Physics 271, Section . . .
Quiz #5

Thursday, Oct 9, 2014
Kinetic Energy & Work

Name: [5 pts]

1) We have a rope which breaks if the tension force is equal to T_c. We connect this rope to a mass m and rotate it on a vertical plane on a circular path with radius r, as shown in fig. 1.

a) Name the forces acting on the mass m. **[2 pts]**
b) How much work each force does while the mass travels from A to B? **[2 pts]**
c) If the velocity at A is v_A, find the velocity at point B, in terms of v_A and the radius of the circle, r. **[2 pts]**
d) Write the equation of motion at point A and find the condition on v_A so that the rope does not break. **[2 pts]**
e) Write the equation of motion at point B and find the condition on v_B so that the rope is not loose. **[2 pts]**
f) Find the condition on T_c so that the rope does not break at A and does not become loose at B. **[1 pt]**

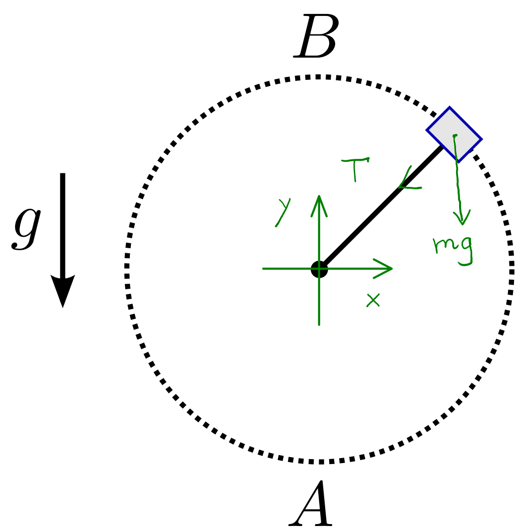


Figure 1: The mass m traveling a vertical circle.

a) tension force T and gravitational force mg.

b) T doesn't do any work as it's normal to the path from A to B.

$W_{g_{A\to B}} = -mg\,(y_B - y_A) = -2mgr.$

$W_{T_{A\to B}} = 0.$

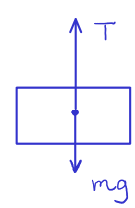
for some forces the path matters

c) $W_{A\to B} = W_{g_{A\to B}} = -2mgr = K_B - K_A = \frac{1}{2}mv_B^2 - \frac{1}{2}mv_A^2$

So, $v_B^2 = v_A^2 - 4gr$ (iii)

d) $T - mg = m\dfrac{v_A^2}{r}$,

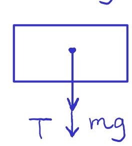
at point A:



Condition: $T < T_c \rightarrow mg + \dfrac{mv_A^2}{r} < T_c$

$\rightarrow \boxed{v_A^2 < \dfrac{T_c r}{m} - gr}$ (i)

at point B:



e) $T + mg = m\dfrac{v_B^2}{r}$,

$-v_B^2 < -gr$

Condition: $T > 0 \rightarrow \dfrac{mv_B^2}{r} - mg > 0 \rightarrow \boxed{v_B^2 > gr}$ (ii)

f) (i) − (ii) $\rightarrow v_A^2 - v_B^2 < \dfrac{T_c r}{m} - 2gr \xrightarrow{\text{(iii)}} 4gr < \dfrac{T_c r}{m} - 2gr$

$\rightarrow \boxed{T_c > 6mg}$