Errata — Elementary Mechanics Using Matlab

Anders Malthe-Sørenssen

Department of Physics, University of Oslo

May 6, 2024

Errata

1

Chapter 03: Units and Measurements

p. 36 ... a car driving 2.0km in ... $\rightarrow$ 2.0m

Chapter 04: Motion in one dimension

- p.47 eq 4.7 0.5 in denominator
- p.59 table Fig 4.7 should be Table 4.3
- p.59 eq 4.31-4.34, $v(0.1s) = 0.0$m/s, $x(0.1) = 0.0m$, $a(0.0) = 0.0$, $v(0.2s) = 0.143$m/s, $a(0.1s) = 1.43m/s^2$, $x(0.2s) = 0.0$m.
- p.62 eq 4.43 $v0 \rightarrow v_0$.
- p. 54 Replace program with the following

```
import numpy as np
import matplotlib.pyplot as plt

t,y = np.loadtxt('tennis002.d',usecols=[0,1],unpack=True);

plt.plot(t,y)
plt.xlabel('t [s]')
plt.ylabel('y [m]')

n = len(y)
dt = t[1] - t[0]
v = np.zeros(n-1,float)
for i in range(n-1):
   v[i] = (y[i+1] - y[i])/dt
```

```
a = np.zeros(n-1,float)
for i in range(1,n-1):
   a[i] = (v[i] - v[i-1])/dt

plt.subplot(3,1,1)
plt.plot(t,y)
plt.ylabel('y [m]')
plt.subplot(3,1,2)
plt.plot(t[0:n-1],v)
plt.ylabel('v [m/s]')
plt.subplot(3,1,3)
plt.plot(t[1:n-1],a[1:n-1])
plt.xlabel('t [s]')
plt.ylabel('a [m/s^2]')

imax = np.max(np.where(t<=0.5))
plt.plot(t[1:imax],a[1:imax])
plt.xlabel('t [s]')
plt.ylabel('a [m/s^2]')

g = 9.8 # m/s^2
y0 = 1.6 # m
vt = -g*t
yt = y0 - 0.5*g*t**2
plt.subplot(2,1,1)
plt.plot(t[0:imax],y[0:imax],'-r')
plt.plot(t[0:imax],yt[0:imax],'--b')
plt.xlabel('t [s]')
plt.ylabel('y [m]')
plt.subplot(2,1,2)
plt.plot(t[0:imax],v[0:imax],'-r')
plt.plot(t[0:imax],vt[0:imax],'--b')
plt.xlabel('t [s]')
plt.ylabel('v [m/s]')
```

- p. 60 Replace program with the following

```
import numpy as np
import matplotlib.pyplot as plt
t,a = np.loadtxt('therocket.d',usecols=[0,1],unpack=True)
dt = t[1] - t[0]
n = len(t)
x = np.zeros(n,float)
v = np.zeros(n,float)
x[0] = 0.0 # Initial value
v[0] = 0.0 # Initial value
for i in range(1,n):
  v[i] = v[i-1] + a[i-1]*dt
  x[i] = x[i-1] + v[i-1]*dt
plt.subplot(3,1,1)
plt.plot(t,x)
plt.xlabel('t [s]'); plt.ylabel('x [m]')
```

```
plt.subplot(3,1,2)
plt.plot(t,v)
plt.xlabel('t [s]'); plt.ylabel('v [m/s]')
plt.subplot(3,1,3)
plt.plot(t,a)
plt.xlabel('t [s]'); plt.ylabel('a [m/s^2]')
```

- p. 68 Replace program with the following

```
import numpy as np
import matplotlib.pyplot as plt
D = 0.0245 # m^-1
g = 9.8    # m/s^2
y0 = 2.0
v0 = 0.0
time = 0.5
dt = 0.00001
# Variables
n = int(np.ceil(time/dt))
y = np.zeros(n,float)
v = np.zeros(n,float)
a = np.zeros(n,float)
t = np.zeros(n,float)
# Initialize
y[0] = y0
v[0] = v0
# Integration loop
for i in range(n-1):
    a[i] = -g -D*v[i]*abs(v[i])
    v[i+1] = v[i] + a[i]*dt
    y[i+1] = y[i] + v[i+1]*dt
    t[i+1] = t[i] + dt
# Plot results
plt.subplot(3,1,1)
plt.plot(t,y)
plt.xlabel('t [s]'); plt.ylabel('y [m]')
plt.subplot(3,1,2)
plt.plot(t,v)
plt.xlabel('t [s]'); plt.ylabel('v [m/s]')
plt.subplot(3,1,3)
plt.plot(t[0:n-2],a[0:n-2])
plt.xlabel('t [s]'); plt.ylabel('a [m/s^2]')
```

Chapter 05: Forces in one dimension

Chapter 06: Motion in Two and Three Dimensions

- p. 147, eq. 6.28: For example, the positioon at $t = 1.0$s is:

- p. 152, eq. 6.49: the time interval from 0.5s to 1.5s.

Chapter 07: Forces in Two and Three Dimensions

- p. 191, eq. 7.15 $\int_{t_0}^{t} v_0 \cos(\alpha) dt = \int_{x(t_0)}^{x} dx$
- p. 202, eq. 7.48 $\mathbf{N} = k(R - y(t))\mathbf{j}$
- p. 202, eq. 7.49 $k(R - y(t))\mathbf{j}$

Chapter 09: Forces and Constrained Motion

- p. 248 Correct program code:

```
#start1
import numpy as np
import matplotlib.pyplot as plt
# Initialize
m = 2e-12 # kg
A = 1e-5  # m
k = 10.0  # N/m
N = 1e-4  # N
T = 0.01  # s
omega = 2*np.pi/T
time = 2*T
dt = time/100000
n = int(np.round(time/dt))
mud = 0.2
mus = 0.4
# Variables
t = np.zeros(n,float)
x = np.zeros(n,float)
v = np.zeros(n,float)
f = np.zeros(n,float)
# Initial conditions
x[0] = 0.0
v[0] = 0.0
for i in range(n-1):
    x0 = A*np.sin(omega*t[i])
    FD = -k*(x[i]-x0)
    if v[i]==0.0: # Static friction
        f[i] = -FD
        if abs(f[i])>mus*N: # Slips
            f[i] = -np.sign(FD)*mud*N
    else:          # Dynamic friction
        f[i] = -np.sign(v[i])*mud*N
    Fnet = FD + f[i]
    a = Fnet/m
```

```
    v[i+1] = v[i] + a*dt
    if (v[i]!=0.0) and (np.sign(v[i+1])!=np.sign(v[i])):
        v[i+1] = 0.0 # The block has stopped
    x[i+1] = x[i] + v[i+1]*dt
    t[i+1] = t[i] + dt
#end1
plt.subplot(2,1,1)
plt.plot(t,f,'-k')
plt.ylabel('f')
plt.xlabel('t')
plt.subplot(2,1,2)
x0 = A*np.sin(omega*t)
plt.plot(t,x,'-k',t,x0,'k:')
plt.ylabel('x')
plt.xlabel('t')
```

Chapter 10: Work

- p. 270, eq. 10.2: $\int_C m\mathbf{a} \cdot d\mathbf{r} = \ldots$
- p. 270, eq. 10.5, Right-hand side: $m\mathbf{v} \cdot \mathbf{v} - \int_{t_0}^{t} m\mathbf{v} \cdot \frac{d\mathbf{v}}{dt} dt$.
- p. 276, eq. 10.27: $W = -\left(\frac{1}{2}kx_1^2 - \frac{1}{2}kx_0^2\right)$.

Chapter 11: Energy

- p. 307, eq. 11.9: $= -U(x_1) + U(x_0) = K_1 + K_0$
- p. 310, eq. 11.19: $U(x) = \int -F(x)\, dx + C$
- p. 320, eq. 11.59 $y_0 + \frac{\frac{1}{2}k\Delta y^2}{mg} = y_2$

Chapter 12: Momentum, Impulse and Collisions

- p. 363, eq. 12.38, $J_y = \mathbf{J} \cdot \mathbf{j} = m\left(v_{y,1} - v_{y,0}\right)$

Chapter 13: Multiparticle Systems

- p. 407, eq. 13.23, $\mathbf{R} = 2a\ \mathbf{i} + a\ \mathbf{j}$.
- p. 409. eq. 13.31, $MY = \ldots = \rho b^2 \frac{1}{2} \int_1^0 u^2(-a)\, du = \rho b^2 \frac{1}{2} \frac{1}{3} a$
- p. 414, eq. 13.43, $x_B(t) = x_B(t_0) + v_B t = v_1 t$

Chapter 15: Rotation of Rigid Bodies

- p. 477, eq. 15.53, $\mathbf{v}_{P,cm} = \boldsymbol{\omega} \times \mathbf{p}_{cm}$
- p. 477, eq, 15.56, $\mathbf{v}_P = \mathbf{v}_{cm} + \mathbf{v}_{P,cm} = \mathbf{V} + \omega R\,\mathbf{i}$

Chapter 16: Dynamics of Rigid Bodies

- p. 512, eq. 16.62, $\sum \mathbf{F}_y = N - Mg\cos\phi - f = MA_y = 0$
- p. 520, eq. 16.94, $\mathbf{l} = \mathbf{r} \times m\mathbf{v} = (b\,\mathbf{i} + y(t)\,\mathbf{j}) \times mv_y\,\mathbf{j} = bmv_y\,\mathbf{k}$
- p. 531, eq. 16.133, $\mathbf{L}_O^b = \mathbf{r}_b \times m\mathbf{v} = -L\,\mathbf{j} \times mv\,\mathbf{i} = Lmv\,\mathbf{k}$

Appendix B: Solutions

- Chapter 10, B.11, (c) $h > 3L/5$
- Chapter 13, B.9, (b) $(1/5, 1/5, 1/5)$
- Chapter 13, B.10, (a) $-(L/2 - d/2)(d/L)^3/(1 - (d/L)^3)\mathbf{i}$
- Chapter 13, B.11, (a) $\mathbf{R}_{CM} = (0, (1/3)a)$
- Chapter 13, B.12, (a) $\mathbf{R}_{CM} = (0, b/(2\sqrt{3})$
- Chapter 14, B.8, (b) $\theta(t) = 5\,\mathrm{rad/s}^2 t^2$, (c)
- Chapter 15, B.4, (b) $I_{cm} = (14/3)ma^2$, (c) $I_{0,z} = (43/9)ma^2$
- Chapter 15, B.5, (a) $(1/12)mL^2 + (4/5)MR^2 + (1/2)ML^2 + 2MRL$, (c) $\frac{24}{5}MR^2 + \frac{1}{3}mL^2 + mR^2 + mRL + 4MRL + ML^2$