=0.1157\*0.01+2\*0.23674\*0.000001\*x

def cp(x):

cp=(0.637\*0.0001-0.5057\*0.000001\*x+0.6265\*0.00000001\*x\*x-0.1595\*0.0000000001\*x\*x\*x+0.13\*0.0000000000001\*x\*x\*x\*x)

def cpp(x):

cpp=(-0.5057\*0.000001+2\*0.6265\*0.00000001\*x-3\*0.1595\*0.0000000001\*x\*x+4\*0.13\*0.0000000000001\*x\*x\*x)

def gmap(x):

gmap=194.899-0.42974\*0.1\*x+0.1335\*0.0001\*x\*x-0.6053\*0.000001\*x\*x\*x+0.622\*0.000000001\*x\*x\*x\*x

def gampp(x):

gampp=-0.42974\*0.1+2\*0.1335\*0.0001\*x-3\*0.6053\*0.000001\*x\*x+4\*0.622\*0.000000001\*x\*x\*x

def mugp(x):

mugp=((0.0126+0.257\*0.0001\*x+0.1633\*0.0000001\*x\*x)\*0.00000001/(86400))

def mukp(x):

mukp=((0.6+0.3295\*0.01\*x+0.1044\*0.0001\*x\*x-0.1558\*0.0000001\*x\*x\*x+0.85\*0.00000000001\*x\*x\*x\*x)\*0.00000001/(86400))

def fq(x):

fq=2.0833\*x\*x\*x\*x+4.9167\*x\*x\*x-5.5708\*x\*x-0.277\*x+0.882

def fk(x):

fk=1.8864\*x\*x+0.1889\*x+0.0005

def nn1(x):

nn1=((x\*bet\*(1-cp(x)\*gamp(x)))/(mugp(x)\*zx(x)))\*kp(x)

def nn2(x):

nn2=((x\*bet\*cp(x))/(mugp(x)\*zx(x)))\*kp(x)

def mm1(x):

mm1=(sp(x)/(mukp(x)\*ap(x)))\*kp(x)

def mm2(x):

mm2=(1/(mukp(x)\*ap(x)))\*kp(x)

def ll1(x):

ll1=(x\*bet\*(1-cp(x)\*gamp(x))/zx(x))

def ll11(x):

ll11=(1/sqr(zx(x)))\*(bet\*zx(x)\*((1-cp(x)\*gamp(x))-x\*(cpp(x)\*gamp(x)+cp(x)\*gampp(x)))-x\*bet\*(1-cp(x)\*gamp(x))\*zpp(x))

def ll2(x):

ll2=(x\*bet\*cp(x))/zx(x)

def ll22(x):

ll22=(1/sqr(zx(x)))\*(bet\*zx(x)\*(cp(x)+x\*cpp(x))-bet\*x\*cp(x)\*zpp(x))

def q1(x):

q1=(sp(x)/ap(x))

def q2(x):

q2=(1/ap(x))

def q11(x):

q11=(1/sqr(ap(x)))\*(spp(x)\*ap(x)-sp(x)\*app(x))

def q22(x):

q22=-(1/sqr(ap(x)))\*app(x)

def ff0(x):

ff0=(q1(x)-ll1(x))/(q2(x)-ll2(x))

def ff1(x,y,z):

ff1=ll11(x)\*z\*(1-y)+q11(x)\*z\*y

def ff2(x,y,z):

ff2=ll22(x)\*z\*(1-y)+q22(x)\*z\*y

def ff3(x,y,z):

ff3=ll1(x)\*(1-y)+q1(x)\*y

def ff4(x,y,z):

ff4=ll2(x)\*(1-y)+q2(x)\*y

def ff5(x,y,z):

ff5=z\*q2(x)-z\*ll2(x)

def f1g(x,y,z):

f1g=0.5\*(fq(y)\*nn1(x)+fq(y1)\*nn1(x1))

def f2g(x,x1,y,y1):

f2g=0.5\*(fq(y)\*nn2(x)+fq(y1)\*nn2(x1))

def f1k(x,x1,y,y1):

f1k=0.5\*(fk(y)\*mm1(x)+fk(y1)\*mm1(x1))

def f2k(x,x1,y,y1):

f2k=0.5\*(fk(y)\*mm2(x)+fk(y1)\*mm2(x1))

for i in range(0,N):

r[i]=i\*math.log(rk/rc)/N

for i in range(0,N):

p[i,0]=p0

sig[i,0]=0

m[i,0]=m0

h=math.log(rk/rc)/N

j=1

k1=1

k=0

k2=1

while j>0:

as1=(f1g(p[0,j-1],p[0,j-1],sig[0,j-1],sig[0,j-1])+f1k(p[0,j-1],p[0,j-1],sig[0,j-1],sig[0,j-1]))

a[0,j]=1

c[0,j]=-qq\*h/as1

for i in range(1,n-1):

aa=(exp(-2\*r[i])\*taut/((rc\*rc)\*h\*h))

m[i,j]=m0\*exp(bc\*(p[i,j-1]-p0))

df1=aa\*(f1g(p[i,j-1],p[i+1,j-1],sig[i+1,j-1],sig[i+1,j-1])+f1k(p[i,j-1],p[i+1,j-1],sig[i+1,j-1],sig[i+1,j-1]))-aa\*ff0(p[i,j-1])\*(f2g(p[i,j-1],p[i+1,j-1],sig[i+1,j-1],sig[i+1,j-1])+f2k(p[i,j-1],p[i+1,j-1],sig[i+1,j-1],sig[i+1,j-1]))

df2=aa\*(f1g(p[i,j-1],p[i-1,j-1],sig[i,j-1],sig[i,j-1])+f1k(p[i,j-1],p[i-1,j-1],sig[i,j-1],sig[i,j-1]))-aa\*ff0(p[i,j-1])\*(f2g(p[i,j-1],p[i-1,j-1],sig[i,j-1],sig[i,j-1])+f2k(p[i,j-1],p[i-1,j-1],sig[i,j-1],sig[i,j-1]))

a[i,j]=df1/(df1+df2\*(1-a[i-1,j])+(ff1(p[i,j-1],sig[i,j-1],m[i,j-1])-ff0(p[i,j-1])\*ff2(p[i,j-1],sig[i,j-1],m[i,j-1])))

c[i,j]=(df2\*c[i-1,j]+p[i,j-1]\*(ff1(p[i,j-1],sig[i,j-1],m[i,j-1])-ff0(p[i,j-1])\*ff2(p[i,j-1],sig[i,j-1],m[i,j-1]))-(ff3(p[i,j-1],sig[i,j-1],m[i,j-1])-ff0(p[i,j-1])\*ff4(p[i,j-1],sig[i,j-1],m[i,j-1]))\*(m[i,j]-m[i,j-1]))/(df1+df2\*(1-a[i-1,j])+(ff1(p[i,j-1],sig[i,j-1],m[i,j-1])-ff0(p[i,j-1])\*ff2(p[i,j-1],sig[i,j-1],m[i,j-1])));

p[n-1,j]=c[n-1,j]/(1-a[n-1,j])

p[n,j]=p[n-1,j]

i=n-1

while i!=0:

p[i-1,j]=a[i-1,j]\*p[i,j]+c[i-1,j]

i=i-1

m[0,j]=m0\*exp(bc\*(p[0,j-1]-p0))

aa=(exp(-2\*r[0])\*taut/((rc\*rc)\*h\*h))

st2=aa\*(f2g(p[1,j-1],p[2,j-1],sig[1,j-1],sig[2,j-1])+f2k(p[1,j-1],p[2,j-1],sig[1,j-1],sig[2,j-1]))\*(p[2,j]-p[1,j])-aa\*(f2g(p[0,j-1],p[1,j-1],sig[0,j-1],sig[1,j-1])+f2k(p[0,j-1],p[1,j-1],sig[0,j-1],sig[1,j-1]))\*(p[1,j]-p[0,j])

st1=aa\*(f1g(p[1,j-1],p[1,j-1],sig[1,j-1],sig[1,j-1])+f1k(p[1,j-1],p[1,j-1],sig[1,j-1],sig[1,j-1]))\*(p[2,j-1]-p[1,j-1])-aa\*(f1g(p[0,j-1],p[0,j-1],sig[0,j-1],sig[0,j-1])+f1k(p[0,j-1],p[0,j-1],sig[0,j-1],sig[0,j-1]))\*(p[1,j-1]-p[0,j-1])

i=0

stt=st1-ff0(p[0,j-1])\*st2-(ff3(p[i,j-1],sig[i,j-1],m[i,j-1])-ff0(p[i,j-1])\*ff4(p[i,j-1],sig[i,j-1],m[i,j-1]))\*(m[i,j]-m[i,j-1])

sig[i,j]=sig[i,j-1]+(st2/ff5(p[i,j-1],sig[i,j-1],m[i,j-1]))-(ff2(p[i,j-1],sig[i,j-1],m[i,j-1])/ff5(p[i,j-1],sig[i,j-1],m[i,j-1]))\*(1/(ff1(p[i,j-1],sig[i,j-1],m[i,j-1])-ff0(p[i,j-1])\*ff2(p[i,j-1],sig[i,j-1],m[i,j-1])))\*stt-(ff4(p[i,j-1],sig[i,j-1],m[i,j-1])/ff5(p[i,j-1],sig[i,j-1],m[i,j-1]))\*(m[i,j]-m[i,j-1])

i=1

while i==n:

if i==1:

sdd=sig[0,j]

else :

sdd=sig[i,j-1]

m[i,j]=m0\*exp(bc\*(p[i,j-1]-p0))

aa=(exp(-2\*r[i])\*taut/((rc\*rc)\*h\*h))

st2=aa\*(f2g(p[i,j-1],p[i+1,j-1],sig[i+1,j-1],sig[i+1,j-1])+f2k(p[i,j-1],p[i+1,j-1],sig[i+1,j-1],sig[i+1,j-1]))\*(p[i+1,j]-p[i,j])-aa\*(f2g(p[i,j-1],p[i-1,j-1],sig[i,j-1],sdd)+f2k(p[i,j-1],p[i-1,j-1],sig[i,j-1],sdd))\*(p[i,j]-p[i-1,j])

st1=aa\*(f1g(p[i,j-1],p[i+1,j-1],sig[i+1,j-1],sig[i+1,j-1])+f1k(p[i,j-1],p[i+1,j-1],sig[i+1,j-1],sig[i+1,j-1]))\*(p[i+1,j]-p[i,j])-aa\*(f1g(p[i,j-1],p[i-1,j-1],sig[i,j-1],sdd)+f1k(p[i,j-1],p[i-1,j-1],sig[i,j-1],sdd))\*(p[i,j]-p[i-1,j])

stt=st1-ff0(p[i,j-1])\*st2-(ff3(p[i,j-1],sig[i,j-1],m[i,j-1])-ff0(p[i,j-1])\*ff4(p[i,j-1],sig[i,j-1],m[i,j-1]))\*(m[i,j]-m[i,j-1])

sig[i,j]=sig[i,j-1]+(st2/ff5(p[i,j-1],sig[i,j-1],m[i,j-1]))-(ff2(p[i,j-1],sig[i,j-1],m[i,j-1])/ff5(p[i,j-1],sig[i,j-1],m[i,j-1]))\*(1/(ff1(p[i,j-1],sig[i,j-1],m[i,j-1])-ff0(p[i,j-1])\*ff2(p[i,j-1],sig[i,j-1],m[i,j-1])))\*stt-(ff4(p[i,j-1],sig[i,j-1],m[i,j-1])/ff5(p[i,j-1],sig[i,j-1],m[i,j-1]))\*(m[i,j]-m[i,j-1])

i=i+1

sig[n,j]=sig[n-1,j]

if trunc((taut\*j)/10)==k2:

gk=(sp(p[0,j])+(mukp(p[0,j])/mugp(p[0,j]))\*(fk(sig[0,j])/fq(sig[0,j]))\*ap(p[0,j])\*(p[0,j]/zx(p[0,j]))\*bet\*(1-cp(p[0,j])\*gamp(p[0,j])))/(1+cp(p[0,j])\*(mukp(p[0,j])/mugp(p[0,j]))\*(fk(sig[0,j])/fq(sig[0,j]))\*ap(p[0,j])\*(p[0,j]/zx(p[0,j])))

print((taut\*j),' ',(m[0,j]),' ',(p[0,j]),' ',(p[1,j]),' ',(p[2,j]),' ',(p[3,j]),' ',(p[4,j]),' ',(p[5,j]),' ',(p[6,j]),' ',(p[7,j]),' ',(p[8,j]),' ',(p[9,j]),' ',(p[10,j]),' ',(p[11,j]),' ',(p[12,j]),' ',(p[13,j]),' ',(p[14,j]),' ',(p[15,j]),' ',(sig[0,j]),' ',(sig[1,j]),' ',(sig[2,j]),' ',(sig[3,j]),' ',sig[4,j],' ',sig[5,j],' ',sig[6,j],' ',sig[7,j],' ',sig[8,j],' ',sig[9,j],' ',sig[10,j],' ',(sig[11,j]),' ',(sig[12,j]),' ',(sig[13,j]),' ',(sig[14,j]),' ',sig[15,j],' ',(q/gk),' ',gk)

print("\n\n")

print(f,(taut\*j),' ',' ',(m[0,j]),' ',(p[0,j]),' ',(p[1,j]),' ',(p[2,j]),' ',(p[3,j]),' ',(p[4,j]),' ',(p[5,j]),' ',(p[6,j]),' ',(p[7,j]),' ',(p[8,j]),' ',(p[9,j]),' ',(p[10,j]),' ',(p[11,j]),' ',(p[12,j]),' ',(p[13,j]),' ',(p[14,j]),' ',(p[15,j]),' ',(sig[0,j]),' ',(sig[1,j]),' ',(sig[2,j]),' ',(sig[3,j]),' ',sig[4,j],' ',sig[5,j],' ',sig[6,j],' ',sig[7,j],' ',sig[8,j],' ',sig[9,j],' ',sig[10,j],' ',(sig[11,j]),' ',(sig[12,j]),' ',(sig[13,j]),' ',(sig[14,j]),' ',sig[15,j],' ',(m[0,j]),' ',m[n,j],' ',(q/gk),' ',gk)

print(f)

k2=k2+1

j=j+1