

Work

$$W = Fd \cos\theta$$

Work done by gravity

$$PE: U_g = mgh$$

Gravitational Potential Energy

$$U_g = mgh$$

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Work and Potential Energy

$$\Delta U = U_b - U_a = \int_a^b F(x) \cdot dx$$

Work Done by Variable Force

$$Work = \int_{x_i}^{x_f} F(x) \cdot dx$$

Work – Energy Theorem

$$W_{net} = \Delta KE$$

$$W_{net} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

Work Done by Spring / Potential Energy of spring

$$W_s = \frac{1}{2}k\Delta x^2$$

$$U_s = \frac{1}{2}k\Delta x^2$$

Kinetic Energy

$$KE = \frac{1}{2}mv^2$$

Power

$$P = \frac{W}{t} = \frac{Fd}{t}$$

$$P = Fv$$

Mechanical Energy

$$ME = K + U$$

$$ME_i = ME_f$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

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Mechanical Energy or Total Energy

Hooke's Law - Spring Force

Vertically hanging Spring

$$ME = \frac{1}{2}kA^2 = \frac{1}{2}mv^2 + \frac{1}{2}k\Delta x^2$$

$$F = k\Delta x$$

$$U_s = \frac{1}{2}k\Delta x^2 + mgh$$

Speed at any point

$$v = \sqrt{(A^2 - x^2) \frac{k}{m}}$$

Linear Momentum

$$P = mv$$

Impulse Momentum

$$I = J = \Delta P = F\Delta t$$

Momentum of Kinetic Energy

$$P^2 = KE 2m$$

Conservation of Momentum and Collisions

$$P_i = P_f$$

$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$$

Perfectly Inelastic

$$m_1v_{1i} + m_2v_{2i} = m_1v_f + m_2v_f$$

$$m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$$

Impulse of a Force given as a Function of time

$$I = J = \Delta P = \int_{t_1}^{t_2} F(x) \cdot dt = F_{avg} \Delta t$$

Recoil Momentum

$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$$

In Recoil Momentum the first side is usually zero (not always)

$$0 = m_1v_{1f} + m_2v_{2f}$$

$$m_1v_{1f} = -m_2v_{2f}$$

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Conservation of 2 – Dimensional Collisions

$$P_f = \sqrt{(P_{fx})^2 + (P_{fy})^2}$$

Direction of Final Momentum

$$\theta = \tan^{-1} \left(\frac{P_{fy}}{P_{fx}} \right)$$

Speed

$$v_f = \left(\frac{P_f}{m_1 + m_2} \right)$$

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Kinematics

$$v_f^2 = v_i^2 + 2a\Delta x$$

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Elastic Collisions

Momentum

$$P_i = P_f$$

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

Kinetic Energy

$$\frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_2 v_{2i}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$$

$W = \text{Work (J)}, F = \text{Force (N)}, d = \text{distance (m)}, \theta = \text{Angle (°)}, x_i = \text{Initial distance (m)}, x_f = \text{Final distance (m)},$

$F(x) = \text{Force as a function of } x (\text{N}), dx = \text{Distance (m)}, KE = \text{Kinetic Energy (J)},$

$m = \text{mass (kg)}, v = \text{velocity (m/s)}, PE = \text{Potential Energy (J)}, g = \text{gravity} = 9.8/-9.8 (\text{m/s}^2), h = \text{height (m)}, P =$

$\text{Power (W)}, P = \text{Momentum (kg·m/s)}, U = \text{Potential Energy (J)},$

$U_g = \text{Gravitational Potential Energy (J)}, U_s = \text{Potential energy of a spring (J)}, W_s$

$= \text{Work Done by spring (J)}, t = \text{time (s)}, \Delta x = \text{Distance/Displacement (m)}, ME = \text{Mechanical Energy (J)},$

$A = \text{Amplitude/Maximum Displacement (m)}, k = \text{Spring Constant (N/m)}, \Delta = \text{Difference/change in}, I =$

$\text{Momentum (kg·m/s)}, J = \text{Momentum (kg·m/s)}, a = \text{acceleration (m/s}^2)$

Note:

You can use

$$F = m \times g$$

$g = 9.8/-9.8$ (always)

To get the Force and use it when it's not given

For Example

$$W = Fd \cos \theta$$

$d = 10\text{m}, \theta = 30^\circ, m = 4\text{kg}$, find Work

$$W = (m \times g) d \cos \theta$$