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Orifices and Mouthpieces Formulas

Calculators! Examples! Conversions!

List of 33 Orifices and Mouthpieces Formulas

Orifices and Mouthpieces

Flow Head

1) Absolute pressure head at constant head and atmospheric pressure head

Open Calculator

fx $$H_{AP} = H_a + H_c - \left(\left(\left(\frac{V_o}{0.62} \right)^2 \right) \cdot \left(\frac{1}{2 \cdot 9.81} \right) \right)$$

ex $$13.48909\text{m} = 7\text{m} + 10.5\text{m} - \left(\left(\left(\frac{5.5\text{m/s}}{0.62} \right)^2 \right) \cdot \left(\frac{1}{2 \cdot 9.81} \right) \right)$$

2) Atmospheric pressure head at constant head and absolute pressure head

Open Calculator

fx $$H_a = H_{AP} - H_c + \left(\left(\left(\frac{V_o}{0.62} \right)^2 \right) \cdot \left(\frac{1}{2 \cdot 9.81} \right) \right)$$

ex $$7.510911\text{m} = 14\text{m} - 10.5\text{m} + \left(\left(\left(\frac{5.5\text{m/s}}{0.62} \right)^2 \right) \cdot \left(\frac{1}{2 \cdot 9.81} \right) \right)$$

3) Head of Liquid above Centre of Orifice

Open Calculator

fx $$H = \frac{V_{th}^2}{2 \cdot 9.81}$$

ex $$4.12844\text{m} = \frac{(9\text{m/s})^2}{2 \cdot 9.81}$$

4) Head of liquid for head loss and coefficient of velocity

Open Calculator

fx $$H = \frac{h_f}{1 - (C_v^2)}$$

ex $$7.8125\text{m} = \frac{1.2\text{m}}{1 - \left((0.92)^2 \right)}$$

5) Loss of head due to fluid resistance

Open Calculator

fx $$h_f = H \cdot \left(1 - \left(C_v^2\right)\right)$$

ex $$6.144\text{m} = 40\text{m} \cdot \left(1 - \left((0.92)^2\right)\right)$$

6) Loss of head due to sudden enlargement

Open Calculator

fx $$h_L = \frac{(V_i - V_o)^2}{2 \cdot 9.81}$$

ex $$0.37156\text{m} = \frac{(8.2\text{m/s} - 5.5\text{m/s})^2}{2 \cdot 9.81}$$

Flow Rate

7) Coefficient of discharge

Open Calculator

fx $$C_d = \frac{Q_a}{Q_{th}}$$

ex $$0.875 = \frac{0.7\text{m}^3/\text{s}}{0.8\text{m}^3/\text{s}}$$

8) Coefficient of discharge for area and velocity

Open Calculator

fx $$C_d = \frac{v_a \cdot A_a}{V_{th} \cdot A_t}$$

ex $$0.820513 = \frac{8\text{m/s} \cdot 4.80\text{m}^2}{9\text{m/s} \cdot 5.2\text{m}^2}$$

9) Coefficient of Discharge given Time for Emptying Tank

Open Calculator

fx $$C_d = \frac{2 \cdot A_T \cdot \left(\left(\sqrt{H_i}\right) - \left(\sqrt{H_f}\right)\right)}{t_{total} \cdot a \cdot \sqrt{2 \cdot 9.81}}$$

ex $$0.786502 = \frac{2 \cdot 1144\text{m}^2 \cdot \left(\left(\sqrt{24\text{m}}\right) - \left(\sqrt{20.1\text{m}}\right)\right)}{30\text{s} \cdot 9.1\text{m}^2 \cdot \sqrt{2 \cdot 9.81}}$$

10) Coefficient of Discharge given Time of Emptying Circular Horizontal Tank

Open Calculator

fx $$C_d = \frac{4 \cdot L \cdot \left(\left(\left((2 \cdot r_1) - H_f \right)^{\frac{3}{2}} \right) - \left((2 \cdot r_1) - H_i \right)^{\frac{3}{2}} \right)}{3 \cdot t_{total} \cdot a \cdot \left(\sqrt{2 \cdot 9.81} \right)}$$

ex $$0.26326 = \frac{4 \cdot 31\text{m} \cdot \left(\left(\left((2 \cdot 12\text{m}) - 20.1\text{m} \right)^{\frac{3}{2}} \right) - \left((2 \cdot 12\text{m}) - 24\text{m} \right)^{\frac{3}{2}} \right)}{3 \cdot 30\text{s} \cdot 9.1\text{m}^2 \cdot \left(\sqrt{2 \cdot 9.81} \right)}$$

11) Coefficient of Discharge given Time of Emptying Hemispherical Tank

Open Calculator

fx $$C_d = \frac{\pi \cdot \left(\left(\left(\frac{4}{3} \right) \cdot R_t \cdot \left(\left(H_i^{\frac{3}{2}} \right) - \left(H_f^{\frac{3}{2}} \right) \right) \right) - \left(\left(\frac{2}{5} \right) \cdot \left(\left(H_i^{\frac{5}{2}} \right) - (H_f)^{\frac{5}{2}} \right) \right) \right)}{t_{total} \cdot a \cdot \left(\sqrt{2 \cdot 9.81} \right)}$$

ex $$0.376754 = \frac{\pi \cdot \left(\left(\left(\frac{4}{3} \right) \cdot 15\text{m} \cdot \left(\left((24\text{m})^{\frac{3}{2}} \right) - \left((20.1\text{m})^{\frac{3}{2}} \right) \right) \right) - \left(\left(\frac{2}{5} \right) \cdot \left(\left((24\text{m})^{\frac{5}{2}} \right) - (20.1\text{m})^{\frac{5}{2}} \right) \right) \right)}{30\text{s} \cdot 9.1\text{m}^2 \cdot \left(\sqrt{2 \cdot 9.81} \right)}$$

12) Discharge in Borda's Mouthpiece Running Free

Open Calculator

fx $$Q_M = 0.5 \cdot A \cdot \sqrt{2 \cdot 9.81 \cdot H_c}$$

ex $$36.60027\text{m}^3/\text{s} = 0.5 \cdot 5.1\text{m}^2 \cdot \sqrt{2 \cdot 9.81 \cdot 10.5\text{m}}$$

13) Discharge in Borda's Mouthpiece Running Full

Open Calculator

fx $$Q_M = 0.707 \cdot A \cdot \sqrt{2 \cdot 9.81 \cdot H_c}$$

ex $$51.75279\text{m}^3/\text{s} = 0.707 \cdot 5.1\text{m}^2 \cdot \sqrt{2 \cdot 9.81 \cdot 10.5\text{m}}$$

14) Discharge in Convergent-Divergent Mouthpiece

Open Calculator

fx $$Q_M = a_c \cdot \sqrt{2 \cdot 9.81 \cdot H_c}$$

ex $$30.1414\text{m}^3/\text{s} = 2.1\text{m}^2 \cdot \sqrt{2 \cdot 9.81 \cdot 10.5\text{m}}$$

15) Discharge through fully sub-merged orifice

Open Calculator

fx $$Q_O = C_d \cdot w \cdot (H_{bottom} - H_{top}) \cdot \left(\sqrt{2 \cdot 9.81 \cdot H_L} \right)$$

ex $$4.157178\text{m}^3/\text{s} = 0.87 \cdot 3.5\text{m} \cdot (20\text{m} - 19.9\text{m}) \cdot \left(\sqrt{2 \cdot 9.81 \cdot 9.5\text{m}} \right)$$

16) Discharge through large rectangular orifice

Open Calculator

fx $$Q_O = \left(\frac{2}{3}\right) \cdot C_d \cdot b \cdot \left(\sqrt{2 \cdot 9.81}\right) \cdot \left(\left(H_{bottom}^{1.5}\right) - \left(H_{top}^{1.5}\right)\right)$$

ex $$3.786716 m^3/s = \left(\frac{2}{3}\right) \cdot 0.87 \cdot 2.2m \cdot \left(\sqrt{2 \cdot 9.81}\right) \cdot \left(\left((20m)^{1.5}\right) - \left((19.9m)^{1.5}\right)\right)$$

17) Discharge through partially sub-merged orifice

Open Calculator

fx $$Q_O = \left(C_d \cdot w \cdot (H_{bottom} - H_L) \cdot \left(\sqrt{2 \cdot 9.81 \cdot H_L}\right)\right) + \left(\left(\frac{2}{3}\right) \cdot C_d \cdot b \cdot \left(\sqrt{2 \cdot 9.81}\right) \cdot \left(\left(H_L^{1.5}\right.\right.\right.$$

ex $$100.2577 m^3/s = \left(0.87 \cdot 3.5m \cdot (20m - 9.5m) \cdot \left(\sqrt{2 \cdot 9.81 \cdot 9.5m}\right)\right) + \left(\left(\frac{2}{3}\right) \cdot 0.87 \cdot 2.2m \cdot \left(\sqrt{2 \cdot 9.81}\right) \cdot \left(\left(\left(\right.\right.\right.\right.$$

Geometric Dimensions

18) Area at vena contracta for discharge and constant head

Open Calculator

fx $$a_c = \frac{Q_M}{\sqrt{2 \cdot 9.81 \cdot H_c}}$$

ex $$2.104083 m^2 = \frac{30.2 m^3/s}{\sqrt{2 \cdot 9.81 \cdot 10.5m}}$$

19) Area of Mouthpiece in Borda's Mouthpiece Running Free

Open Calculator

fx $$A = \frac{Q_M}{0.5 \cdot \sqrt{2 \cdot 9.81 \cdot H_c}}$$

ex $$4.208165 m^2 = \frac{30.2 m^3/s}{0.5 \cdot \sqrt{2 \cdot 9.81 \cdot 10.5m}}$$

20) Area of Mouthpiece in Borda's Mouthpiece Running Full

Open Calculator

fx $$A = \frac{Q_M}{0.707 \cdot \sqrt{2 \cdot 9.81 \cdot H_c}}$$

ex $$2.976072 m^2 = \frac{30.2 m^3/s}{0.707 \cdot \sqrt{2 \cdot 9.81 \cdot 10.5m}}$$

21) Area of Orifice given Time of Emptying Hemispherical Tank

Open Calculator

fx $$a = \frac{\pi \cdot \left(\left(\left(\frac{4}{3} \right) \cdot R_t \cdot \left(\left(H_i^{\frac{3}{2}} \right) - \left(H_f^{\frac{3}{2}} \right) \right) \right) - \left(\left(\frac{2}{5} \right) \cdot \left(\left(H_i^{\frac{5}{2}} \right) - (H_f)^{\frac{5}{2}} \right) \right) \right)}{t_{total} \cdot C_d \cdot \left(\sqrt{2 \cdot 9.81} \right)}$$

ex $$3.940758\text{m}^2 = \frac{\pi \cdot \left(\left(\left(\frac{4}{3} \right) \cdot 15\text{m} \cdot \left(\left((24\text{m})^{\frac{3}{2}} \right) - \left((20.1\text{m})^{\frac{3}{2}} \right) \right) \right) - \left(\left(\frac{2}{5} \right) \cdot \left(\left((24\text{m})^{\frac{5}{2}} \right) - (20.1\text{m})^{\frac{5}{2}} \right) \right) \right)}{30\text{s} \cdot 0.87 \cdot \left(\sqrt{2 \cdot 9.81} \right)}$$

22) Area of Tank given Time for Emptying Tank

Open Calculator

fx $$A_T = \frac{t_{total} \cdot C_d \cdot a \cdot \left(\sqrt{2 \cdot 9.81} \right)}{2 \cdot \left(\left(\sqrt{H_i} \right) - \left(\sqrt{H_f} \right) \right)}$$

ex $$1265.451\text{m}^2 = \frac{30\text{s} \cdot 0.87 \cdot 9.1\text{m}^2 \cdot \left(\sqrt{2 \cdot 9.81} \right)}{2 \cdot \left(\left(\sqrt{24\text{m}} \right) - \left(\sqrt{20.1\text{m}} \right) \right)}$$

23) Coefficient of Contraction given Area of Orifice

Open Calculator

fx $$C_c = \frac{A_c}{a}$$

ex $$0.549451 = \frac{5\text{m}^2}{9.1\text{m}^2}$$

24) Horizontal distance for coefficient of velocity and vertical distance

Open Calculator

fx $$R = C_v \cdot \left(\sqrt{4 \cdot V \cdot H} \right)$$

ex $$23.27436\text{m} = 0.92 \cdot \left(\sqrt{4 \cdot 4\text{m} \cdot 40\text{m}} \right)$$

25) Vertical distance for coefficient of velocity and horizontal distance

Open Calculator

fx $$V = \frac{R^2}{4 \cdot \left(C_v^2 \right) \cdot H}$$

ex $$3.90625\text{m} = \frac{(23\text{m})^2}{4 \cdot \left((0.92)^2 \right) \cdot 40\text{m}}$$

Velocity and Time

26) Coefficient of velocity

Open Calculator

fx $$C_v = \frac{v_a}{V_{th}}$$

ex $$0.888889 = \frac{8\text{m/s}}{9\text{m/s}}$$

27) Coefficient of velocity for horizontal and vertical distance

Open Calculator

fx $$C_v = \frac{R}{\sqrt{4 \cdot V \cdot H}}$$

ex $$0.909155 = \frac{23\text{m}}{\sqrt{4 \cdot 4\text{m} \cdot 40\text{m}}}$$

28) Coefficient of Velocity given Head Loss

Open Calculator

fx $$C_v = \sqrt{1 - \left(\frac{h_f}{H}\right)}$$

ex $$0.984886 = \sqrt{1 - \left(\frac{1.2\text{m}}{40\text{m}}\right)}$$

29) Theoretical velocity

Open Calculator

fx $$v = \sqrt{2 \cdot 9.81 \cdot H_p}$$

ex $$28.7061\text{m/s} = \sqrt{2 \cdot 9.81 \cdot 42\text{m}}$$

30) Time of Emptying Circular Horizontal Tank

Open Calculator

fx $$t_{total} = \frac{4 \cdot L \cdot \left(\left(((2 \cdot r_1) - H_f)^{\frac{3}{2}}\right) - ((2 \cdot r_1) - H_i)^{\frac{3}{2}}\right)}{3 \cdot C_d \cdot a \cdot \left(\sqrt{2 \cdot 9.81}\right)}$$

ex $$9.077938\text{s} = \frac{4 \cdot 31\text{m} \cdot \left(\left(((2 \cdot 12\text{m}) - 20.1\text{m})^{\frac{3}{2}}\right) - ((2 \cdot 12\text{m}) - 24\text{m})^{\frac{3}{2}}\right)}{3 \cdot 0.87 \cdot 9.1\text{m}^2 \cdot \left(\sqrt{2 \cdot 9.81}\right)}$$

31) Time of Emptying Hemispherical Tank

Open Calculator

fx $$t_{total} = \frac{\pi \cdot \left(\left(\left(\frac{4}{3} \right) \cdot R_t \cdot \left(\left(H_i^{1.5} \right) - \left(H_f^{1.5} \right) \right) \right) - \left(0.4 \cdot \left(\left(H_i^{\frac{5}{2}} \right) - \left(H_f \right)^{\frac{5}{2}} \right) \right) \right)}{C_d \cdot a \cdot \left(\sqrt{2 \cdot 9.81} \right)}$$

ex $$12.99151\text{s} = \frac{\pi \cdot \left(\left(\left(\frac{4}{3} \right) \cdot 15\text{m} \cdot \left(\left((24\text{m})^{1.5} \right) - \left((20.1\text{m})^{1.5} \right) \right) \right) - \left(0.4 \cdot \left(\left((24\text{m})^{\frac{5}{2}} \right) - (20.1\text{m})^{\frac{5}{2}} \right) \right) \right)}{0.87 \cdot 9.1\text{m}^2 \cdot \left(\sqrt{2 \cdot 9.81} \right)}$$

32) Time of Emptying Tank through Orifice at Bottom

Open Calculator

fx $$t_{total} = \frac{2 \cdot A_T \cdot \left(\left(\sqrt{H_i} \right) - \left(\sqrt{H_f} \right) \right)}{C_d \cdot a \cdot \sqrt{2 \cdot 9.81}}$$

ex $$27.12077\text{s} = \frac{2 \cdot 1144\text{m}^2 \cdot \left(\left(\sqrt{24\text{m}} \right) - \left(\sqrt{20.1\text{m}} \right) \right)}{0.87 \cdot 9.1\text{m}^2 \cdot \sqrt{2 \cdot 9.81}}$$

33) Velocity of liquid at C-C for Hc, Ha, and H

Open Calculator

fx $$V_i = \sqrt{2 \cdot 9.81 \cdot \left(H_a + H_c - H_{AP} \right)}$$

ex $$8.286736\text{m/s} = \sqrt{2 \cdot 9.81 \cdot (7\text{m} + 10.5\text{m} - 14\text{m})}$$

Variables Used

- **a** Area of Orifice *(Square Meter)*
- **A** Area *(Square Meter)*
- A_a Actual Area *(Square Meter)*
- a_c Area at Vena Contracta *(Square Meter)*
- A_c Area of jet *(Square Meter)*
- A_t Theoretical area *(Square Meter)*
- A_T Area of Tank *(Square Meter)*
- **b** Thickness of Dam *(Meter)*
- C_c Coefficient of Contraction
- C_d Coefficient of Discharge
- C_v Coefficient of Velocity
- **H** Head of the liquid *(Meter)*
- H_a Atmospheric Pressure Head *(Meter)*
- H_{AP} Absolute Pressure Head *(Meter)*
- H_{bottom} Height of liquid bottom edge *(Meter)*
- H_c Constant Head *(Meter)*
- h_f Head Loss *(Meter)*
- H_f Final height of liquid *(Meter)*
- H_i Initial height of liquid *(Meter)*
- h_L Loss of Head *(Meter)*
- H_L Difference in liquid level *(Meter)*
- H_p Pelton Head *(Meter)*
- H_{top} Height of Liquid Top Edge *(Meter)*
- **L** Length *(Meter)*
- Q_a Actual Discharge *(Cubic Meter per Second)*
- Q_M Discharge through Mouthpiece *(Cubic Meter per Second)*
- Q_O Discharge through Orifice *(Cubic Meter per Second)*
- Q_{th} Theoretical Discharge *(Cubic Meter per Second)*
- **R** Horizontal Distance *(Meter)*
- r_1 Radius 1 *(Meter)*
- R_t Hemispherical tank radius *(Meter)*
- t_{total} Total Time Taken *(Second)*
- **v** Velocity *(Meter per Second)*

- **V** Vertical distance *(Meter)*
- v_a Actual velocity *(Meter per Second)*
- V_i Velocity of Liquid Inlet *(Meter per Second)*
- V_o Velocity of Liquid Outlet *(Meter per Second)*
- V_{th} Theoretical velocity *(Meter per Second)*
- **w** Width *(Meter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m^3/s)
  Volumetric Flow Rate Unit Conversion

Check other formula lists

- **Notches and Weirs Formulas**
- **Orifices and Mouthpieces Formulas**

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