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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

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

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

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

4) Frictional Force on Body B

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

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

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

5) Tension in String given Mass of Body A

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

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

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

6) Tension in String given Mass of Body B

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

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

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



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



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

[Open Calculator](#)

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

Bodies Connected by String and Passing over Smooth Pulley

11) Acceleration of Bodies

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

[Open Calculator](#)

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

12) Mass of Body B of Smaller Mass

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

[Open Calculator](#)

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



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

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

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107_img.jpg\)](#)

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

20) Inclination of Plane for given Frictional Force

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

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6_img.jpg\)](#)

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

21) Mass of Body B given Frictional Force

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

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

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

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

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

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

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



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

23) Acceleration in System

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

Open Calculator 

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

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

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

Open Calculator 

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

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

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

Open Calculator 

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



26) Angle of Inclination given Acceleration 

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

Open Calculator 


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

27) Angle of Inclination given Tension 

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

Open Calculator 

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

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

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

Open Calculator 

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







Variables Used

- **a** Acceleration (Meter per Square Second)
- **F_{friction}** Force of Friction (Newton)
- **m₁** Mass of Body A (Kilogram)
- **m₂** Mass of Body B (Kilogram)
- **T** Tension of String (Newton)
- **α₁** Inclination of Plane 1 (Degree)
- **α₂** Inclination of Plane 2 (Degree)
- **θ** Inclination of Plane (Degree)
- **μ** Coefficient of Friction













Constants, Functions, Measurements used

- **Constant:** **[g]**, 9.80665 Meter/Second²
Gravitational acceleration on Earth
- **Constant:** **e**, 2.71828182845904523536028747135266249
Napier's constant
- **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/s²)
Acceleration Unit Conversion 
- **Measurement:** **Force** in Newton (N)
Force Unit Conversion 
- **Measurement:** **Angle** in Degree (°)
Angle Unit Conversion 



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