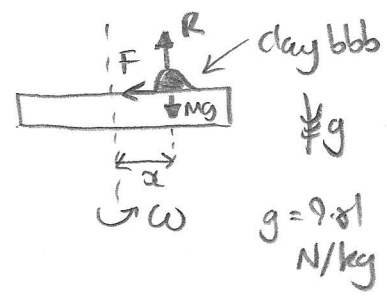
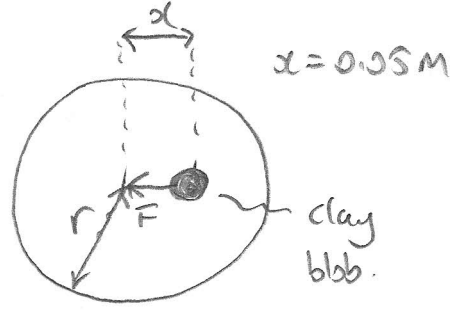
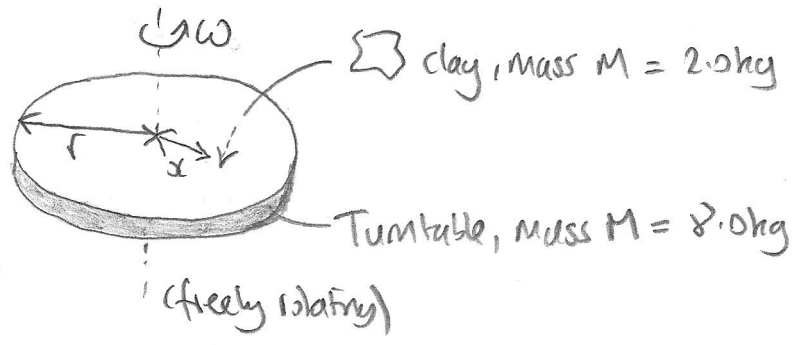


2/



Initial angular momentum of turntable is:

$$\frac{1}{2} M r^2 \omega_0 \quad (\omega_0 = \frac{2\pi \times 160}{60} \text{ rad s}^{-1})$$

Final angular momentum of turntable + clay is:

$$\frac{1}{2} M r^2 \omega + m x^2 \omega$$

∴ By conservation of angular momentum

$$\omega \left( \frac{1}{2} M r^2 + m x^2 \right) = \frac{1}{2} M r^2 \omega_0$$

$$\text{so } \omega = \frac{\omega_0}{1 + \frac{m x^2}{\frac{1}{2} M r^2}} = \boxed{152 \text{ RPM}}$$

Now if clay is on the point of slipping, friction  $F = \mu R$

Now  $R = mg$  (vertical equilibrium), ∴  $\boxed{F = \mu mg}$

Newton II radially inward, on clay  $\Rightarrow \boxed{m x \omega^2 = \mu mg}$

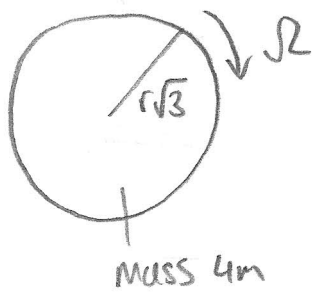
$$\therefore \mu = \frac{x \omega^2}{g}$$

$$\therefore \mu = \frac{x}{g} \omega_0^2 \left( 1 + \frac{m x^2}{\frac{1}{2} M r^2} \right)^{-2}$$

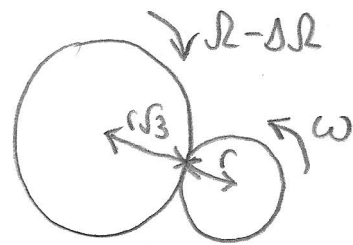
$$\therefore \mu = \frac{0.05}{9.81} \left( \frac{2\pi \times 160}{60} \right)^2 \left( 1 + \frac{2.0 \times 5^2}{\frac{1}{2} \times 8.0 \times 15^2} \right)^{-2} = \boxed{1.28} \quad [\text{clay would slide on a plane at } 52.1^\circ]$$

①

3/



BEFORE



AFTER

original rotational KE:  $E_0 = \frac{1}{2} \left( \frac{1}{2} 4m (r\sqrt{3})^2 \right) \Omega^2$

$$E_0 = 3mr^2 \Omega^2$$

$\therefore \Delta E = 3\epsilon mr^2 \Omega^2$  i.e. energy lost

Final rotational KE:  $E_1 = \frac{1}{2} \left( \frac{1}{2} 4m (r\sqrt{3})^2 \right) (\Omega - \Delta\Omega)^2 + \frac{1}{2} \left( \frac{1}{2} mr^2 \right) \omega^2$

$$E_1 = 3mr^2 (\Omega - \Delta\Omega)^2 + \frac{1}{4} mr^2 \omega^2$$

Now  $E_1 = E_0 - \Delta E$

$$\therefore 3mr^2 (\Omega - \Delta\Omega)^2 + \frac{1}{4} mr^2 \omega^2 = 3mr^2 \Omega^2 - 3\epsilon mr^2 \Omega^2$$

$$(\Omega - \Delta\Omega)^2 + \frac{1}{12} \omega^2 = \Omega^2 - \epsilon \Omega^2 = \Omega^2 (1 - \epsilon)$$

Now if contact between cylinders is slip free

$$r\sqrt{3} (\Omega - \Delta\Omega) = r\omega$$

(i.e. match speeds at cylinder edge)

$$\therefore \Omega - \Delta\Omega = \frac{\omega}{\sqrt{3}}$$

so

$$\frac{\omega^2}{3} + \frac{1}{12} \omega^2 = \Omega^2 (1 - \epsilon)$$

$$\omega^2 \left( \frac{4+1}{12} \right) = \Omega^2 (1 - \epsilon)$$

$$\omega^2 = \Omega^2 (1 - \epsilon) \times \frac{12}{5}$$

$$\therefore \omega = \sqrt{\frac{12}{5}} \Omega (1 - \epsilon)^{\frac{1}{2}}$$

(2)

