Name KEY

Date ________ Pd____

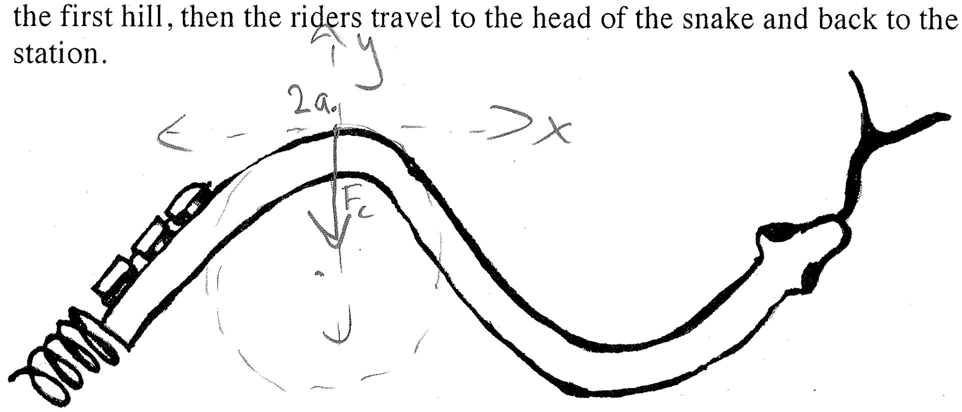
Unit V: Worksheet 2

1. Remember the scene in *Spies Like Us* where Dan Akroyd and Chevy Chase are having their g-force tolerance test? Most humans can withstand about 7 g's, that is 7 times the acceleration due to gravity. If the machine they are being tested on has a radius of 20 meters, what speed would they be traveling at to reach the 7 g threshold?

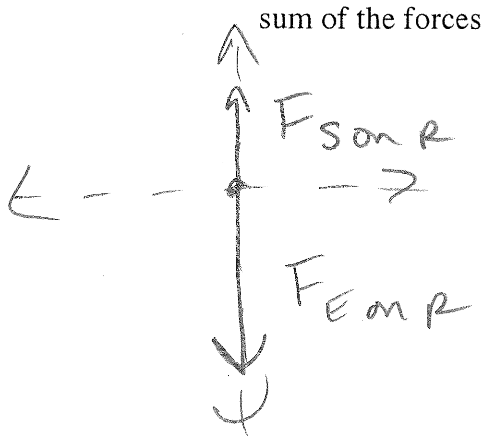
$7g = 7(-9.8 m/s^2) = 68.6 m/s^2 = a_c$

$a_c = v^2/r \quad v = \sqrt{(r)(a_c)} = \sqrt{(20 m)(68.6 m/s^2)} =$ $v = 37.0 m/s$

2. You have been hired to design a new roller coaster at Great America called *The Rattlesnake*, pictured below. A large spring (the rattle) launches riders up the first hill, then the riders travel to the head of the snake and back to the station.



a. Draw an arrow showing the direction of the net force at the top of the hill and at the bottom of the valley. (TOWARD CENTER OF CIRCLE)
b. Draw a separate arrow showing the direction of the acceleration at the top of the hill and at the bottom of the valley. (SAME DIR. AS NET FORCE)
c. What is the sign of the acceleration at the top of the hill? How do you know? a_c IS NEGATIVE BECAUSE NET FORCE & ACCEL. ARE ACTING DOWNWARD.
d. Draw a picture of the rider in the car. Draw a force diagram and write a sum of the forces equation for the rider at the top of the hill.



$\Sigma F_y = F_{E on R} + F_{S on R} \neq 0 N$

e. If the radius of curvature of the hill is 15 meters and the car is traveling at 10 m/s, what is the centripetal acceleration?

$$a_c = \frac{v^2}{r} = \frac{(10\,m/s)^2}{15\,m} = \boxed{-6.67\,m/s^2}$$

f. If a rider has a mass of 95 kg, what centripetal force does the rider experience?

$$F_c = ma_c$$
$$= (95\,kg)(-6.67\,m/s^2) = \boxed{-633\,N}$$

g. How much force does the seat exert on the rider?

$$\Sigma F_y = F_{EonR} + F_{SonR}$$
$$-633\,N = -931\,N + F_{SonR} \rightarrow \boxed{F_{SonR} = 298\,N}$$

$$F_{EonR} = -9.8\,N/kg\; m$$
$$= (-9.8\,N/kg)(95\,kg)$$
$$F_{EonR} = -931\,N$$

h. Your boss comes back to you and says that she wants the riders to feel weightless at the top of the first hill (in other words $a_c = a_{eonr}$). What velocity would the coaster need in order to achieve this?

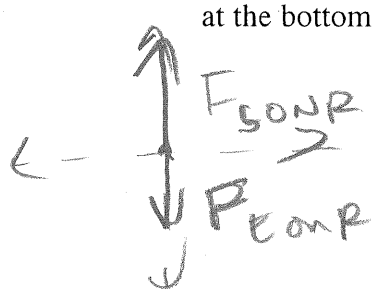
$$a_c = \frac{v^2}{r}$$

$$\sqrt{v^2} = \sqrt{r a_c}$$

$$v = \sqrt{(15\,m)(9.8\,m/s^2)} = \boxed{12.1\,m/s}$$

i. What is the sign of the acceleration at the bottom of the valley? How do you know? (+) BECAUSE THE CENTER OF CIRCLE IS UPWARD W/ RESPECT TO THE RIDER

j. Draw a force diagram and write a sum of the forces equation for the rider at the bottom of the valley.



$$\Sigma F_y = F_{EonR} + F_{SonR}$$

k. Amusement park rides rarely exceed 4 g's on the riders. If the car is traveling at 25 m/s when it passes through the bottom of the valley, what should be the radius of curvature?

$$4g = 4(9.8\,m/s^2)$$
$$= 39.2\,m/s^2$$

$$a_c = \frac{v^2}{r}$$
$$r = v^2/a_c$$

$$r = \frac{(25\,m/s)^2}{39.2\,m/s^2}$$
$$\boxed{r = 15.9\,m}$$