

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

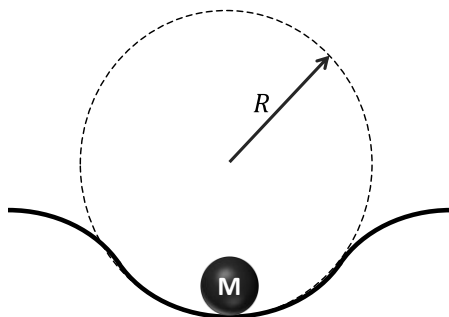
10

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
80 kg	160 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  $\vec{v} = 30 \text{ m/s}$  due East. You drop (*not throw*) a baseball out of the window. The window is  $2 \text{ m}$  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):

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

Speed (2 pts):

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