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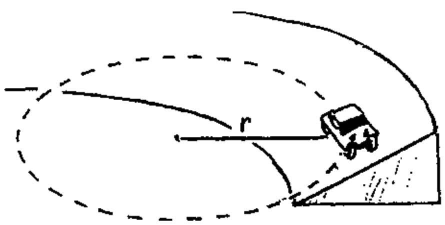
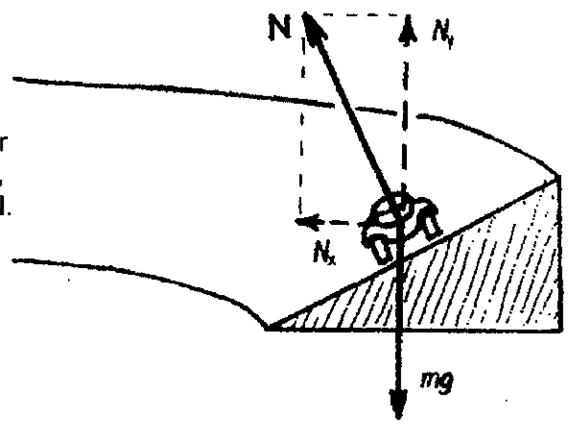
CONCEPTUAL **Physics** PRACTICE PAGE

Chapter 8 Rotational Motion
Banked Track



A car rounds a banked curve with just the right speed so that it has no tendency to slide down or up the banked road surface. Shown below are two main forces that act on the car perpendicular to its motion—gravitational m**g** and the normal force **N** (the support force of the surface).



Vector Component Analysis:
Note that vector **N** is resolved into two perpendicular components, horizontal N_x and vertical N_y. As usual, these vectors are dashed to distinguish them from **N**.

Circle the correct answers.

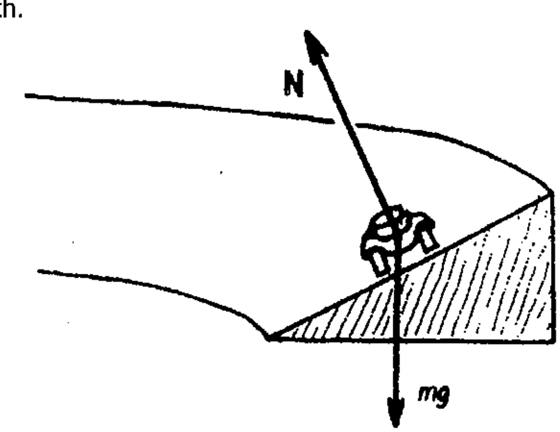
1. If **N** were somehow replaced with N_x and N_y, the car [would] [would not] behave identically to being supported by **N**.

2. Since the car doesn't accelerate vertically, component N_y must be [greater than] [equal and opposite to] [less than] m**g**.

3. The velocity of the car at any instant is [along the radius of] [tangent to] its circular path.

4. Since the car continues in uniform circular motion, component N_x must equal [zero] [mv^2/r] and be a [centripetal] [centrifugal] [nonexistent] force. Furthermore, N_x is [along the radius of] [tangent to] the circular path.

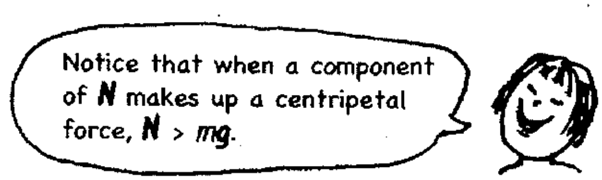
Vector Resultant Analysis:



5. Rather than resolving **N** into horizontal and vertical components, use your pencil to sketch the resultant of m**g** and **N** using the *parallelogram rule*.

6. The resultant lies in a [horizontal] [vertical] direction and [toward] [away from] the center of the circular path. The resultant of m**g** and **N** is a [centripetal] [centrifugal] force.

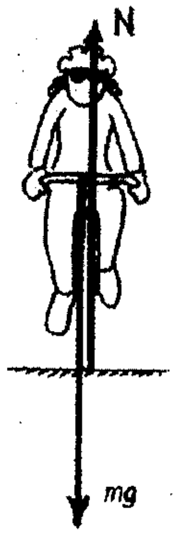
7. The resultant of m**g** and **N** is the same as [N_x] [N_y] and provides the [centripetal] [centrifugal] force.



thanx to Pablo Robinson

Chapter 8 Rotational Motion
Leaning

When turning a corner on a bicycle, everyone knows that you've got to lean "into the curve." What is the physics of this leaning? It involves torque, friction, and centripetal force (mv^2/r).



First, consider the simple case of riding a bicycle along a straight-line path. Except for the force that propels the bike forward (friction of the road in the direction of motion) and air resistance (friction of air against the direction of motion), only two significant forces act: weight m**g** and the normal force **N**. (The vectors are drawn side-by-side, but actually lie along a single vertical line.)

Circle the correct answers.

1. Since there is no vertical acceleration, we can say that the magnitude of

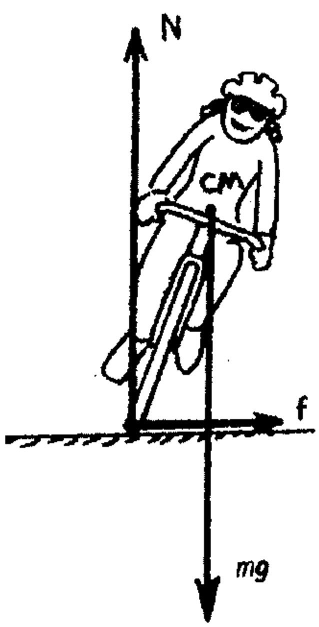
   [**N** > m**g**] [**N** < m**g**] [**N** = m**g**], which means that in the vertical direction,

   [$\Sigma F_y > 0$] [$\Sigma F_y < 0$] [$\Sigma F_y = 0$].

2. Since the bike doesn't rotate or change in its rotational state, then the total torque

   is [zero] [not zero].

Now consider the same bike rounding a corner. In order to safely make the turn, the bicyclist leans in the direction of the turn. A force of friction pushes sideways on the tire toward the center of the curve.



3. The friction force **f** provides the centripetal force that produces a curved path. Then [**f** = mv^2/r] [**f** $\neq mv^2/r$].

4. Consider the net torque about the center of mass (*CM*) of the bike-rider system. Gravity produces no torque about this point, but **N** and **f** do. The torque involving **N** tends to produce

   [clockwise] [counterclockwise] rotation and the one involving **f**

   tends to produce [clockwise] [counterclockwise] rotation.

   These torques cancel each other when the resultant of vectors **N** and **f** pass through the *CM*.

5. With your pencil, use the parallelogram rule and sketch in the resultant of vectors **N** and **f**. Label your resultant **R**. Note the **R** passes through the center of mass of the bike-rider system. That means that **R** produces [a clockwise] [a counterclockwise] [no] torque about the *CM*. Therefore the bike-rider system

   [topples clockwise] [topples counterclockwise] [doesn't topple].

When learning how to turn on a bike, you lean so that the sum of the torques about your CM is zero. You may not be calculating torques, but your body learns to feel them.

thanx to Pablo Robinson