Friction Formulas... 1/15





### **Friction Formulas**

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#### **List of 28 Friction Formulas**

#### Friction

### **Angle Friction**

1) Angle of Repose

$$\left| lpha_{
m r} = a an igg( rac{{
m F}_{
m lim}}{{
m R}_{
m n}} igg) 
ight|$$

Open Calculator 🗗

$$oxed{ex} 18.45335^\circ = a anigg(rac{2.15 ext{N}}{6.4431 ext{N}}igg)$$

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

$$\mu = rac{ an( heta_{
m i})}{3}$$

Open Calculator

$$extbf{ex} \left[ 0.3333333 = rac{ an(45\degree)}{3} 
ight]$$



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

$$\eta = rac{ an(lpha_{
m i} - \Phi)}{ an(lpha_{
m i})}$$

Open Calculator

$$oxed{ex} 0.904327 = rac{ an(23\degree-2\degree)}{ an(23\degree)}$$

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

$$\eta = rac{ an(lpha_{
m i})}{ an(lpha_{
m i} + \Phi)}$$

Open Calculator

$$extbf{ex} 0.910289 = rac{ an(23\degree)}{ an(23\degree+2\degree)}$$

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

$$\eta = rac{\sin(lpha_{
m i} - \Phi)}{\sin(lpha_{
m i}) \cdot \cos(\Phi)}$$

Open Calculator

$$= \frac{\sin(23° - 2°)}{\sin(23°) \cdot \cos(2°)}$$



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

 $\eta = rac{\sin(lpha_{
m i})\cdot\cos(\Phi)}{\sin(lpha_{
m i}+\Phi)}$ 

Open Calculator 🗗

 $oxed{ex} 0.923985 = rac{\sin(23°) \cdot \cos(2°)}{\sin(23°+2°)}$ 

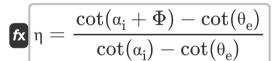
## 7) Efficiency of Inclined Plane when Effort Applied to Move Body

 $\eta = rac{\cot(lpha_{
m i}) - \cot( heta_{
m e})}{\cot(lpha_{
m i} - \Phi) - \cot( heta_{
m e})}$ 

Open Calculator

 $oxed{ex} 0.901002 = rac{\cot(23°) - \cot(85°)}{\cot(23° - 2°) - \cot(85°)}$ 

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





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

 $\mathbf{E} \left[ \mathrm{P_d} = \mathrm{W} \cdot \left( \sin(lpha_\mathrm{i}) - \mu \cdot \cos(lpha_\mathrm{i}) 
ight) 
ight]$ 

Open Calculator

 $= 10.06758 \mathrm{N} = 120 \mathrm{N} \cdot (\sin(23°) - 0.333333 \cdot \cos(23°))$ 

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

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

Open Calculator

 $\texttt{ex} \ 83.70789 \text{N} = 120 \text{N} \cdot (\sin(23°) + 0.333333 \cdot \cos(23°)) \Big]$ 

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

fx  $P_0 = W \cdot \sin(lpha_i)$ 

Open Calculator

 $= 46.88774 \mathrm{N} = 120 \mathrm{N} \cdot \sin(23^\circ)$ 

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

 $\mathbf{E} \left[ \mathrm{P}_0 = \mathrm{W} \cdot \mathrm{tan}(\mathrm{a_i}) 
ight]$ 

Open Calculator

 $\texttt{ex} \ 50.93698 \texttt{N} = 120 \texttt{N} \cdot \tan(23°)$ 



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

 $\mathbf{F}_{\mathrm{d}} = \mathbf{W} \cdot an(lpha_{\mathrm{i}} - \Phi)$ 

Open Calculator 🗗

 $ag{46.06368N} = 120N \cdot an(23\degree - 2\degree)$ 

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

 $ag{P_{
m u} = W \cdot ag{tan}(lpha_{
m i} + \Phi)}$ 

Open Calculator

 $\texttt{ex} \ 55.95692 \texttt{N} = 120 \texttt{N} \cdot \tan(23\degree + 2\degree)$ 

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

 $ext{P}_{ ext{d}} = rac{ ext{W} \cdot \sin(lpha_{ ext{i}} - \Phi)}{\sin( heta_{ ext{o}} - (lpha_{ ext{i}} - \Phi))}$ 

Open Calculator

 $= \frac{120 \mathrm{N} \cdot \sin(23°-2°)}{\sin(85°-(23°-2°))}$ 

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

 $ext{Fix} ext{P}_{ ext{u}} = rac{ ext{W} \cdot \sin(lpha_{ ext{i}} + \Phi)}{\sin( heta_{ ext{o}} - (lpha_{ ext{i}} + \Phi))}$ 

Open Calculator

 $extbf{ex} egin{aligned} extbf{58.5597N} &= rac{120 extbf{N} \cdot \sin(23\degree + 2\degree)}{\sin(85\degree - (23\degree + 2\degree))} \end{aligned}$ 





#### 17) Effort Required to Move Body down Plane Neglecting Friction 🗗



Open Calculator 2

$$ext{P}_0 = rac{ ext{W} \cdot \sin(lpha_{ ext{i}})}{\sin( heta_{ ext{e}} - lpha_{ ext{i}})}$$

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

### 18) Effort Required to Move Body up Plane Neglecting Friction



Open Calculator 🗗

 $ext{P}_0 = rac{ ext{W} \cdot \sin(lpha_{ ext{i}})}{\sin( heta_{ ext{p}} - lpha_{ ext{i}})}$ 

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

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

$$ext{F}_{ ext{f}} = rac{ ext{M}_{ ext{c}} \cdot ext{g} \cdot ext{sin}( heta_{ ext{i}})}{3}$$

$$ext{ex} \ 22.17487 ext{N} = rac{9.6 ext{kg} \cdot 9.8 ext{m/s}^2 \cdot ext{sin} (45\degree)}{3}$$



### 20) Limiting Angle of Friction

 $\Phi = a an\!\left(rac{ ext{F}_{ ext{lf}}}{ ext{R}_{n}}
ight)$ 

Open Calculator 🚰

 $oxed{ex} \left[ 2.000018 
ight.^\circ = a anigg( rac{0.225 \mathrm{N}}{6.4431 \mathrm{N}} igg) 
ight]$ 

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

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

Open Calculator

 $(85^{\circ})$ 

### Laws of Friction

# 22) Coefficient of Friction

fx  $\mu = rac{F_{
m lim}}{R}$ 

Open Calculator

### 23) Coefficient of Friction using Forces

 $\mu = rac{\mathrm{F_c} \cdot \mathrm{tan}( heta_\mathrm{f}) + \mathrm{P_t}}{\mathrm{F_c} - \mathrm{P_t} \cdot \mathrm{tan}( heta_\mathrm{f})}$ 

Open Calculator







#### 24) Total Torque Required to Overcome Friction in Rotating Screw

**7** 

$$T = W \cdot an(\psi + \Phi) \cdot rac{d_m}{2} + \mu_c \cdot W \cdot R_c$$

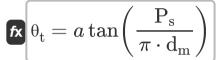
Open Calculator 🗗

ex

$$52.3556 ext{N*m} = 120 ext{N} \cdot an(25.00\degree + 2\degree) \cdot rac{1.7 ext{m}}{2} + 0.16 \cdot 120 ext{N} \cdot 0.02 ext{m}$$

### **Screw Friction**

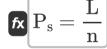
### 25) Angle of inclination of thread



Open Calculator 🗗

$$oxed{ex} 66.86508^\circ = a anigg(rac{12.5 \mathrm{m}}{\pi \cdot 1.7 \mathrm{m}}igg)$$

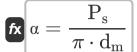
### 26) Pitch of screw



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



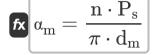
#### 27) Slope of thread



Open Calculator 🗗

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

### 28) Slope of thread in multi-threaded screw



Open Calculator 🗗

$$=$$
  $35.10771 = rac{15 \cdot 12.5 ext{m}}{\pi \cdot 1.7 ext{m}}$ 



Friction Formulas... 11/15

#### Variables Used

- d<sub>m</sub> Mean Diameter of Screw (Meter)
- Fc Centripetal Force (Newton)
- **F**<sub>f</sub> Force of Friction (Newton)
- F<sub>If</sub> Limit Force (Newton)
- Flim Limiting Force (Newton)
- **q** Acceleration Due to Gravity (Meter per Square Second)
- L Lead of Screw (Meter)
- M<sub>C</sub> Mass of Cylinder (Kilogram)
- n Number of Threads
- P<sub>0</sub> Effort Required to Move Neglecting Friction (Newton)
- P<sub>d</sub> Effort to Move Downwards Considering Friction (Newton)
- Pmin Minimum Effort (Newton)
- P<sub>s</sub> Pitch (Meter)
- Pt Tangential Force (Newton)
- P<sub>II</sub> Effort to Move Upwards Considering Friction (Newton)
- Rc Mean Radius of Collar (Meter)
- R<sub>n</sub> Normal Reaction (Newton)
- **T** Total Torque (Newton Meter)
- **W** Weight of Body (Newton)
- α Slope of Thread
- α<sub>i</sub> Angle of Inclination of Plane to Horizontal (Degree)





Friction Formulas... 12/15

- α<sub>m</sub> Slope of Multiple Threads
- α<sub>r</sub> Angle of Repose (Degree)
- **η** Efficiency of Inclined Plane
- θ<sub>A</sub> Angle of Effort (Degree)
- θ<sub>f</sub> Angle of Friction (Degree)
- θ<sub>i</sub> Angle of Inclination (Degree)
- θ<sub>t</sub> Thread Angle (Degree)
- µ Coefficient of Friction
- μ<sub>c</sub> Coefficient of Friction For Collar
- Φ Limiting Angle of Friction (Degree)
- Ψ Helix Angle (Degree)





Friction Formulas... 13/15

### 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





Friction Formulas... 14/15

• Measurement: Angle in Degree (°)

Angle Unit Conversion

• Measurement: Torque in Newton Meter (N\*m)

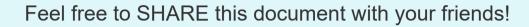
Torque Unit Conversion





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