Name Key Hour _____

Level 2: Circular Motion and Gravity

r=3.42 m
T=4.1 sec.
m=95 kg

1. The Carousel at Valleyfair has a radius of 3.42 m and takes 4.1 sec to circle once. What is the **centripetal force** you would feel if your mass was 95 kg and **how many g's** will you feel? (Find v first!) (763 N, 0.82 g's)

① $V = \frac{2\pi r}{T}$ (5.24 m/s)

② $F_c = \frac{mv^2}{r}$ 763 N

③ $\left|\frac{\text{total force}}{m \cdot g}\right|$

2. Two similar trucks each having a mass of 200,000 kg are 40 m apart.
   a. What is the gravitational force of attraction between them? *(ans. 0.00167 N)*

r = 40 m
$m_1 = m_2 = 200{,}000$ kg

$F = \frac{G m_1 m_2}{r^2}$

   b. What is the weight (how much gravity pulls on mass) of 1 truck? (1.96 x 10^6 N)

$w = m \cdot g$

   c. Using the 2 numbers you just calculated, WHY do you think the two trucks do not become attracted to each other like a magnet?

$\frac{\text{weight}}{F_g} = \frac{1.96 \times 10^6 \text{ N}}{.00167 \text{ N}}$ = force downward 1.17×10^9 x larger!

Not enough mass!

3. Calculate the **centripetal force** exerted by the sun on the earth. (The radius of the earth's orbit is 1.5 x 10^{11} m. You will also need the mass of the earth and its period (T) in seconds.) *(ans. 3.56 x 10^{22} N)*

$r = 1.5 \times 10^{11}$ m
$m = 5.98 \times 10^{24}$ kg
$T = 365 d \times 24 hr \times 3600 sec = 3.1536 \times 10^7$ sec

① $V = \frac{2\pi r}{T}$ (29,880 m/s)

$F_c = \frac{mv^2}{r}$

4.
   a. Find the **gravitational force** between the earth and the sun. (The radius of the earth's orbit is 1.5 x 10^{11} m.) *(ans. 3.5 x 10^{22} N)*

$F_g = \frac{G m_1 m_2}{r^2}$

$r = 1.5 \times 10^{11}$ m
$M_E = 5.98 \times 10^{24}$ kg
$M_S = 2 \times 10^{30}$ kg

   b. Compare your answers to number **3** and number **4a.** Explain what you notice.

same... $F_g = F_c$ to stay in orbit!

Name _____ Hour _____

5.

a. What is the acceleration due to gravity at a point 400,000 m above the earth's surface? *(8.7 m/s²)* **Don't forget the radius of the earth!**

$r = 6.37\times10^6\ m + 400{,}000\ m = 6.77\times10^6\ m$

$m = 5.98\times10^{24}\ kg$

$$g = \frac{Gm}{r^2}$$

b. What velocity must a satellite maintain to stay in orbit at the distance from part a? *(≈7,676 m/s)*

$F_g = F_c$

$mg = \frac{mv^2}{r}$ so $g = \frac{v^2}{r}$

6. How far away from the center of the Earth (r) would you (150 kg) need to go in order for the acceleration due to gravity to be equal to 7.65 m/sec²? (≈7,220,758 m)

$g = \frac{Gm}{r^2}$

$g = 7.65\ m/s^2$

$m = 5.98\times10^{24}\ kg$

$7.65 = \frac{G(5.98\times10^{24})}{r^2}$

7. What would your weight (in N) be if acceleration due to gravity was 7.65 m/sec²? = g (1147.5 N)

$W = m\cdot g$

8. The space shuttle files at roughly 200 **miles** above the earth's surface. Calculate your weight in Newtons at that height if your mass is 110 kg. **Don't forget the radius of the earth and to find g first!** *(ans. 979 N)* (Find g at that location, then w=mg)

$r = 200\ mile \times 1609 = 3.22\times10^5\ m + 6.37\times10^6\ m = 6.69\times10^6\ m$

① Find g

$g = \frac{Gm}{r^2}$

$m = 5.98\times10^{24}$

② $W = m\cdot g$ $(m = 110\ kg)$

9. Use an equation to solve for the acceleration due to gravity at the earth's surface. Does this number look right?

$g = \frac{Gm}{r^2}$

Should be $\approx 9.8\ m/s^2$!