2/36 Particle 1 : $a = -kv$

$$-kv = \frac{dv}{dt}$$

$$-k\int_0^t dt = \int_{v_0}^{v} \frac{dv}{v} \Rightarrow \underline{v = v_0 e^{-kt}}$$

Then $\frac{ds}{dt} = v_0 e^{-kt}$

$$\int_{s_0=0}^{s} ds = v_0 \int_{t_0=0}^{t} e^{-kt} dt \Rightarrow \underline{s = \frac{v_0}{k}\left(1 - e^{-kt}\right)}$$

Particle 2: $a = -kt$

$$-kt = \frac{dv}{dt}$$

$$-k\int_0^t t\, dt = \int_{v_0}^{v} dv \Rightarrow \underline{v = v_0 - \frac{1}{2}kt^2}$$

Then $\frac{ds}{dt} = v_0 - \frac{1}{2}kt^2$

$$\int_0^s ds = \int_0^t \left(v_0 - \frac{1}{2}kt^2\right) dt \Rightarrow \underline{s = v_0 t - \frac{1}{6}kt^3}$$

Particle 3 : $a = -ks$

$$-ks = v\frac{dv}{ds}$$

$$-k\int_0^s s\,ds = \int_{v_0}^{v} v\,dv \Rightarrow \underline{v = \pm\sqrt{v_0^2 - ks^2}}$$

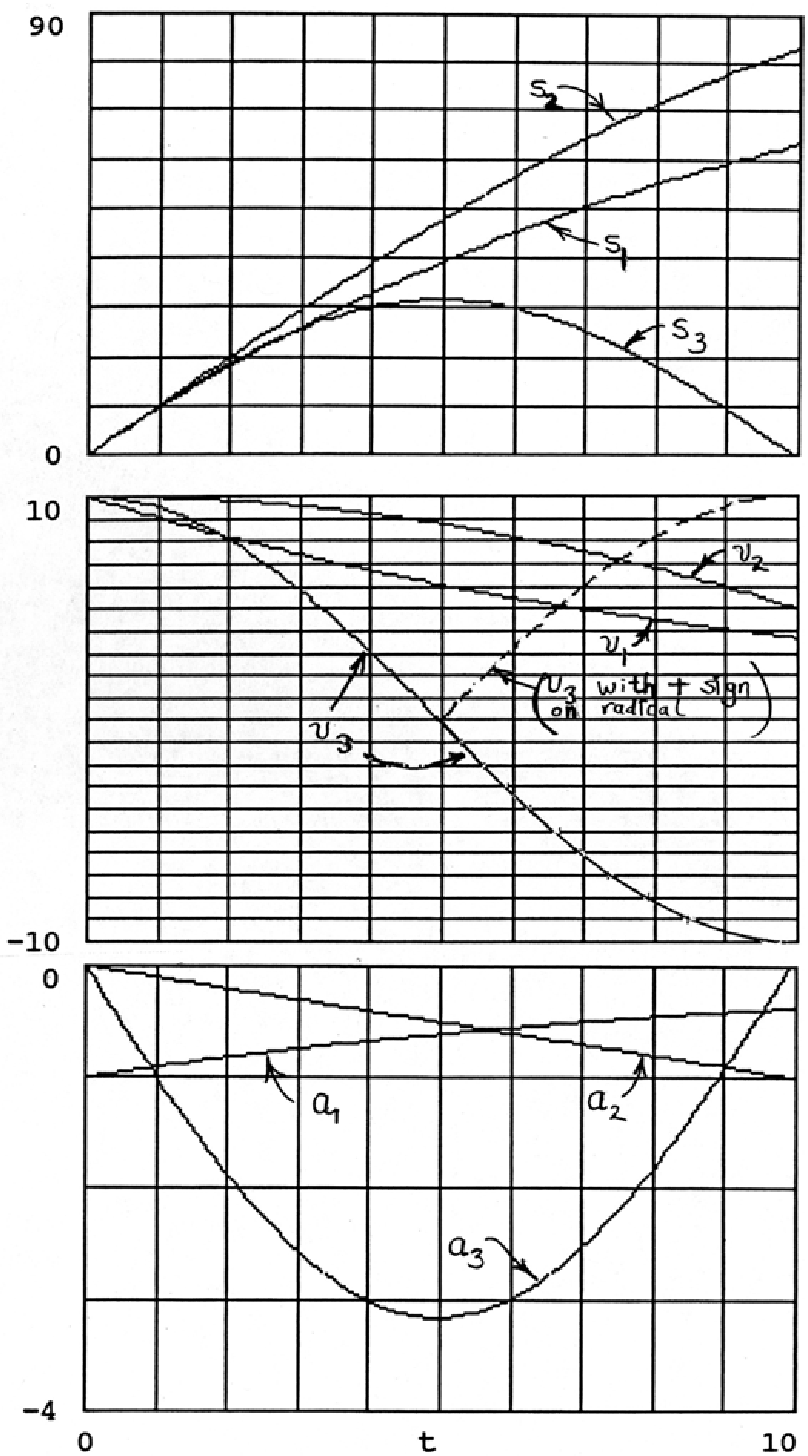
Note: Plus sign is chosen until first reversal $(v=0)$, thereafter take minus sign, etc.

Then

$$\frac{ds}{dt} = \pm\sqrt{v_0^2 - ks^2}$$

$$\int_0^s \frac{ds}{\sqrt{v_0^2 - ks^2}} = \int_0^t dt$$

$$\frac{1}{\sqrt{k}} \sin^{-1}\left(\frac{\sqrt{k}}{v_0} s\right) = t \Rightarrow \underline{s = \frac{v_0}{\sqrt{k}} \sin\left(\sqrt{k}\, t\right)}$$


90
0
10
-10
0
-4
0
t
10
s_2
s_1
s_3
v_2
v_1
v_3
(v_3 with + sign on radical)
a_1
a_2
a_3