Physics 221  Take home test #1 (due 12/4/09 by 2:00PM)  11/30/09

(4pts)

1. (2.5pts) A small object is shot at a block that is attached to an ideal spring. After the collision, the block moves over a horizontal surface for which it has friction. The masses of the two objects are given as well as the spring constant of the spring, the initial velocity of the small object, the coefficient of restitution for the collision, and the coefficient of kinetic friction between the block and the surface. Find the power output of both the spring force and the kinetic frictional force at the position when the velocity of the block after the collision is 5.00 m/s to the right.

\[
\begin{align*}
m &= 0.200 \text{ kg} \\
M &= 4.00 \text{ kg} \\
k &= 250 \text{ N/m} \\
v &= 220 \text{ m/s} \\
\mu_k &= 0.500 \\
\epsilon &= 0.800 \\
\end{align*}
\]

2. (1.5pts) Assume now that the horizontal surface is replaced by a quarter of a spherical shell, as shown below, and the same question is asked.

{ Find the power output of both the spring force and the kinetic frictional force at the position when the speed of the block after the collision is 5.00 m/s tangent to the surface of the hemisphere. }

\[
\begin{align*}
R &= 6.0 \text{ m} \\
k &= 24.0 \text{ N/m (changed)} \\
\end{align*}
\]

a. Describe qualitatively the steps you would take to solve this problem.

b. Describe what parts of the problem would now become very difficult to solve and why they would have become more difficult to solve.

c. Make crude estimates of the answers to the two questions. Clearly state the assumptions that you are making in arriving at your answers.
1. (2.5 pts) A small object is shot at a block that is attached to an ideal spring. After the collision, the block moves over a horizontal surface for which it has friction. The masses of the two objects are given as well as the spring constant of the spring, the initial velocity of the small object, the coefficient of restitution for the collision, and the coefficient of kinetic friction between the block and the surface. Find the power output of both the spring force and the kinetic frictional force at the position when the velocity of the block after the collision is 4.00 m/s to the right.

\[ m = 0.200 \text{ kg} \quad M = 5.00 \text{ kg} \quad k = 250 \text{ N/m} \]
\[ v = 240 \text{ m/s} \quad \mu_k = 0.400 \quad \epsilon = 0.900 \]

2. (1.5 pts) Assume now that the horizontal surface is replaced by a quarter of a spherical shell, as shown below, and the same question is asked. Find the power output of both the spring force and the kinetic frictional force at the position when the speed of the block after the collision is 4.00 m/s tangent to the surface of the hemisphere.

\[ R = 7.0 \text{ m} \quad k = 28.0 \text{ N/m} \text{ (changed)} \]

a. Describe qualitatively the steps you would take to solve this problem.

b. Describe what parts of the problem would now become very difficult to solve and why they would have become more difficult to solve.

c. Make crude estimates of the answers to the two questions. Clearly state the assumptions that you are making in arriving at your answers.
1. (2.5pts) A small object is shot at a block that is attached to an ideal spring. After the collision, the block moves over a horizontal surface for which it has friction. The masses of the two objects are given as well as the spring constant of the spring, the initial velocity of the small object, the coefficient of restitution for the collision, and the coefficient of kinetic friction between the block and the surface. Find the power output of both the spring force and the kinetic frictional force at the position when the velocity of the block after the collision is 3.00 m/s to the right.

\[
\begin{align*}
  m &= 0.200 \text{ kg} \\
  M &= 6.00 \text{ kg} \\
  k &= 250 \text{ N/m} \\
  v &= 220 \text{ m/s} \\
  \mu_k &= 0.300 \\
  \epsilon &= 0.700 \\
  x &= \text{position} \\
\end{align*}
\]

2. (1.5pts) Assume now that the horizontal surface is replaced by a quarter of a spherical shell, as shown below, and the same question is asked. Find the power output of both the spring force and the kinetic frictional force at the position when the speed of the block after the collision is 3.00 m/s tangent to the surface of the hemisphere.

\[
\begin{align*}
  R &= 9.0 \text{ m} \\
  k &= 32.0 \text{ N/m (changed)} \\
\end{align*}
\]

a. Describe qualitatively the steps you would take to solve this problem.

b. Describe what parts of the problem would now become very difficult to solve and why they would have become more difficult to solve.

c. Make crude estimates of the answers to the two questions. Clearly state the assumptions that you are making in arriving at your answers.
1. (2.5 pts) A small object is shot at a block that is attached to an ideal spring. After the collision, the block moves over a horizontal surface for which it has friction. The masses of the two objects are given as well as the spring constant of the spring, the initial velocity of the small object, the coefficient of restitution for the collision, and the coefficient of kinetic friction between the block and the surface. Find the power output of both the spring force and the kinetic frictional force at the position when the velocity of the block after the collision is 4.00 m/s to the right.

\[ m = .200 \text{ kg} \quad M = 8.00 \text{ kg} \quad k = 250 \text{ N/m} \]
\[ v = 240 \text{ m/s} \quad \mu_k = .600 \quad \epsilon = .500 \]

2. (1.5 pts) Assume now that the horizontal surface is replaced by a quarter of a spherical shell, as shown below, and the same question is asked.

Find the power output of both the spring force and the kinetic frictional force at the position when the speed of the block after the collision is 4.00 m/s tangent to the surface of the hemisphere.

\[ R = 7.0 \text{ m} \quad k = 25.0 \text{ N/m} \text{ (changed)} \]

a. Describe qualitatively the steps you would take to solve this problem.

b. Describe what parts of the problem would now become very difficult to solve and why they would have become more difficult to solve.

c. Make crude estimates of the answers to the two questions. Clearly state the assumptions that you are making in arriving at your answers.
1. (2.5 pts) A small object is shot at a block that is attached to an ideal spring. After the collision, the block moves over a horizontal surface for which it has friction. The masses of the two objects are given as well as the spring constant of the spring, the initial velocity of the small object, the coefficient of restitution for the collision, and the coefficient of kinetic friction between the block and the surface. Find the power output of both the spring force and the kinetic frictional force at the position when the velocity of the block after the collision is 4.00 m/s to the right.

\[ m = 0.200 \text{ kg} \quad M = 6.00 \text{ kg} \quad k = 250 \text{ N/m} \]
\[ v = 220 \text{ m/s} \quad \mu_k = 0.700 \quad \varepsilon = 0.900 \]

2. (1.5 pts) Assume now that the horizontal surface is replaced by a quarter of a spherical shell, as shown below, and the same question is asked. Find the power output of both the spring force and the kinetic frictional force at the position when the speed of the block after the collision is 4.00 m/s tangent to the surface of the hemisphere.

\[ R = 5.0 \text{ m} \quad k = 21.0 \text{ N/m} \text{ (changed)} \]

a. Describe qualitatively the steps you would take to solve this problem.

b. Describe what parts of the problem would now become very difficult to solve and why they would have become more difficult to solve.

c. Make crude estimates of the answers to the two questions. Clearly state the assumptions that you are making in arriving at your answers.
1. (2.5 pts) A small object is shot at a block that is attached to an ideal spring. After the collision, the block moves over a horizontal surface for which it has friction. The masses of the two objects are given as well as the spring constant of the spring, the initial velocity of the small object, the coefficient of restitution for the collision, and the coefficient of kinetic friction between the block and the surface. Find the power output of both the spring force and the kinetic frictional force at the position when the velocity of the block after the collision is 5.00 m/s to the right.

\[ m = 0.200 \text{ kg} \quad M = 4.00 \text{ kg} \quad k = 220 \text{ N/m} \]
\[ v = 260 \text{ m/s} \quad \mu_k = 0.600 \quad \epsilon = 0.800 \]

2. (1.5 pts) Assume now that the horizontal surface is replaced by a quarter of a spherical shell, as shown below, and the same question is asked. Find the power output of both the spring force and the kinetic frictional force at the position when the speed of the block after the collision is 5.00 m/s tangent to the surface of the hemisphere.

\[ R = 8.0 \text{ m} \quad k = 32.0 \text{ N/m} \](changed)

a. Describe qualitatively the steps you would take to solve this problem.

b. Describe what parts of the problem would now become very difficult to solve and why they would have become more difficult to solve.

c. Make crude estimates of the answers to the two questions. Clearly state the assumptions that you are making in arriving at your answers.