Inclined Plane with Friction: Force to Push Up and Down

Force parallel to an inclined plane to push a load up, to lower it and to hold it, with friction, the angle of repose and the mechanical efficiency.

Method: Textbook mechanics (resolution of forces on an inclined plane)

Input parameters

Unit system: SI

Parameter	Value	Unit
Mass of the load	500.00	kg
Slope angle	20.000	°
Coefficient of friction	0.25000	

Calculated results

Parameter	Value	Unit
Force to push up the slope	2.8289	kN
Force to push down (negative: it slides by itself)	-0.52513	kN
Normal force	4.6076	kN
Angle of repose atan μ	14.036	°
Efficiency of raising	59.281	%

Notes for this case

- The load slides down by itself: the slope is steeper than the angle of repose.

Formula and method

$$F_{up} = W(\sin\theta + \mu\cos\theta), \quad F_{down} = W(\mu\cos\theta - \sin\theta), \quad \eta = \frac{\sin\theta}{\sin\theta + \mu\cos\theta}$$

Variables

m	Mass of the load	kg
θ	Slope angle	rad
μ	Coefficient of friction	-
F_{up}	Force to push up the slope	N
F_{down}	Force to push down (negative: it slides by itself)	N
N	Normal force	N
ϕ	Angle of repose atan μ	rad
η	Efficiency of raising	-

Method and standards

Equilibrium along the plane.

Assumptions and limits

- Dry (Coulomb) friction with one coefficient: use the static μ for holding and starting, the (lower) kinetic μ for steady sliding.

References

- Textbook mechanics (resolution of forces on an inclined plane)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/mechanical/statics-dynamics/inclined-plane-friction

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Reopens the calculator with the inputs of this report.