PHYSICS 101 Week 2 Quiz 1, Form A

Name: ______________________ DISC: __________ Score: ______________

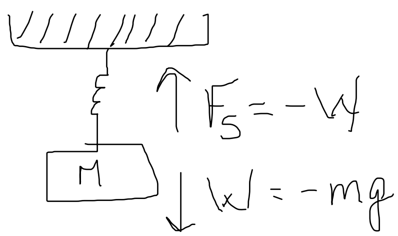
Instructions:
- Do your own work.
- Answer the questions below in the space provided.
- Make sure you show all your work and any equations that you use.
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers

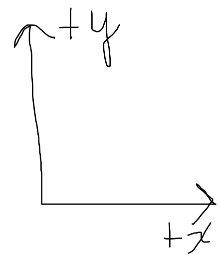
Remember: Each quiz form has the same questions with different numerical values and in a different order. I have provided grading guidance on only Form A.

1. Consider a system of a mass (M) on a vertical spring with force equation $F_{Spring} = -k\,x$:
   a. Given that the units of force are $[F] = \frac{kg\,m}{s^2}$ use dimensional analysis to find the units on the *spring constant* k.

$$\left.\begin{aligned}[F] &= [k][x] \\ [k] &= [F]/[x]\end{aligned}\right\} \Rightarrow [k] = \frac{kg\,\cancel{m}}{s^2\,\cancel{m}}$$

   b. Draw a picture of the mass-spring system. Make sure you add a coordinate system and draw the vectors which represent the forces on the mass.





Problem 1: Total Points 5
Part a) 3
Divide: 1 for set-up
1 for algebra
1 for unit substitution
Part b) 2
Divide: 1 for picture
(including coordinate system)
1 for vectors

2. For a $M = 5\ kg$ mass attached to a spring:
   a. When the mass is at rest, the spring is stretched $8\ cm$. Find the *spring constant*.

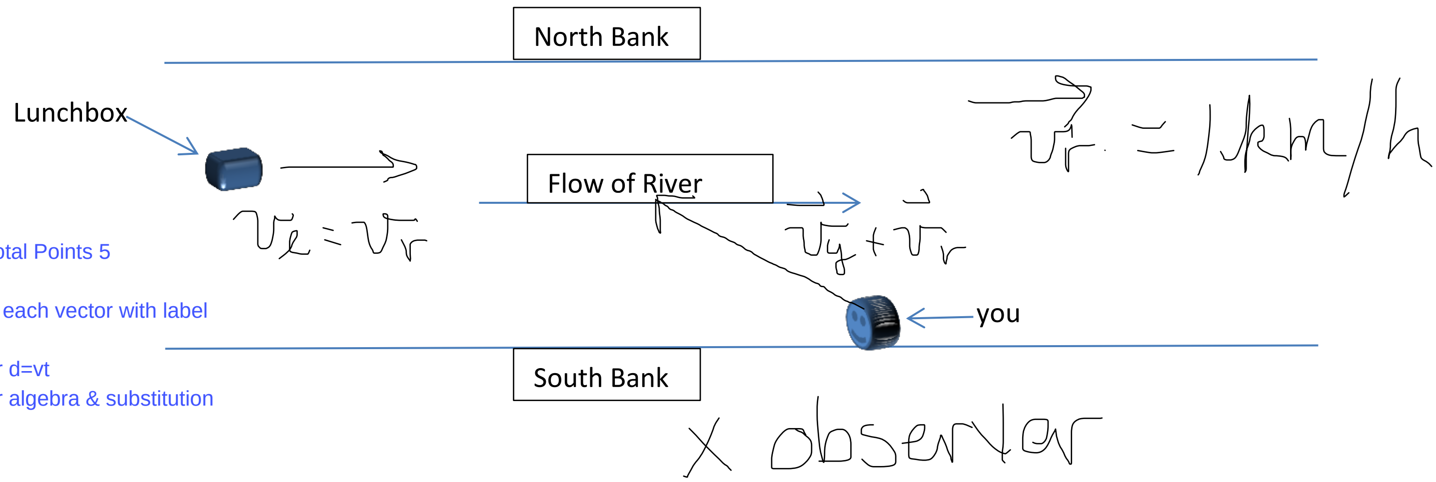
$$\left.\begin{aligned}&F = -kx \Rightarrow k = -F/x \\ &F = -Mg\ ;\ x = 8\ cm \times \frac{1m}{100cm} = 0.08\ m\end{aligned}\right\} \Rightarrow k = \frac{5\,kg(9.81\,m/s^2)}{0.08\ \ m} = 613.125\ N/m$$

   b. If you hang the mass by two springs with the *same* k, how far do the springs ~~stretch~~? Explain your reasoning.

The spring will stretch half as far (4 cm) because the force on each spring is half the force on any one spring for $k_1 = k_2$.

Problem 2: Total Points 5
Part a) 3
Divide: 1 for set-up
1 for algebra
1 for substitution
Part b) 2
Divide: 1 for "half as far"
1 for the physics reason why

3. You are camping near a rapidly flowing river. You are eating your lunch when a hawk swoops down and steals your lunchbox. Realizing the lunchbox is not a good hawk meal, he drops it in the river. The river flows *east at 5 km/h.*
    a. The hawk drops your lunchbox *1 km away* from your starting position. You decide to swim out and retrieve your lunchbox. On the diagram below, draw the vectors representing the motion of both you and your lunchbox as viewed by an observer on the *south bank*.



Problem 3: Total Points 5
Part a) 3
Divide: 1 for each vector with label
Part b) 2
Divide: 1 for d=vt
1 for algebra & substitution

b. You can swim at a speed of *1 km/h relative* to the flowing water. How long does it take you to get to your lunchbox?

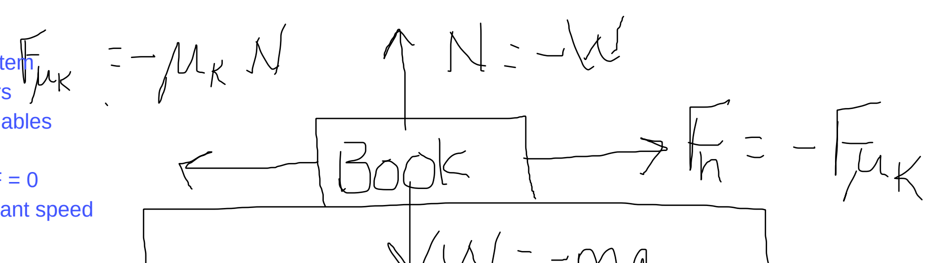
$$\left.\begin{array}{l} d = vt \\ t = d/v \end{array}\right\} \Rightarrow t = \frac{1\,km}{1\,km/h} = \underline{1\,h}$$

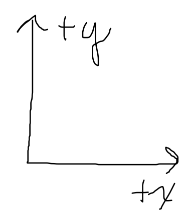
$d = 1\,km$

$v = 1\,km/h$

4. While studying for today's quiz at the library, you start pushing your Physics 101 text at constant speed across the flat, horizontal library table.
    a. Let μ_s be the coefficient of static friction and μ_k be the coefficient of kinetic friction. Draw the free body diagram (including a coordinate system) in the space below. Identify all forces in terms of *m*, the mass of the text, *g*, the acceleration of gravity, and the coefficients of friction.

Problem 4: Total Points 5
Part a) 3
Divide: 1 for figure with coordinate system
1 for vectors
1 for force lables
Part b) 2
Divide: 1 for sum F = 0
1 for constant speed





b. What is the net external force on the book? Explain your reasoning.

$\Sigma F_{ext} = 0$ because the book moves at constant speed.

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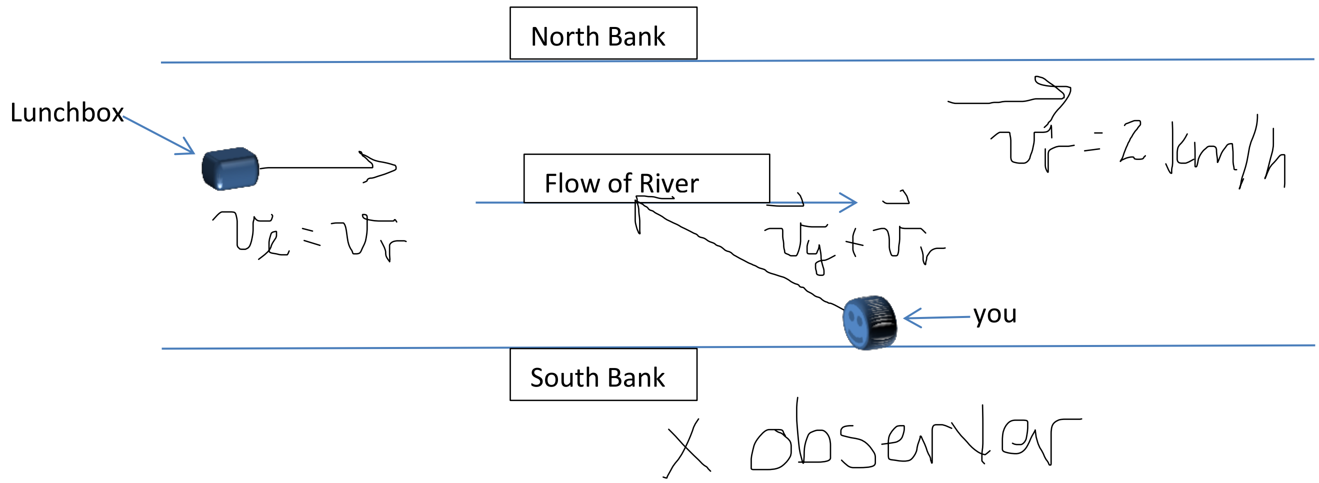
- Remember to give the correct units with all numerical answers

1. You are camping near a rapidly flowing river. You are eating your lunch when a hawk swoops down and steals your lunchbox. Realizing the lunchbox is not a good hawk meal, he drops it in the river. The river flows *east at 2 km/h.*
   a. The hawk drops your lunchbox *1.5 km away* from your starting position. You decide to swim out and retrieve your lunchbox. On the diagram below, draw the vectors representing the motion of both you and your lunchbox as viewed by an observer on the *south bank*.



   b. You can swim at a speed of *0.25 km/h relative* to the flowing water. How long does it take you to get to your lunchbox?

$$\left.\begin{array}{l} d = vt \\ t = d/v \end{array}\right\} \Rightarrow t = \frac{1.5\text{ km}}{0.25\text{ km/h}} = \underline{\underline{6\text{ h}}}$$

$d = 1.5$ km

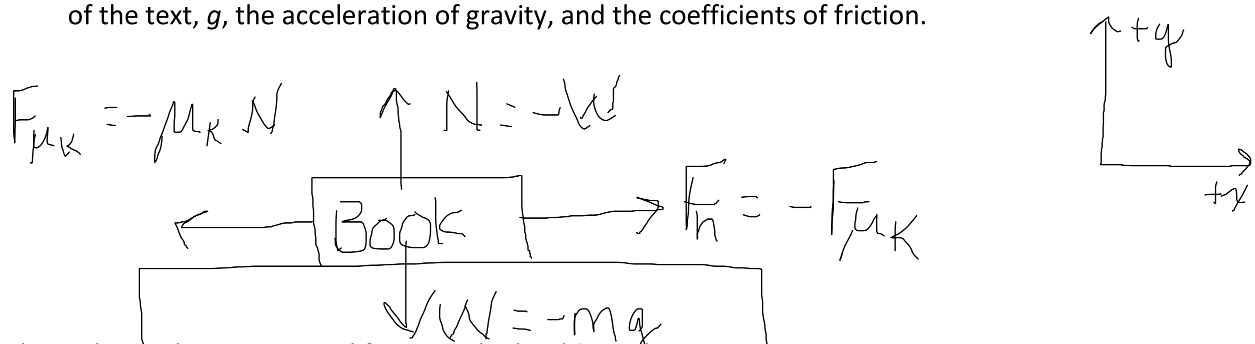
$v = 0.25$ km/h

2. Consider a system of a mass (M) on a vertical spring with force equation $F_{Spring} = -k\,x$:
   a. Given that the units of force are $[F] = \frac{kg\,m}{s^2}$ use dimensional analysis to find the units on the *spring constant* k.

$$\left.\begin{array}{l} [F] = [k][x] \\ [k] = [F]/[x] \end{array}\right\} \Rightarrow [k] = \frac{kg\,\cancel{m}}{\underline{\underline{s^2}}\,\cancel{m}}$$

   b. Draw a picture of the mass-spring system. Make sure you add a coordinate system and draw the vectors which represent the forces on the mass.

3. While studying for today's quiz at the library, you start pushing your Physics 101 text at constant speed across the flat, horizontal library table.
   a. Let μ_s be the coefficient of static friction and μ_k be the coefficient of kinetic friction. Draw the free body diagram (including a coordinate system) in the space below. Identify all forces in terms of *m*, the mass of the text, *g*, the acceleration of gravity, and the coefficients of friction.



   b. What is the net external force on the book? Explain your reasoning.

$\sum F_{ext} = 0$ because the book moves at constant speed.

4. For a $M = 2\ kg$ mass attached to a spring:
   a. When the mass is at rest, the spring is stretched 10 cm. Find the *spring constant*.

$$\left.\begin{array}{l} F = -kx \\ F = -Mg = -2kg(9.81 m/s^2) = 19.62\,N \\ x = 10cm \times \frac{1m}{100cm} = 0.1m \end{array}\right\} \frac{-F}{x} = k = \frac{Mg}{x} = \frac{19.62N}{0.1m} = 196.2\,N/m$$

   b. If you hang the mass by two springs with the *same k*, how far do the springs stretch? Explain your reasoning.

The springs will stretch half as far (5cm) because the force on each spring is half as large for $k_1 = k_2$.

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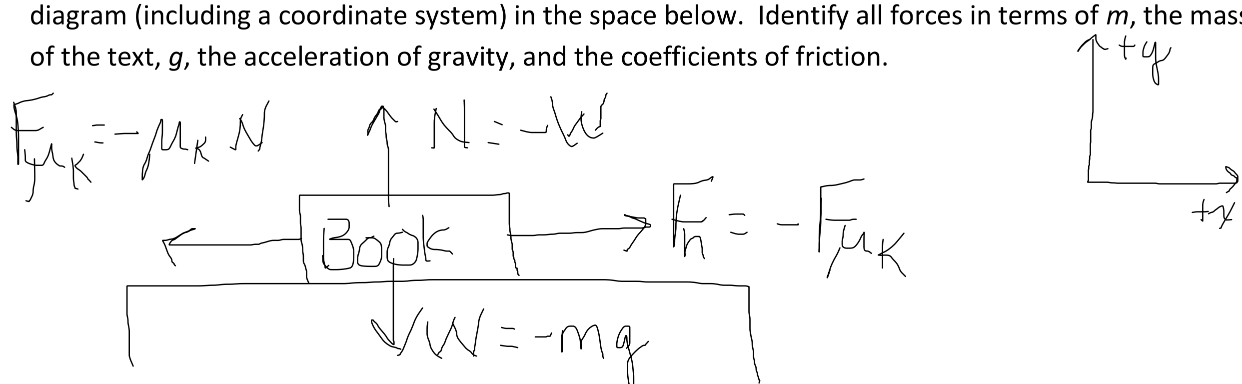
1. For a $M = 10\ kg$ mass attached to a spring:
   a. When the mass is at rest, the spring is stretched $0.2\ cm$. Find the *spring constant*.

$$\left.\begin{aligned} F &= -kx \\ F &= -Mg = -10\,kg(9.81\,m/s^2) \\ &= -98.1\,N \\ x &= 0.2\,cm \times \frac{1m}{100cm} = 0.002m \end{aligned}\right\} \Rightarrow \begin{aligned} k &= -F/x \\ &= \frac{98.1\,N}{0.002m} \\ &= 49050\,N/m \end{aligned}$$

   b. If you hang the mass by two springs with the *same* k, how far do the springs stretch? Explain your reasoning.

The springs will stretch half as far (0.1cm) because the force on each spring is half as large for $k_1 = k_2$.

2. While studying for today's quiz at the library, you start pushing your Physics 101 text at constant speed across the flat, horizontal library table.
   a. Let μ_s be the coefficient of static friction and μ_k be the coefficient of kinetic friction. Draw the free body diagram (including a coordinate system) in the space below. Identify all forces in terms of *m*, the mass of the text, *g*, the acceleration of gravity, and the coefficients of friction.



   b. What is the net external force on the book? Explain your reasoning.

$\Sigma F_{ext} = 0$ because the book moves at constant speed.

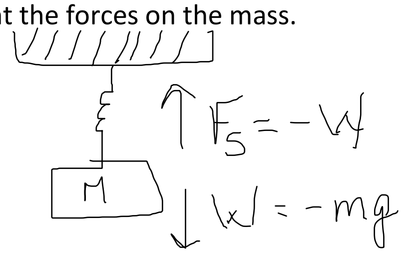
3. Consider a system of a mass (M) on a vertical spring with force equation $F_{Spring} = -k\,x$:

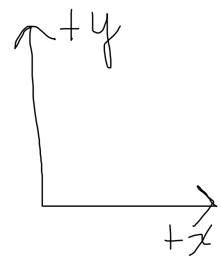
   a. Given that the units of force are $[F] = \frac{kg\,m}{s^2}$ use dimensional analysis to find the units on the *spring constant* k.

   $[F] = [k][x] \Rightarrow [k] = \frac{[F]}{[x]}$

   $[k] = \frac{kg\,\cancel{m}}{s^2\,\cancel{m}} = \underline{\frac{kg}{s^2}}$

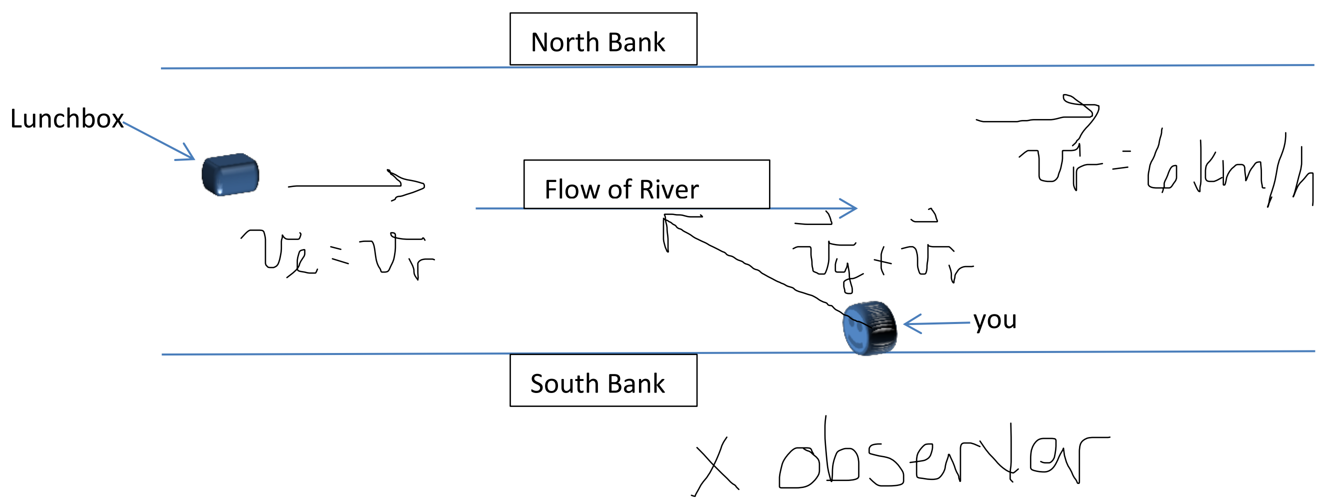
   b. Draw a picture of the mass-spring system. Make sure you add a coordinate system and draw the vectors which represent the forces on the mass.





4. You are camping near a rapidly flowing river. You are eating your lunch when a hawk swoops down and steals your lunchbox. Realizing the lunchbox is not a good hawk meal, he drops it in the river. The river flows *east at 6 km/h.*

   a. The hawk drops your lunchbox *1 km away* from your starting position. You decide to swim out and retrieve your lunchbox. On the diagram below, draw the vectors representing the motion of both you and your lunchbox as viewed by an observer on the *south bank*.



   b. You can swim at a speed of *2 km/h relative* to the flowing water. How long does it take you to get to your lunchbox?

   $d = vt$ $\quad d = 1\ km$

   $v = d/t$ $\quad v = 2\ km/h$

   $= 1\ km / 2\ km/h = \underline{\underline{0.5\ h}}$

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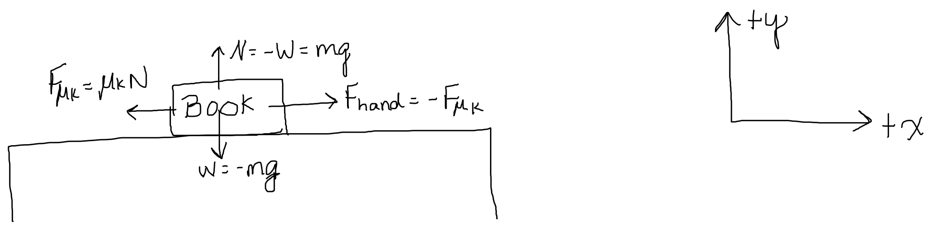
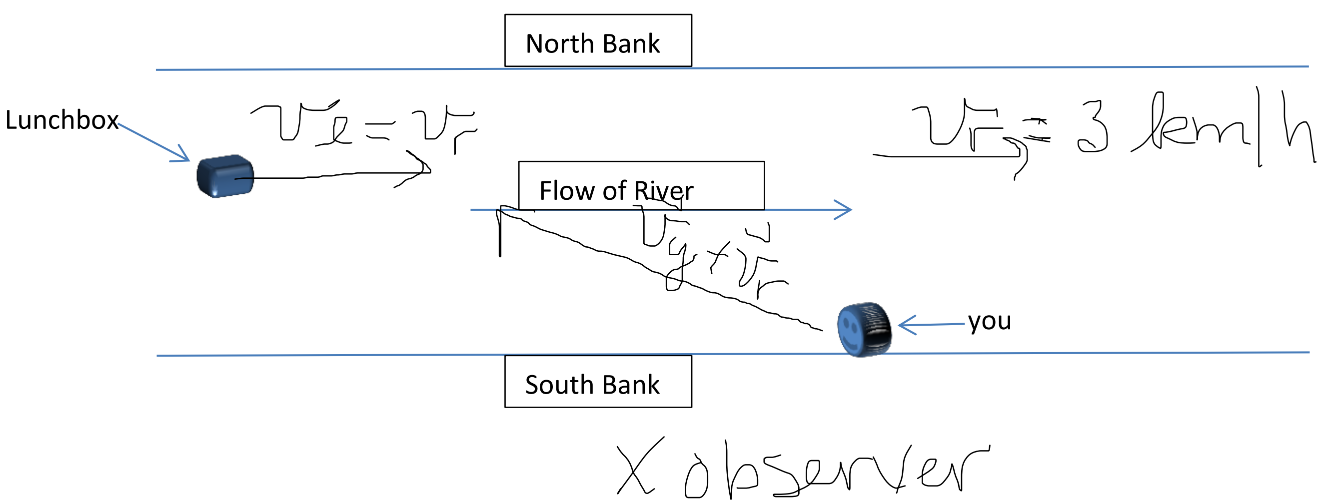


   b. What is the net external force on the book? Explain your reasoning.

$\Sigma F_{ext} = 0$ because the book moves at a constant speed.

2. You are camping near a rapidly flowing river. You are eating your lunch when a hawk swoops down and steals your lunchbox. Realizing the lunchbox is not a good hawk meal, he drops it in the river. The river flows *east at 3 km/h.*
   a. The hawk drops your lunchbox *2 km away* from your starting position. You decide to swim out and retrieve your lunchbox. On the diagram below, draw the vectors representing the motion of both you and your lunchbox as viewed by an observer on the *south bank*.



b. You can swim at a speed of *0.5 km/h relative* to the flowing water. How long does it take you to get to your lunchbox?

$d = vt \qquad d = 2\,km$
$v = 0.5\,km/h$

$t = \frac{d}{v} = \frac{2\,km}{0.5\,km/h} = \underline{\underline{4h}}$

3. For a $M = 1\ kg$ mass attached to a spring:

a. When the mass is at rest, the spring is stretched $0.1\ cm$. Find the *spring constant*.

$$\left.\begin{array}{l} F = -kx \Rightarrow k = -F/x \\ F = -Mg\,;\ x = 0.1cm \times \frac{1m}{100cm} = 0.001m \end{array}\right\} \Rightarrow k = +\frac{1kg(9.81m/s^2)}{0.001m} = \underline{9810\ N/m}$$

b. If you hang the mass by two springs with the *same* k, how far do the springs stretch? Explain your reasoning.

The spring will stretch half as far (0.05cm) because the force on each spring is half the force on any one spring for $k_1 = k_2$.

4. Consider a system of a mass (M) on a vertical spring with force equation $F_{Spring} = -k\,x$:

a. Given that the units of force are $[F] = \frac{kg\,m}{s^2}$ use dimensional analysis to find the units on the *spring constant* k.

$[F] = [k][x] \Rightarrow [k] = [F]/[x]$

$[k] = \frac{kg\,\cancel{m}}{s^2\,\cancel{m}} = \underline{\underline{\frac{kg}{s^2}}}$

b. Draw a picture of the mass-spring system. Make sure you add a coordinate system and draw the vectors which represent the forces on the mass.