Eng-Phy113 Physical Foundations of Engineering II
Maple Assignment 1 : Numerical Problem

A nerfball has a mass of 9.8 g and a terminal velocity in air of 7.0 m/s. It is thrown straight upward with an initial velcity of 15m/s from the top edge of a building 30 m high above the ground. Assume that the force of air resistance is – bv , where v is the velocity of the ball. The y axis is vertically upward.
Equation of motion is : – m*g – b*v = m*(dv/dt)
Using the explanations in the sample problem, this translates into the following numerical prescriptions for the velocity and position.
v[i]:= (v[i–1]*(1–0.5*b/m*delt)–g*delt)/(1+0.5*b/m*delt);
y[i]:= y[i–1]+(v[i]+v[i–1])*0.5*delt;
Using Maple and numerical intergration, calculate
a) The coordinate and velocity of the ball every 0.1 seconds from its initial positon (y = 0) to its return to the ground.
b) For each of these times, calculate the potential energy, kinetic energy and the total mechanical energy. Take the initial potential energy to be zero.
c) Include a plot of the velocity and position as a function of time.
d) Include a plot of the potential, kinetic and total energy as a function of time.
e) From your calculations determine
i) the time at which it returns to the ground level.
ii) the energy dissipated by the resistive force on its way up and
iii) the energy dissipated on its way down.

```
> vterm:=7.0; vo:=15; m:=0.0098;b:=m*g/vterm;
  yo:=0;g:=9.8;delt:=0.1;
```

$$vterm := 7.0$$
$$vo := 15$$
$$m := .0098$$
$$b := .01372000000$$
$$yo := 0$$
$$g := 9.8$$
$$delt := .1$$

```
> v[0]:=15;y[0]:=0;t[0]:=0;u[0]:=0;k[0]:=0.5*m*v[0]^2;e[0]:=u[0]+k[0
  ];L:=(t[0],v[0]):
```

$$v_0 := 15$$
$$y_0 := 0$$
$$t_0 := 0$$
$$u_0 := 0$$
$$k_0 := 1.10250$$
$$e_0 := 1.10250$$

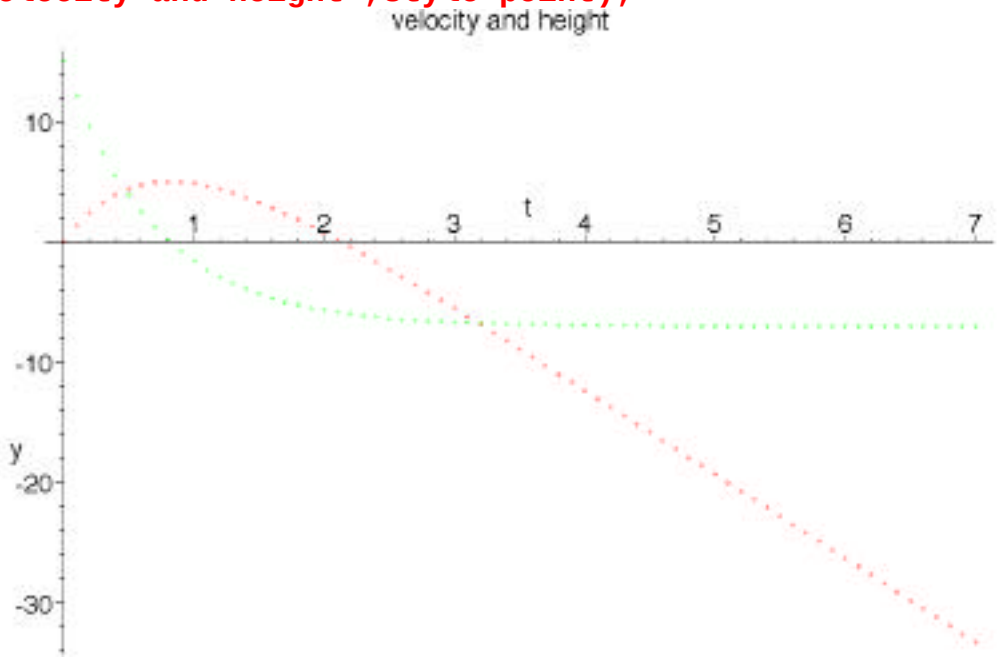
```
> for i from 1 to 70                    do t[i]:=t[i-1]+delt;
  v[i]:=(v[i-1]*(1-0.5*b/m*delt)-g*delt)/(1+0.5*b/m*delt);
  y[i]:=y[i-1]+(v[i]+v[i-1])*0.5*delt;    u[i]:=m*g*y[i];
  k[i]:=0.5*m*v[i]^2; e[i]:=u[i]+k[i];
```

```
  printf(`%4.3f   %4.3f    %4.3f   %4.3f   %4.3f   %4.3f\n`,
  t[i-1],v[i-1],y[i-1],u[i-1],k[i-1],e[i-1]);od:
```

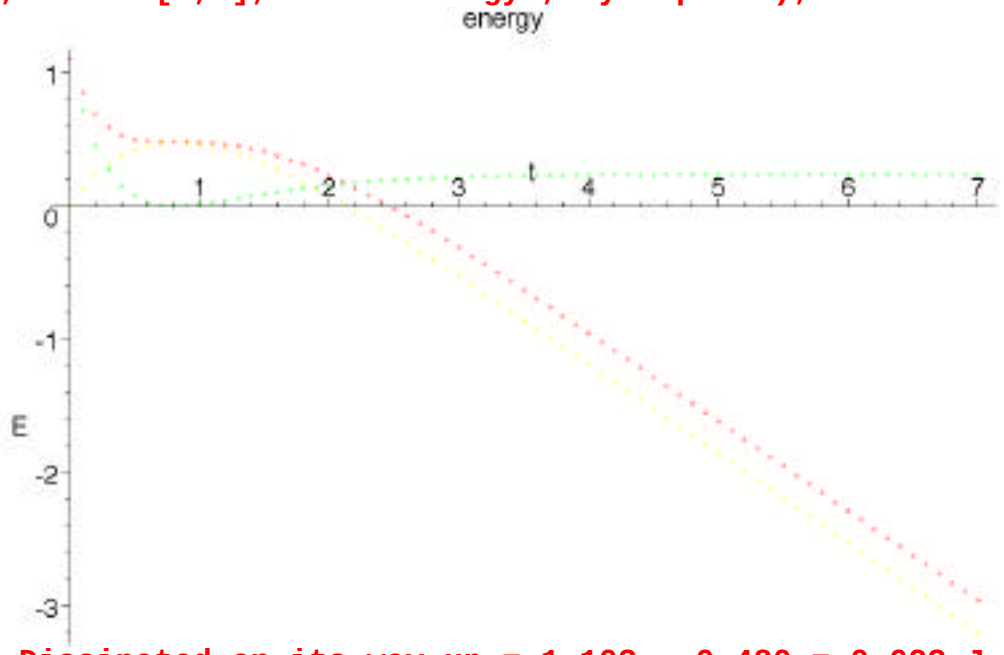
0.000	15.000	0.000	0.000	1.103	1.103
.100	12.121	1.356	.130	.720	.850
.200	9.620	2.443	.235	.453	.688
.300	7.445	3.296	.317	.272	.588
.400	5.555	3.946	.379	.151	.530
.500	3.912	4.420	.424	.075	.499
.600	2.485	4.740	.455	.030	.485
.700	1.244	4.926	.473	.008	.481
.800	.165	4.996	.480	.000	.480
.900	-.772	4.966	.477	.003	.480
1.000	-1.587	4.848	.466	.012	.478
1.100	-2.295	4.654	.447	.026	.473
1.200	-2.911	4.394	.422	.042	.463
1.300	-3.446	4.076	.391	.058	.450
1.400	-3.911	3.708	.356	.075	.431
1.500	-4.315	3.297	.317	.091	.408
1.600	-4.666	2.847	.273	.107	.380
1.700	-4.972	2.366	.227	.121	.348
1.800	-5.237	1.855	.178	.134	.313
1.900	-5.468	1.320	.127	.146	.273
2.000	-5.668	.763	.073	.157	.231
2.100	-5.843	.188	.018	.167	.185
2.200	-5.994	-.404	-.039	.176	.137
2.300	-6.126	-1.010	-.097	.184	.087
2.400	-6.240	-1.629	-.156	.191	.034
2.500	-6.339	-2.258	-.217	.197	-.020
2.600	-6.426	-2.896	-.278	.202	-.076
2.700	-6.501	-3.542	-.340	.207	-.133
2.800	-6.566	-4.196	-.403	.211	-.192
2.900	-6.623	-4.855	-.466	.215	-.251
3.000	-6.672	-5.520	-.530	.218	-.312
3.100	-6.715	-6.189	-.594	.221	-.373
3.200	-6.752	-6.863	-.659	.223	-.436
3.300	-6.785	-7.539	-.724	.226	-.499
3.400	-6.813	-8.219	-.789	.227	-.562
3.500	-6.837	-8.902	-.855	.229	-.626
3.600	-6.859	-9.587	-.921	.231	-.690
3.700	-6.877	-10.273	-.987	.232	-.755
3.800	-6.893	-10.962	-1.053	.233	-.820
3.900	-6.907	-11.652	-1.119	.234	-.885
4.000	-6.919	-12.343	-1.185	.235	-.951
4.100	-6.930	-13.036	-1.252	.235	-1.017
4.200	-6.939	-13.729	-1.319	.236	-1.083
4.300	-6.947	-14.424	-1.385	.236	-1.149
4.400	-6.954	-15.119	-1.452	.237	-1.215
4.500	-6.960	-15.814	-1.519	.237	-1.281
4.600	-6.965	-16.511	-1.586	.238	-1.348
4.700	-6.970	-17.207	-1.653	.238	-1.415
4.800	-6.974	-17.904	-1.720	.238	-1.481
4.900	-6.977	-18.602	-1.787	.239	-1.548
5.000	-6.980	-19.300	-1.854	.239	-1.615
5.100	-6.983	-19.998	-1.921	.239	-1.682
5.200	-6.985	-20.696	-1.988	.239	-1.749
5.300	-6.987	-21.395	-2.055	.239	-1.816
5.400	-6.989	-22.094	-2.122	.239	-1.883
5.500	-6.990	-22.793	-2.189	.239	-1.950
5.600	-6.991	-23.492	-2.256	.240	-2.017
5.700	-6.993	-24.191	-2.323	.240	-2.084
5.800	-6.994	-24.890	-2.390	.240	-2.151
5.900	-6.994	-25.590	-2.458	.240	-2.218
6.000	-6.995	-26.289	-2.525	.240	-2.285
6.100	-6.996	-26.989	-2.592	.240	-2.352
6.200	-6.996	-27.688	-2.659	.240	-2.419
6.300	-6.997	-28.388	-2.726	.240	-2.487

```
6.400   -6.997    -29.088   -2.794   .240   -2.554
6.500   -6.998    -29.787   -2.861   .240   -2.621
6.600   -6.998    -30.487   -2.928   .240   -2.688
6.700   -6.998    -31.187   -2.995   .240   -2.755
6.800   -6.998    -31.887   -3.062   .240   -2.822
6.900   -6.999    -32.587   -3.130   .240   -2.890
```

```
> plot({[[t[n],y[n]]$n=0..71],[[t[n],v[n]]$n=0..71]},labels=[t,y],ti
  tle=`velocity and height`,style=point);
```




```
> plot({[[t[n],u[n]]$n=0..71],[[t[n],k[n]]$n=0..71],[[t[n],e[n]]$n=0
  ..71]},labels=[t,E],title=`energy`,style=point);
```




```
> Energy Dissipated on its way up = 1.103 - 0.480 = 0.623 J.
> Energy dissipated on its way down = 0.480 - (-2.621) =3.101 J.
> It returns to ground at t= 6.5 seconds.
```