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# Motion of Connected Bodies Formulas

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# List of 28 Motion of Connected Bodies Formulas

## Motion of Connected Bodies

### Bodies Connected by String and Lying on Rough Inclined Plane

#### 1) Acceleration of System given Mass of Body A

**fx**Open Calculator 

$$a = \frac{m_1 \cdot [g] \cdot \sin(\alpha_1) - \mu \cdot m_1 \cdot [g] \cdot \cos(\alpha_1) - T}{m_1}$$

**ex**

$$-0.464523\text{m/s}^2 = \frac{29\text{kg} \cdot [g] \cdot \sin(35^\circ) - 0.2 \cdot 29\text{kg} \cdot [g] \cdot \cos(35^\circ) - 130\text{N}}{29\text{kg}}$$

#### 2) Acceleration of System given Mass of Body B

**fx**Open Calculator 

$$a = \frac{T - m_2 \cdot [g] \cdot \sin(\alpha_2) - \mu \cdot m_2 \cdot [g] \cdot \cos(\alpha_2)}{m_2}$$

**ex**

$$-0.67416\text{m/s}^2 = \frac{130\text{N} - 17\text{kg} \cdot [g] \cdot \sin(45^\circ) - 0.2 \cdot 17\text{kg} \cdot [g] \cdot \cos(45^\circ)}{17\text{kg}}$$



### 3) Frictional Force on Body A

$$\text{fx } F_{\text{friction}} = \mu \cdot m_1 \cdot [g] \cdot \cos(\alpha_1)$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$\text{ex } 46.5922\text{N} = 0.2 \cdot 29\text{kg} \cdot [g] \cdot \cos(35^\circ)$$

### 4) Frictional Force on Body B

$$\text{fx } F_{\text{friction}} = \mu \cdot m_2 \cdot [g] \cdot \cos(\alpha_2)$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$\text{ex } 23.57679\text{N} = 0.2 \cdot 17\text{kg} \cdot [g] \cdot \cos(45^\circ)$$

### 5) Tension in String given Mass of Body A

$$\text{fx } T = m_1 \cdot ([g] \cdot \sin(\alpha_1) - \mu \cdot [g] \cdot \cos(\alpha_1) - a)$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$\text{ex } -28.471159\text{N} = 29\text{kg} \cdot ([g] \cdot \sin(35^\circ) - 0.2 \cdot [g] \cdot \cos(35^\circ) - 5\text{m/s}^2)$$

### 6) Tension in String given Mass of Body B

$$\text{fx } T = m_2 \cdot ([g] \cdot \sin(\alpha_2) + \mu \cdot [g] \cdot \cos(\alpha_2) + a)$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754\_img.jpg\)](#)

$$\text{ex } 226.4607\text{N} = 17\text{kg} \cdot ([g] \cdot \sin(45^\circ) + 0.2 \cdot [g] \cdot \cos(45^\circ) + 5\text{m/s}^2)$$



## Bodies Connected by String and Lying on Smooth Inclined Planes

### 7) Acceleration of System with Bodies Connected by String and Lying on Smooth Inclined Planes

$$\text{fx } a = \frac{m_1 \cdot \sin(\alpha_1) - m_2 \cdot \sin(\alpha_2)}{m_1 + m_2} \cdot [g]$$

[Open Calculator !\[\]\(23d9fc146e83b5c3013cfa32c784f8d5\_img.jpg\)](#)

$$\text{ex } 0.983415\text{m/s}^2 = \frac{29\text{kg} \cdot \sin(35^\circ) - 17\text{kg} \cdot \sin(45^\circ)}{29\text{kg} + 17\text{kg}} \cdot [g]$$

### 8) Angle of Inclination of Plane with Body A

$$\text{fx } \alpha_1 = a \sin\left(\frac{m_1 \cdot a + T}{m_1 \cdot [g]}\right)$$

[Open Calculator !\[\]\(aa53ad6fea213b8b2226d3077e30533a\_img.jpg\)](#)

$$\text{ex } 75.23343^\circ = a \sin\left(\frac{29\text{kg} \cdot 5\text{m/s}^2 + 130\text{N}}{29\text{kg} \cdot [g]}\right)$$

### 9) Angle of Inclination of Plane with Body B

$$\text{fx } \alpha_1 = a \sin\left(\frac{T - m_2 \cdot a}{m_2 \cdot [g]}\right)$$

[Open Calculator !\[\]\(626ce8ac21792b9405bfddfea8e0c96a\_img.jpg\)](#)

$$\text{ex } 15.6598^\circ = a \sin\left(\frac{130\text{N} - 17\text{kg} \cdot 5\text{m/s}^2}{17\text{kg} \cdot [g]}\right)$$



## 10) Tension in String if Both Bodies are Lying on Smooth Inclined Planes



$$\text{fx } T = \frac{m_1 \cdot m_2}{m_1 + m_2} \cdot [g] \cdot (\sin(\alpha_1) + \sin(\alpha_2))$$

[Open Calculator](#)

$$\text{ex } 134.602\text{N} = \frac{29\text{kg} \cdot 17\text{kg}}{29\text{kg} + 17\text{kg}} \cdot [g] \cdot (\sin(35^\circ) + \sin(45^\circ))$$

## Bodies Connected by String and Passing over Smooth Pulley



### 11) Acceleration of Bodies



$$\text{fx } a = \frac{m_1 - m_2}{m_1 + m_2} \cdot [g]$$

[Open Calculator](#)

$$\text{ex } 2.558257\text{m/s}^2 = \frac{29\text{kg} - 17\text{kg}}{29\text{kg} + 17\text{kg}} \cdot [g]$$

### 12) Mass of Body B of Smaller Mass



$$\text{fx } m_2 = \frac{T}{a + [g]}$$

[Open Calculator](#)

$$\text{ex } 8.779839\text{kg} = \frac{130\text{N}}{5\text{m/s}^2 + [g]}$$



### 13) Tension in String if Both Bodies are Freely Hanging

$$\text{fx } T = \frac{2 \cdot m_1 \cdot m_2}{m_1 + m_2} \cdot [g]$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0\_img.jpg\)](#)

$$\text{ex } 210.2034\text{N} = \frac{2 \cdot 29\text{kg} \cdot 17\text{kg}}{29\text{kg} + 17\text{kg}} \cdot [g]$$

### Bodies Connected by String One Hanging Free Other Lying on Rough Horizontal Plane

#### 14) Acceleration of System with Bodies One Hanging Free and Other Lying on Rough Horizontal Plane

$$\text{fx } a = \frac{m_1 - \mu \cdot m_2}{m_1 + m_2} \cdot [g]$$

[Open Calculator !\[\]\(73002692dd5e7a64e60946be3158e719\_img.jpg\)](#)

$$\text{ex } 5.457614\text{m/s}^2 = \frac{29\text{kg} - 0.2 \cdot 17\text{kg}}{29\text{kg} + 17\text{kg}} \cdot [g]$$

#### 15) Tension in String given Coefficient of Friction of Horizontal Plane

$$\text{fx } T = (1 + \mu) \cdot \frac{m_1 \cdot m_2}{m_1 + m_2} \cdot [g]$$

[Open Calculator !\[\]\(104fbf564e2e5a8fbd84f31656d114c7\_img.jpg\)](#)

$$\text{ex } 126.122\text{N} = (1 + 0.2) \cdot \frac{29\text{kg} \cdot 17\text{kg}}{29\text{kg} + 17\text{kg}} \cdot [g]$$



## Bodies Connected by String One Hanging Free Other Lying on Rough Inclined Plane

### 16) Acceleration of System with Bodies One Hanging Free, Other Lying on Rough Inclined Plane

$$\text{fx } a = \frac{m_1 - m_2 \cdot \sin(\theta) - \mu \cdot m_2 \cdot \cos(\theta)}{m_1 + m_2} \cdot [g]$$

[Open Calculator !\[\]\(83f22ed94ec5517769dd76d702c6bfd8\_img.jpg\)](#)

$$\text{ex } 3.742626\text{m/s}^2 = \frac{29\text{kg} - 17\text{kg} \cdot \sin(30^\circ) - 0.2 \cdot 17\text{kg} \cdot \cos(30^\circ)}{29\text{kg} + 17\text{kg}} \cdot [g]$$

### 17) Coefficient of Friction given Frictional Force

$$\text{fx } \mu = \frac{F_{\text{friction}}}{m_2 \cdot [g] \cdot \cos(\theta)}$$

[Open Calculator !\[\]\(3cb60d42b10e53f9522bb0b392c1c4cd\_img.jpg\)](#)

$$\text{ex } 0.103894 = \frac{15\text{N}}{17\text{kg} \cdot [g] \cdot \cos(30^\circ)}$$

### 18) Coefficient of Friction given Tension

$$\text{fx } \mu = \frac{m_1 + m_2}{m_1 \cdot m_1 \cdot [g]} \cdot T \cdot \sec(\theta) - \tan(\theta) - \sec(\theta)$$

[Open Calculator !\[\]\(0d7ca0919e6c47bbd874bfa0189fe22e\_img.jpg\)](#)

$$\text{ex } -0.894803 = \frac{29\text{kg} + 17\text{kg}}{29\text{kg} \cdot 29\text{kg} \cdot [g]} \cdot 130\text{N} \cdot \sec(30^\circ) - \tan(30^\circ) - \sec(30^\circ)$$



## 19) Frictional Force

$$\text{fx } F_{\text{friction}} = \mu \cdot m_2 \cdot [g] \cdot \cos(\theta)$$

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107\_img.jpg\)](#)

$$\text{ex } 28.87555\text{N} = 0.2 \cdot 17\text{kg} \cdot [g] \cdot \cos(30^\circ)$$

## 20) Inclination of Plane for given Frictional Force

$$\text{fx } \theta = a \cos\left(\frac{F_{\text{friction}}}{\mu \cdot m_2 \cdot [g]}\right)$$

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6\_img.jpg\)](#)

$$\text{ex } 63.26435^\circ = a \cos\left(\frac{15\text{N}}{0.2 \cdot 17\text{kg} \cdot [g]}\right)$$

## 21) Mass of Body B given Frictional Force

$$\text{fx } m_2 = \frac{F_{\text{friction}}}{\mu \cdot [g] \cdot \cos(\theta)}$$

[Open Calculator !\[\]\(4688aadfd656ded00cd6bdfae55089a9\_img.jpg\)](#)

$$\text{ex } 8.831001\text{kg} = \frac{15\text{N}}{0.2 \cdot [g] \cdot \cos(30^\circ)}$$

## 22) Tension in String given Coefficient of Friction of Inclined Plane

$$\text{fx } T = \frac{m_1 \cdot m_2}{m_1 + m_2} \cdot [g] \cdot (1 + \sin(\theta) + \mu \cdot \cos(\theta))$$

[Open Calculator !\[\]\(4146d17f71dced09c6ad789cacceaa6d\_img.jpg\)](#)

$$\text{ex } 175.8567\text{N} = \frac{29\text{kg} \cdot 17\text{kg}}{29\text{kg} + 17\text{kg}} \cdot [g] \cdot (1 + \sin(30^\circ) + 0.2 \cdot \cos(30^\circ))$$





## Bodies Connected by String One Hanging Free Other Lying on Smooth Horizontal Plane

### 23) Acceleration in System

$$\text{fx } a = \frac{m_1}{m_1 + m_2} \cdot [g]$$

[Open Calculator !\[\]\(d66ff64371a51729ac8c1cdaa685ba6f\_img.jpg\)](#)

$$\text{ex } 6.182453\text{m/s}^2 = \frac{29\text{kg}}{29\text{kg} + 17\text{kg}} \cdot [g]$$

### 24) Tension in String if only One Body is Freely Suspended

$$\text{fx } T = \frac{m_1 \cdot m_2}{m_1 + m_2} \cdot [g]$$

[Open Calculator !\[\]\(faf942dc3e59ce8eb64b4ac481eca7e0\_img.jpg\)](#)

$$\text{ex } 105.1017\text{N} = \frac{29\text{kg} \cdot 17\text{kg}}{29\text{kg} + 17\text{kg}} \cdot [g]$$

## Bodies Connected by String One Hanging Free Other Lying on Smooth Inclined Plane

### 25) Acceleration of System with Bodies One Hanging Free and Other Lying on Smooth Inclined Plane

$$\text{fx } a = \frac{m_1 - m_2 \cdot \sin(\theta)}{m_1 + m_2} \cdot [g]$$

[Open Calculator !\[\]\(b4eeff342f60cc7bcd67d869b4fedca2\_img.jpg\)](#)

$$\text{ex } 4.370355\text{m/s}^2 = \frac{29\text{kg} - 17\text{kg} \cdot \sin(30^\circ)}{29\text{kg} + 17\text{kg}} \cdot [g]$$



## 26) Angle of Inclination given Acceleration

[Open Calculator !\[\]\(99f58673407353e96a019fbca558fd72\_img.jpg\)](#)

$$\text{fx } \theta = a \sin \left( \frac{m_1 \cdot [g] - m_1 \cdot a - m_2 \cdot a}{m_2 \cdot [g]} \right)$$

$$\text{ex } 19.04231^\circ = a \sin \left( \frac{29\text{kg} \cdot [g] - 29\text{kg} \cdot 5\text{m/s}^2 - 17\text{kg} \cdot 5\text{m/s}^2}{17\text{kg} \cdot [g]} \right)$$

## 27) Angle of Inclination given Tension

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2\_img.jpg\)](#)

$$\text{fx } \theta = a \sin \left( \frac{T \cdot (m_1 + m_2)}{m_1 \cdot m_2 \cdot [g]} - 1 \right)$$

$$\text{ex } 13.70348^\circ = a \sin \left( \frac{130\text{N} \cdot (29\text{kg} + 17\text{kg})}{29\text{kg} \cdot 17\text{kg} \cdot [g]} - 1 \right)$$

## 28) Tension in String when One Body is Lying on Smooth Inclined Plane

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa\_img.jpg\)](#)

$$\text{fx } T = \frac{m_1 \cdot m_2}{m_1 + m_2} \cdot [g] \cdot (1 + \sin(\theta))$$

$$\text{ex } 157.6526\text{N} = \frac{29\text{kg} \cdot 17\text{kg}}{29\text{kg} + 17\text{kg}} \cdot [g] \cdot (1 + \sin(30^\circ))$$







## Variables Used

- **a** Acceleration (Meter per Square Second)
- **F<sub>friction</sub>** Force of Friction (Newton)
- **m<sub>1</sub>** Mass of Body A (Kilogram)
- **m<sub>2</sub>** Mass of Body B (Kilogram)
- **T** Tension of String (Newton)
- **α<sub>1</sub>** Inclination of Plane 1 (Degree)
- **α<sub>2</sub>** Inclination of Plane 2 (Degree)
- **θ** Inclination of Plane (Degree)
- **μ** Coefficient of Friction













## Constants, Functions, Measurements used

- **Constant:** **[g]**, 9.80665 Meter/Second<sup>2</sup>  
*Gravitational acceleration on Earth*
- **Function:** **acos**, acos(Number)  
*Inverse trigonometric cosine function*
- **Function:** **asin**, asin(Number)  
*Inverse trigonometric sine function*
- **Function:** **cos**, cos(Angle)  
*Trigonometric cosine function*
- **Function:** **sec**, sec(Angle)  
*Trigonometric secant function*
- **Function:** **sin**, sin(Angle)  
*Trigonometric sine function*
- **Function:** **tan**, tan(Angle)  
*Trigonometric tangent function*
- **Measurement:** **Weight** in Kilogram (kg)  
*Weight Unit Conversion* 
- **Measurement:** **Acceleration** in Meter per Square Second (m/s<sup>2</sup>)  
*Acceleration Unit Conversion* 
- **Measurement:** **Force** in Newton (N)  
*Force Unit Conversion* 
- **Measurement:** **Angle** in Degree (°)  
*Angle Unit Conversion* 



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