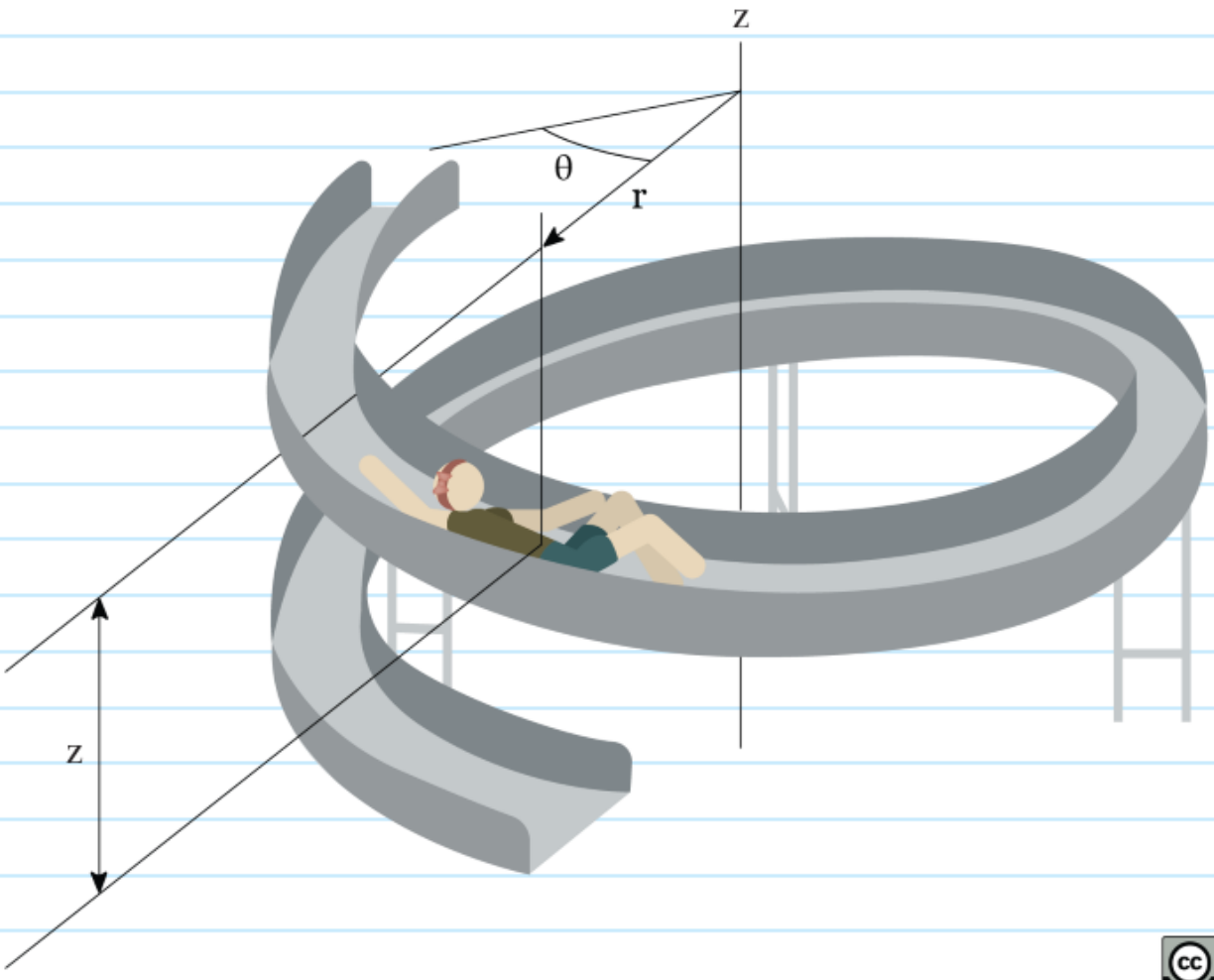
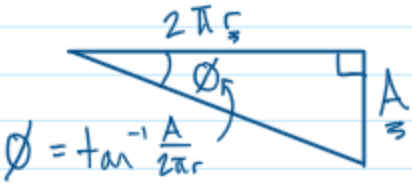
21-P-FA-GD-011



You are sliding down the smooth spiral slide of radius r_s at the playground down the street from your house. Your vertical component is $z = -A_3$ m/s and your speed is B_3 m/s.

What are the F_r, F_θ, F_z force components the slide exerts on you, if your mass is m_3 kg?

$r = r$
$\dot{r} = 0$
$\ddot{r} = 0$

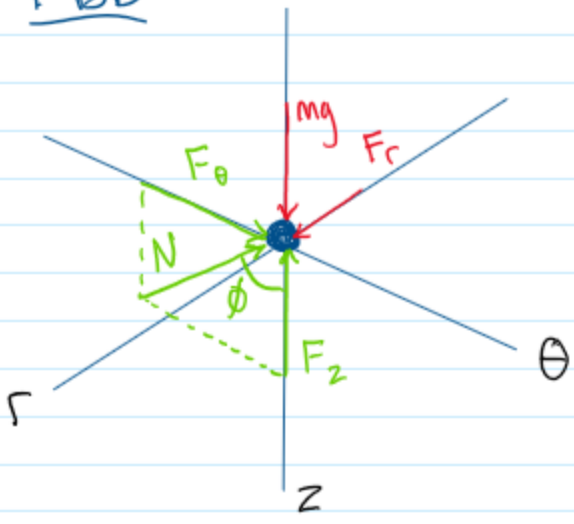


$\phi = \tan^{-1}\frac{A}{2\pi r}$

$v_\theta = B\cos\phi$
$v_z = -A\sin\phi$

$v_\theta = r\dot{\theta} \rightarrow \dot{\theta} = \frac{B\cos\phi}{r}$

FBD



$$\begin{cases} a_r = \ddot{r} - r\dot{\theta}^2 \\ a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta} \\ a_z = \ddot{z} \end{cases}$$

relate a_z & a_θ

$\tan\phi = \frac{a_z}{a_\theta}$

$a_\theta = \cot\phi\, a_z$

$a_r = 0 - r\left(\frac{B\cos\phi}{r}\right)^2 = -\frac{(B\cos\phi)^2}{r}$
$a_\theta = 0$
$a_z = 0$

$\Sigma F_r = ma_r$
$F_r = ma_r$
$F_r = -\frac{m(B\cos\phi)^2}{r}$

$\Sigma F_\theta = ma_\theta$
$N\sin\phi = ma_\theta$
$N\sin\phi = ma_z\cot\phi$
$N\tan\phi\sin\phi = ma_z$

$\Sigma F_z = ma_z$
$-N\cos\phi + mg = ma_z$

$N\tan\phi\sin\phi = -N\cos\phi + mg$

$N = \frac{mg}{\tan\phi\sin\phi + \cos\phi}$

$F_r = -\frac{m(B\cos\phi)^2}{r}$ $\quad F_\theta = N\sin\phi$ $\quad F_z = N\cos\phi$