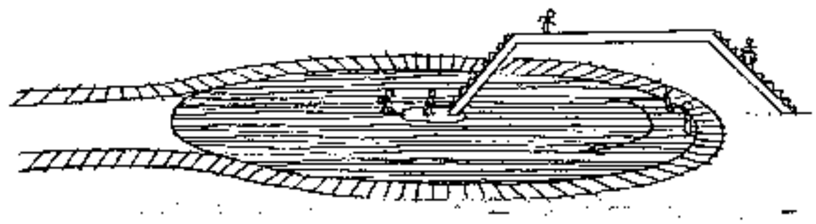
Name ________________ Period ________ Date ________

Concept-Development Practice Page 9-1

Circular Motion

1. Most energy of train systems is used in starting and stopping. The *rotating train platform* design saves energy, for people can board or leave a train while the train is still moving. Study the sketch and convince yourself that this is true. The small circular platform in the middle is stationary, and is connected to a stationary stairway.



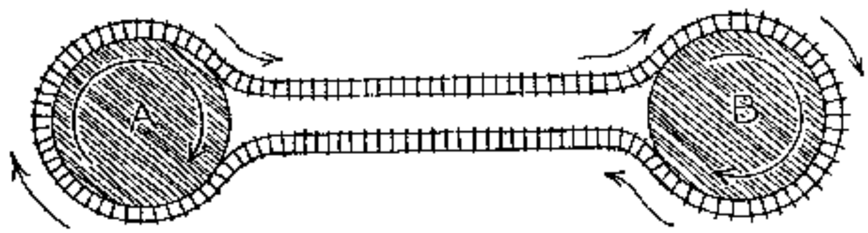
   a. If there is to be no relative motion between the train and the edge of the platform, how fast must the train move compared to the rim speed of the rotating platform?

   ____

   b. Why is the stairway located at the center of the platform?

   ____

2. The design below shows a train that makes round trips from Station A to Station B in a continuous loop.



   a. How is the size of the round platform and train speed related to the amount of time that passengers have for boarding?

   ____

   ____

   b. Why would this rotating platform be impractical for high-speed trains?

   ____

   ____

3. Here are some people standing on a giant rotating platform in a fun house. In the view shown, the platform is not rotating and the people stand at rest.

When the platform rotates, the person in the middle stands as before. The person at the edge must lean inward as shown. Make a sketch of the missing people to show how they must lean in comparison.

4. The sketch at the left shows a stationary container of water and some floating toy ducks. The sketch at the right shows the same container rotating about a central axis at constant speed. Note the curved surface of the water. The duck in the center floats as before. Make a sketch to show the orientation of the other two ducks with respect to the water surface.

5. Consider an automobile tire half filled with water. In the cross-sectional views below the left-hand sketch shows the water surface when the tire is not rotating. The right-hand sketch shows the water surface when the tire and water rotate about its central axis.

Now suppose the tire is rotating about the same axis while orbiting in outer space. Draw the shape of the water surface in the cross-sectional view below.

In your mind, scale up the rotating tire model to a rotating space habitat orbiting in space. If the space habitat were half filled with water, could inhabitants float on the surface as they do here on earth? Discuss this with [illegible] team [illegible]

Concept-Development Practice Page 9-2

Acceleration and Circular Motion

Newton's 2nd law, $a = F/m$, tells us that net force and its corresponding acceleration are always in the same direction. (Both force and acceleration are vector quantities.) But force and acceleration are not always in the direction of velocity (another vector).

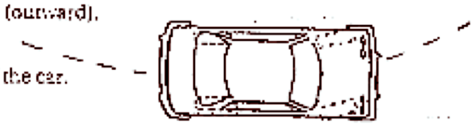
1. You're in a car at a traffic light. The light turns green and the driver "steps on the gas."
   a. Your body lurches (forward) (not at all) (backward).
   b. The car accelerates (forward) (not at all) (backward).
   c. The force on the car acts (forward) (not at all) (backward).

The sketch shows the top view of the car. Note the directions of the velocity and acceleration vectors.

2. You're driving along and approach a stop sign. The driver steps on the brakes.
   a. Your body lurches (forward) (not at all) (backward).
   b. The car accelerates (forward) (not at all) (backward).
   c. The force on the car acts (forward) (not at all) (backward).

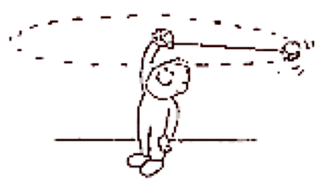
The sketch shows the top view of the car. Draw vectors for velocity and acceleration.

3. You continue driving, and round a sharp curve to the left at constant speed.
   a. Your body leans (inward) (not at all) (outward).
   b. The direction of the car's acceleration is (inward) (not at all) (outward).
   c. The force on the car acts (inward) (not at all) (outward).



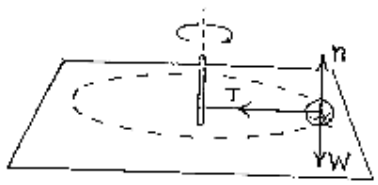
Draw vectors for velocity and acceleration of the car.

4. In general, the directions of lurch and acceleration, and therefore the directions of lurch and force, are (the same) (not related) (opposite).



5. The whirling stone's direction of motion keeps changing.
   a. If it moves faster, its direction changes (faster) (slower).
   b. This indicates that as speed increases, acceleration (increases) (decreases) (stays the same).

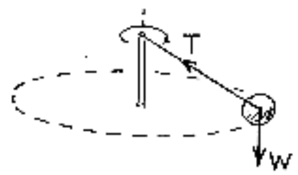
6. Consider whirling the stone on a shorter string—that is, of smaller radius.
   a. For a given speed, the rate that the stone changes direction is (less) (more) (the same).
   b. This indicates that as the radius decreases, acceleration (increases) (decreases) (stays the same).



1. A rock tied [illegible] moves in a circle at constant speed on a frictionless horizontal surface. All the forces acting on the rock are shown: Tension T, support force n by the table, and the force due to gravity W.

a. The vector responsible for circular motion is ______.

b. The net force on the rock is ______.



2. In this case the rock is tied to a string and swings in a circular path as shown. It is not resting on a surface. No friction. Use the parallelogram rule and find the resultant of vectors T and W.

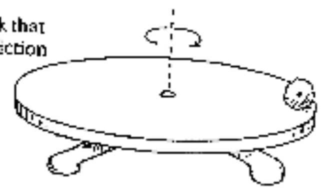
a. What is the direction of the resultant of T and W? ______

b. Does this resultant lie in the plane of the circular path? ______

c. Is this resultant also the horizontal component of T? ______

d. Is the resultant T + W (or the horizontal component of T) a centripetal force? ______

3. In the case shown at the right, the rock rides on a horizontal disk that rotates at constant speed about its vertical axis (dotted line). Friction prevents the rock from sliding.

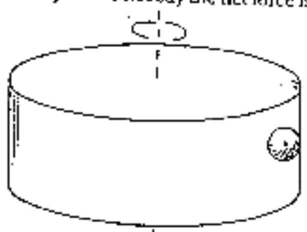


a. Draw and label vectors for all forces that act on the rock.

b. Which force is centripetal? ______

c. Which force provides the net force? ______

d. Why do we *not* say the net force is zero? ______

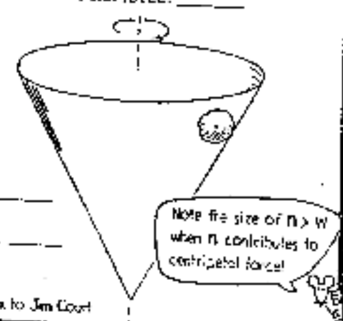


4. Now the rock is held in place by friction against the inside wall of the rotating drum. Draw and label vectors for all forces that act on the rock.

a. Which force is centripetal? ______

b. Which force provides the net force? ______

5. More challenging: This time the rock rests against the frictionless inside wall of a cone. It moves with the cone, which rotates about its vertical axis (dotted line). The rock does not slide up or down in the cone as it rotates. Draw and label vectors for all forces that act on the rock.



Should the resultant force lie in the plane of the circular path? ______

Why? ______

from ___ to Jim Court