



Impulse Momentum Equation and its Applications Formulas

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List of 41 Impulse Momentum Equation and its Applications Formulas

Angular Momentum Principles 🗗

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

$$\mathbf{f}$$
 $\mathbf{q}_{\mathrm{flow}} = rac{ au}{\mathrm{r} 2 \cdot \mathrm{V}_2 - \mathrm{r} 1 \cdot \mathrm{V}_1} \cdot \Delta$

Open Calculator 🗗

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

2) Radial Distance r1 given Torque Exerted on Fluid

$$\mathbf{r}1 = rac{(\mathbf{r}2 \cdot \mathbf{V}_2 \cdot \mathbf{q}_{\mathrm{flow}}) - (\mathbf{ au} \cdot \Delta)}{\mathbf{q}_{\mathrm{flow}} \cdot \mathbf{V}_1}$$

Open Calculator 🗗





3) Radial Distance r2 given Torque Exerted on Fluid

 $\mathbf{r} = rac{\left(rac{ au}{\mathrm{q}_{\mathrm{flow}}}\cdot\Delta
ight) + \mathrm{r} \mathbf{1}\cdot\mathrm{V}_{1}}{\mathrm{V}_{2}}$

Open Calculator

 $oxed{ex} 6.317196 \mathrm{m} = rac{\left(rac{91 \mathrm{N^*m}}{24 \mathrm{m^3/s}} \cdot 49 \mathrm{m}
ight) + 2 \mathrm{m} \cdot 101.2 \mathrm{m/s}}{61.45 \mathrm{m/s}}$

4) Torque Exerted on Fluid

 $au = \left(rac{ ext{q}_{ ext{flow}}}{\Delta}
ight) \cdot \left(ext{r2} \cdot ext{V}_2 - ext{r1} \cdot ext{V}_1
ight)$

Open Calculator

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

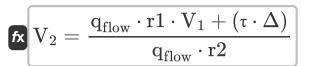
 $ag{V}_1 = rac{{
m q}_{
m flow} \cdot {
m r} 2 \cdot {
m V}_2 - ({
m r} \cdot \Delta)}{{
m r} 1 \cdot {
m q}_{
m flow}}$

Open Calculator

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



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



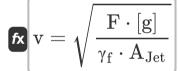
Open Calculator 🚰

 $oxed{egin{align*} egin{align*} egin{align*} egin{align*} egin{align*} egin{align*} egin{align*} egin{align*} egin{align*} 24 ext{m}^3/ ext{s} \cdot 6.3 ext{m} \ & 24 ext{m}^3/ ext{s} \cdot 6.3$

Jet Propulsion - Reaction of Jet 🗗

Jet Propulsion of Orifice Tank

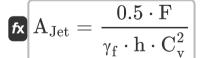
7) Actual Velocity given Force exerted on Tank due to Jet



Open Calculator 🗗

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

8) Area of Hole given Coefficient of Velocity for Jet



Open Calculator

$$ext{ex} 1.193418 ext{m}^2 = rac{0.5 \cdot 240 ext{N}}{9.81 ext{kN/m}^3 \cdot 12.11 ext{m} \cdot \left(0.92
ight)^2}$$





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

 $\mathbf{A}_{\mathrm{Jet}} = rac{\mathbf{F}^{'}}{\gamma_{\mathrm{f}} \cdot rac{\mathrm{v}^{2}}{|\mathrm{g}|}}$

Open Calculator 🗗

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

10) Force exerted on Tank due to Jet

 $\mathbf{F} = \gamma_{\mathrm{f}} \cdot \mathbf{A}_{\mathrm{Jet}} \cdot rac{\mathrm{v}^2}{[\mathrm{g}]}$

Open Calculator

$$\mathbf{ex} = 238.6535 \mathrm{N} = 9.81 \mathrm{kN/m^3 \cdot 1.2m^2 \cdot rac{(14.1 \mathrm{m/s})^2}{[g]}}$$

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

 $h = rac{0.5 \cdot \mathrm{F}}{\left(\mathrm{C_v^2}
ight) \cdot \gamma_\mathrm{f} \cdot \mathrm{A_{Jet}}}$

Open Calculator 🚰

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



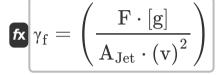
12) Specific Weight of Liquid given Coefficient of Velocity for Jet

 $\gamma_{
m f} = rac{0.5 \cdot {
m F}}{{
m A}_{
m Jet} \cdot {
m h} \cdot {
m C}_{
m v}^2}$

Open Calculator 🗗

 $= \frac{0.5 \cdot 240 \mathrm{N}}{1.2 \mathrm{m}^2 \cdot 12.11 \mathrm{m} \cdot \left(0.92\right)^2}$

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

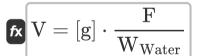


Open Calculator

 $oxed{ex} 9.865349 \mathrm{kN/m^3} = \left(rac{240 \mathrm{N} \cdot [\mathrm{g}]}{1.2 \mathrm{m^2} \cdot \left(14.1 \mathrm{m/s}
ight)^2}
ight)$

Jet Propulsion of Ships 🗗

14) Absolute Velocity of Issuing jet given Propelling Force



Open Calculator 🗗

 $extbf{ex} 2.353596 ext{m/s} = [ext{g}] \cdot rac{240 ext{N}}{1000 ext{kg}}$



Open Calculator 2

Open Calculator

Open Calculator



Open Calculator fx $V = V_r - u$

6 m/s = 10.1 m/s - 4.1 m/s

16) Area of Issuing Jet given Weight of Water

 $\mathbf{K} \mathbf{A}_{\mathrm{Jet}} = rac{\mathbf{W}_{\mathrm{Water}}}{\gamma_{\mathtt{r}} \cdot \mathbf{V}_{\mathtt{r}}}$

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

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

 $\mathbf{f} \mathbf{A} egin{aligned} \mathbf{A}_{\mathrm{Jet}} &= rac{\mathbf{W} \cdot [\mathbf{g}]}{\mathbf{V} \cdot \mathbf{u} \cdot \mathbf{\gamma_f}} \end{aligned}$

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

18) Efficiency of Propulsion

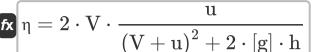
 $\eta = 2 \cdot \mathrm{V} \cdot rac{\mathrm{u}}{\left(\mathrm{V} + \mathrm{u}
ight)^2}$

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





19) Efficiency of Propulsion given Head Loss due to Friction



Open Calculator 🗗

4.1

20) Kinetic Energy of Water



Open Calculator 🖸

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

21) Propelling Force



Open Calculator

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



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

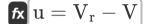


 $V_{
m r} = \sqrt{{
m KE} \cdot 2 \cdot rac{[g]}{W_{
m body}}}$

Open Calculator 🗗

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

23) Velocity of Moving Ship given Relative Velocity

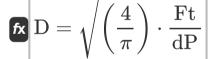


Open Calculator

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

Momentum Theory of Propellers 🗗

24) Diameter of Propeller given Thrust on Propeller 🗲



Open Calculator 🗗

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



25) Flow Velocity given Power Lost

 $V_{
m f} = V - \sqrt{\left(rac{P_{
m loss}}{
ho_{
m Fluid} \cdot q_{
m flow} \cdot 0.5}
ight)}$

Open Calculator 🗗

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

26) Flow Velocity given Rate of Flow through Propeller

 $V_{
m f} = \left(8 \cdot rac{
m q_{
m flow}}{\pi \cdot
m D^2}
ight) - V_{
m f}$

Open Calculator 🗗

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

27) Flow Velocity given Theoretical Propulsive efficiency

 $V_{
m f} = rac{V}{rac{2}{\eta}-1}$

Open Calculator

 $\boxed{ 4\mathrm{m/s} = \frac{6\mathrm{m/s}}{\frac{2}{0.80} - 1} }$



28) Flow Velocity given Thrust on Propeller G

Open Calculator 2

 $\left| \mathbf{V}_{\mathrm{f}} = - \left(rac{\mathbf{F}^{\mathrm{t}}\mathbf{t}}{
ho_{\mathrm{Water}} \cdot \mathbf{q}_{\mathrm{flow}}}
ight) + \mathbf{V}
ight|$

 $ext{ex} \left[5.979167 ext{m/s} = - \left(rac{0.5 ext{kN}}{1000 ext{kg/m}^3 \cdot 24 ext{m}^3/ ext{s}}
ight) + 6 ext{m/s}
ight.$

29) Input Power

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

Open Calculator

Open Calculator

Open Calculator 🚰

Open Calculator

52J/s = 36.3W + 15.7W

30) Output Power given Input Power 🗗

 $P_{\text{out}} = P_{\text{i}} - P_{\text{loss}}$

36.3W = 52J/s - 15.7W

$P_{\mathrm{out}} = ho_{\mathrm{Water}} \cdot q_{\mathrm{flow}} \cdot V_{\mathrm{f}} \cdot (V - V_{\mathrm{f}})$

32) Power Lost

 $\left[P_{loss} =
ho_{Fluid} \cdot q_{flow} \cdot 0.5 \cdot (V - V_f)^2
ight]$

 $extstyle = 0.5 ext{kg/m}^3 \cdot 24 ext{m}^3/ ext{s} \cdot 0.5 \cdot \left(6 ext{m/s} - 5 ext{m/s}
ight)^2$

31) Output Power given Rate of Flow through Propeller 🖸

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



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33) Power Lost given Input Power

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

Open Calculator 🗗

 $m ex \ 15.7W = 52J/s - 36.3W$

34) Rate of Flow given Power Lost

, D,

Open Calculator

 $q_{
m flow} = rac{{
m P}_{
m loss}}{
ho_{
m Fluid}} \cdot 0.5 \cdot {
m (V-V_f)}^2$

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

35) Rate of Flow through Propeller

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

Open Calculator 🗗

 $oxed{ex} 915.7466 \mathrm{m}^3/\mathrm{s} = \left(rac{\pi}{8}
ight) \cdot \left((14.56 \mathrm{m})^2
ight) \cdot (6 \mathrm{m/s} + 5 \mathrm{m/s})$

36) Theoretical Propulsive Efficiency

 $\eta = rac{2}{1 + \left(rac{
m V}{
m V_f}
ight)}$

Open Calculator

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





37) Thrust on Propeller

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

Open Calculator 🗗

Jet Velocity

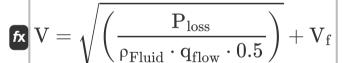
38) Jet Velocity given Output Power

 $V = \left(rac{P_{out}}{
ho_{Water} \cdot q_{flow} \cdot V_f}
ight) + V_f$

Open Calculator 🗗

 $ext{ex} \ \ \, 5.000302 ext{m/s} = \left(rac{36.3 ext{W}}{1000 ext{kg/m}^3 \cdot 24 ext{m}^3/ ext{s} \cdot 5 ext{m/s}}
ight) + 5 ext{m/s}$

39) Jet Velocity given Power Lost



Open Calculator 🗗

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



Open Calculator 2

Open Calculator

40) Jet Velocity given Theoretical Propulsive Efficiency

$$V = \left(rac{2}{\eta} - 1
ight) \cdot V_{
m f}$$

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

41) Jet Velocity given Thrust on Propeller

$$V = \left(rac{\mathrm{Ft}}{
ho_{\mathrm{Water}} \cdot \mathrm{q}_{\mathrm{flow}}}
ight) + \mathrm{V}_{\mathrm{f}}$$

$$ext{ex} \ 5.020833 ext{m/s} = \left(rac{0.5 ext{kN}}{1000 ext{kg/m}^3 \cdot 24 ext{m}^3/ ext{s}}
ight) + 5 ext{m/s}$$



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)
- Pi Total Input Power (Joule per Second)
- Ploss Power Loss (Watt)
- Pout 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)
- V₁ Velocity at Point 1 (Meter per Second)
- V₂ 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)
- Wwater Weight of Water (Kilogram)
- V_f Specific Weight of Liquid (Kilonewton per Cubic Meter)
- ▲ Delta Length (Meter)
- n Efficiency of Jet
- PFluid Density of Fluid (Kilogram per Cubic Meter)
- **P**Water Water Density (Kilogram per Cubic Meter)
- T Torque Exerted on Fluid (Newton Meter)





Constants, Functions, Measurements used

- Constant: pi, 3.14159265358979323846264338327950288
 Archimedes' constant
- Constant: [g], 9.80665 Meter/Second²
 Gravitational acceleration on Earth
- Function: sqrt, sqrt(Number)
 Square root function
- Measurement: Length in Meter (m)
 Length Unit Conversion
- Measurement: Weight in Kilogram (kg)
 Weight Unit Conversion
- Measurement: Area in Square Meter (m²)
 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 (m³/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





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- Impact of Free Jets Formulas
- Impulse Momentum Equation and its Applications Formulas
- Liquids in Relative Equilibrium Formulas
- Most Economical or Most
 Efficient Section of Channel
 Formulas
- Non-uniform Flow in Channels Formulas
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