Name: _____   DISC: _____   Score: _____ / 20

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.

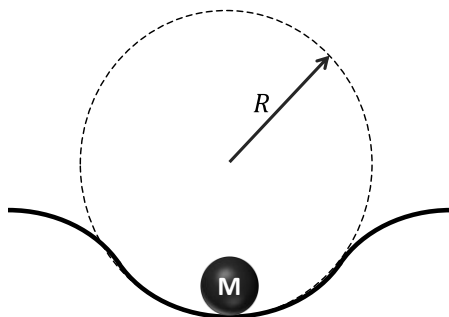| Q1	Q2	Q3	Q4
10	10	5	5

1. A bolder rolls down a hill into a valley. Let's approximate the hill-valley combination as part of a circle of radius R as shown in the figure:

M	R
$100\ kg$	$200\ m$

Table 1: Useful Information

Diagram (2pts):

a. On the figure complete the free-body diagram of the bolder at the bottom of the valley.

Explanation (3 pts):

b. As the bolder travels in its path down the hill and back up the other side, it undergoes *uniform circular motion*. For *uniform circular motion* the acceleration of a rotating object is $a = \frac{v^2}{r}$. The bolder moves at a constant *speed*, why is there an acceleration?

Acceleration (3 pts):

c. At the bottom of the valley, the normal force on the bolder is measured to be $1010\ N$. What is the acceleration of the bolder? (Use $g = 9.8\frac{m}{s^2}$, and the information in the table.)

Speed (2 pts):

d. What is the speed of the bolder?

2. You are traveling on a train with a velocity of $\vec{v} = 20 \; m/s$ due East. You drop (*not throw*) a baseball out of the window. The window is $2 \; m$ from the ground.

    a. You observe the baseball from the window as it travels to the ground. Answer the following questions about the *path you see* as the baseball travels:

        i. With what velocity do you see the baseball travel in the eastward direction?

v_{East} (2 pt):

$$v_{East} =$$

Ball position (2 pt):

        ii. When the baseball hits the ground which part of the train is it near (select the correct option from the list):
            1. A window in front of yours
            2. A window behind yours
            3. Your window

    b. Your friend is on the ground observing the baseball's path. Answer the following questions about the *path your friend sees* the baseball travels:

        i. With what velocity does your friend see the baseball travel in the eastward direction?

v_{East} (2 pt):

$$v_{East} =$$

Ball position (2 pt):

        ii. When the baseball hits the ground which part of the train is it near (select the correct option from the list):

Speed (2 pts):

            1. Your window
            2. A window behind yours
            3. A window in front of yours

        iii. Find the vertical speed of the baseball when it hits the ground.