Name: _____ Date: _____

WS 4.1B: Centripetal Force and Acceleration

Unit 4: Circular Motion and Gravitation

1. A child on a merry-go-round is moving with a tangential velocity of 1.5 m/s. If she is sitting at a position that is 1.1 m from the centre, what is her centripetal acceleration?

2. On the same a merry-go-round described above, how long would it take her to complete one revolution at this speed?

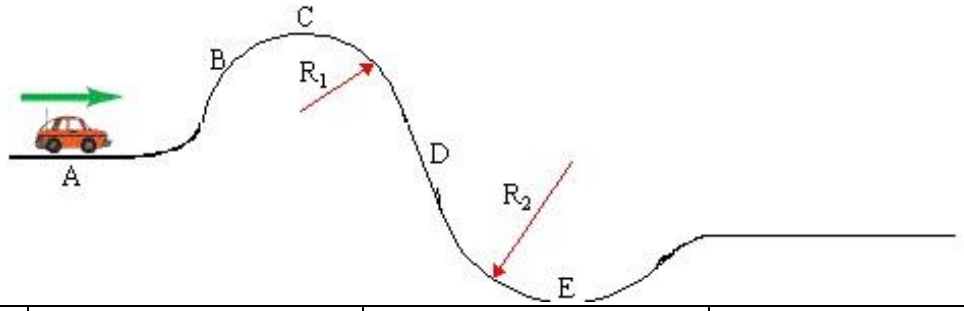
3. On the same a merry-go-round again, what is the speed of a point located 2.2m from the centre of the merry-go-round. What would the acceleration of this point be?

4. A pilot is doing the loop-de-loop manoeuvre.
   a. Draw a FBD of the pilot at the bottom of the loop then draw a FBD of the pilot at the top of the loop. What's different?

   b. It is said that the pilot is more likely to black out (due to blood leaving the brain) at the bottom of the loop as opposed to the top. With the help of Newton's First Law, explain why the bottom location of the loop creates the most danger for black-outs.

   c. Research - Describe how flight-suits are designed to help prevent black-outs from occurring.

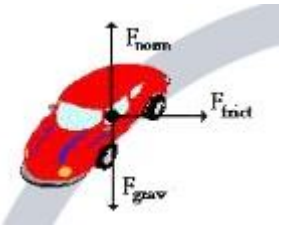
5. Newton's First Law states that objects will maintain their original motion unless they are acted on by a Net Force. Newton's Second Law states that objects will accelerate in the direction of the Net Force. Use these two laws to explain the driver's experience (what he/she feels) as well as the direction of the car's acceleration at the five locations shown below. You may assume that the driver keeps his/her **speed constant throughout** (to avoid tickets). Parts are done for you.



Location	***FBD***	***Use "F_{NET} = ma" to solve for F_N***	***What it "feels" like as v (a_c) increases.***
A		$F_{NET} = ma$ *(up=positive)* $F_N - F_g = 0$ $F_N = F_g$	Same (regular) force from seat.
C		$F_{NET} = ma$ *(a_c=down=positive)* $= ma_c$ $F_N =$ _____	
E		$F_{NET} = ma$ *(a_c=up=positive)* $= ma_c$ $F_N =$ _____	

Centripetal Forces:

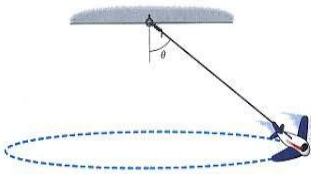
6. Consider the FBD provided for a toy car turning a corner.
   a. Which force here could be called the centripetal force?



   b. Write a horizontal F_{NET} equation and identify the acceleration as a_c.

   c. If F_{frict}=50N and mass=2kg, what is the centripetal acceleration of the car?

7. A 3.6 kg toy plane is hanging from string and moving in a horizontal circle of radius 2m, as shown (θ=45°). The tension in the string is 50N. What is the speed of the plane? Start with a FBD and F_{NET}=ma.



8. A 1.50-kg rock is being twirled in a circle on a frictionless surface using a horizontal rope. The radius of the circle is 2.00 m and the rope make 100 revolutions in 1.00 minutes.

   a. What is the tension in the rope? Show all work.

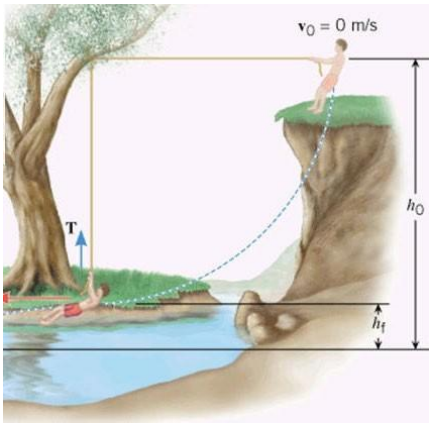
   b. The above will break when the tension exceeds 1000 N. What will be the speed of the rock just as the rope breaks? Show all work.

9. What is the apparent weight (F_N) of a 75.0-kg driver travelling at 100 km/h
   a. over the peak of a hill with radius of curvature equal to 500 m (R_1). Show all work.

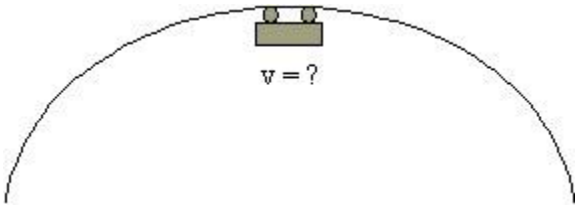
   b. at the bottom of the hollow of the same radius ($R_2 = R_1$)? Show all work.

10. A favourite swimming hole includes a rope swing from an elevated landing. The boy swings down and releases with a velocity of v_f at the bottom of the swing. Use a combination of Energy and Dynamics knowledge to determine the tension on the rope at the bottom (in terms of m and g).

    Note: *the initial height of the boy from the bottom of the swing is $h_0 - h_f$. This height will be equivalent to the radius on the circle, r*



11. What is the minimum speed for a rollercoaster to remain in contact with the tracks if it is doing an upside down loop of radius 350 m. **Show your work**.



***Answers**: **1:** 2.05 m/s² **| 2:** 4.6s | **3:** 3 m/s and 4.1 m/s² **| 4.** a) Top: F_N & F_g down; Bottom: F_N up & F_g down; b) Normal force greater (sum of both) **| 5.** $F_N=F_g$, $F_N=F_g-ma_c$, $F_N=F_g+ma_c$ **| 6.** a) F_f b) $F_f=ma_c$ c) 25 m/s² [inward] **| 7.** 4.43 m/s **| 8.** a) 329N b) 36.5 m/s **| 9.** a) 619N b) 851N **| 10.** 3mg **| 11.** 58.6*