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Friction Formulas

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List of 28 Friction Formulas

Friction

Angle Friction

1) Angle of Repose

$$fx \quad \alpha_r = a \tan\left(\frac{F_{lim}}{R_n}\right)$$

Open Calculator 

$$ex \quad 18.45335^\circ = a \tan\left(\frac{2.15N}{6.4431N}\right)$$

2) Coefficient of Friction between Cylinder and Surface of Inclined Plane for Rolling without Slipping

$$fx \quad \mu = \frac{\tan(\theta_i)}{3}$$

Open Calculator 

$$ex \quad 0.333333 = \frac{\tan(45^\circ)}{3}$$



3) Efficiency of Inclined Plane when Effort Applied Horizontally to Move Body Downward

$$\text{fx } \eta = \frac{\tan(\alpha_i - \Phi)}{\tan(\alpha_i)}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$\text{ex } 0.904327 = \frac{\tan(23^\circ - 2^\circ)}{\tan(23^\circ)}$$

4) Efficiency of Inclined Plane when Effort Applied Horizontally to Move Body Upward

$$\text{fx } \eta = \frac{\tan(\alpha_i)}{\tan(\alpha_i + \Phi)}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 0.910289 = \frac{\tan(23^\circ)}{\tan(23^\circ + 2^\circ)}$$

5) Efficiency of Inclined Plane when Effort Applied Parallel to Move Body Downward

$$\text{fx } \eta = \frac{\sin(\alpha_i - \Phi)}{\sin(\alpha_i) \cdot \cos(\Phi)}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 0.917732 = \frac{\sin(23^\circ - 2^\circ)}{\sin(23^\circ) \cdot \cos(2^\circ)}$$



6) Efficiency of Inclined Plane when Effort Applied Parallel to Move Body Upward

$$\text{fx } \eta = \frac{\sin(\alpha_i) \cdot \cos(\Phi)}{\sin(\alpha_i + \Phi)}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$\text{ex } 0.923985 = \frac{\sin(23^\circ) \cdot \cos(2^\circ)}{\sin(23^\circ + 2^\circ)}$$

7) Efficiency of Inclined Plane when Effort Applied to Move Body Downward

$$\text{fx } \eta = \frac{\cot(\alpha_i) - \cot(\theta_e)}{\cot(\alpha_i - \Phi) - \cot(\theta_e)}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$\text{ex } 0.901002 = \frac{\cot(23^\circ) - \cot(85^\circ)}{\cot(23^\circ - 2^\circ) - \cot(85^\circ)}$$

8) Efficiency of Inclined Plane when Effort Applied to Move Body Upward

$$\text{fx } \eta = \frac{\cot(\alpha_i + \Phi) - \cot(\theta_e)}{\cot(\alpha_i) - \cot(\theta_e)}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$\text{ex } 0.906829 = \frac{\cot(23^\circ + 2^\circ) - \cot(85^\circ)}{\cot(23^\circ) - \cot(85^\circ)}$$



9) Effort Applied Parallel to Inclined Plane to Move Body Downward Considering Friction

$$fx \quad P_d = W \cdot (\sin(\alpha_i) - \mu \cdot \cos(\alpha_i))$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 10.06758N = 120N \cdot (\sin(23^\circ) - 0.333333 \cdot \cos(23^\circ))$$

10) Effort Applied Parallel to Inclined Plane to Move Body Upward Considering Friction

$$fx \quad P_u = W \cdot (\sin(\alpha_i) + \mu \cdot \cos(\alpha_i))$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 83.70789N = 120N \cdot (\sin(23^\circ) + 0.333333 \cdot \cos(23^\circ))$$

11) Effort Applied Parallel to Inclined Plane to Move Body Upward or Downward Neglecting Friction

$$fx \quad P_0 = W \cdot \sin(\alpha_i)$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 46.88774N = 120N \cdot \sin(23^\circ)$$

12) Effort Applied Perpendicular to Inclined Plane to Move Body along Inclination Neglecting Friction

$$fx \quad P_0 = W \cdot \tan(\alpha_i)$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 50.93698N = 120N \cdot \tan(23^\circ)$$



13) Effort Applied Perpendicular to Inclined Plane to Move Body Downward Considering Friction

$$\text{fx } P_d = W \cdot \tan(\alpha_i - \Phi)$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$\text{ex } 46.06368\text{N} = 120\text{N} \cdot \tan(23^\circ - 2^\circ)$$

14) Effort Applied Perpendicular to Inclined Plane to Move Body Upward Considering Friction

$$\text{fx } P_u = W \cdot \tan(\alpha_i + \Phi)$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$\text{ex } 55.95692\text{N} = 120\text{N} \cdot \tan(23^\circ + 2^\circ)$$

15) Effort Applied to Move Body Downward on Inclined Plane Considering Friction

$$\text{fx } P_d = \frac{W \cdot \sin(\alpha_i - \Phi)}{\sin(\theta_e - (\alpha_i - \Phi))}$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

$$\text{ex } 47.84651\text{N} = \frac{120\text{N} \cdot \sin(23^\circ - 2^\circ)}{\sin(85^\circ - (23^\circ - 2^\circ))}$$

16) Effort Applied to Move Body Upward on Inclined Plane Considering Friction

$$\text{fx } P_u = \frac{W \cdot \sin(\alpha_i + \Phi)}{\sin(\theta_e - (\alpha_i + \Phi))}$$

[Open Calculator !\[\]\(5abce1a84a655b073239ab33e1199487_img.jpg\)](#)

$$\text{ex } 58.5597\text{N} = \frac{120\text{N} \cdot \sin(23^\circ + 2^\circ)}{\sin(85^\circ - (23^\circ + 2^\circ))}$$



17) Effort Required to Move Body down Plane Neglecting Friction

$$\text{fx } P_0 = \frac{W \cdot \sin(\alpha_i)}{\sin(\theta_e - \alpha_i)}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$\text{ex } 53.10364\text{N} = \frac{120\text{N} \cdot \sin(23^\circ)}{\sin(85^\circ - 23^\circ)}$$

18) Effort Required to Move Body up Plane Neglecting Friction

$$\text{fx } P_0 = \frac{W \cdot \sin(\alpha_i)}{\sin(\theta_e - \alpha_i)}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)

$$\text{ex } 53.10364\text{N} = \frac{120\text{N} \cdot \sin(23^\circ)}{\sin(85^\circ - 23^\circ)}$$

19) Frictional Force between Cylinder and Inclined Plane surface for Rolling without Slipping

$$\text{fx } F_f = \frac{M_c \cdot g \cdot \sin(\theta_i)}{3}$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2_img.jpg\)](#)

$$\text{ex } 22.17487\text{N} = \frac{9.6\text{kg} \cdot 9.8\text{m/s}^2 \cdot \sin(45^\circ)}{3}$$



20) Limiting Angle of Friction

[Open Calculator !\[\]\(3d8c13c92b853674f749aac6fa869926_img.jpg\)](#)

$$fx \quad \Phi = a \tan\left(\frac{F_{lf}}{R_n}\right)$$

$$ex \quad 2.000018^\circ = a \tan\left(\frac{0.225N}{6.4431N}\right)$$

21) Minimum Force Required to Slide Body on Rough Horizontal Plane

[Open Calculator !\[\]\(17acf1afa8cdf0b67c53d4865a5ed469_img.jpg\)](#)

$$fx \quad P_{\min} = W \cdot \sin(\theta_e)$$

$$ex \quad 119.5434N = 120N \cdot \sin(85^\circ)$$

Laws of Friction

22) Coefficient of Friction

[Open Calculator !\[\]\(4688aadfd656ded00cd6bdfae55089a9_img.jpg\)](#)

$$fx \quad \mu = \frac{F_{\lim}}{R_n}$$

$$ex \quad 0.33369 = \frac{2.15N}{6.4431N}$$

23) Coefficient of Friction using Forces

[Open Calculator !\[\]\(4146d17f71dced09c6ad789cacceaa6d_img.jpg\)](#)

$$fx \quad \mu = \frac{F_c \cdot \tan(\theta_f) + P_t}{F_c - P_t \cdot \tan(\theta_f)}$$

$$ex \quad 0.600559 = \frac{1200N \cdot \tan(29.793805347^\circ) + 25N}{1200N - 25N \cdot \tan(29.793805347^\circ)}$$



24) Total Torque Required to Overcome Friction in Rotating Screw

$$fx \quad T = W \cdot \tan(\psi + \Phi) \cdot \frac{d_m}{2} + \mu_c \cdot W \cdot R_c$$

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0_img.jpg\)](#)
ex

$$52.3556N \cdot m = 120N \cdot \tan(25.00^\circ + 2^\circ) \cdot \frac{1.7m}{2} + 0.16 \cdot 120N \cdot 0.02m$$

Screw Friction

25) Angle of inclination of thread

$$fx \quad \theta_t = a \tan\left(\frac{P_s}{\pi \cdot d_m}\right)$$

[Open Calculator !\[\]\(cf531ed27e91483460120fcc057b3901_img.jpg\)](#)

$$ex \quad 66.86508^\circ = a \tan\left(\frac{12.5m}{\pi \cdot 1.7m}\right)$$

26) Pitch of screw

$$fx \quad P_s = \frac{L}{n}$$

[Open Calculator !\[\]\(b4eeff342f60cc7bcd67d869b4fedca2_img.jpg\)](#)

$$ex \quad 12.53333m = \frac{188m}{15}$$




27) Slope of thread 

$$\text{fx } \alpha = \frac{P_s}{\pi \cdot d_m}$$

[Open Calculator](#) 

$$\text{ex } 2.340514 = \frac{12.5\text{m}}{\pi \cdot 1.7\text{m}}$$

28) Slope of thread in multi-threaded screw 

$$\text{fx } \alpha_m = \frac{n \cdot P_s}{\pi \cdot d_m}$$

[Open Calculator](#) 

$$\text{ex } 35.10771 = \frac{15 \cdot 12.5\text{m}}{\pi \cdot 1.7\text{m}}$$



Variables Used





- d_m Mean Diameter of Screw (Meter)
- F_c Centripetal Force (Newton)
- F_f Force of Friction (Newton)
- F_{lf} Limit Force (Newton)
- F_{lim} Limiting Force (Newton)
- g Acceleration Due to Gravity (Meter per Square Second)
- L Lead of Screw (Meter)
- M_c Mass of Cylinder (Kilogram)
- n Number of Threads
- P_0 Effort Required to Move Neglecting Friction (Newton)
- P_d Effort to Move Downwards Considering Friction (Newton)
- P_{min} Minimum Effort (Newton)
- P_s Pitch (Meter)
- P_t Tangential Force (Newton)
- P_u Effort to Move Upwards Considering Friction (Newton)
- R_c Mean Radius of Collar (Meter)
- R_n Normal Reaction (Newton)
- T Total Torque (Newton Meter)
- W Weight of Body (Newton)
- α Slope of Thread
- α_i Angle of Inclination of Plane to Horizontal (Degree)



- α_m Slope of Multiple Threads
- α_r Angle of Repose (Degree)
- η Efficiency of Inclined Plane
- θ_e Angle of Effort (Degree)
- θ_f Angle of Friction (Degree)
- θ_i Angle of Inclination (Degree)
- θ_t Thread Angle (Degree)
- μ Coefficient of Friction
- μ_c Coefficient of Friction For Collar
- Φ Limiting Angle of Friction (Degree)
- ψ Helix Angle (Degree)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Function:** **atan**, atan(Number)
Inverse tan is used to calculate the angle by applying the tangent ratio of the angle, which is the opposite side divided by the adjacent side of the right triangle.
- **Function:** **cos**, cos(Angle)
Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- **Function:** **cot**, cot(Angle)
Cotangent is a trigonometric function that is defined as the ratio of the adjacent side to the opposite side in a right triangle.
- **Function:** **sin**, sin(Angle)
Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- **Function:** **tan**, tan(Angle)
The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- **Measurement:** **Length** in Meter (m)
Length Unit Conversion 
- **Measurement:** **Weight** in Kilogram (kg)
Weight Unit Conversion 
- **Measurement:** **Acceleration** in Meter per Square Second (m/s²)
Acceleration Unit Conversion 
- **Measurement:** **Force** in Newton (N)
Force Unit Conversion 



- **Measurement: Angle** in Degree ($^{\circ}$)
Angle Unit Conversion 
- **Measurement: Torque** in Newton Meter (N*m)
Torque Unit Conversion 



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