PHYS 172 - Spring 2008 **ANSWER KEY**

Hand-Graded part of Exam 2:

Name (Print):_____

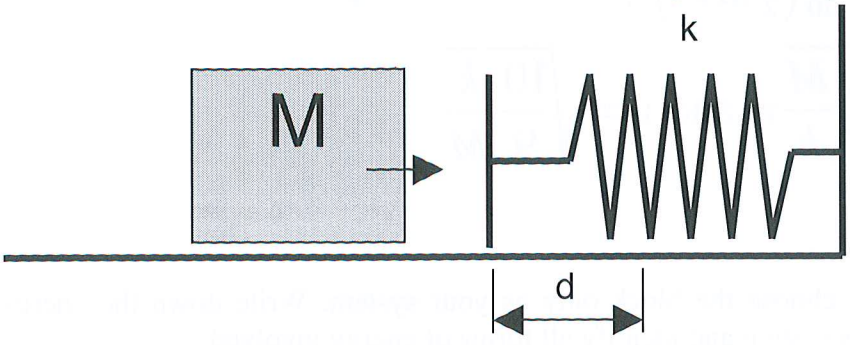
Signature:_____

PUID:_____

Circle your Recitation:

| | Tu | W | Th | F |
|---|---|---|---|---|
| 8:30 | 1 | 10 | 19 | 28 |
| 9:30 | 2 | 11 | 20 | 29 |
| 10:30 | 3 | 12 | 21 | |
| 11:30 | 4 | 13 | 22 | |
| 12:30 | 5 | 14 | 23 | |
| 1:30 | 6 | 15 | 24 | |
| 2:30 | 7 | 16 | 25 | |
| 3:30 | 8 | 17 | 26 | |
| 4:30 | 9 | 18 | 27 | |

A moving block of mass $M$ collides with a horizontal spring whose spring constant is $k$ (see figure). The block compresses the spring a maximum distance of $d$ from the spring's initial position. There is friction between the block and the horizontal surface, but neglect air drag.




a. [8 points] Choose the block + spring as your system. Write down the energy principle for this system. Identify all forms of energy involved.

$$\Delta E_{system} = W_{external\_forces} + Q \text{ or } \Delta E = W + Q$$

$$E_{system} = \tfrac{1}{2} Mv^2 + \tfrac{1}{2} k\Delta x^2 + E_{internal}(block) + Mc^2$$

$W$ = work done by friction

Q = heat flow into system

Assumptions: small/thin spring
non-relativistic motion

b. [7 points] Assume there is no friction. Find the initial speed v of the block at the moment at which it hit the spring.

$$\Delta E = 0 = E_{final} - E_{initial} = \tfrac{1}{2} kd^2 - \tfrac{1}{2} Mv^2$$

$$v = \sqrt{\frac{k}{M}}\, d$$

c. [7 points] With friction present, find the initial speed of the block which results in the same maximum compression the spring d. Assume that during this process an amount of energy equal to 10% of the block's original kinetic energy is dissipated.

$$E_{final} = \tfrac{1}{2}kd^2 \qquad E_{initial} = \tfrac{1}{2}Mv^2$$

$$E_{final} - E_{initial} = -\left(\tfrac{1}{10}\right)\tfrac{1}{2}Mv^2 = -0.10 \times E_{initial}$$

$$\tfrac{1}{2}kd^2 = \tfrac{9}{10}\left(\tfrac{1}{2}Mv^2\right)$$

$$d = \sqrt{\tfrac{9}{10}\frac{M}{k}}v \text{ and } v = \sqrt{\frac{10}{9}\frac{k}{M}}$$

d. [8 points] Now choose the block only as your system. Write down the energy principle for this system and identify all forms of energy involved.

$$\Delta E_{system} = W_{external\_forces} + Q \text{ or } \Delta E = W + Q$$

$$E_{system} = \tfrac{1}{2}Mv^2 + E_{internal}(block) + Mc^2$$

$W$ = work done by friction ***+ work done by spring***

Q = heat flow into system