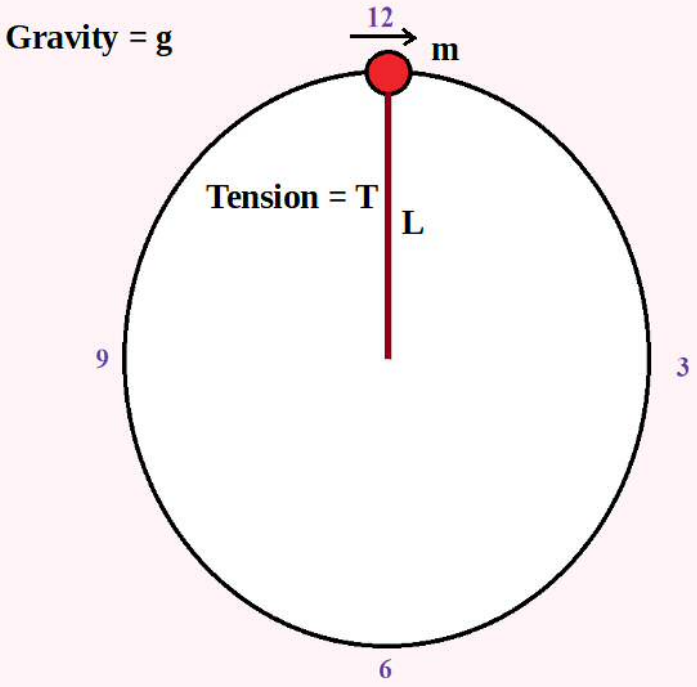
# Rotation in a Vertical Plane




**A ball of mass m is rotating clockwise in a vertical circle of radius L. The tension in the string when the ball is passing the 12 o'clock position is T. What should be the tension in the string at the 3 o'clock position? For gravity use g. Write your answer in terms of m, L, g, and T.**

## SOLUTION:

**First we do a balance of forces at 12 o'clock:**
**Centrifugal force = Tension + Weight**
$m \cdot v^2/L = T + m \cdot g$
$m \cdot v^2 = L(T + m \cdot g)$
**KE at 12 o'clock is:** $KE = (1/2) \cdot m \cdot v^2$
$KE = (1/2) \cdot L(T + m \cdot g)$
**A balance of energy between 12 o'clock and 3 o'clock gives:**
$KE_{12} + PE_{12} = KE_3$
$(1/2) \cdot L(T + m \cdot g) + m \cdot g \cdot L = (1/2) \cdot m \cdot v_3^2$

**Thus:** $L(T + m \cdot g) + 2 \cdot m \cdot g \cdot L = m \cdot v_3^2$

**At 3 o'clock the tension $T_3$ in the string is equal to the centrifugal force:**
$T_3 = m \cdot v_3^2 / L$
$T_3 = [L(T + m \cdot g) + 2 \cdot m \cdot g \cdot L] / L =$

$T_3 = T + 3 \cdot m \cdot g$