# Unit 6 - Motion in a Circle  Name _____

**Vocabulary:**

| | | |
|---|---|---|
| Albert Einstein | | |
| Centripetal Force | Galileo Galilei | Centrifugal Force |
| Centripetal acceleration | Isaac Newton | Henry Cavendish |

**Questions:**

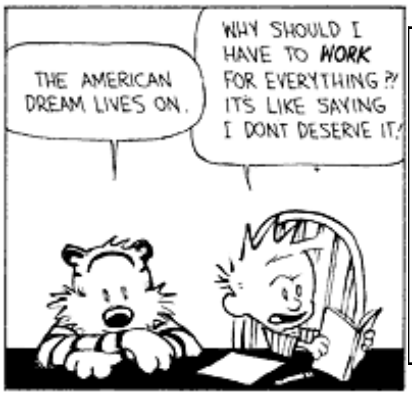
1. The moon and the earth are attracted to each other by a gravitational force. Does the larger earth attract the smaller moon with a greater, smaller or equal-sized force than the moon exerts on the earth? explain.
2. Why do we say an object moving in a circle at a constant speed is accelerating?
3. Why is an object orbiting a planet in a continual state of falling?
4. The earth's gravity provides the _____ for the moon, to keep it in orbit.
5. What happens to the orbital period of a satellite when it goes into a higher orbit? What happens to it's speed?

**Problems A: Centripetal Force & Acceleration - Orbital Velocity.**

1. A 750 kg race car takes 12.5 secs to round a circular racetrack of 55 m radius. What is the angular acceleration of the car? What frictional force must be between the tires and the track so that the car doesn't skid off?
2. A .20 kg yo-yo is being twirled around Ricky's head. The string is .85 m long, and she twirls it at a rate of 2.5 revolutions per second. What is the tension in the string? If the string breaks, what will the path of the projectile be?
3. Al is placing a satellite in orbit around the earth. He wants it 1500 km above the earth's surface, where the acceleration due to gravity is about 6.39 $m/s^2$. If the earth's radius is 6400 km, calculate the velocity needed for a circular orbit.
4. Mr. Paulson aims his old-fashioned slingshot at his disobedient student and fires away with a .159 kg stone. The sling is 1.24 m long and he whipped it around his head three times in one second before launching his projectile. A. How fast does the stone leave the sling? B. What is the tension in the sling right before he launches the rock?
5. A 1250 kg car is traveling at 27.8 m/s, and it enters a curve (radius 450 m) on the road. At what angle must the road be tilted to insure that you don't have to steer into the curve?
6. Your 56.3 kg mass is on a spinning ride at the park. The μ between you and the ride is .489 and you are sitting 1.57 m from the center. How fast does your friend have to spin the ride before you slide off?
7. You are 1.870 m away from the center of a spinning ride at the carnival. Your 68.90 kg mass is flying at 12.76 m/s. How hard are you squashing the guy sitting next to you?

Answers!
1) 14 $m/s^2$;
$1.0 \times 10^4$ N
2) 42 N
3) 7100 m/s
4) 23.4 m/s
70.0 N
5) 10°
6) 2.74 m/s
7) 5999 N





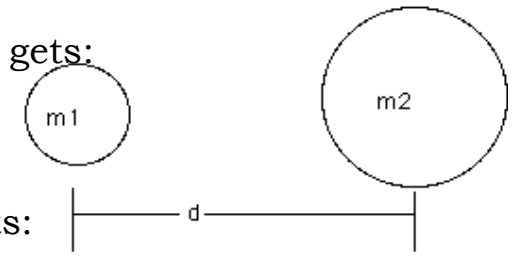
**Problems B - Universal Gravitation**

**Thought Problems**:
If $m_1$ gets 2x bigger, then the force between them gets:

If the d between them gets 2x bigger then the force gets:

If $m_2$ gets 3x smaller, the force between them gets:

If the d between them gets 3x smaller, the force gets:




**Math Problems:** Work out using Newton's rule of Universal Gravitation.

5. Andrea is attracted (gravitationally) to José. Her mass is 51.3 kg and his is 81.6 kg. If they are sitting 1.75 m apart, how large is their gravitational force?
6. The earth's radius is 6.378 Mm. If you have a mass of 65 Kg, your **weight** is 638 N due to the gravitational force between you and the earth. Based on this, calculate the earth's mass.
7. Two planets exert a force of 495 x $10^{-6}$ N on each other. Planet #1 has a mass of 1250 Mg, while planet #2 has a 45.9 Gg mass. How far apart are the planets?

**Pbs C - Acceleration Due to Gravity**
1. You are on planet X. This small planet's mass is 159 Tg, and it's radius is only 198 m. What is g on this planet?
2. The acceleration due to gravity on Saturn's "surface" is not much different than earth's even though its mass is 100x larger - why?
3. Frank is trying to establish orbit over a planet. His ship's sensors indicate that the planet's acceleration due to gravity is 3.21 x $10^{-6}$ m/$s^2$. How high above the planet's surface is he orbiting if the planet's radius is 159 Gm and its mass is 4.23 x $10^{28}$ kg?
4. Venus has a mass of 4.86 x $10^{24}$ kg, and a radius of 6.052 Mm. What is g at the planet's surface? What would your weight be here?
5. Phonch is trying to colonize a planet. If the planet's radius is 159 Gm and its mass is 4.23 x $10^{32}$ kg, what is “g” here?

T
G
M
k

B (5) ( 9.12 x $10^{-8}$N)
(6) (5.98 x $10^{24}$ kg)
(7) (2780 m apart)

C1) (2.71 x $10^{-4}$ $m/s^2$)
#2 uses words to answer
3) ( 7.79 x $10^{11}$m)
4) (8.85 $m/s^2$; your weight times .902)
5) (1.12 $m/s^2$)