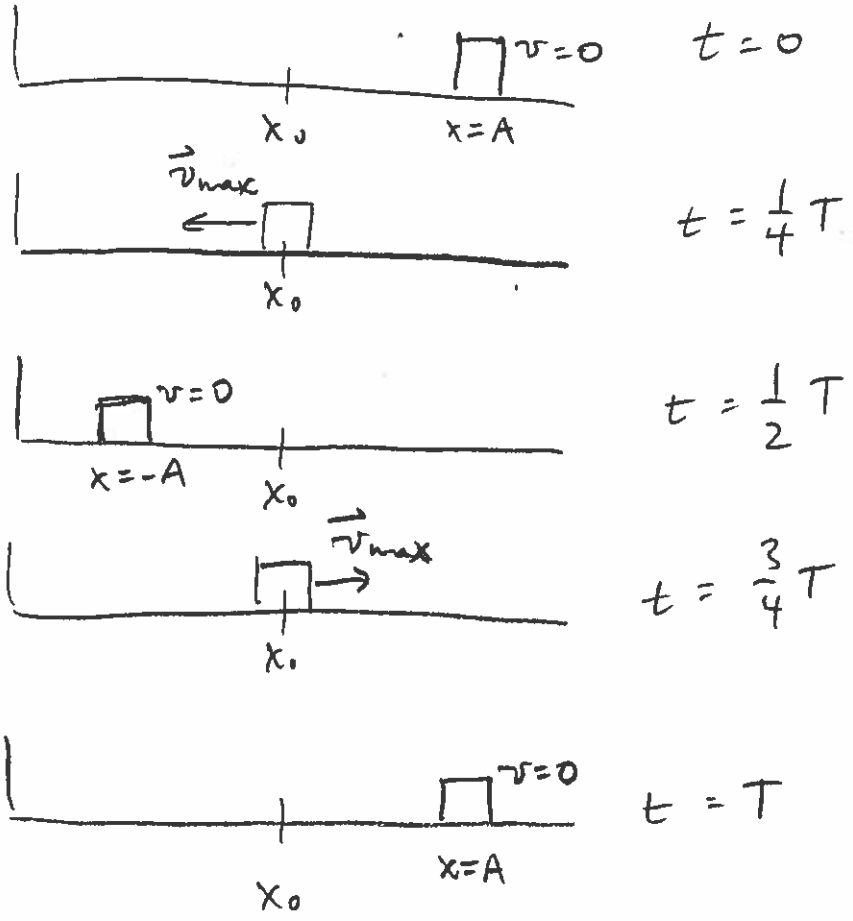
GW1:



a. $v_{max} \Rightarrow$ at equilibrium

$t_1 = \frac{1}{4}T \quad t_2 = \frac{3}{4}T$

b. $x = A \Rightarrow$ at original amplitude

$t_1 = T \quad t_2 = 2T$

c. $v = 0 \rightarrow$ at either amplitude

$t_1 = \frac{1}{2}T \quad t_2 = T$

d. $E = K \Rightarrow U_s = 0$ at equilibrium

$t_1 = \frac{1}{4}T \quad t_2 = \frac{3}{4}T$

e. $E = U_s \Rightarrow K = 0 \Rightarrow$ at either amplitude

$t_1 = \frac{1}{2}T \quad t_2 = T$

GW2: Need position as function of time

$A = 0.30\,m \qquad \frac{A}{2} = 0.15\,m$

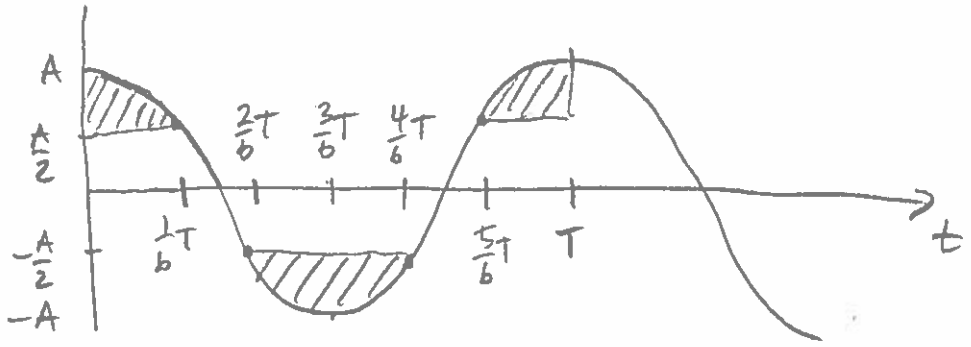
$x(t) = A\cos\omega t$

$\frac{A}{2} = A\cos\omega t$

$\frac{1}{2} = \cos\omega t$

$\omega t = \cos^{-1}\left(\frac{1}{2}\right) = \frac{\pi}{3}$

$t = \frac{1}{3}\left(\frac{\pi}{\omega}\right) = \frac{1}{6}\left(\frac{2\pi}{\omega}\right) = \frac{1}{6}T$



Total time with $x > \frac{A}{2} = \frac{1}{6}T + \frac{1}{3}T + \frac{1}{6}T = \frac{2}{3}T$

Total time with $x < \frac{A}{2} = \frac{1}{6}T + \frac{1}{6}T = \frac{1}{3}T$

GW3: $K = U_s$

$E = K + U_s = U_s + U_s = 2U_s$

$\frac{1}{2}kA^2 = 2\left(\frac{1}{2}kx^2\right)$

$x^2 = \frac{A^2}{2}$

$x = \sqrt{\frac{A^2}{2}} = \frac{1}{\sqrt{2}}A = 0.707A$

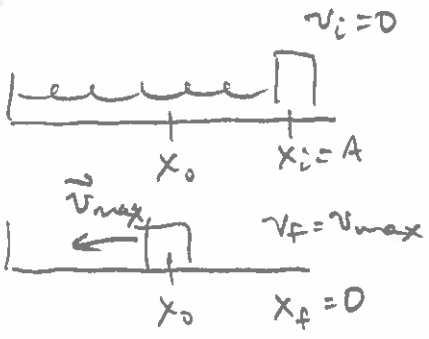
EX1: a. NSL approach

$|v_{max}| = \omega A$ $\qquad \omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{200}{0.5}} = 20 \frac{rad}{s}$

$= 20(0.4)$

$= 8 \frac{m}{s}$

COE approach



$K_i + U_{si} = K_f + U_{sf}$

$0 + \frac{1}{2} k A^2 = \frac{1}{2} m v_{max}^2 + 0$

$v_{max}^2 = \frac{k}{m} A^2$

$v_{max} = \sqrt{\frac{k}{m} A^2} = \sqrt{\frac{k}{m}} A = \omega A = 8 \frac{m}{s}$

b. $|v(t)| = +\omega A \sin \omega t$

$\frac{1}{2} v_{max} = \omega A \sin \omega t$

$\frac{1}{2} \omega A = \omega A \sin \omega t$

$\sin \omega t = \frac{1}{2}$

$\omega t = \sin^{-1}\left(\frac{1}{2}\right) = \frac{\pi}{6}$

$t = \frac{\pi}{6\omega} = \frac{\pi}{6 \cdot 20} = 0,0262 \text{ s}$

c. $|a_{max}| = \omega^2 A$

$= (20)^2 (0.4)$

$= 160 \frac{m}{s^2}$

d. For speed:

$$K_i + U_{si} = K_f + U_{sf}$$

$$0 + \frac{1}{2}kA^2 = \frac{1}{2}mv_f^2 + \frac{1}{2}k\left(\frac{1}{2}A\right)^2$$

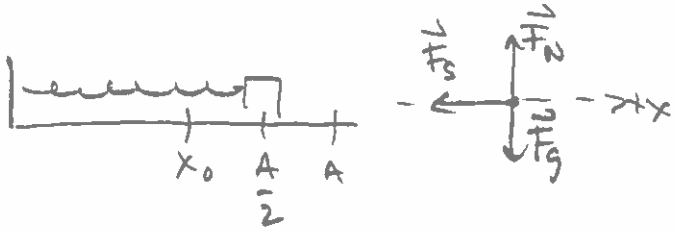
$$v_f^2 = \frac{k}{m}\left(A^2 - \frac{1}{4}A^2\right) = \frac{k}{m}\left(\frac{3}{4}A^2\right) = \omega^2\left(\frac{3}{4}A^2\right)$$

$$v_f = \sqrt{\omega^2\left(\frac{3}{4}A^2\right)} = \frac{\sqrt{3}}{2}\omega A$$

$$= \frac{\sqrt{3}}{2}(20)(0.4)$$

$$= 6.93 \ \frac{m}{s}$$

For acceleration



$$\sum F_x = ma_x$$

$$-kx = ma$$

$$a = -\frac{k}{m}\left(\frac{A}{2}\right) = -\omega^2\left(\frac{A}{2}\right)$$

$$= -(20)^2\left(\frac{0.4}{2}\right)$$

$$= -80 \ \frac{m}{s^2}$$

$$|\vec{a}| = 80 \ \frac{m}{s^2}$$

e. $K = \frac{1}{2} m v^2$

$= \frac{1}{2}(0.5)(6.93)^2$

$= 12 \text{ J}$

$U_s = \frac{1}{2} k x^2$

$= \frac{1}{2} k \left(\frac{1}{2} A\right)^2$

$= \frac{1}{2}(200)\left(\frac{1}{2} \cdot 0.4\right)^2$

$= 4 \text{ J}$

$E = K + U_s = 12 + 4 = 16 \text{ J}$

Check: $E = \frac{1}{2} k A^2$

$= \frac{1}{2}(200)(0.4)^2$

$= 16 \text{ J}$