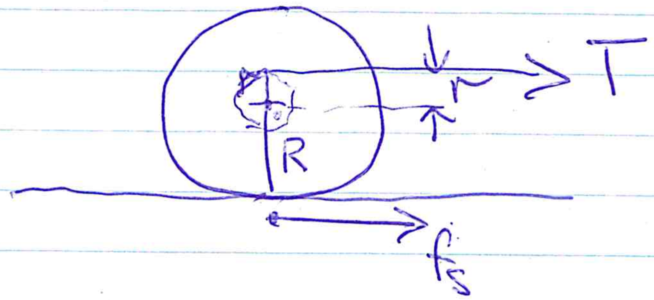
Example 2



f_s is to right

to prevent slipping.

$$\sum F = T + f_s = ma \quad (1)$$

$$\sum \tau_o = f_s R - T r = I\alpha \quad (2)$$

$$a = -\alpha R$$

$$\therefore \alpha = -\frac{a}{R}$$

$I = \beta m R^2$ $\quad \beta = \frac{1}{2}$ for solid disc.

$\therefore$ substitute I, α into (2) and

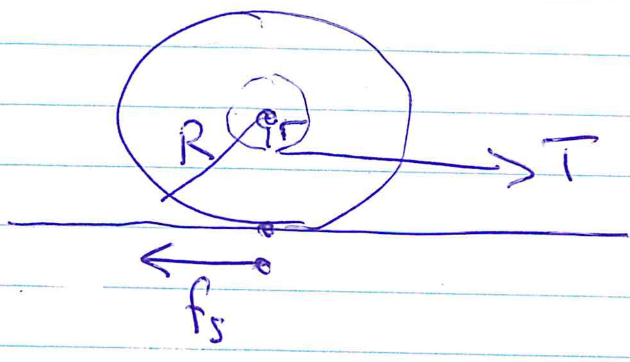
divide by R:

$$\Rightarrow f_s - T\frac{r}{R} = \frac{\beta m R^{\cancel{2}}}{\cancel{R}}\left(-\frac{a}{\cancel{R}}\right) = -\beta m a \quad (3$$

$f_s = -T + ma$ $\quad \therefore -T + ma - T\frac{r}{R} = -\beta ma$

$$\therefore ma(1+\beta) = T\left(1 + \frac{r}{R}\right)$$

Example 3



f_s is to left to prevent slipping

$$\sum F = T - f_s = ma \quad (1)$$

$$\sum \tau_o = Tr - f_s R = I\alpha = (\beta m R^2)\left(\frac{-a}{R}\right)$$

$$= -\beta m a$$

$$\therefore T\frac{r}{R} - f_s = -\beta m a \quad (2)$$

$$f_s = T - ma$$

$$\therefore T\frac{r}{R} - T + ma = -\beta m a$$

$$\therefore ma(1+\beta) = T\left(1 - \frac{r}{R}\right)$$

Example 4 L is conserved

(no torque for radial gravitational force)

$$L_P = L_A$$

P: perigee
A: apogee

$$\cancel{m} r_P v_P = \cancel{m} r_A v_A$$

$$\therefore v_A = \frac{r_P v_P}{r_A}$$

$$= \frac{8.37 \times 10^6 \cancel{m}}{25.1 \times 10^6 \cancel{m}} \left(8450 \frac{m}{s}\right)$$

$$= 2820 \frac{m}{s}$$