1. Multiple Choice (4pts each) Fill in the most correct answer on the bubble sheet, and circle the correct answer on this page for future reference.

1) (5pts) From Newton's laws of motion what is the most correct definition of mass?
   a) the density of an object
   b) the amount of matter in an object
   c) the volume of an object
   d) the amount of inertia of an object
   e) the relative speed of an object

2) A starcruiser with a mass of $1.5 \times 10^6$ kg flies though deep space at constant velocity of 370 m/s. What is the net force on the starcruiser in $10^8$ Newtons?
   a) 0
   b) 0.15
   c) 1.5
   d) 4.8
   e) 0.3

3) What is the main difference between Aristotle's ideas of natural motion and Newton and Galileo's ideas of natural motion?
   a) they are essentially the same
   b) Newton stated that the natural motion of objects would be to move in straight lines at constant speed, while Aristotle did not.
   c) Newton stated that objects can accelerate at the surface of the Earth, while Aristotle did not.
   d) Aristotle claimed that air would rise, while Newton's laws don't allow this.

4) You toss ball 1 straight up into the air from atop a 10m building with an initial speed $v_0$. You then toss ball 2 straight down from atop the building with an initial speed also $v_0$. Which hits the ground with the greatest speed?
   a) ball 1
   b) ball 2
   c) both have same speed
   d) unable to determine

5) From (4), if ball 2 has an initial speed of $v_0=3.0$ m/s, what is its time of flight?
   a) 1.0s
   b) 0.75s
   c) 0.75s
   d) 0.5s
   e) 0.0s

6) From (4) if ball 1 has an initial speed of $v_0=3.0$ m/s, what is its final speed in m/s?
   a) 14.3
   b) 15.3
   c) 16.3
   d) 17.3

7) A ball is rolling along a floor. It is rolling toward the east, and slowing as it rolls. As the ball rolls:
   a) the net force is toward the west
   b) its velocity is toward the west
   c) both of the above
   d) the net force is toward the east
   e) the net force is zero
8) How would a helium filled balloon move if it were released on the surface of the moon, which has no atmosphere?
   a) it would rise
   b) it would remain suspended at the point of release
   c) it would fall at the same rate a rock falls when dropped on the moon
   d) it would turn into a giant pumpkin

9) (5pts) If you push against a very heavy table, it doesn’t move. Explain why this is so.
   a) The table is too heavy and doesn’t accelerate according to Newton’s 2\textsuperscript{nd} law.
   b) When pushing against the table, Newton’s 3\textsuperscript{rd} law states that the table pushes equally back against you, so there is no acceleration
   c) The frictional force against your feet is not enough to overcome the mass of the table.
   The force you push against the table is not enough to overcome the frictional force of the table with the ground.

10) You are driving at 60mph (25m/s) and suddenly spot a deer in front of your car. If the coefficient of kinetic friction between your tires and the ground is 0.15, while the coefficient of static friction is 0.2. You slam on your brakes and lock the tires, what is the shortest distance you can stop in meters?
    a) 115
    b) 165
    c) 183
    d) 213
    e) 233

11) In the rain, the relevant coefficient of friction is now 0.075, by how much will your stopping distance increase?
    a) 5
    b) 1
    c) 2
    d) 3
    e) 4

12) You slide a 2 kg object along the ground with an initial speed of 6m/s and it comes to rest, with constant acceleration, in 2s. What is the frictional force applied to the object, in newtons?
    a) 6
    b) 9
    c) 12
    d) 18
    e) 24

\[ F = ma \]
\[ \frac{\Delta v}{t} = \frac{v_f - v_i}{t} \]
\[ \frac{\Delta x}{t} = \frac{v_f - v_i}{2} \]
\[ F = \mu N \]
II. **Written Solution: 30 Points.** Be sure to show all of your work for full credit.

Three blocks are attached to massless strings as shown below. The coefficient of friction between blocks 1 and 2 is \( \mu_s \), and there is no friction between blocks 2 and 3 and the floor. There is a force \( F \) applied to the massless string pointing to the left. The blocks have masses given by \( m_1, m_2, \) and \( m_3 \).

\[
\begin{align*}
F &\quad \text{(force applied)} \\
\mu_s &\quad \text{(coefficient of static friction)} \\
(m_1 + m_2 + m_3)g &\quad \text{(total weight)} \\
\end{align*}
\]

1. Draw free body diagrams for each of the blocks. Label the forces for full credit.

2. Draw the direction of the acceleration on each block.

3. If \( \mu_s = 0.15 \) and \( m_1 = m_2 = m_3 = 5 \text{kg} \), what is the maximum force \( F \) that can be applied before mass 1 slides?

\[
\sum F_x = F = (m_1 + m_2 + m_3) \ddot{x} \\
\sum F_y = F_{12} - m_1 g = 0 \\
F_{12} = m_1 g \\
\]

4. Given a force \( F \) applied as in the top figure, what is the tension in the string between the masses?

\[
\sum F_x = F = (m_1 + m_2 + m_3) \ddot{x} \\
\sum F_y = T_{32} = m_3 \ddot{a} \\
T = \frac{F \cdot m_3}{m_1 + m_2 + m_3} \\
\]