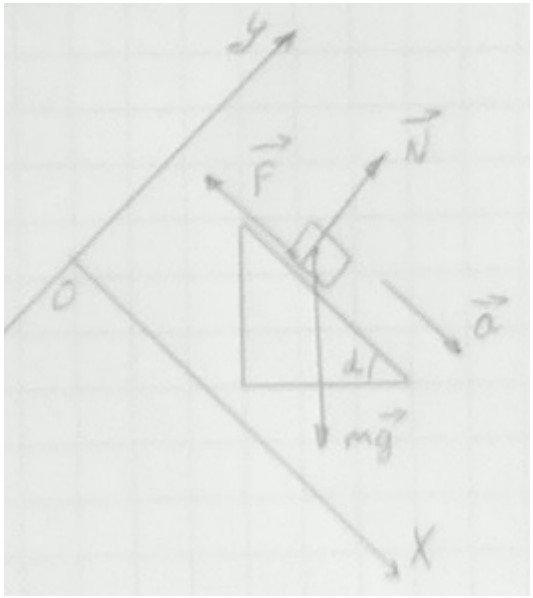
1. On smooth incline plane of inclination = 45 degree a body takes time 2s to reach the bottom. When plane is made rough (coefficient of friction=0.75), the same body will take time?

$\alpha = 45^0$
$t = 2\,s$
$\mu = 0.75$
$t_1 - ?$

Solution.



Let write down the equation of the motion of the body (Newton second law) and also write in projectives onto the *X*- and *Y*-axes.

$$m\vec{a} = m\vec{g} + \vec{N} + \vec{F}.$$

$\begin{cases} ma = mg\sin\alpha - F \\ m\cdot 0 = -mg\cos\alpha + N \end{cases}$, where the friction force is $F = \mu N$.

So, the acceleration of the body is constant:

$$a = g\sin\alpha - \frac{F}{m} = g\sin\alpha - \frac{\mu\cdot mg\cos\alpha}{m} = g(\sin\alpha - \mu\cos\alpha).$$

Let the length of the plane be l.

We can find the time of the motion of the body with the constant acceleration:

$$t = \sqrt{\frac{2l}{a}} = \sqrt{\frac{2l}{g(\sin\alpha - \mu\cos\alpha)}}.$$

So, time of the motion in the case of smooth plane ($\mu = 0$) and rough one

$$t = \sqrt{\frac{2l}{g\sin\alpha}}, \quad t_1 = \sqrt{\frac{2l}{2g(\sin\alpha - \mu\cos\alpha)}}.$$

So, $\frac{t_1}{t} = \sqrt{\frac{2l}{2g(\sin\alpha - \mu\cos\alpha)}} : \sqrt{\frac{2l}{g\sin\alpha}}$.

As one can find out,

$$\boxed{t_1 = \frac{t}{\sqrt{1 - \mu\, ctg\alpha}}}.$$

Let check the dimension.

$[t_1] = s$.

Let evaluate the quantity.

$$t_1 = \frac{2}{\sqrt{1 - 0.75\cdot ctg\,45^0}} = \frac{2}{\sqrt{1 - 0.75\cdot 1}} = 4(s).$$

Answer: 4 s.