"Circular Motion" Answers

PROCEDURE 1 QUESTIONS:

1) The marble followed a straight line path after it left the pie plate.

2) Inertia.

3) The force was the push of the pie plate; it was towards the center of the plate.

PROCEDURE 2:

2. There should be more of a tug when you increase the orbital speed of the washer.

3. There should be more of a tug when the string is long, if you kept the orbital speed the same.

PROCEDURE 2 QUESTIONS:

1) The force was the pull of the string; the force was inward, toward your hand, toward the center of the circular path.

2) More force is needed to maintain a circular orbit when the speed of the orbiting object is increased.

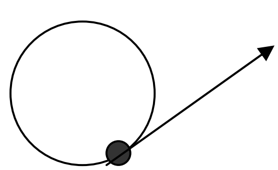
Mathematically: $F = \frac{mv^2}{r}$

If velocity is increased, the force required to maintain an orbit is increased.

3) As the radius is increased, more force is needed if an object is maintaining a fast orbital speed. Increasing the velocity increases the tangential speed which then increases the force required.

Mathematically: $F = \frac{mv^2}{r} = \frac{m(2\pi r)^2}{r} = 2.5\ mr$

4) To hit your target, you must release the stone when its instantaneous velocity is in the direction of the object. After it leaves the sling, it will travel in the direction it was last heading when it was released.



5) m = 20 grams
r = 10 cm

First we need to find the orbital velocity…

$v = \text{rev/sec} \times 2\pi r = 2/\text{sec} \times 2(3.14)(0.10\text{ m}) = 1.256\text{ m/sec}$

$$a_c = \frac{v^2}{r} = \frac{(1.256\ m/sec)^2}{(0.10\ m)} = \mathbf{15.79\ m/s^2}$$ (**toward the center** of the circular path)

The force on the washer is…

$F_c = ma_c = (0.020\ kg)(15.79\ m/s^2) = \mathbf{0.32\ N}$

The direction of the force is **toward the center** of the circular path.

For the sake of "real life", if we convert these units to kg m/s^2, which is a Newton, and then to lbs., then the answer is 0.32 N or 0.07 lbs of force

PROCEDURE 3:

1. The orbital radius is the radius of the Earth plus the 300 km.

r = (radius of Earth) + (300 km)
= 6.37×10^6 m + 300,000 m
= $\mathbf{6.67 \times 10^6\ m}$

2. $v = 30{,}000\ m/s$

$$a_c = \frac{v^2}{r} = \frac{(30{,}000\ m/s)^2}{(6.67 \times 10^6\ m)} = \mathbf{134.9\ m/s^2}$$

$m = 500\ kg$

$F_c = ma_c = (500\ kg)(134.9\ m/s^2) = \mathbf{67{,}450\ N}$

PROCEDURE 3 QUESTIONS:

1) The force is gravity with a pull toward the center of the orbital path.

2) When the ship turns off its engines and turns on its gravitational deflector shield, the ship will still have a velocity so it will **travel in a straight-line tangent to the circular path**; it will leave the orbit in the direction it was last heading because of inertia.

GENERAL QUESTIONS:

1) **b.** A centripetal force always acts toward the center of the circular path.

2) Turning is a change in velocity (i.e., acceleration). If you do not slow down, the changes in direction will require additional force to keep your car on the road.