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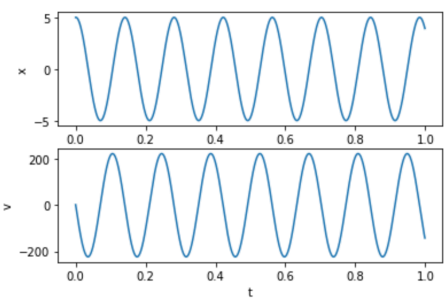
[HW9-1] $T = 2\pi \cdot \sqrt{\frac{K}{M}} = 2\pi\sqrt{\frac{7400}{3.7}} \simeq 281 s^{-1}$.

A good time step would be .001 as the professor explained to us earliear in the quarter. It does not matter which initial values we use.

```
0.996999979019165 4.19171667098999
0.9980000257492065 4.065456867218018
0.9990000128746033 3.9310660362243652
```



[HW9-2]

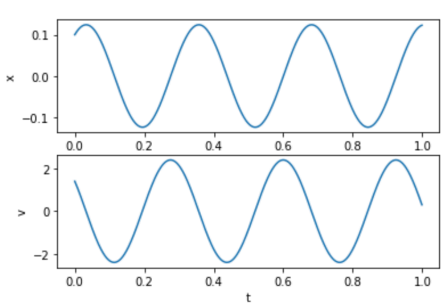
from energy conservation we know that the amplitude is given by the following

$$A = \sqrt{x_0^2 + \frac{v_0^2}{\omega^2}}, \qquad \omega^2 = \frac{K}{M}$$

$$A = \sqrt{(0.1)^2 + \frac{(1.4)^2}{(75/0.2)}} = \boxed{0.12339638 = A}$$

for $\underline{V_{max}}$: $V_{max} = \sqrt{\frac{K}{M}} \cdot A = \sqrt{\frac{75}{0.2}} \cdot 0.12339638 = \boxed{2.389560624 = V_{max}}$

```
0.9990000128746033 0.12282311916351318
The Amplitude for x is 0.12396789342164993
The Amplitude for v is 2.400632381439209
```



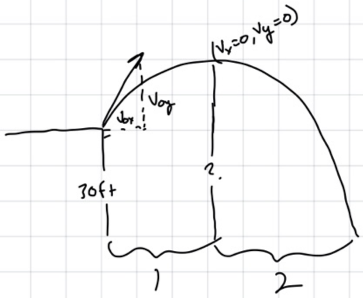
[HW9_3]

$x = v_{0x} t$ $y = v_0 t - \frac{1}{2} g t^2$

$\tan\theta = \frac{v_y}{v_x}$ $\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

$\theta = 53.1301$

$v = 25$



@ top $\cancel{v_y}^{0} = v_{0y} - g t_1$

$v_{0y} = g t_1 \Rightarrow t_1 = \frac{v_{0y}}{g} = \underbrace{2.040816327}_{} = t_1$

$h = y_0 + v_{0y} t_1 - \frac{1}{2} g t_1^2 = 30 + (20)(2.0408) - (0.5)(9.8)(2.040816327)^2$

$h = 50.40816326$ m

$t_0 \to t_2$: $y_f - y_0 = v_{0y} t - 4.9 t^2$

$4.9 t^2 - 20t - 30$

$\Rightarrow t = \frac{20 \pm \sqrt{20^2 - 4(4.9)(-30)}}{2(4.9)}$

$= 5.24821$

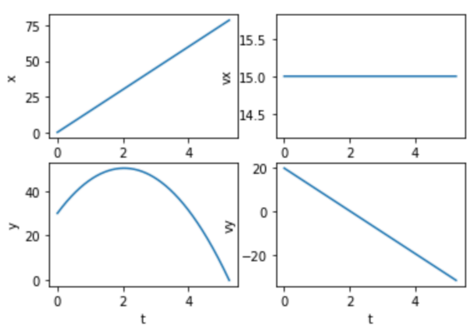
$\cancel{y_f}^{0} = 50.40816326 + \cancel{v_0 t_2}^{0} - \frac{1}{2} g t_2^2$

$\frac{1}{2} g t_2^2 = 50.40816326$

$t_2 = \sqrt{\frac{2(50.40816326)}{g}} = 3.207394$

$t_{tot} = 3.207394 + 2.040816327$

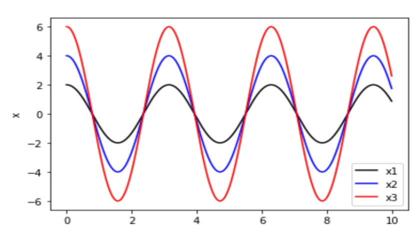
$t_{tot} = 5.24821$



[HW9.4]

we can see from the graph that the amplitude is directly $\propto$ to X_0. It also tells us the period doesn't depend on x here as seen in the graph.

```
9.989999771118164 0.8700094819068909
9.989999771118164 1.7400189638137817
9.989999771118164 2.6100285053253174
```

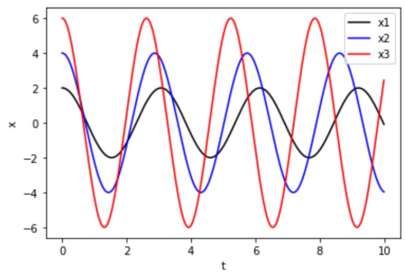


[HW9.5]

If $F = -kx - bx^3$

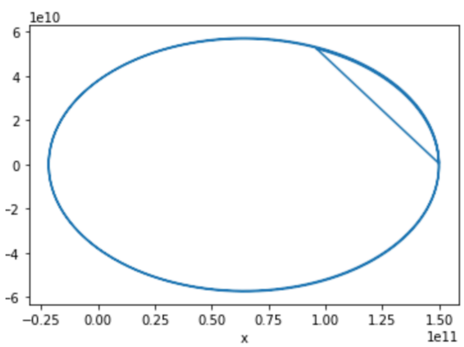
$$\frac{kg\,m}{s^2} = \left(\frac{kg}{s^2}\right)m - \left(\frac{c\,kg}{m^2 s^2}\right)m^3$$ This tells us the units for $[b] = \left[\frac{kg}{m^2 s^2}\right]$

when x is larger, the period is shorter. When x is smaller, the period is longer

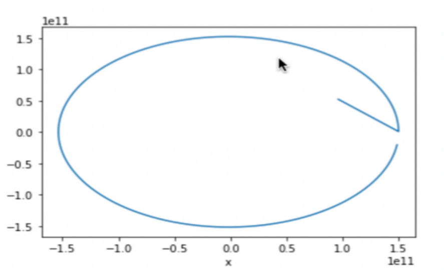


[HW9.6]

V = 15000



V=30000



V=60000