```
PROGRAM Pendulo_doble
! ***********************
! Se resuelve el pendulo doble
REAL*8, DIMENSION(:), ALLOCATABLE :: theta1,omega1,theta2,omega2,t
REAL*8 :: 11,12,m1,m2,dt
 !print*, "numero de pasos"
 !read*, n
n = 500000
ALLOCATE (theta1(0:n),theta2(0:n),omega1(0:n),omega2(0:n),t(0:n))
call inicializa(theta1,theta2, omega1,omega2, t, l1,l2,m1,m2, dt)
call calcula (theta1, omega1, theta2, omega2, 11, 12, m1, m2, t, n, dt)
call despliega (theta1, theta2, t, n)
END PROGRAM Pendulo_doble
Ţ
SUBROUTINE inicializa(theta1,theta2,omega1,omega2, t,11,12,m1,m2, dt)
REAL*8, INTENT (INOUT), DIMENSION(0:n) :: theta1, theta2, omega1, omega2, t
REAL*8, INTENT (INOUT) :: 11,12,m1,m2,dt
 !print*,'Angulo inicial del pendulo (en radianes)'
 !read*, theta(0)
theta1(0) = 0.5d0
theta2(0) = 0.4d0
 !print*, 'Velocidad angular inicial del pendulo (en radianes/s)'
 !read*, omega(0)
omega1(0) = 0.1d0
omega2(0) = 0.1d0
t(0)=0.d0
 !print*,'Longitud del pendulo (in m)'
 !read*, length
11 = 1.d0
12 = 1.d0
m1 = 2.d0
m2 = 2.d0
 !print*, 'Tamaño de paso (en segundos)'
 !read*, dt
dt = 0.001
END SUBROUTINE inicializa
```

```
SUBROUTINE calcula(theta1, omega1, theta2, omega2,11,12,m1,m2, t, n, dt)
    INTEGER, INTENT (IN) :: n
    REAL*8, INTENT (IN) ::11,12,m1,m2,dt
    REAL*8, INTENT (INOUT), DIMENSION(0:n) :: theta1, omega1, theta2, omega2, t
    REAL*8 :: g,k11,k12,k13,k14,k21,k22,k23,k24
    REA1*8 :: k31,k32,k33,k34,141,142,143,144,PI
    INTEGER :: i
    PI = 4.*ATAN(1.)
    i = 0
    g = 9.80d0
    D0
    t(i+1) = t(i) + dt
    k11 = dt*omega1(i)
    k21 = dt*omega2(i)
    k31 = dt*OME1(g,m1,m2,theta1(i),theta2(i),omega1(i),omega2(i),11,12)
    k41 = dt*OME2(g,m1,m2,theta1(i),theta2(i),omega1(i),omega2(i),11,12)
    k12 = dt*(omega1(i)+(0.5d0)*k11)
    k22 = dt*(omega2(i)+(0.5d0)*k21)
    k32 = dt*OME1(g,m1,m2,theta1(i)+(0.5d0)*k11,theta2(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k2
    k42 = dt*OME2(g,m1,m2,theta1(i)+(0.5d0)*k11,theta2(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k21,omega1(i)+(0.5d0)*k2
    k13 = dt*(omega1(i)+(0.5d0)*k12)
    k23 = dt*(omega2(i)+(0.5d0)*k22)
    k33 = dt*OME1(g,m1,m2,theta1(i)+(0.5d0)*k12,theta2(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k33
    k43 = dt*OME2(g,m1,m2,theta1(i)+(0.5d0)*k12,theta2(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k22,omega1(i)+(0.5d0)*k2
    k14 = dt*(omega1(i)+(0.5d0)*k13)
    k24 = dt*(omega2(i)+(0.5d0)*k23)
    k34 = dt*OME1(g,m1,m2,theta1(i)+k13,theta2(i)+k23,omega1(i)+k33,omega2(i)+k43,l1,l2)
    k44 = dt*OME2(g,m1,m2,theta1(i)+k13,theta2(i)+k23,omega1(i)+k33,omega2(i)+k43,l1,l2)
    theta1(i+1) = theta1(i)+((1/6.d0)*(k11+((0.5d0)*(k12+k13))+k14))
    theta2(i+1) = theta2(i)+((1/6.d0)*(k21+((0.5d0)*(k22+k23))+k24))
    omega1(i+1) = omega1(i)+((1/6.d0)*(k31+((0.5d0)*(k32+k33))+k34))
    omega2(i+1) = omega2(i)+((1/6.d0)*(k41+((0.5d0)*(k42+k43))+k44))
    if (theta1(i+1) > PI) theta1(i+1)=theta1(i+1)-2.*PI
    if (theta1(i+1) < -PI) theta1(i+1)=theta1(i+1)+2.*PI
    if (theta2(i+1) > PI) theta2(i+1)=theta2(i+1)-2.*PI
    if (theta2(i+1) < -PI) theta2(i+1)=theta2(i+1)+2.*PI
    IF (i > n) EXIT
    i=i+1
    ENDDO
END SUBROUTINE calcula
```

```
SUBROUTINE despliega(theta1, theta2, t, n)
   INTEGER, INTENT (IN) :: n
   REAL*8, INTENT (IN), DIMENSION(0:n) :: theta1,theta2,t
   INTEGER :: i
   CHARACTER(LEN=10), PARAMETER :: f1 = '(3ES16.6)'
   CHARACTER(10) :: archivo
    !print*," archivo de datos"
   !read*, archivo
   archivo = "datos.dat"
   OPEN (UNIT=1,FILE=archivo,STATUS='UNKNOWN')
   WRITE(1,f1)(theta1(i),theta2(i),t(i), i=0,n)
   CLOSE(1)
END SUBROUTINE despliega
REAL FUNCTION OME1(g,m1,m2,x1,x2,y1,y2,11,12)
   REAl*8, INTENT(IN) :: g,m1,m2,x1,x2,y1,y2,l1,l2
   OME1 = (-g*(2*m1+m2)*SIN(x1)-m2*g*SIN(x1-2*x2)-2*SIN(x1-x2)*m2*(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*y1*11*COS)+(y2*y2*12+y1*11*COS)+(y2*y2*12+y1*11*COS)+(y2*y2*12+y1*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*y2*12*11*COS)+(y2*
END FUNCTION OME1
REAL FUNCTION OME2(g,m1,m2,x1,x2,y1,y2,11,12)
  REAl*8, INTENT(IN) :: g,m1,m2,x1,x2,y1,y2,l1,l2
   END FUNCTION OME2
```

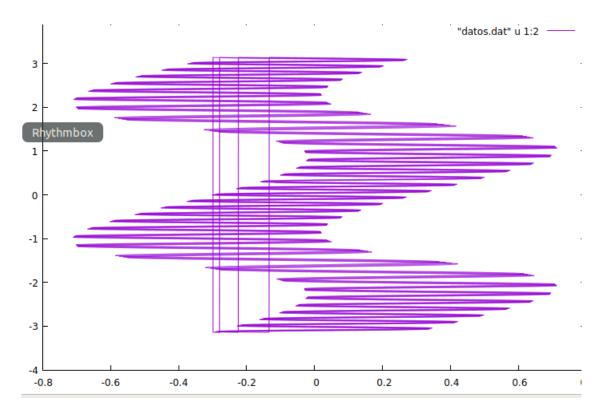


Figura 1:  $\theta_1$  vs  $\theta_2$ 

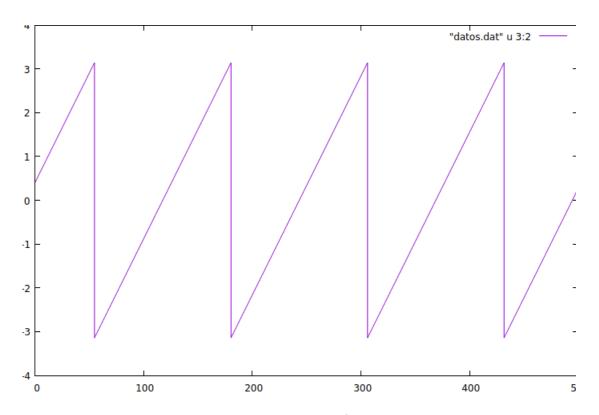


Figura 2: t vs  $\theta_2$