Name:_____ Date:_____ Period:_____

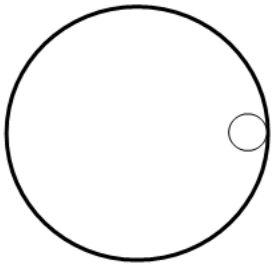
Plate Lab

Goal: to analyze the forces needed for circular motion and understand what happens when those forces are removed.

On the table, without the plate, the marble would go in a straight line if pushed.
A marble on a plate can be made to go in a circle. Push a marble along the edge of a whole (uncut) plate and think about and answer the questions below. For this activity, the drawings and images will be from the viewpoint directly above the plate looking down.

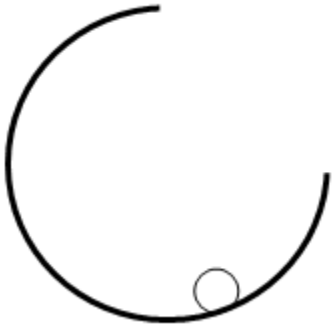
After your push, what is the force causing this circular motion? _____

In the diagram below, imagine the ball is going anti-clockwise. Draw an arrow representing the instantaneous velocity at this point. Label it "V". Draw another arrow showing the direction of the force acting on the marble to make it go in a circle. Label it "F". Also label which way you think the acceleration is with an arrow labeled "a"

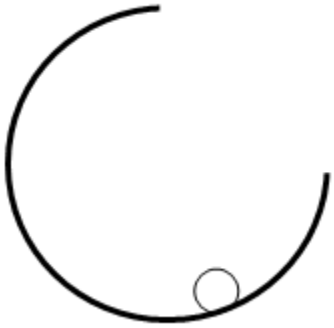


A second plate has a section cut out of it. If you give the marble a push near the top so that it travels along the plate counter-clockwise, predict what path you think the marble take when it exits the plate. Draw the predicted path on the picture below. Write a short sentence why you think this will happen.

Predicted:



Actual:



Test out your guess with the plate and marble. Do the experiment several times to make sure you know what actually happens. Draw the path it actually takes.

7.1 Quizlette - Centripetal Force and Acceleration **Name**_____

$a = \frac{v^2}{r}$ Velocity - radius equation

1. What is the centripetal acceleration of a skier going 23.0 m/s around a corner with a radius of 56.0 m? (9.45 m/s/s)

2. A car going around a corner with a radius of 340. m is accelerating laterally at 6.40 m/s/s. What is its speed? (46.6 m/s)

3. A car goes 23.0 m/s around a corner with a lateral acceleration of 4.50 m/s/s. What is the radius of the corner? (118 m)

$a = \frac{4\pi^2 r}{T^2}$ Period - radius equation

4. A centrifuge has a radius of 0.0870 m, and a period of 0.0230 s. What is its centripetal acceleration? (6493 m/s/s)

5. A centrifuge generates a centripetal acceleration of 3760 m/s/s with a period of 0.0310 s. What is the radius of the centrifuge? (0.0915 m)

6. A centrifuge generates an acceleration of 9250 m/s/s with a radius of 0.0680 m. What is its period of motion? (0.0170 s)

$F = ma$, so $F = \frac{mv^2}{r}$ and $F = \frac{m4\pi^2 r}{T^2}$ Centripetal force

7. What centripetal force do you need to make a 78.0 kg skier go 39.0 m/s around a 98.0 m radius corner? (1211 N)

8. What is the maximum velocity you can twirl a 3.90 kg hammer in a 1.80 m radius circle if the string it is attached to has a tensile strength of 190. N? (9.36 m/s)

9. A centrifuge makes 0.0140 kg test tubes go in a 0.0860 m radius circle with a period of 0.0455 s. What force does it exert on the test tubes? (23.0 N)

10. A centrifuge exerts 213 N on a 0.0120 kg test tube spinning in a 0.0750 m radius circle. What is its period of motion? (0.0129 s)

Friction provides centripetal force:

$$\mu mg = \frac{mv^2}{r} \qquad \mu mg = \frac{m4\pi^2 r}{T^2}$$

11. A 1450 kg car with a coefficient of friction of 0.870 goes around a level corner at 27.0 m/s. What is the minimum radius the corner can have? (85.5 m)

12. There is a coefficient of friction of 0.930 between a 1230 kg car and the level road. What is its maximum possible velocity around a 330. m radius corner? (54.8 m/s)

13. A 0.120 kg mass is on a level turntable. If there is a coefficient of friction of 0.340 between the turntable and the mass, and the turntable has a period of 1.33 s, what is the maximum distance the mass can be from the center and not fly off? (0.149 m)

14. A 0.0110 kg eraser is on a level turntable 0.180 m from the center. If there is a coefficient of friction of 0.880 between the turntable and the eraser, what is the minimum period of motion the turntable can have for the eraser to remain without flying off? (0.908 s)

Physics
FA7.1 - Circular Motion

Name_____

Favorite TV Show_____

When you have finished this, go to the website and check your answers. If you got a problem wrong, cross it off on the front, and do it correctly on the back.

Show your work, and circle your answers and use sig figs to receive full credit.

1. With what maximum velocity can a car go around a 312 m radius curve if it cannot exceed 3.136 m/s/s of lateral acceleration?

2. A Centrifuge has a radius of 5.75 cm, and spins with a period of 0.0171s. What is the centripetal acceleration?

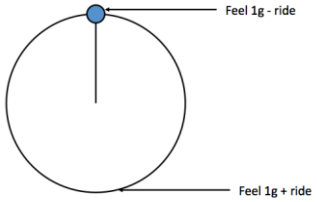
3. What centripetal force would make a 120. kg bike and rider go 17.0 m/s around a 178 m radius corner?

4. A spinning carnival ride has a radius of 4.20 m. What is the period of the ride if it is exerting a centripetal force of 895 N on a 64.0 kg person?

5. What is the minimum coefficient of friction needed for a 1205 kg car to go 27.0 m/s around a level corner with a radius of 280. m? What about a 3450 kg SUV?

7.2 Quizlette - Vertical Circle Name_____

1. An airplane goes in a 232 m radius vertical circle (inside loop). What is the minimum velocity the plane can have for the pilot to stay in her seat without requiring a seatbelt?
(47.7 m/s)



"g" Forces in a vertical circle:
Top: Measure = 1-ride **Bottom: Measure = 1+ ride**

2. A Ferris wheel is pulling 0.130 "g"s of centripetal acceleration. What "g"s do the riders feel and measure at the top and bottom of the ride? (top: 0.870 "g"s, bottom: 1.130 "g"s)

3. Riders on a Ferris wheel measure 0.880 "g"s at the top of the ride. What "g"s do the riders feel and measure at the bottom, and how many "g"s is the ride really pulling? What is the acceleration of the ride in m/s/s? (bottom: 1.120 "g"s, ride: 0.120 "g"s, 1.176 m/s/s)

4. Riders on the "Zero g" at Oaks park feel 0.820 inverted "g"s at the top (feel -0.820 "g"s). What "g" force does the ride pull? What "g"s do they feel at the bottom? What is the acceleration of the ride in m/s/s? (ride: 1.820 "g"s, bottom: 2.820 "g"s, 17.8 m/s/s)

5. Riders on the "Hurl-O-Matic" register a "g" force of 2.780 "g"s at the bottom of the ride. What "g" force is the ride pulling, and what "g"s do they feel at the top? What is the acceleration of the ride in m/s/s?
(ride: 1.780 "g"s, top: -0.780 "g"s (inverted), 17.4 m/s/s)

$$a = \frac{v^2}{r} \qquad a = \frac{4\pi^2 r}{T^2}$$

1. Find ac
2. Convert to "g"s (divide m/s/s by 9.8 m/s/s)
3. Top: 1-ride, Bottom: 1+ride

6. A Ferris wheel has a radius of 8.10 m, and a tangential velocity of 4.30 m/s. What "g" force do they read at the top and bottom of the ride? (top: 0.767 "g"s, bottom: 1.233 "g"s)

7. A vertical circle ride has a radius of 9.20 m, and a period of 10.5 s. What "g" force to the riders feel and measure at the top and at the bottom of the ride? (top: 0.664 "g"s, bottom: 1.336 "g"s)

8. A vertical circle ride has a radius of 4.70 m, and a velocity of 9.50 m/s. What "g" force to the riders feel and measure at the top and at the bottom of the ride? (top: -0.959 "g"s inverted, bottom: 2.959 "g"s)

9. A vertical circle ride has a radius of 5.20 m, and a period of 4.20 s. What "g" force to the riders feel and measure at the top and at the bottom of the ride? (top: -0.188 "g"s inverted, bottom: 2.188 "g"s)

$$a = \frac{v^2}{r} \qquad a = \frac{4\pi^2 r}{T^2}$$

1. Find the "g"s of the ride: Top: 1-ride, Bottom: 1+ride
2. Convert to m/s/s (multiply "g"s by 9.8 m/s/s)
3. Use formulas to find v or T

10. Riders at the bottom of a Ferris wheel measure a "g" force of 1.305 "g"s. What is the tangential velocity of the ride if the radius is 8.10 m? (4.92 m/s)

11. Riders at the top of a Ferris wheel measure a "g" force of 0.860 "g"s. What is the period of the ride if the radius is 8.30 m? (15.45 s)

12. A 3.10 m radius vertical circle ride makes riders feel 2.600 "g"s at the bottom of the ride. What is the tangential velocity of the ride? (6.97 m/s)

14. A vertical circle ride has a radius of 5.40 m and generates an inverted "g" force of -0.310 "g"s at the top. What is the period of the ride? (4.08 s)

Physics
FA7.2 - Vertical Circle

Name_____

Favorite Movie_____

When you have finished this, go to the website and check your answers. If you got a problem wrong, cross it off on the front, and do it correctly on the back.

Show your work, and circle your answers and use sig figs to receive full credit.

1. A clever Physics teacher swings a bucket in a 1.12 m radius vertical circle at a constant speed. What is the maximum period the motion can have for the water to stay in the bucket?

2. The Zero-G at Oaks Park pulls 1.80 "g"s of centripetal acceleration in a vertical circle. What "g" force do the riders feel at the top and at the bottom?

3. Riders on a Ferris wheel read 0.72 "g"s at the top. What "g"s is the ride doing, and what "g"s would they measure at the bottom? What is the acceleration of the ride in m/s/s?

4. A Rock-O-Plane has a radius of 5.64 m and a period of 6.25 s. What "g" force do they read at the top and the bottom of the ride?

5. A vertical circle ride generates a "g" force of -0.850 "g" (inverted "g"s) at the top. If the ride has a radius of 4.20 m, what is the tangential velocity at the top?

7.3 Quizlette - Gravity and Orbit **Name**_____

Gravity - Use $G = 6.67 \times 10^{-11}\ Nm^2/kg^2$.

1. What is the force of gravity between a 3.50×10^{13} kg asteroid and a 29,300 kg spaceship if their centers are 1,720 m distant? (23.1 N)

2. What is the force of gravity between a 2.50×10^{14} kg asteroid and a 48,420 kg spaceship if their centers are 5,580 m distant? (25.9 N)

3. The centers of two lead spheres are separated by 2.70 m. If one sphere has a mass of 32.0 kg, and there is an attractive force of 1.70×10^{-9} N, what is the mass of the other sphere? (5.81 kg)

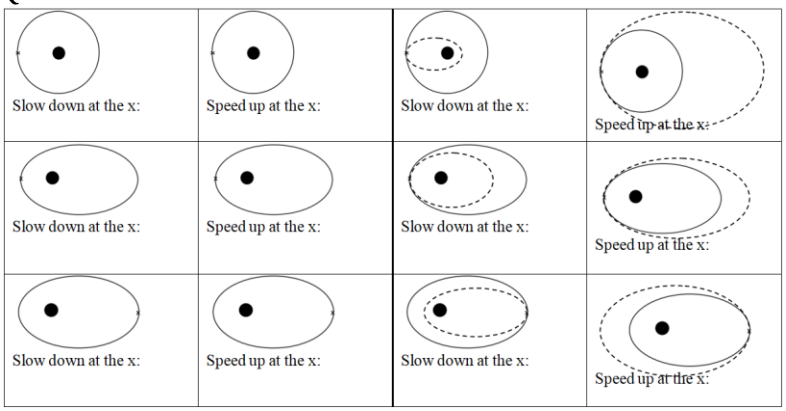
4. The centers of two lead spheres are separated by 1.55 m. If one sphere has a mass of 223 kg, and there is an attractive force of 1.90×10^{-8} N, what is the mass of the other sphere? (3.07 kg)

5. What distance separates the centers of two lead spheres if one has a mass of 502 kg, the other a mass of 56.0 kg and there is an attractive force of 2.60×10^{-12} N? (849 m)

6. What distance separates the centers of two lead spheres if one has a mass of 215 kg, the other a mass of 197 kg and there is an attractive force of 2.40×10^{-8} N? (10.8 m)

Orbital Trajectories:

Questions: Answers:



In general, speeding up brings the far side <u>out</u>, slowing down brings the far side <u>in</u>. Speeding up brings the entire trajectory <u>outside</u> the old one, and slowing down brings entire trajectory <u>inside</u> the old one.

Orbit:

Useful things to know:

Mass of the Earth	5.97×10^{24} kg	Radius of the Moon	1.738×10^{6} m
Mass of the Moon	7.35×10^{22} kg	Radius of the Earth	6.38×10^{6} m
Mass of the Sun	1.99×10^{30} kg	Earth-Moon Distance	3.84×10^{8} m
$G = 6.67 \times 10^{-11}$ Nm^2/kg^2		Earth-Sun Distance	1.496×10^{11} m

1. What is the orbital velocity 3400 m from the center of a 5.6×10^{18} kg asteroid? ($331.4 \approx 330$ m/s)

2. You find that you can orbit at 516 m/s 12,150 m from the center of a small moon. What is its mass? (4.85×10^{19} kg)

3. A satellite orbits a planet at a distance of 7.5×10^{6} m from the center every 8900 seconds. What is the mass of the planet? (3.2×10^{24} kg)

4. What distance from the center of Earth's moon is your orbital velocity 120 m/s? (3.4×10^{8} m)

5. What is the period of orbit of a satellite that orbits 1.95×10^{6} m from the center of Earth's moon? (7730 s)

6. What is the radius of an orbit with a period of 3.16×10^{7} s around the sun? (1.50×10^{11} m – yep – it's the earth)

Physics
FA 7.3 – Orbit and Gravity

Name_____

Show your work, round to the correct significant figures, circle your answers, and label them with units.
When you have finished this, go to the website and check your answers. If you got a problem wrong, cross it off on the front, and do it correctly on the back.

1. What is the force of gravity between the Philae probe with a mass of 100. kg and comet 67P with a mass of 1.05×10^{13} kg if the probe is resting on the surface of the 2.05 km (2.05×10^{3} m) radius comet. (That we will pretend is spherical - it's highly not)

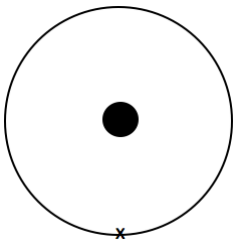
2. What distance needs to separate the centers of two 5.20 kg spheres so that the force of gravity between them is 1.20×10^{-9} N

3. Your 12,500 kg spaceship is orbiting 1.16×10^{7} m from the center of a planet every 17,500 s. What is the mass of the planet?

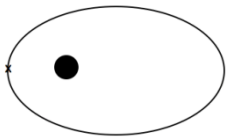
4. At what distance from the center of our 7.35×10^{22} kg moon is the orbital velocity 340. m/s?

5. Draw the new orbit: (Circle or oval indicates your <u>current</u> orbit)

Slow at x:
(elliptical, inside, tangent at x)



Speed up at x:
(more elliptical, outside orbit, tangent at x)



Speed up at x:
(less elliptical, outside orbit, tangent at x)