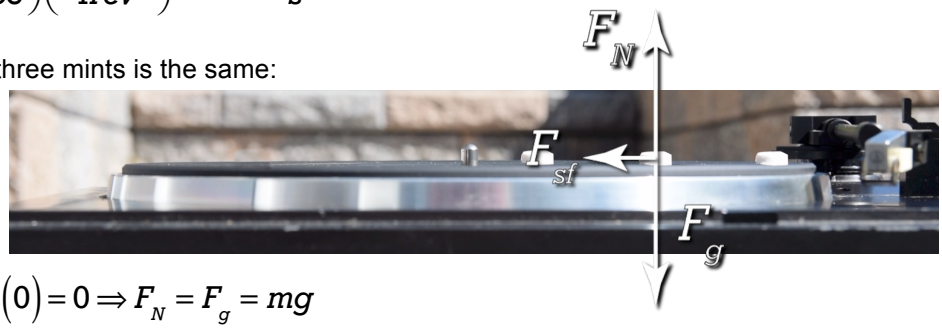
Flipping Physics Lecture Notes:

Mints on a Rotating Turntable
Determining the Static Coefficient of Friction

Example: A turntable is turning 45 revolutions per minute. Mints are located 0.030 m, 0.080 m, and 0.130 m from the center of the record. Determine what you can about the coefficient of static friction between the turntable and the mints.

Knowns: $\omega = 45\dfrac{rev}{\min}\left(\dfrac{1\min}{60\sec}\right)\left(\dfrac{2\pi rad}{1rev}\right) = 1.5\pi\dfrac{rad}{s}$; $r_1 = 0.030m$; $r_2 = 0.080m$; $r_3 = 0.130m$; $\mu_s = ?$

The free body diagram for all three mints is the same:



$$\sum F_y = F_N - F_g = ma_y = m(0) = 0 \Rightarrow F_N = F_g = mg$$

$$\sum F_{in} = F_{sf\,\max} = ma_c \Rightarrow \mu_s F_N = mr\omega^2 \Rightarrow \mu_s mg = mr\omega^2 \Rightarrow \mu_s g = r\omega^2$$

$$\Rightarrow \mu_{s1} = \frac{r_1\omega^2}{g} = \frac{(0.03)(1.5\pi)^2}{9.81} = 0.067910 \approx 0.068$$

$$\Rightarrow \mu_{s2} = \frac{r_2\omega^2}{g} = \frac{(0.08)(1.5\pi)^2}{9.81} = 0.18109 \approx 0.18$$

$$\Rightarrow \mu_{s3} = \frac{r_3\omega^2}{g} = \frac{(0.13)(1.5\pi)^2}{9.81} = 0.29428 \approx 0.29$$

Because the force of static friction is actually less than or equal to the coefficient of static friction times force normal and we used the maximum force of static friction, we actually determined the minimum coefficient of friction necessary to keep each mint on the turntable. Therefore the answer is that the coefficient of static friction must be greater than or equal to 0.29.

$$\boxed{\mu_s \geq 0.29}$$