KEY

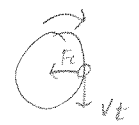
Circular Motion and Universal Gravitation Review Sheet

Equations: $a_c = v_t^2/r$ $F_c = mv_t^2/r$ $F_g = (Gm_1m_2) / r^2$ $v_t^2 = Gm/r$

Constants: $G = 6.67 \times 10^{-11}$ Mass of Earth = 5.98×10^{24} kg Radius of Earth = 6.38×10^6 m

1. A ball is attached to a string and swung at constant speed overhead.
   a. Explain this scenario using the following terms: inertia, centripetal acceleration, tension and centripetal force.
   b. Draw a free body diagram showing all forces,acting on this system.
   c. Indicate the direction of the net force on the ball inward

2. Explain inertia's role in circular motion.
   Keeps the object in motion at a constant speed
3. Diagram and explain a situation in which the force maintaining circular motion is:
   a. Fn – Clothes in a top loading washer
   b. Ff – Car on road
   c. Fg – Space shuttle in orbit
4. The earth and the international space station (ISS) are attracted to each other by gravitational forces.
   a. How does the gravitational force the earth places on the International Space Station compare to the gravitational force the international space station puts on the earth? The gravitational forces are equal
   b. What impact would changing the mass of the ISS have on the Fg between the Earth and the ISS? The Fg would increase by the same factor as the mass increased.
5. Draw a picture of two planets orbiting the sun at different distances. Assume they both orbit the sun in the same amount of time (1 year).
   a. Which planet has the highest tangential speed? Why? – Planet 2 (larger distance)
   b. Which planet would experience the greatest Fg from the sun? – Planet 1 (closer)
   c. The sun exerts a force of gravity on each planet. Explain why it makes sense to say that each planet also exerts an equal force of gravity on the sun. Newton's 3rd Law



6. Draw a picture of an object spinning clockwise. Include arrows showing the F_c and v_t.

7. Would you weigh slightly more in the basement of the Sears (Willis) Tower or on the top floor? Why?
   You weigh more in the basement because your radius (to earth's center) is smaller
8. As a discus thrower spins in a circle to prepare for his throw, he has a centripetal acceleration of 6.7 m/s^2. If the length of the thrower's arm is 0.75 m, what is the tangential speed of the discus?
   $a = \frac{v^2}{r}$ $6.7 = \frac{v^2}{0.75}$ $v = 2.24 m/s$
9. A 115 kg golf cart traveling at 5.0 m/s takes a turn of radius 14 m.
   a. What is the centripetal acceleration of the cart? $a = \frac{v^2}{r} = \frac{5^2}{14} = 1.8 m/s^2$
   b. What is the centripetal force on the cart? $F_c = \frac{mv^2}{r} = \frac{115 \cdot 5^2}{14} = 205 N$
10. What is the maximum v_t a 3500 kg school bus can take a turn with radius 250 m if F_c is 450 N?
    $F_c = \frac{mv^2}{r}$ $450 = \frac{3500 \cdot v^2}{250}$ $v = 5.7 m/s$
11. When a skydiver jumps out of plane, Earth exerts a force of gravity on the skydiver, causing the skydiver to accelerate at a rate of "g". According to Newton's third law, the person must then exert the same force back on the Earth. Is it accurate to say that the earth accelerates towards the person at a rate of "g"? Why or why not? No, the earth has the same force on it, but since the earth has more mass, the acceleration would be less (2nd Law F=ma) (3rd Law)
12. A 20 kg child is standing 2 m away from a 55 kg parent.
    a. What would happen to the Fg between them if the distance decreases to 1 m? Fg would be 4 times the original
    b. If the child ate their weight in candy, increasing the mass to 40 kg, what would happen to Fg?
    Fg would be 2 times the original