Important Simple Harmonic Motion Formulas PDF

Formulas
Examples
with Units

List of 22
Important Simple Harmonic Motion Formulas

1) Basics Formulas

1.1) Frequency of Oscillation for SHM Formula

Evaluate Formula

Formula	Example with Units
$f = \frac{1}{t_p}$	$0.2\,\text{Hz} = \frac{1}{5\,\text{s}}$

1.2) Frequency of Particle Moving with Angular Simple Harmonic Motion Formula

Evaluate Formula

Formula	Example with Units
$f = \frac{\sqrt{\frac{\alpha}{\theta}}}{2 \cdot \pi}$	$0.2003\,\text{Hz} = \frac{\sqrt{\frac{190\,\text{rad/s}^2}{120\,\text{rad}}}}{2 \cdot 3.1416}$

1.3) Periodic Time for SHM Formula

Evaluate Formula

Formula	Example with Units
$t_p = 2 \cdot \pi \cdot \sqrt{\frac{d_m}{g}}$	$5\,\text{s} = 2 \cdot 3.1416 \cdot \sqrt{\frac{6206\,\text{mm}}{9.8\,\text{m/s}^2}}$

1.4) Periodic Time of Particle Moving with Angular Simple Harmonic Motion Formula

Evaluate Formula

Formula	Example with Units
$t_p = 2 \cdot \pi \cdot \sqrt{\frac{\theta}{\alpha}}$	$4.9934\,\text{s} = 2 \cdot 3.1416 \cdot \sqrt{\frac{120\,\text{rad}}{190\,\text{rad/s}^2}}$

2) Closely Coiled Helical Spring Formulas

2.1) Deflection of Spring when Mass m is Attached to it Formula

Evaluate Formula

Formula	Example with Units
$\delta = M \cdot \frac{g}{k}$	$6164.7529\,\text{mm} = 12.6\,\text{kg} \cdot \frac{9.8\,\text{m/s}^2}{20.03\,\text{N/m}}$

2.2) Frequency of Mass Attached to Closely Coiled Helical Spring which is Hanged Vertically Formula

Evaluate Formula

Formula

$$f = \frac{\sqrt{\frac{k}{M}}}{2 \cdot \pi}$$

Example with Units

$$0.2007\,\text{Hz} = \frac{\sqrt{\frac{20.03\,\text{N/m}}{12.6\,\text{kg}}}}{2 \cdot 3.1416}$$

2.3) Frequency of Mass Attached to Spring of given Mass Formula

Evaluate Formula

Formula

$$f = \frac{\sqrt{\frac{k}{M + \frac{m}{3}}}}{2 \cdot \pi}$$

Example with Units

$$0.2004\,\text{Hz} = \frac{\sqrt{\frac{20.03\,\text{N/m}}{12.6\,\text{kg} + \frac{0.1\,\text{kg}}{3}}}}{2 \cdot 3.1416}$$

2.4) Periodic Time of Mass Attached to Closely Coiled Helical Spring which is Hanged Vertically Formula

Evaluate Formula

Formula

$$t_p = 2 \cdot \pi \cdot \sqrt{\frac{M}{k}}$$

Example with Units

$$4.9834\,\text{s} = 2 \cdot 3.1416 \cdot \sqrt{\frac{12.6\,\text{kg}}{20.03\,\text{N/m}}}$$

2.5) Periodic Time of Mass Attached to Spring of given Mass Formula

Evaluate Formula

Formula

$$t_p = 2 \cdot \pi \cdot \sqrt{\frac{M + \frac{m}{3}}{k}}$$

Example with Units

$$4.99\,\text{s} = 2 \cdot 3.1416 \cdot \sqrt{\frac{12.6\,\text{kg} + \frac{0.1\,\text{kg}}{3}}{20.03\,\text{N/m}}}$$

2.6) Restoring Force Due to Spring Formula

Evaluate Formula

Formula

$$F = k \cdot x$$

Example with Units

$$2.5038\,\text{N} = 20.03\,\text{N/m} \cdot 125\,\text{mm}$$

3) Compound Pendulum Formulas

3.1) Frequency of Compound Pendulum in SHM Formula

Evaluate Formula

Formula

$$f = \frac{1}{t'_p}$$

Example with Units

$$0.2\,\text{Hz} = \frac{1}{5.00\,\text{s}}$$

3.2) Minimum Periodic Time of SHM for Compound Pendulum Formula

Evaluate Formula

Formula

$$t_p = 2 \cdot \pi \cdot \sqrt{2 \cdot \frac{k_G}{g}}$$

Example with Units

$$5\,\text{s} = 2 \cdot 3.1416 \cdot \sqrt{2 \cdot \frac{3103\,\text{mm}}{9.8\,\text{m/s}^2}}$$

3.3) Periodic Time of SHM for Compound Pendulum given Radius of Gyration Formula

Evaluate Formula

Formula

$$t'_p = 2 \cdot \pi \cdot \sqrt{\frac{k_G^2 + h^2}{g \cdot h}}$$

Example with Units

$$5\,\text{s} = 2 \cdot 3.1416 \cdot \sqrt{\frac{3103\,\text{mm}^2 + 3100\,\text{mm}^2}{9.8\,\text{m/s}^2 \cdot 3100\,\text{mm}}}$$

4) Simple Pendulum Formulas

4.1) Angular Acceleration of String Formula

Evaluate Formula

Formula

$$\alpha = g \cdot \frac{\theta}{L_s}$$

Example with Units

$$190.2913\,\text{rad/s}^2 = 9.8\,\text{m/s}^2 \cdot \frac{120\,\text{rad}}{6180\,\text{mm}}$$

4.2) Angular Frequency of Simple Pendulum Formula

Evaluate Formula

Formula

$$\omega = \sqrt{\frac{g}{L}}$$

Example with Units

$$2.7456\,\text{rad/s} = \sqrt{\frac{9.8\,\text{m/s}^2}{1300\,\text{mm}}}$$

4.3) Angular Frequency of Spring of given Stiffness Constant Formula

Evaluate Formula

Formula

$$\omega = \sqrt{\frac{K_s}{M}}$$

Example with Units

$$2.0119\,\text{rad/s} = \sqrt{\frac{51\,\text{N/m}}{12.6\,\text{kg}}}$$

4.4) Periodic Time for One Beat of SHM Formula

Evaluate Formula

Formula

$$t_p = \pi \cdot \sqrt{\frac{L_s}{g}}$$

Example with Units

$$2.4948\,\text{s} = 3.1416 \cdot \sqrt{\frac{6180\,\text{mm}}{9.8\,\text{m/s}^2}}$$

4.5) Restoring Torque for Simple Pendulum Formula

Evaluate Formula

Formula

$$\tau = M \cdot g \cdot \sin\left(\theta_d\right) \cdot L_s$$

Example with Units

$$547.419\,\text{N*m} = 12.6\,\text{kg} \cdot 9.8\,\text{m/s}^2 \cdot \sin\left(0.8\,\text{rad}\right) \cdot 6180\,\text{mm}$$

5) Stiffness Formulas

5.1) Stiffness of Cantilever Beam Formula

Evaluate Formula

Formula

$$\kappa = \frac{3 \cdot E \cdot I}{L^3}$$

Example with Units

$$993.4001\,\text{N/m} = \frac{3 \cdot 15\,\text{N/m} \cdot 48.5\,\text{kg·m²}}{1300\,\text{mm}^3}$$

5.2) Stiffness of Fixed-Fixed Beam with Load at Middle Formula

Evaluate Formula

Formula

$$K = \frac{192 \cdot E \cdot I}{L^3}$$

Example with Units

$$17.3036\,\text{N/m} = \frac{192 \cdot 15\,\text{N/m} \cdot 0.0132\,\text{kg·m²}}{1300\,\text{mm}^3}$$

5.3) Stiffness of Rod under Axial Load Formula

Evaluate Formula

Formula

$$K = \frac{E \cdot A_c}{L}$$

Example with Units

$$17.3077\,\text{N/m} = \frac{15\,\text{N/m} \cdot 1.5\,\text{m²}}{1300\,\text{mm}}$$

5.4) Stiffness of Tapered Rod under Axial Load Formula

Evaluate Formula

Formula

$$K = \frac{\pi \cdot E \cdot d_1 \cdot d_2}{4 \cdot L}$$

Example with Units

$$17.3144\,\text{N/m} = \frac{3.1416 \cdot 15\,\text{N/m} \cdot 466000.2\,\text{mm} \cdot 4.1\,\text{mm}}{4 \cdot 1300\,\text{mm}}$$

Variables used in list of Simple Harmonic Motion Formulas above

- A_c Rod Cross Sectional Area *(Square Meter)*
- d_1 End Diameter 1 *(Millimeter)*
- d_2 End Diameter 2 *(Millimeter)*
- d_m Total Displacement *(Millimeter)*
- **E** Young's Modulus *(Newton per Meter)*
- **f** Frequency *(Hertz)*
- **F** Force *(Newton)*
- **g** Acceleration Due to Gravity *(Meter per Square Second)*
- **h** Distance of PT of Suspension of Pendulum From CG *(Millimeter)*
- **I** Moment of Inertia *(Kilogram Square Meter)*
- **k** Stiffness of Spring *(Newton per Meter)*
- **K** Stiffness Constant *(Newton per Meter)*
- k_G Radius of Gyration *(Millimeter)*
- K_s Spring Constant *(Newton per Meter)*
- **L** Total Length *(Millimeter)*
- L_s Length of String *(Millimeter)*
- **m** Mass of Spring *(Kilogram)*
- **M** Mass of Body *(Kilogram)*
- t_p Time Period SHM *(Second)*
- t'_p Periodic Time for Compound Pendulum *(Second)*
- **x** Displacement of Load Below Equilibrium Position *(Millimeter)*
- **α** Angular Acceleration *(Radian per Square Second)*
- **δ** Deflection of Spring *(Millimeter)*
- **θ** Angular Displacement *(Radian)*
- θ_d Angle through which the String is Displaced *(Radian)*
- **I** Moment of Inertia of Beam About Bending Axis *(Kilogram Square Meter)*
- **κ** Spring Constant of Cantilever Beam *(Newton per Meter)*
- **τ** Torque Exerted on Wheel *(Newton Meter)*

Constants, Functions, Measurements used in list of Simple Harmonic Motion Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **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.*
- Functions: **sqrt**, sqrt(Number) *A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- Measurement: **Length** in Millimeter (mm) *Length Unit Conversion*
- Measurement: **Weight** in Kilogram (kg) *Weight Unit Conversion*
- Measurement: **Time** in Second (s) *Time Unit Conversion*
- Measurement: **Area** in Square Meter (m²) *Area 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 Radian (rad) *Angle Unit Conversion*
- Measurement: **Frequency** in Hertz (Hz) *Frequency Unit Conversion*
- Measurement: **Surface Tension** in Newton per Meter (N/m) *Surface Tension Unit Conversion*
- Measurement: **Torque** in Newton Meter (N*m) *Torque Unit Conversion*
- Measurement: **Moment of Inertia** in Kilogram Square Meter (kg·m²) *Moment of Inertia Unit Conversion*
- Measurement: **Angular Acceleration** in Radian per Square Second (rad/s²) *Angular Acceleration Unit Conversion*

- **ω** Angular Frequency *(Radian per Second)*

- Measurement: **Angular Frequency** in Radian per Second (rad/s)
  Angular Frequency Unit Conversion
- Measurement: **Stiffness Constant** in Newton per Meter (N/m)
  Stiffness Constant Unit Conversion

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