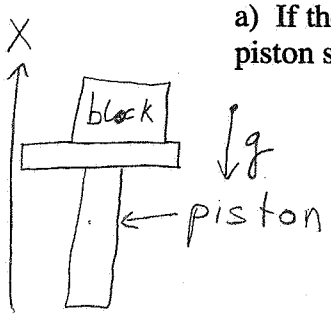
Key

QUIZ 1
Spring 2005
3:30 Section
2:30 recitation Thursday Quiz
Frank De Lucia

A block rides on a piston that is moving vertically with simple harmonic motion.



a) If the SHM has a period of 1.0 s, at what amplitude of motion will the block and piston separate?

Block and piston will separate when $a_{max} \geq g$.

For SHM $a(t) = -\underbrace{\omega^2 X_m}_{a_{max}} \cos(\omega t + \phi)$

Separation will begin when $a_{max} = g$

$$\Rightarrow \omega^2 X_m = g \Rightarrow X_m = \frac{g}{\omega^2}$$

$$\Rightarrow X_m = \frac{g}{\left(\frac{2\pi}{T}\right)^2} = \frac{T^2 g}{4\pi^2} = \boxed{\frac{(9.8\,\frac{m}{s^2})(1.0\,s)}{4\pi^2}}$$

$$\boxed{= 0.25\,m}$$

b) If the piston has an amplitude of 5.0 cm, what is the maximum frequency for which the block and piston will be in contact continuously?

$f_m \equiv f_{max}$

$\omega_m \equiv \omega_{max}$

Same procedure as a.) leads to

$$\omega_m^2 X_m = g \Rightarrow (2\pi f_m)^2 X_m = g$$

$$\Rightarrow f_m^2 = \frac{g}{(2\pi)^2 X_m} \Rightarrow f_m = \frac{1}{2\pi}\sqrt{\frac{g}{X_m}}$$

$$= \frac{1}{2\pi}\sqrt{\frac{9.8\ m/s^2}{0.05\ m}} = \boxed{2.2\,\frac{1}{s}}$$

$$\boxed{\omega_m = 2\pi f_m = 14\,\frac{1}{s}}$$