**5.41** A rectangular box lies on a rough inclined surface. The co-efficient of friction between the surface and the box is $\mu$. Let the mass of the box be $m$.

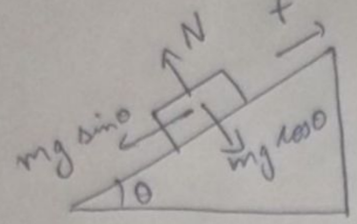
(a) At what angle of inclination $\theta$ of the plane to the horizontal will the box just start to slide down the plane?

(b) What is the force acting on the box down the plane, if the angle of inclination of the plane is increased to $\alpha > \theta$?

(c) What is the force needed to be applied upwards along the plane to make the box either remain stationary or just move up with uniform speed?

(d) What is the force needed to be applied upwards along the plane to make the box move up the plane with acceleration $a$?

=>




a) Angle at which the box just start to slide down the plane =>

$$mg \sin\theta = \mu mg \cos\theta$$

$$\mu = \tan\theta$$

$$\boxed{\theta = \tan^{-1}(\mu)}$$

b) If a > θ, the angle of inclination will be the the angle of repose and the net force acting will be in the downward =>

$$F_1 = mg \sin\phi - f = mg \sin\phi - \mu N$$

$$= mg \sin\phi - \mu mg \cos\phi$$

$$F_1 = mg(\sin a - \mu \cos a)$$

c) $F_2$ is required to keep box stationary and to move with uniform velocity

$$F_2 - mg \sin a - \mu N = 0$$

$$F_2 = mg \sin a - \mu N$$

$$F_2 = mg(\sin a - \mu \cos a)$$

d) $F_3$ is required to move the box upward with a as acceleration

~~$F_3 =$~~

$$F_3 - mg \sin a - \mu mg \cos a = ma$$