

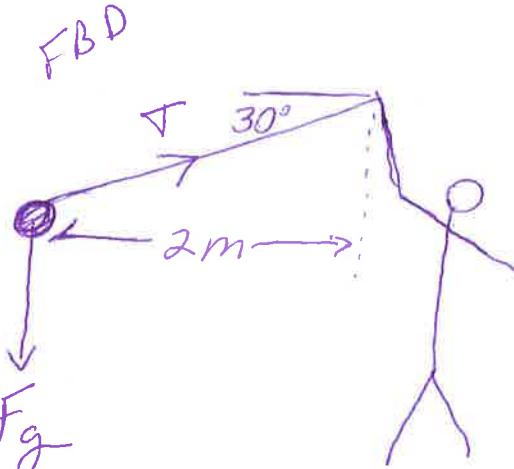
- 1) I spin a 500g rock over my head (David and Goliath style) on a string at constant speed such that it makes a circle around my hand of radius 2 m and makes an angle of 30 degrees below the horizon.

 - a) Find the Tension in the String.
 - b) Find the acceleration of the rock.
 - c) Find the speed of the rock.

Uniform circular motion

$$\vec{L} = 0, \vec{\omega}, \vec{v} \text{ constant!}$$

$$\vec{a}_c = \frac{v^2}{r} = \omega^2 r \text{ inward}$$



Forces, $a_c \Rightarrow$ dynamics!
poop! what do I know?

In this picture \vec{a} is \rightarrow , so
 $\sum \vec{F}$ is \rightarrow , so
 $T + F_g$ must be horizontal!

$$\sin 30^\circ = \frac{F_g}{T}$$

$$T = \frac{F_g}{\sin 30^\circ} = 2F_g = 10N$$

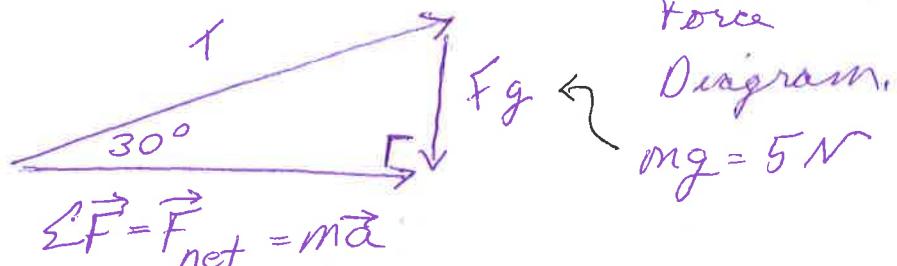
$$\sum \vec{F} = T \cos \theta = \underline{8.7N}$$

$$\sum \vec{F} = 8.7N = m a_c = \frac{1}{2} k g \cdot a_c$$

$$a_c = \frac{8.7N}{\frac{1}{2} k g} = \frac{8.7 \cancel{kg} \cancel{m/s^2}}{\frac{1}{2} \cancel{kg}} = 17.4 \frac{m}{s^2}$$

$$a_c = \frac{v^2}{r} \quad v^2 = r a_c, v = \sqrt{r a_c} = (2m \cdot 17.4 \frac{m}{s^2})^{\frac{1}{2}}$$

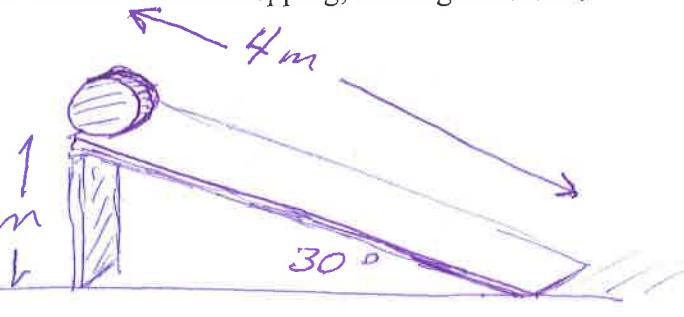
$$\approx (35 \frac{m^3}{s^2})^{\frac{1}{2}} \approx 6 \frac{m}{s}$$



Force
Diagram.
 $m g = 5N$

2) A disk of radius 30 cm and mass 5 kg rolls 4 m down a 30° incline without slipping, starting from rest. Please find in any order:

- The rotational velocity at the bottom of the incline
- The angular acceleration
- The angle that the disk has rolled through



There's friction but no heat because there's no slipping

so $\vec{W}_f = \vec{F}_f \cdot \vec{S}X = 0$, so we conserve KE, but
Energy Loss * slipped distance = s

friction creates some \vec{F} creating some KE_{rot}
from what would have been only KE_{linear}
had it been frictionless, or

$$PE_g \Rightarrow KE_{linear} + KE_{rot} \text{ or we know } E_0 = E_f, KE_0 = 0,$$

so!
 $mgh_0 = \frac{1}{2}mV_f^2 + \frac{1}{2}I\omega_f^2$ 2 unknowns!, but $V = \omega r$
 $\omega = \frac{V}{r}$

$$mgh_0 = \frac{1}{2}mV_f^2 + \frac{1}{2}\left(\frac{1}{2}mR^2\right)\frac{V_f^2}{R^2}$$

same r , which isn't always the case! so please be careful.

$$mgh_0 = \frac{1}{2}mV_f^2 + \underbrace{\frac{1}{4}mRV_f^2}_{\text{this term means it's not going as fast as if it were frictionlessly sliding}}$$

$$\frac{10}{s^2} 2m = \frac{3}{4} V_f^2$$

$$V_f^2 = 20 \frac{m^3}{s^2} \left(\frac{4}{3}\right) \approx 27 \frac{m^2}{s^2}$$

$$V_f \approx \sqrt{27 \frac{m^2}{s^2}} \approx 5.1 \frac{m}{s}$$

$$\omega_f = \frac{V}{r} \approx \frac{5.1 \frac{m}{s}}{0.3 \text{ m}} \approx 17 \frac{rad}{s}$$

$$\text{Wave} \approx \left(\frac{17}{s}\right) \left(\frac{1}{2}\right) = 8.5 \frac{rad}{s}$$

$$\theta = \frac{\ell}{r} = \frac{4 \text{ m}}{0.3 \text{ m}} = 13.3$$

$$\alpha = \frac{\Delta \omega}{\Delta t} = \frac{\omega_f - \omega_0}{\Delta t} = \frac{17 \frac{rad}{s}}{1.6 \text{ s}} \approx 10 \frac{rad}{s} \rightarrow \text{closer to } \frac{1}{s^2}$$

$$\text{Wave} = \frac{\Delta \theta}{\Delta t} \quad \Delta t = \frac{\Delta \theta}{\text{Wave}} = \frac{13.3}{8.5 \frac{rad}{s}} \approx 1.6 \text{ s}$$