Vertical Circular Motion
Concept Check Sheet

Name:

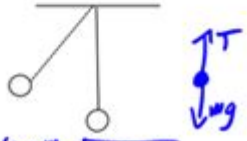
1. A child is on a swing. What direction is the centripetal force on the child when they are at the bottom of the swing? What direction is the child's velocity? What direction is the child's acceleration? Draw vectors.


2. A bucket full of water is swung in a vertical circle by a rope. Where in its motion is the tension in the rope a maximum? bottom
Where in its motion is the tension in the rope a minimum? top

3. A pendulum bob with a mass of 1 kg is connected to a string 1m and allowed to swing so that its speed at the bottom of is swinging motion is 10 m/s.
   a. What is the centripetal force on the pendulum bob?

$F_{NET_c} = \frac{mv^2}{r} = \frac{(1\,kg)(10\frac{m}{s})^2}{1m} = 100\,N$

   b. What is the tension in the string at the bottom of its swing? (use a force diagram to help)




$F_{NET_c} = T - mg = 100 \Rightarrow T = mg + 100 = 100\,N + (1\,kg)(9.81\frac{m}{s^2}) = 109.81\,N$

4. What is the period of a pendulum that has a length of 0.5 meters?

$T = 2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{0.5m}{9.81\frac{m}{s^2}}} = 1.42\,s$

5. The period of the pendulum in a grandfather clock is 2 second (1 second over ("tick") and 1 second back ("tock")). How long is the pendulum in a grandfather clock?

$T = 2\pi\sqrt{\frac{l}{g}} \rightarrow \frac{T^2}{4\pi^2} = \frac{l}{g} \rightarrow l = \frac{gT^2}{4\pi^2} = \frac{(9.81\frac{m}{s^2})(2s)^2}{4\pi^2} = 1m$

6. On planet X a pendulum with a length of 0.5 m has a period of 1.0 second. What is the acceleration due to gravity (g) on planet X?

$T = 2\pi\sqrt{\frac{l}{g}} \Rightarrow g = \frac{4\pi^2 l}{T^2} = \frac{4(.5m)(\pi^2)}{(1s)^2} = 19.7\frac{m}{s^2}$

7. A plane comes out of a power dive, turning upward in a curve of radius 1500 m. The plane's speed is 300 m/s.
   a. What is the Centripetal force on the pilot if he has a mass of 80 kg?

$F_{NET_c} = \frac{mv^2}{r} = \frac{(80\,kg)(300\frac{m}{s})^2}{1500\,m} = 4800\,N$

   b. What force must the seat of the plane apply to his body for this motion to happen? (use a force diagram)


$F_{NET_c} = F_N - mg = 4800\,N \Rightarrow F_N = 4800\,N + (80\,kg)(9.81\frac{m}{s^2}) \Rightarrow$

$F_N = 5580\,N$

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