UCONN Physics
Practice Quiz A,B,C,D / 40
Unit 5 : Circular Motion

Name: KEY
Date: ____________ Period _____

Formula's: $F_{cp} = \frac{mv^2}{r}$ $F = ma$ $F_{fr} = \mu F_N$ $F = G\frac{m_1 m_2}{r^2}$ Density = $\frac{\text{mass}}{\text{volume}}$

$\frac{r^3}{T^2} = \frac{r^3}{T^2}$ T = 2 ¶ $\sqrt{\frac{L}{g}}$ Spherical Volume = $4/3\,\pi\, r^3$ $G = 6.67 \times 10^{-11}\ \frac{N\,m^2}{kg^2}$

Earth Radius = 6380 km

Earth Mass = 5.98×10^{24} kg

Problems: Show all your work and label all your units!!

1. A ball on the end of a string is revolving at a uniform rate in a vertical circle or radius of 60 cm. If its speed is 25 m/s and is mass is 0.75 kg, calculate the tension in the string when the ball is:

a. At the top of its path. 3 pts. [773.9 N]

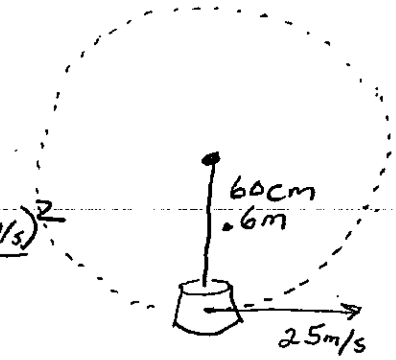
$F_T = mg - ma$ $F_T = .75(9.8) - \frac{.75(25)^2}{.6}$

$F_T = mg - \frac{mv^2}{r}$ $\boxed{F_T = -773.9N}$

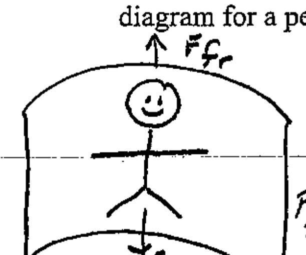
b. At the bottom of its path. 3 pts. [788.6 N]

$F_T = \overset{wt}{mg} + \overset{F_c}{ma}$ $F_T = .75kg(9.8\,m/s^2) + \frac{.75kg(25m/s)^2}{.6m}$

$F_T = mg + \frac{mv^2}{r}$ $\boxed{F_T = 788.6N}$



2. In a "Rotor-ride" at a carnival, people are rotated in a cylindrically walled "room." (See Fig. below) The room radius is 5.3 m, and the rotation frequency is 0.333 revolutions per second when the floor drops out. What is the minimum coefficient of static friction so that the people will not slip down? [*Hint*: First draw the free-body diagram for a person.] [0.42] 10 pts.



Side View

$F_{fr} = F_w$

$F_{fr} = \mu F_N$

$mg = \mu \frac{mv^2}{r}$

$g = \frac{\mu v^2}{r}$

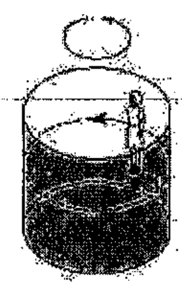
$\mu = \frac{g \cdot r}{v^2}$

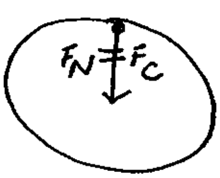
$\omega = \frac{.333\ rev}{sec}$

$T = \frac{1}{.333}\frac{sec}{rev} = 3\ sec/rev$

$V = \frac{d}{t} = \frac{2\pi r}{T} = \frac{6.28 \cdot 5.3m}{3sec}$

$V = 11.1\ m/s$



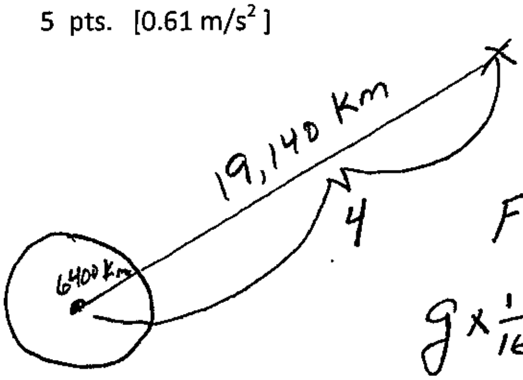


Top View

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

$\mu = \frac{9.8m/s^2 \cdot 5.3m}{(11.1\ m/s)^2} = \boxed{.42}$

3. Calculate the effective value of "g", the acceleration of gravity at 19140 km above the earth's surface. 5 pts. [0.61 m/s^2]

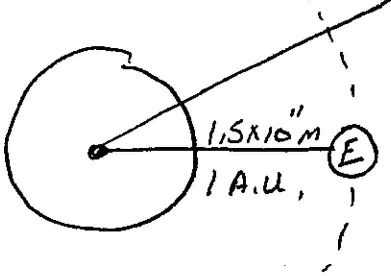


$\frac{19{,}140km}{6400\ km} = 3 + 1 = 4$

$F \propto \frac{1}{r^2} = \frac{1}{16}$

$g \times \frac{1}{16} = 9.8 \times \frac{1}{16} = \boxed{.6125\,m/s^2}$

4. A planet in our solar system is 5 times as far from the sun as the earth (1.5×10^{11} m). How many earth years does it take for that planet to make one revolution around the sun? 5 pts. [11.18 yrs]



$$\frac{R_E^3}{T_E^2} = \frac{R_P^3}{T_P^2} \qquad \frac{(1\ \text{A.U.})^3}{(1\ \text{yr})^2} = \frac{(5\ \text{A.U.})^3}{T_P^2}$$

$$T_P^2 = \frac{125\ \text{A.U.}^3\ \text{yr}^2}{1\ \text{A.U.}^3} \qquad \boxed{T = 11.18 \text{ years}}$$

5. A pendulum clock on the moon has a length of 2 meters, and its period is carefully measured to be 7.00 seconds. What is the acceleration of gravity on the moon? 4 pts. [g = 1.61 meters/sec2]

$$T = 2\pi\sqrt{\frac{L}{g}} \qquad \frac{T}{2\pi} = \sqrt{\frac{L}{g}} \qquad \frac{7\text{sec}}{6.28} = \sqrt{\frac{L}{g}} \qquad 1.115 = \sqrt{\frac{L}{g}}$$

$$(1.115\text{ sec})^2 = \frac{L}{g} \qquad g = \frac{L}{(1.115\text{ sec})^2} = \frac{2\text{ m}}{1.24\text{ sec}^2} = \boxed{1.61\text{ m/s}^2}$$

6. On Earth, prospectors are looking for a deposit of iron ore beneath the ground. They decide to use the acceleration of gravity to find where the iron is located because the additional mass should change the acceleration of gravity. They use a carefully-made pendulum with a length of 2.00000 meters and measure the period of the swing as they walk around the area where they think the deposit is located. To the nearest millionth of a second, how much will the period change if the acceleration of gravity between two spots changes from 9.80000 meters/sec2 to 9.80010 meters/sec2 ? (use π = 3.14159). 10 pts. [difference in period will be 0.000014 seconds or 14 microseconds]

$$T = 2\pi\sqrt{\frac{L}{g}}$$

SPOT #1

$$T_1 = 2\pi\sqrt{\frac{2.00000}{9.80000}}$$

$$T_1 = 2.838451393 \text{ sec}$$

SPOT #2

$$T_2 = 2\pi\sqrt{\frac{2.00000}{9.80010}}$$

$$T_2 = 2.83843 6911$$

$$\boxed{\Delta T = T_1 - T_2 = 0.000014482 \text{ sec}}$$

BONUS: Suppose the mass of the earth was increased 1.8 times, but it kept the same density and spherical shape. How would the weight of objects at the earth's surface change? 5 pts.

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Bonus:

Earth Original

$$F_E = G\frac{m_1 m_2}{r_1^2}$$

NEW EARTH

$$F_E = G\frac{m_1(m_2 \times 1.8)}{r_2^2}$$

$$m_1 g = G\frac{m_1(m_2 \times 1.8)}{r_2^2}$$

$$g = G\frac{m_2 \times 1.8}{r_2^2}$$

IF MASS goes up AND DENSITY remains the same the volume must go up as well ∴ Increasing the radius

$$\text{Density} = \frac{\text{mass}}{\text{Volume}} = \frac{\text{mass}}{4/3\,\pi r^3}$$

[IN THE FORMULA mass is directly related to radius cubed] → $\text{Density} \times \frac{4}{3}\pi r^3 = \text{mass}$

(#1) solve the new radius with new mass

$$\text{Density} = \frac{\text{mass}}{4/3\,\pi r^3} \qquad r_2^3 = \frac{\text{mass}}{4/3\,\pi \cdot \text{Density}}$$

$$r_2^3 = \frac{5.98\times10^{24}\,kg\,(1.8m)}{4/3\,(3.14)\,5500\,kg/m^3} \qquad r_2^3 = 4.675\times10^{20}\,m^3$$

$$r_2 = 7.76117\times10^{6}\,m \quad \text{or} \quad 7761\ Km$$

(#2) Put "r_2" back into the universal gravitational formula and solve for "g".

$$g = 6.67\times10^{-11}\frac{N\cdot m^2}{kg^2}\times\left(\frac{5.98\times10^{24}\times1.8}{(7.76117\times10^{6}m)^2}\right)$$

$$\boxed{g = 11.92\ m/s^2}$$