Vertical Circle Problems

① 

a) at top = $T_E = mgh + \frac{1}{2}mv^2$ ($\frac{1}{2}mv^2 = 0$)

$= 50(9.8)(5) = 2450\ J$

at bottom $2450 = mgh + \frac{1}{2}mv^2$ ($mgh = 0$)

$v = 9.9\ m/s$

b) $\frac{mv^2}{r} = \frac{50(9.9)^2}{5} = 980\ N$

c) $mg + \frac{mv^2}{r} = 490 + 980 = 1470\ N$

d) $1470 = 50a$ $\quad a_{net} = 29.4\ m/s^2 \div 9.8 = \boxed{3\ g's}$

OR

$\frac{v^2}{r} = \frac{98}{5} = 19.6\ m/s^2 = 2\ g's$

$+1$ for being alive $= \boxed{3}$

② 1 rev / 6 sec, $r = 5$ $\quad v = \frac{2\pi(5)}{6} = 5.24\ m/s$

at a) $F_{net} = mg + \frac{mv^2}{r} = 45(9.8) + \frac{45(5.24)^2}{5}$

$441 + 205.6 = 646.6\ N$ (688 N; 247)

at b) Net down $F = mg = 441\ N$

at c) Net down $F = mg - \frac{mv^2}{r} = 441 - 205.6 = 235.4\ N$ (247; 194)

at d) F = same as b $= 441\ N$

g's

at a) $646.6 = 45a$ (688) $\quad a = 14.4$ (15.3) $\div 9.8 = 1.47\ g's$ (1.56 g's)

at b & d) 1 g

at c) $235.4 = 45a$ (194) $\quad a = 5.23$ (4.31) $\div 9.8 = .534$ (.44 g's)

3. Max speed

At top, down F > up F

$mg > \frac{mv^2}{r}$

$9.8 = \frac{v^2}{5}$

$v = 7 \text{ m/s}$ Max

4. a) At bottom $TE = mgh^{\nearrow 0} + \frac{1}{2}(10)(15)^2 = 1125 \text{ J}$

At top $1125 = mgh + \frac{1}{2}mv^2$

$1125 = 10(9.8)(6) + \frac{1}{2}(10)v^2$

$v = 10.36 \text{ m/s}$

b) 

$F_{net} = \frac{mv^2}{r} - mg \quad \frac{10(10.36)^2}{3} - 10(9.8)$

$358 - 98 = 260 \text{ N}$

c) At top $\frac{mv^2}{r} = mg \quad \frac{v^2}{3} = 9.8$

$V_{top} = 5.42 \text{ m/s}$

Therefore, TE at top

$= \frac{1}{2}(10)(5.42)^2 + 10(9.8)(6)$

$= 735 \text{ J}$

At bottom

$735 \text{ J} = \frac{1}{2}mv^2 + mgh^{\nearrow 0}$

$735 = \frac{1}{2}(10)v^2$

12.1 m/s

5. $\frac{mv^2}{r} = mg$

$\frac{.6v^2}{2.5} = 9.8$

$v = 6.39 \text{ m/s}$

$v = \frac{2\pi r}{T} \quad 6.39 = \frac{2\pi(2.5)}{T}$

$T = 2.46 \text{ sec}$