# Impulse Momentum Equation and its Applications Formulas

# List of 41 Impulse Momentum Equation and its Applications Formulas

## Impulse Momentum Equation and its Applications

## Angular Momentum Principles

### 1) Change in Rate of Flow given Torque Exerted on Fluid

Open Calculator

fx $$q_{flow} = \frac{\tau}{r2 \cdot V_2 - r1 \cdot V_1} \cdot \Delta$$

ex $$24.13728\text{m}^3/\text{s} = \frac{91\text{N*m}}{6.3\text{m} \cdot 61.45\text{m/s} - 2\text{m} \cdot 101.2\text{m/s}} \cdot 49\text{m}$$

### 2) Radial Distance r1 given Torque Exerted on Fluid

Open Calculator

fx $$r1 = \frac{\left(r2 \cdot V_2 \cdot q_{flow}\right) - \left(\tau \cdot \Delta\right)}{q_{flow} \cdot V_1}$$

ex $$1.989559\text{m} = \frac{\left(6.3\text{m} \cdot 61.45\text{m/s} \cdot 24\text{m}^3/\text{s}\right) - \left(91\text{N*m} \cdot 49\text{m}\right)}{24\text{m}^3/\text{s} \cdot 101.2\text{m/s}}$$

## 3) Radial Distance r2 given Torque Exerted on Fluid

Open Calculator

fx $$r2 = \frac{\left(\frac{\tau}{q_{flow}} \cdot \Delta\right) + r1 \cdot V_1}{V_2}$$

ex $$6.317196\text{m} = \frac{\left(\frac{91\text{N*m}}{24\text{m}^3/\text{s}} \cdot 49\text{m}\right) + 2\text{m} \cdot 101.2\text{m/s}}{61.45\text{m/s}}$$

## 4) Torque Exerted on Fluid

Open Calculator

fx $$\tau = \left(\frac{q_{flow}}{\Delta}\right) \cdot (r2 \cdot V_2 - r1 \cdot V_1)$$

ex $$90.48245\text{N*m} = \left(\frac{24\text{m}^3/\text{s}}{49\text{m}}\right) \cdot (6.3\text{m} \cdot 61.45\text{m/s} - 2\text{m} \cdot 101.2\text{m/s})$$

## 5) Velocity at Radial Distance r1 given Torque Exerted on Fluid

Open Calculator

fx $$V_1 = \frac{q_{flow} \cdot r2 \cdot V_2 - (\tau \cdot \Delta)}{r1 \cdot q_{flow}}$$

ex $$100.6717\text{m/s} = \frac{24\text{m}^3/\text{s} \cdot 6.3\text{m} \cdot 61.45\text{m/s} - (91\text{N*m} \cdot 49\text{m})}{2\text{m} \cdot 24\text{m}^3/\text{s}}$$

### 6) Velocity at Radial Distance r2 given Torque Exerted on Fluid

Open Calculator

fx $$V_2 = \frac{q_{flow} \cdot r1 \cdot V_1 + (\tau \cdot \Delta)}{q_{flow} \cdot r2}$$

ex $$61.61772\text{m/s} = \frac{24\text{m}^3\text{/s} \cdot 2\text{m} \cdot 101.2\text{m/s} + (91\text{N*m} \cdot 49\text{m})}{24\text{m}^3\text{/s} \cdot 6.3\text{m}}$$

# Jet Propulsion Reaction of Jet

## Jet Propulsion of Orifice Tank

### 7) Actual Velocity given Force exerted on Tank due to Jet

Open Calculator

fx $$v = \sqrt{\frac{F \cdot [g]}{\gamma_f \cdot A_{Jet}}}$$

ex $$14.13972\text{m/s} = \sqrt{\frac{240\text{N} \cdot [g]}{9.81\text{kN/m}^3 \cdot 1.2\text{m}^2}}$$

### 8) Area of Hole given Coefficient of Velocity for Jet

Open Calculator

fx $$A_{Jet} = \frac{0.5 \cdot F}{\gamma_f \cdot h \cdot C_v^2}$$

ex $$1.193418\text{m}^2 = \frac{0.5 \cdot 240\text{N}}{9.81\text{kN/m}^3 \cdot 12.11\text{m} \cdot (0.92)^2}$$

## 9) Area of Jet given Force exerted on Tank due to Jet

Open Calculator

$$A_{Jet} = \frac{F}{\gamma_f \cdot \frac{v^2}{[g]}}$$

$$1.20677\text{m}^2 = \frac{240\text{N}}{9.81\text{kN/m}^3 \cdot \frac{(14.1\text{m/s})^2}{[g]}}$$

## 10) Force exerted on Tank due to Jet

Open Calculator

$$F = \gamma_f \cdot A_{Jet} \cdot \frac{v^2}{[g]}$$

$$238.6535\text{N} = 9.81\text{kN/m}^3 \cdot 1.2\text{m}^2 \cdot \frac{(14.1\text{m/s})^2}{[g]}$$

## 11) Head over Jet Hole given Force exerted on Tank due to Jet

Open Calculator

$$h = \frac{0.5 \cdot F}{\left(C_v^2\right) \cdot \gamma_f \cdot A_{Jet}}$$

$$12.04357\text{m} = \frac{0.5 \cdot 240\text{N}}{\left((0.92)^2\right) \cdot 9.81\text{kN/m}^3 \cdot 1.2\text{m}^2}$$

### 12) Specific Weight of Liquid given Coefficient of Velocity for Jet

Open Calculator

fx $$\gamma_f = \frac{0.5 \cdot F}{A_{Jet} \cdot h \cdot C_v^2}$$

ex $$9.756189\text{kN/m}^3 = \frac{0.5 \cdot 240\text{N}}{1.2\text{m}^2 \cdot 12.11\text{m} \cdot (0.92)^2}$$

### 13) Specific Weight of Liquid given Force exerted on Tank due to Jet

Open Calculator

fx $$\gamma_f = \left(\frac{F \cdot [g]}{A_{Jet} \cdot (v)^2}\right)$$

ex $$9.865349\text{kN/m}^3 = \left(\frac{240\text{N} \cdot [g]}{1.2\text{m}^2 \cdot (14.1\text{m/s})^2}\right)$$

## Jet Propulsion of Ships

### 14) Absolute Velocity of Issuing jet given Propelling Force

Open Calculator

fx $$V = [g] \cdot \frac{F}{W_{Water}}$$

ex $$2.353596\text{m/s} = [g] \cdot \frac{240\text{N}}{1000\text{kg}}$$

## 15) Absolute Velocity of Issuing Jet given Relative Velocity

Open Calculator

fx $$V = V_r - u$$

ex $$6\text{m/s} = 10.1\text{m/s} - 4.1\text{m/s}$$

## 16) Area of Issuing Jet given Weight of Water

Open Calculator

fx $$A_{Jet} = \frac{W_{Water}}{\gamma_f \cdot V_r}$$

ex $$10.09275\text{m}^2 = \frac{1000\text{kg}}{9.81\text{kN/m}^3 \cdot 10.1\text{m/s}}$$

## 17) Area of Issuing Jet given Work done by Jet on Ship

Open Calculator

fx $$A_{Jet} = \frac{W \cdot [g]}{V \cdot u \cdot \gamma_f}$$

ex $$6.095479\text{m}^2 = \frac{150\text{J} \cdot [g]}{6\text{m/s} \cdot 4.1\text{m/s} \cdot 9.81\text{kN/m}^3}$$

## 18) Efficiency of Propulsion

Open Calculator

fx $$\eta = 2 \cdot V \cdot \frac{u}{(V + u)^2}$$

ex $$0.482306 = 2 \cdot 6\text{m/s} \cdot \frac{4.1\text{m/s}}{(6\text{m/s} + 4.1\text{m/s})^2}$$

## 19) Efficiency of Propulsion given Head Loss due to Friction

Open Calculator

fx
$$\eta = 2 \cdot V \cdot \frac{u}{(V+u)^2 + 2 \cdot [g] \cdot h}$$

ex
$$0.144907 = 2 \cdot 6\text{m/s} \cdot \frac{4.1\text{m/s}}{(6\text{m/s} + 4.1\text{m/s})^2 + 2 \cdot [g] \cdot 12.11\text{m}}$$

## 20) Kinetic Energy of Water

Open Calculator

fx
$$KE = W_{Water} \cdot \frac{V_f^2}{2 \cdot [g]}$$

ex
$$1274.645\text{J} = 1000\text{kg} \cdot \frac{(5\text{m/s})^2}{2 \cdot [g]}$$

## 21) Propelling Force

Open Calculator

fx
$$F = W_{Water} \cdot \frac{V}{[g]}$$

ex
$$611.8297\text{N} = 1000\text{kg} \cdot \frac{6\text{m/s}}{[g]}$$

### 22) Velocity of Jet Relative to Motion of Ship given Kinetic Energy

Open Calculator

fx $$V_r = \sqrt{KE \cdot 2 \cdot \frac{[g]}{W_{body}}}$$

ex $$20.41237\text{m/s} = \sqrt{1274.64\text{J} \cdot 2 \cdot \frac{[g]}{60\text{N}}}$$

### 23) Velocity of Moving Ship given Relative Velocity

Open Calculator

fx $$u = V_r - V$$

ex $$4.1\text{m/s} = 10.1\text{m/s} - 6\text{m/s}$$

## Momentum Theory of Propellers

### 24) Diameter of Propeller given Thrust on Propeller

Open Calculator

fx $$D = \sqrt{\left(\frac{4}{\pi}\right) \cdot \frac{Ft}{dP}}$$

ex $$14.56731\text{m} = \sqrt{\left(\frac{4}{\pi}\right) \cdot \frac{0.5\text{kN}}{3\text{Pa}}}$$

## 25) Flow Velocity given Power Lost

Open Calculator

fx $$V_f = V - \sqrt{\left( \frac{P_{loss}}{\rho_{Fluid} \cdot q_{flow} \cdot 0.5} \right)}$$

ex $$4.382389\text{m/s} = 6\text{m/s} - \sqrt{\left( \frac{15.7\text{W}}{0.5\text{kg/m}^3 \cdot 24\text{m}^3\text{/s} \cdot 0.5} \right)}$$

## 26) Flow Velocity given Rate of Flow through Propeller

Open Calculator

fx $$V_f = \left( 8 \cdot \frac{q_{flow}}{\pi \cdot D^2} \right) - V$$

ex $$-5.711711\text{m/s} = \left( 8 \cdot \frac{24\text{m}^3\text{/s}}{\pi \cdot (14.56\text{m})^2} \right) - 6\text{m/s}$$

## 27) Flow Velocity given Theoretical Propulsive efficiency

Open Calculator

fx $$V_f = \frac{V}{\frac{2}{\eta} - 1}$$

ex $$4\text{m/s} = \frac{6\text{m/s}}{\frac{2}{0.80} - 1}$$

## 28) Flow Velocity given Thrust on Propeller

Open Calculator

fx $$V_f = -\left(\frac{Ft}{\rho_{Water} \cdot q_{flow}}\right) + V$$

ex $$5.979167\text{m/s} = -\left(\frac{0.5\text{kN}}{1000\text{kg/m}^3 \cdot 24\text{m}^3/\text{s}}\right) + 6\text{m/s}$$

## 29) Input Power

Open Calculator

fx $$P_i = P_{out} + P_{loss}$$

ex $$52\text{J/s} = 36.3\text{W} + 15.7\text{W}$$

## 30) Output Power given Input Power

Open Calculator

fx $$P_{out} = P_i - P_{loss}$$

ex $$36.3\text{W} = 52\text{J/s} - 15.7\text{W}$$

## 31) Output Power given Rate of Flow through Propeller

Open Calculator

fx $$P_{out} = \rho_{Water} \cdot q_{flow} \cdot V_f \cdot (V - V_f)$$

ex $$120000\text{W} = 1000\text{kg/m}^3 \cdot 24\text{m}^3/\text{s} \cdot 5\text{m/s} \cdot (6\text{m/s} - 5\text{m/s})$$

## 32) Power Lost

Open Calculator

fx $$P_{loss} = \rho_{Fluid} \cdot q_{flow} \cdot 0.5 \cdot (V - V_f)^2$$

ex $$6\text{W} = 0.5\text{kg/m}^3 \cdot 24\text{m}^3/\text{s} \cdot 0.5 \cdot (6\text{m/s} - 5\text{m/s})^2$$

## 33) Power Lost given Input Power

Open Calculator

$$P_{loss} = P_i - P_{out}$$

$$15.7\text{W} = 52\text{J/s} - 36.3\text{W}$$

## 34) Rate of Flow given Power Lost

Open Calculator

$$q_{flow} = \frac{P_{loss}}{\rho_{Fluid}} \cdot 0.5 \cdot (V - V_f)^2$$

$$15.7\text{m}^3\text{/s} = \frac{15.7\text{W}}{0.5\text{kg/m}^3} \cdot 0.5 \cdot (6\text{m/s} - 5\text{m/s})^2$$

## 35) Rate of Flow through Propeller

Open Calculator

$$Q = \left(\frac{\pi}{8}\right) \cdot (D^2) \cdot (V + V_f)$$

$$915.7466\text{m}^3\text{/s} = \left(\frac{\pi}{8}\right) \cdot \left((14.56\text{m})^2\right) \cdot (6\text{m/s} + 5\text{m/s})$$

## 36) Theoretical Propulsive Efficiency

Open Calculator

$$\eta = \frac{2}{1 + \left(\frac{V}{V_f}\right)}$$

$$0.909091 = \frac{2}{1 + \left(\frac{6\text{m/s}}{5\text{m/s}}\right)}$$

### 37) Thrust on Propeller

Open Calculator

$$Ft = \left(\frac{\pi}{4}\right) \cdot \left(D^2\right) \cdot dP$$

$$0.499498\text{kN} = \left(\frac{\pi}{4}\right) \cdot \left((14.56\text{m})^2\right) \cdot 3\text{Pa}$$

## Jet Velocity

### 38) Jet Velocity given Output Power

Open Calculator

$$V = \left(\frac{P_{out}}{\rho_{Water} \cdot q_{flow} \cdot V_f}\right) + V_f$$

$$5.000302\text{m/s} = \left(\frac{36.3\text{W}}{1000\text{kg/m}^3 \cdot 24\text{m}^3\text{/s} \cdot 5\text{m/s}}\right) + 5\text{m/s}$$

### 39) Jet Velocity given Power Lost

Open Calculator

$$V = \sqrt{\left(\frac{P_{loss}}{\rho_{Fluid} \cdot q_{flow} \cdot 0.5}\right)} + V_f$$

$$6.617611\text{m/s} = \sqrt{\left(\frac{15.7\text{W}}{0.5\text{kg/m}^3 \cdot 24\text{m}^3\text{/s} \cdot 0.5}\right)} + 5\text{m/s}$$

## 40) Jet Velocity given Theoretical Propulsive Efficiency

Open Calculator

$$V = \left(\frac{2}{\eta} - 1\right) \cdot V_f$$

$$7.5\text{m/s} = \left(\frac{2}{0.80} - 1\right) \cdot 5\text{m/s}$$

## 41) Jet Velocity given Thrust on Propeller

Open Calculator

$$V = \left(\frac{Ft}{\rho_{Water} \cdot q_{flow}}\right) + V_f$$

$$5.020833\text{m/s} = \left(\frac{0.5\text{kN}}{1000\text{kg/m}^3 \cdot 24\text{m}^3/\text{s}}\right) + 5\text{m/s}$$

# Variables Used

- **$A_{Jet}$** Cross Sectional Area of Jet *(Square Meter)*
- **$C_v$** Coefficient of Velocity
- **D** Diameter of Turbine *(Meter)*
- **dP** Change in Pressure *(Pascal)*
- **F** Force of Fluid *(Newton)*
- **Ft** Thrust Force *(Kilonewton)*
- **h** Impulse Height *(Meter)*
- **KE** Kinetic Energy *(Joule)*
- **$P_i$** Total Input Power *(Joule per Second)*
- **$P_{loss}$** Power Loss *(Watt)*
- **$P_{out}$** Output Power *(Watt)*
- **Q** Rate of Flow through Propeller *(Cubic Meter per Second)*
- **$q_{flow}$** Rate of Flow *(Cubic Meter per Second)*
- **r1** Radial Distance 1 *(Meter)*
- **r2** Radial Distance 2 *(Meter)*
- **u** Velocity of Ship *(Meter per Second)*
- **v** Actual Velocity *(Meter per Second)*
- **V** Absolute Velocity of Issuing Jet *(Meter per Second)*
- **$V_1$** Velocity at Point 1 *(Meter per Second)*
- **$V_2$** Velocity at Point 2 *(Meter per Second)*
- **$V_f$** Flow Velocity *(Meter per Second)*
- **$V_r$** Relative Velocity *(Meter per Second)*

- **$W$** Work done *(Joule)*
- **$W_{body}$** Weight of Body *(Newton)*
- **$W_{Water}$** Weight of Water *(Kilogram)*
- **$\gamma_f$** Specific Weight of Liquid *(Kilonewton per Cubic Meter)*
- **$\Delta$** Delta Length *(Meter)*
- **$\eta$** Efficiency of Jet
- **$\rho_{Fluid}$** Density of Fluid *(Kilogram per Cubic Meter)*
- **$\rho_{Water}$** Water Density *(Kilogram per Cubic Meter)*
- **$\tau$** Torque Exerted on Fluid *(Newton Meter)*

# Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  *Archimedes' constant*
- Constant: **[g]**, 9.80665
  *Gravitational acceleration on Earth*
- Function: **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)
  *Length Unit Conversion*
- Measurement: **Weight** in Kilogram (kg)
  *Weight Unit Conversion*
- Measurement: **Area** in Square Meter ($m^2$)
  *Area Unit Conversion*
- Measurement: **Pressure** in Pascal (Pa)
  *Pressure Unit Conversion*
- Measurement: **Speed** in Meter per Second (m/s)
  *Speed Unit Conversion*
- Measurement: **Energy** in Joule (J)
  *Energy Unit Conversion*
- Measurement: **Power** in Watt (W), Joule per Second (J/s)
  *Power Unit Conversion*
- Measurement: **Force** in Newton (N), Kilonewton (kN)
  *Force Unit Conversion*
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second ($m^3/s$)
  *Volumetric Flow Rate Unit Conversion*

- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  *Density Unit Conversion*
- Measurement: **Torque** in Newton Meter (N*m)
  *Torque Unit Conversion*
- Measurement: **Specific Weight** in Kilonewton per Cubic Meter (kN/m³)
  *Specific Weight Unit Conversion*

## Check other formula lists

- Buoyancy And Floatation Formulas
- Culverts Formulas
- Equations of Motion and Energy Equation Formulas
- Flow of Compressible Fluids Formulas
- Flow Over Notches and Weirs Formulas
- Fluid Pressure and Its Measurement Formulas
- Fundamentals of Fluid Flow Formulas
- Hydroelectric Power Generation Formulas
- Hydrostatic Forces on Surfaces Formulas
- Impact of Free Jets Formulas
- Impulse Momentum Equation and its Applications Formulas
- Liquids in Relative Equilibrium Formulas
- Most Efficient Section of Channel Formulas
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