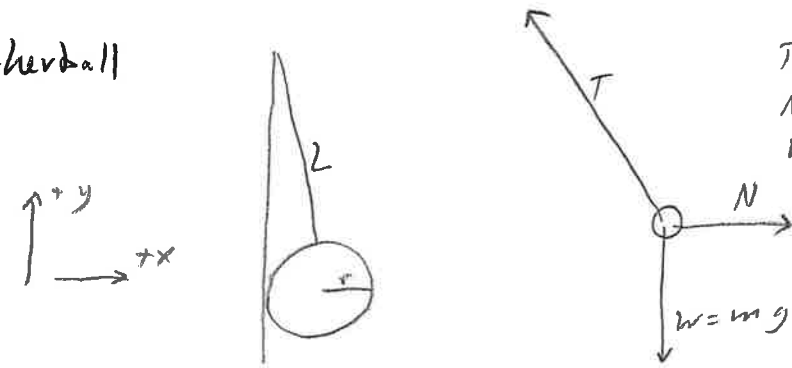
PHYS 1210 Discussion Worksheet 3

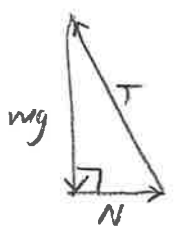
Barron's preliminary solutions

1. Tetherball



T = tension
N = normal
w = weight

b. Some preliminary geometry



Triangle is similar to

$$h^2 = (L+r)^2 - r^2$$
$$= L^2 + 2Lr + r^2 - r^2$$
$$= L^2 + 2Lr$$

We want to find N and T in terms of mg.

$$\frac{N}{mg} = \frac{r}{h} \qquad \frac{T}{mg} = \frac{L+r}{h}$$

$$N = mg\, r/h \qquad T = mg\,(L+r)/h$$

$$N = mg\, r\Big/\sqrt{(L+r)^2 - r^2} \qquad T = mg\,\frac{L+r}{\sqrt{(L+r)^2 - r^2}}$$

c. $m = 1.20\ kg$, so $mg = 11.76\ N$

$r = 16.0\ cm = 0.160\ m$

$L = 1.15\ m$

i Apex angle of triangles θ. $\tan\theta = \frac{r}{h} = \frac{r}{\sqrt{(L+r)^2 - r^2}}$

$h^2 = (1.31\,m)^2 - (0.160\,m)^2 = 1.6905\ m^2$, so $h = 1.300\ m$

$$\tan\theta = \frac{0.160\,m}{1.300\,m} = 0.1230$$

$\theta = \arctan(0.1230) =$ **7.0 degrees** ii Normal force N

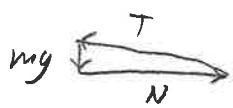
$$N = mgr/h = (11.76\,N)(0.1230) = \boxed{1.45\,N}$$

iii Tension in the cord T

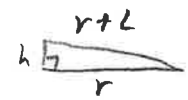
$$T = mg\,\frac{L+r}{h} = (11.76\,N)\,\frac{1.31}{1.300} = (11.76\,N)(1.0075) = \boxed{11.85\,N}$$

d What if $r \gg L$?

Then



because

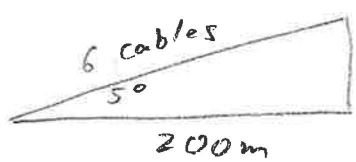


This means that normal force and tension become huge compared to the weight of the ball

Let's look at the formulas in the limit $L \to 0$

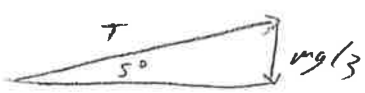
$$N = \frac{mg\,r}{\sqrt{r^2 - r^2}} = \infty \qquad T = mg\,\frac{r}{\sqrt{r^2 - r^2}} = \infty$$

2.



The vertical component of each bundle's tension must support 1/3 of the weight of the instrument cluster.

A free body diagram isn't very practical here, because it's hard to draw one in three dimensions. We can show



so $\sin(5°) = \frac{mg/3}{T}$

$$T = \frac{mg}{3\sin(5°)} = \frac{(820{,}000\,kg)(9.8\,N/kg)}{3 \cdot 0.0872} = 30{,}700{,}000\,N$$

This is shared with six cables, so in one cable the tension is 1/6 th this, or $5.12 \times 10^6\,N$

When the cables snapped, it was bad.