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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

Open Calculator

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

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

4) Frictional Force on Body B

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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

8) Angle of Inclination of Plane with Body A

Open Calculator

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

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

9) Angle of Inclination of Plane with Body B

Open Calculator

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

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

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

Open Calculator

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

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

Bodies Connected by String and Passing over Smooth Pulley

11) Acceleration of Bodies

Open Calculator

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

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

12) Mass of Body B of Smaller Mass

Open Calculator

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

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

13) Tension in String if Both Bodies are Freely Hanging

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

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

17) Coefficient of Friction given Frictional Force

Open Calculator

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

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

18) Coefficient of Friction given Tension

Open Calculator

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

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

19) Frictional Force

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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

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

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

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

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

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

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)*
- m_1 Mass of Body A *(Kilogram)*
- m_2 Mass of Body B *(Kilogram)*
- **T** Tension of String *(Newton)*
- α_1 Inclination of Plane 1 *(Degree)*
- α_2 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
- 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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