Physics 111-01

Test 3

November 19, 1999

Name:_____

Usual Seat #_____

Be sure to show your work **clearly** and **draw a box around your answer**. If any question is unclear, please ask immediately. All answers must have the correct units.

You **must** start with a fundamental physics principle or an equation from the equation sheet. Full credit will **not** be given for use of unsubstantiated memorized equations.

1. (40 pts.) When a 3.0 kg block of metal is hung from a spring, the spring stretches by 0.075 m. The same block is then placed on a frictionless horizontal surface and the spring is connected to a support at the same level as the block. The block is pulled 0.03 m away from its equilibirium position and released.

   a. (10 pts.) What is the initial acceleration of the block?

   b. (10 pts.) How long does it take to reach the equilibrium point?

c. (10 pts.) What is the speed of the block as it passes through the equilibrium point?

d. (10 pts.) Lastly, suppose the block were instead pulled 0.06 m away. Which of your answers to a, b, and c would change? No calculations are required.

Physics 111-01

Test 3

November 19, 1999

Name: SOLUTIONS

Usual Seat #_____

Be sure to show your work **clearly** and **draw a box around your answer**. If any question is unclear, please ask immediately. All answers must have the correct units.

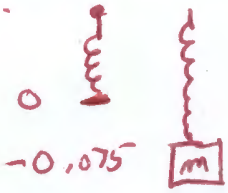
You **must** start with a fundamental physics principle or an equation from the equation sheet. Full credit will **not** be given for use of unsubstantiated memorized equations.

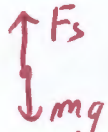
1. (40 pts.) When a 3.0 kg block of metal is hung from a spring, the spring stretches by 0.075 m. The same block is then placed on a frictionless horizontal surface and the spring is connected to a support at the same level as the block. The block is pulled 0.03 m away from its equilibirium position and released.

[See Practice problems #5, 6, 7]

a. (10 pts.) What is the initial acceleration of the block?

First, find k.





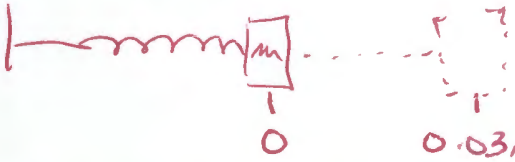
$\Sigma F = ma$

$F_s - mg = 0$

$-k(y - y_R) = mg$

$k = \frac{-mg}{y - y_R} = \frac{-(3)(9.8)}{-0.075} = 392\ N/m$

Then



$\Sigma F = ma$

$F_s = ma$

$-k(0.03) = ma$

$a = \frac{-(392)(0.03)}{3kg}$

$\boxed{a = -3.92\ m/s^2}$

b. (10 pts.) How long does it take to reach the equilibrium point?

$\frac{1}{4}T$, where $T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{3}{392}} = 0.550\ s$

t to reach equilibrium $= \frac{1}{4}(.550) = \boxed{0.137\ s}$

[Can't use constant acceleration formulas because $a \neq$ constant.]

Or, use x(t) = A cos(w t), and solve for t when x == 0. You get wt = pi/2, or t = T/4, since T = 2 pi/w.

c. (10 pts.) What is the speed of the block as it passes through the equilibrium point?

[Can't use $v = v_0 + at$ because $a \neq$ constant.]

$$E_i = E_f$$

$$\frac{1}{2}mv_i^2 + \frac{1}{2}kx_i^2 = \frac{1}{2}mv_f^2 + \frac{1}{2}kx_f^2$$

$$0 + \frac{1}{2}kA^2 = \frac{1}{2}mv_f^2 + 0$$

$$v_f = \sqrt{\frac{k}{m}A^2} = \sqrt{\frac{392}{3}(.03)^2}$$

$$v_f = 0.343 \text{ m/s}.$$

[See Practice Problems # 2.]

d. (10 pts.) Lastly, suppose the block were instead pulled 0.06 m away. Which of your answers to a, b, and c would change? No calculations are required.

a and c would change.

b would not: T is independent of amplitude. [recall lab].