key Level I Physics Pd 2

Circular Motion

At Circular motion (11)

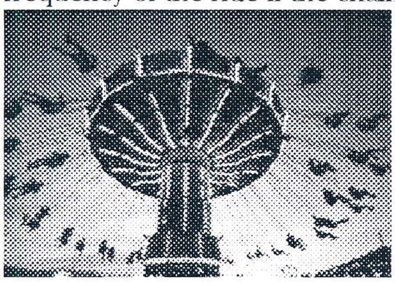
Solve the following problems showing ALL work and CIRCLING your answers. Each is worth 5 points.

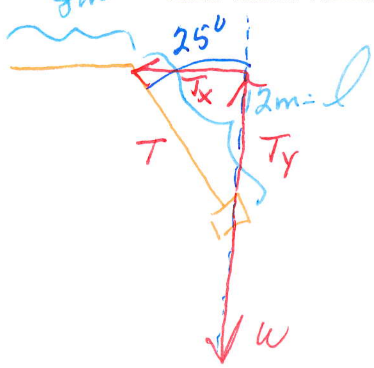
1) Determine the period of the second hand on analog clock

$\frac{60 \text{ seconds}}{1 \text{ Revs}} = 60 \text{ s}$

1 M_{moon} 0.0735×10^{24}kg $M_{earth} = 5.98 \times 10^{24}$kg $R_{earth} = 6.38 \times 10^{6}$m
$R_{moon} = 1.74 \times 10^{6}$m $G = 6.67 \times 10^{-11} Nm^2/kg^2$

2) The swing ride has a chair hanging from a 12 m long chain. This chain is attached to an arm that hangs out horizontally from the center of the ride. This arm is 8 m long. The ride then rotates, resulting in the chairs swinging out. Determine the frequency of the ride if the chains form a 25 degree angle from vertical.





$\Sigma F_y = T_y - w = ma$

$T_y - w = 0$

$T_y = w$

$T \cos\theta = w$

Cos $T \cos\theta = mg$

$T = \dfrac{mg}{\cos\theta}$

$\Sigma F_x = T_x = ma_c$

$\cancel{T_{co}}$

$T \sin\theta = ma_c$

$T \sin\theta = \dfrac{mv^2}{r}$

$\dfrac{mg \sin\theta}{\cos\theta} = \dfrac{mv^2}{r}$

$g \tan\theta = \dfrac{v^2}{r}$

$r = [\text{Arm} + l(\sin\theta)]$ $\quad g \tan\theta = \dfrac{4\pi^2 r^2 f^2}{r}$

$g \tan\theta = 4\pi^2 r f^2$

$g \tan\theta = 4\pi^2 f^2 (\text{Arm} + l \sin\theta)$

$\sqrt{\dfrac{g \tan\theta}{4\pi^2(\text{Arm} + l \sin\theta)}} = f$

$\sqrt{\dfrac{(9.8\,m/s^2)\tan(25°)}{4\pi^2(8m + 12m \sin 25)}} = f$

$f = .094$ Revs/s

10 Sec per Rev

Resonable

M_{moon} 0.0735x10^{24}kg $\quad$ M_{earth}= 5.98x10^{24}kg $\quad$ R_{earth}= 6.38x10^{6}m
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3) Determine the period for a satellite that orbits the moon at a speed of 3,400 m/s

$F_c = F_G$

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

$v^2 = \frac{Gm_m}{r}$

Find r

$\frac{4\pi^2 r^2}{T^2} = \frac{Gm_m}{r}$

$\frac{4\pi^2 r^3}{T^2} = \frac{Gm_m}{\cancel{r}}$

$r = \sqrt[3]{\frac{Gm_m T^2}{4\pi^2}}$

$v^2 = \frac{Gm_m}{\sqrt[3]{\frac{Gm_m T^2}{4\pi^2}}}$

Cube Everything

$v6 = \frac{G^3 m_m^3}{\frac{Gm_m T^2}{4\pi^2}}$

$v6 = \frac{G^3 m^3 4\pi^2}{Gm T^2}$

$v^6 = \frac{G^2 m^2 4\pi^2}{T^2}$

$T^2 = \frac{G^2 m^2 4\pi^2}{v^6}$

$T = \frac{Gm\, 2\pi}{v^3} = \frac{\left(6.67\times10^{-11}\frac{Nm^2}{kg^2}\right)\left(.0735\times10^{24}\,kg\right)(2\pi)}{\left(3400\,m/s\right)^3}$

$\boxed{T = 783 \text{ seconds}}$ 13 min

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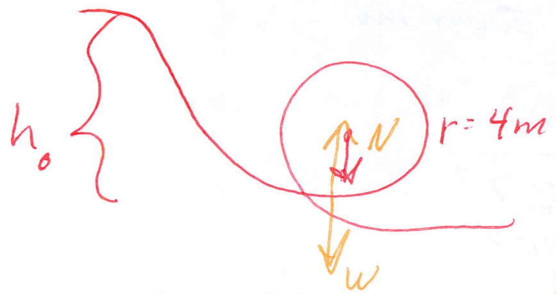
$m = 65Kg$

4) How heavy will a person feel at the bottom of a loop in roller coaster with a circular loop if the radius of the loop is 4 meters? Assume the hill is just high enough for the roller coaster to "Make it" through the circular loop with the riders feeling weightless at the top of the loop, and the roller coaster is frictionless.



$PE = KE + PE$

$mgh_0 = \frac{1}{2}mv^2 + mgh$

$gh_0 = \frac{1}{2}v^2 + g2r$

$gh_0 = \frac{1}{2}gr + 2gr$

$h_0 = 2.5r$

$PE = KE$

$mgh = \frac{1}{2}mv^2$

$2gh_0 = v^2$

$\Sigma F_y = N - W = ma$

$N = ma + W$

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

$N = m\left(\frac{v^2}{r} + g\right)$

$N = m\left(\frac{2gh_0}{r} + g\right)$

$N = m\left(\frac{2g(2.5r)}{r} + g\right)$

$N = mg\left[(2)(2.5) + 1\right]$

$N = mg(6)$

$N = (65Kg)(9.8\frac{m}{s^2})6$

$N = 3822 N$

6 × Normal Weight

5) For the roller coaster given in #4, determine the minimum speed for the roller coaster at the top of the loop. (*Note* No information is needed from your solution in #4)

$$a_c = \frac{v^2}{r}$$

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

$$gr = v^2$$

$$\sqrt{gr} = v$$

$$\sqrt{(9.8\,m/s^2)(4\,m)} = 6.2\,m/s$$

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6) Determine the gravitational attraction between two spheres that have a mass of 150 kg and a radius of 0.65 m. The two spheres are touching.

$$F = \frac{Gmm}{r^2}$$

$$F = \frac{(6.67\times10^{-11})(150\,kg)^2}{[(2)(.65\,m)]^2}$$

$$F = 8.88\times10^{-7}\,N$$

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7) Determine the speed of a satellite that will orbit the Earth 10,000 miles above the surface.

$$v^2 = \frac{Gm_e}{r}$$

$$v = \sqrt{\frac{(6.67\times10^{-11})(5.98\times10^{24})}{(6.38\times10^6 m + [(10{,}000 mi)(1600 m/mi)])}}$$

$$\boxed{v = 4{,}220 \text{ m/s}}$$

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8) Determine the altitude of a Geosynchronous satellite from the surface of the Earth

22,000 mi = 3.57×10^7 m

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

$$\frac{4\pi^2 r^2}{T^2} = \frac{Gm}{r}$$

$$r = \sqrt[3]{\frac{GmT^2}{4\pi^2}}$$

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