Important Equations of Motion and Energy Equation Formulas PDF

Formulas
Examples
with Units

List of 22
Important Equations of Motion and Energy Equation Formulas

1) Elbow Meter Formulas

1.1) Coefficient of Discharge of Elbow Meter given Discharge Formula

Evaluate Formula

Formula

$$C_d = \frac{q}{A \cdot \left(\sqrt{2 \cdot g \cdot h_{elbowmeter}}\right)}$$

Example with Units

$$0.6313 = \frac{5\,m^3/s}{2\,m^2 \cdot \left(\sqrt{2 \cdot 9.8\,m/s^2 \cdot 0.8\,m}\right)}$$

1.2) Cross-Sectional Area of Elbow Meter given Discharge Formula

Evaluate Formula

Formula

$$A = \frac{q}{C_d \cdot \left(\sqrt{2 \cdot g \cdot h_{elbowmeter}}\right)}$$

Example with Units

$$1.9132\,m^2 = \frac{5\,m^3/s}{0.66 \cdot \left(\sqrt{2 \cdot 9.8\,m/s^2 \cdot 0.8\,m}\right)}$$

1.3) Differential Pressure Head of Elbow Meter Formula

Evaluate Formula

Formula

$$H_{Pressurehead} = \frac{\left(\frac{q}{C_d \cdot A}\right)^2}{2 \cdot 9.81}$$

Example with Units

$$0.7313\,m = \frac{\left(\frac{5\,m^3/s}{0.66 \cdot 2\,m^2}\right)^2}{2 \cdot 9.81}$$

1.4) Discharge through Pipe in Elbowmeter Formula

Evaluate Formula

Formula

$$q = C_d \cdot A \cdot \left(\sqrt{2 \cdot g \cdot h_{elbowmeter}}\right)$$

Example with Units

$$5.2269\,m^3/s = 0.66 \cdot 2\,m^2 \cdot \left(\sqrt{2 \cdot 9.8\,m/s^2 \cdot 0.8\,m}\right)$$

2) Euler's Equation of Motion Formulas

2.1) Datum Height at Section 1 from Bernoulli Equation Formula

Evaluate Formula

Formula

$$Z_1 = \frac{P_2}{\gamma_f} + 0.5 \cdot \frac{V_{p2}^2}{[g]} + Z_2 - \frac{P_1}{\gamma_f} - 0.5 \cdot \frac{V_1^2}{[g]}$$

Example with Units

$$11.4763\,\text{m} = \frac{10\,\text{N/mm}^2}{9.81\,\text{kN/m}^3} + 0.5 \cdot \frac{34\,\text{m/s}^2}{9.8066\,\text{m/s}^2} + 12.1\,\text{m} - \frac{8.9\,\text{N/mm}^2}{9.81\,\text{kN/m}^3} - 0.5 \cdot \frac{58.03\,\text{m/s}^2}{9.8066\,\text{m/s}^2}$$

2.2) Datum Height using Piezometric Head for Steady Non-Viscous Flow Formula

Evaluate Formula

Formula

$$Z_1 = P - \frac{P_h}{\gamma_f}$$

Example with Units

$$11.9185\,\text{m} = 12\,\text{m} - \frac{800\,\text{Pa}}{9.81\,\text{kN/m}^3}$$

2.3) Piezometric Head for Steady Non Viscous Flow Formula

Evaluate Formula

Formula

$$P = \left(\frac{P_h}{\gamma_f}\right) + h$$

Example with Units

$$12.0815\,\text{m} = \left(\frac{800\,\text{Pa}}{9.81\,\text{kN/m}^3}\right) + 12\,\text{m}$$

2.4) Pressure at Section 1 from Bernoulli Equation Formula

Evaluate Formula

Formula

$$P_1 = \gamma_f \cdot \left(\left(\frac{P_2}{\gamma_f}\right) + \left(0.5 \cdot \left(\frac{V_{p2}^2}{[g]}\right)\right) + Z_2 - Z_1 - \left(0.5 \cdot \left(\frac{V_1^2}{[g]}\right)\right)\right)$$

Example with Units

$$8.9037\,\text{N/mm}^2 = 9.81\,\text{kN/m}^3 \cdot \left(\left(\frac{10\,\text{N/mm}^2}{9.81\,\text{kN/m}^3}\right) + \left(0.5 \cdot \left(\frac{34\,\text{m/s}^2}{9.8066\,\text{m/s}^2}\right)\right) + 12.1\,\text{m} - 11.1\,\text{m} - \left(0.5 \cdot \left(\frac{58.03\,\text{m/s}^2}{9.8066\,\text{m/s}^2}\right)\right)\right)$$

2.5) Pressure Head for Steady Non Viscous Flow Formula

Evaluate Formula

Formula

$$h_p = \frac{P_h}{\gamma_f}$$

Example with Units

$$81.5494\,\text{mm} = \frac{800\,\text{Pa}}{9.81\,\text{kN/m}^3}$$

2.6) Pressure using Pressure Head for Steady Non Viscous Flow Formula

Evaluate Formula

Formula

$$P_h = \gamma_f \cdot h_p$$

Example with Units

$$804.42\,\text{Pa} = 9.81\,\text{kN/m}^3 \cdot 82\,\text{mm}$$

2.7) Velocity at Section 1 from Bernoulli Equation Formula

Evaluate Formula

Formula

$$V_1 = \sqrt{2 \cdot [g] \cdot \left(\left(\frac{P_2}{\gamma_f} \right) + \left(0.5 \cdot \left(\frac{V_{p2}^2}{[g]} \right) \right) + Z_2 - Z_1 - \frac{P_1}{\gamma_f} \right)}$$

Example with Units

$$58.0936\,\text{m/s} = \sqrt{2 \cdot 9.8066\,\text{m/s}^2 \cdot \left(\left(\frac{10\,\text{N/mm}^2}{9.81\,\text{kN/m}^3} \right) + \left(0.5 \cdot \left(\frac{34\,\text{m/s}^2}{9.8066\,\text{m/s}^2} \right) \right) + 12.1\,\text{m} - 11.1\,\text{m} - \frac{8.9\,\text{N/mm}^2}{9.81\,\text{kN/m}^3} \right)}$$

2.8) Velocity Head for Steady Non Viscous Flow Formula

Evaluate Formula

Formula

$$V_h = \frac{V^2}{2} \cdot [g]$$

Example with Units

$$8.2866\,\text{m} = \frac{1.3\,\text{m/s}^2}{2} \cdot 9.8066\,\text{m/s}^2$$

2.9) Velocity of Flow given Velocity Head for Steady Non Viscous Flow Formula

Evaluate Formula

Formula

$$V = \sqrt{V_h \cdot 2 \cdot [g]}$$

Example with Units

$$12.6818\,\text{m/s} = \sqrt{8.2\,\text{m} \cdot 2 \cdot 9.8066\,\text{m/s}^2}$$

3) Forces Acting on Fluid in Motion Formulas

3.1) Acceleration of Fluid given Sum of Total Forces influencing Motion of Fluid Formula

Evaluate Formula

Formula

$$a_f = \frac{F_g + F_p + F_C + F_s + F_v + F_t}{M_f}$$

Example with Units

$$1.7366\,\text{m/s}^2 = \frac{10.10\,\text{N} + 10.12\,\text{N} + 9.99\,\text{N} + 10.13\,\text{N} + 10.14\,\text{N} + 10.3\,\text{N}}{35\,\text{kg}}$$

3.2) Compressibility Force given Sum of Total Forces influencing Motion of Fluid Formula

Evaluate Formula

Formula

$$F_C = F - \left(F_g + F_p + F_s + F_v + F_t \right)$$

Example with Units

$$9.21\,\text{N} = 60\,\text{N} - \left(10.10\,\text{N} + 10.12\,\text{N} + 10.13\,\text{N} + 10.14\,\text{N} + 10.3\,\text{N} \right)$$

3.3) Gravity Force given Sum of Total Forces influencing Motion of Fluid Formula

Evaluate Formula

Formula

$$F_g = F - \left(F_p + F_C + F_s + F_v + F_t \right)$$

Example with Units

$$9.32\,\text{N} = 60\,\text{N} - \left(10.12\,\text{N} + 9.99\,\text{N} + 10.13\,\text{N} + 10.14\,\text{N} + 10.3\,\text{N} \right)$$

3.4) Mass of Fluid given Sum of Total Forces influencing Motion of Fluid Formula

Evaluate Formula

Formula

$$M_f = \frac{F_g + F_p + F_C + F_s + F_v + F_t}{a_f}$$

Example with Units

$$35.7529\,\text{kg} = \frac{10.10\,\text{N} + 10.12\,\text{N} + 9.99\,\text{N} + 10.13\,\text{N} + 10.14\,\text{N} + 10.3\,\text{N}}{1.7\,\text{m/s}^2}$$

3.5) Pressure Force given Sum of Total Forces influencing Motion of Fluid Formula

Evaluate Formula

Formula

$$F_p = F - \left(F_g + F_C + F_s + F_v + F_t \right)$$

Example with Units

$$9.34\,\text{N} = 60\,\text{N} - \left(10.10\,\text{N} + 9.99\,\text{N} + 10.13\,\text{N} + 10.14\,\text{N} + 10.3\,\text{N} \right)$$

3.6) Sum of Total Forces Influencing Motion of Fluid Formula

Evaluate Formula

Formula

$$F = F_g + F_p + F_C + F_s + F_v + F_t$$

Example with Units

$$60.78\,\text{N} = 10.10\,\text{N} + 10.12\,\text{N} + 9.99\,\text{N} + 10.13\,\text{N} + 10.14\,\text{N} + 10.3\,\text{N}$$

3.7) Surface Tension Force given Sum of Total Forces influencing Motion of Fluid Formula

Evaluate Formula

Formula

$$F_s = F - \left(F_g + F_p + F_C + F_v + F_t \right)$$

Example with Units

$$9.35\,\text{N} = 60\,\text{N} - \left(10.10\,\text{N} + 10.12\,\text{N} + 9.99\,\text{N} + 10.14\,\text{N} + 10.3\,\text{N} \right)$$

3.8) Turbulent Force given Sum of Total Forces influencing Motion of Fluid Formula

Evaluate Formula

Formula

$$F_t = F - \left(F_g + F_p + F_C + F_s + F_v \right)$$

Example with Units

$$9.52\,\text{N} = 60\,\text{N} - \left(10.10\,\text{N} + 10.12\,\text{N} + 9.99\,\text{N} + 10.13\,\text{N} + 10.14\,\text{N} \right)$$

3.9) Viscous Force given Sum of Total Forces influencing Motion of Fluid Formula

Evaluate Formula

Formula

$$F_v = F - \left(F_g + F_p + F_C + F_s + F_t \right)$$

Example with Units

$$9.36\,\text{N} = 60\,\text{N} - \left(10.10\,\text{N} + 10.12\,\text{N} + 9.99\,\text{N} + 10.13\,\text{N} + 10.3\,\text{N} \right)$$

Variables used in list of Equations of Motion and Energy Equation Formulas above

- **A** Cross Sectional Area of Pipe *(Square Meter)*
- a_f Acceleration of Fluid *(Meter per Square Second)*
- C_d Coefficient of Discharge
- **F** Force of Fluid *(Newton)*
- F_C Compressibility Force *(Newton)*
- F_g Gravity Force *(Newton)*
- F_p Pressure Force *(Newton)*
- F_s Surface Tension Force *(Newton)*
- F_t Turbulent Force *(Newton)*
- F_v Viscous Force *(Newton)*
- **g** Acceleration due to Gravity *(Meter per Square Second)*
- **h** Height of Section *(Meter)*
- $h_{elbowmeter}$ Elbowmeter Height *(Meter)*
- h_p Pressure Head *(Millimeter)*
- $H_{Pressurehead}$ Difference in Pressure Head *(Meter)*
- M_f Mass of Fluid *(Kilogram)*
- **P** Piezometric Head *(Meter)*
- P_1 Pressure at Section 1 *(Newton per Square Millimeter)*
- P_2 Pressure at Section 2 *(Newton per Square Millimeter)*
- P_h Pressure of Fluid *(Pascal)*
- **q** Discharge of Pipe Through Elbow meter *(Cubic Meter per Second)*
- **V** Velocity of Fluid *(Meter per Second)*
- V_1 Velocity at Point 1 *(Meter per Second)*
- V_h Velocity Head *(Meter)*
- V_{p2} Velocity at Point 2 *(Meter per Second)*
- Z_1 Datum Height at Section 1 *(Meter)*
- Z_2 Datum Height at Section 2 *(Meter)*
- γ_f Specific Weight of Liquid *(Kilonewton per Cubic Meter)*

Constants, Functions, Measurements used in list of Equations of Motion and Energy Equation Formulas above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- 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 Meter (m), Millimeter (mm)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Newton per Square Millimeter (N/mm²), Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Acceleration** in Meter per Square Second (m/s²)
  Acceleration Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Specific Weight** in Kilonewton per Cubic Meter (kN/m³)
  Specific Weight Unit Conversion

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