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# Specific Energy and Critical Depth Formulas

Calculators!

Examples!

Conversions!

# List of 23 Specific Energy and Critical Depth Formulas

## Specific Energy and Critical Depth

### 1) Area of Section Considering Condition of Maximum Discharge

Open Calculator

fx $$A_{cs} = \left( Q \cdot Q \cdot \frac{T}{[g]} \right)^{\frac{1}{3}}$$

ex $$3.475241\text{m}^2 = \left( 14\text{m}^3/\text{s} \cdot 14\text{m}^3/\text{s} \cdot \frac{2.1\text{m}}{[g]} \right)^{\frac{1}{3}}$$

### 2) Area of Section given Discharge

Open Calculator

fx $$A_{cs} = \frac{Q}{\sqrt{2 \cdot [g] \cdot (E_{total} - d_f)}}$$

ex $$1.37314\text{m}^2 = \frac{14\text{m}^3/\text{s}}{\sqrt{2 \cdot [g] \cdot (8.6\text{J} - 3.3\text{m})}}$$

## 3) Area of Section of Open Channel Considering Condition of Minimum Specific Energy

Open Calculator

$$A_{cs} = \left( Q \cdot \frac{T}{[g]} \right)^{\frac{1}{3}}$$

$$1.441923\text{m}^2 = \left( 14\text{m}^3/\text{s} \cdot \frac{2.1\text{m}}{[g]} \right)^{\frac{1}{3}}$$

## 4) Datum Height for Total Energy per unit Weight of Water in Flow Section

Open Calculator

$$y = E_{total} - \left( \left( \frac{V_{mean}^2}{2 \cdot [g]} \right) + d_f \right)$$

$$98.93746\text{mm} = 8.6\text{J} - \left( \left( \frac{(10.1\text{m/s})^2}{2 \cdot [g]} \right) + 3.3\text{m} \right)$$

## 5) Depth of Flow given Discharge

Open Calculator

$$d_f = E_{total} - \left( \frac{\left( \frac{Q}{A_{cs}} \right)^2}{2 \cdot [g]} \right)$$

$$7.735535\text{m} = 8.6\text{J} - \left( \frac{\left( \frac{14\text{m}^3/\text{s}}{3.4\text{m}^2} \right)^2}{2 \cdot [g]} \right)$$

## 6) Depth of Flow given Total Energy in Flow Section taking Bed Slope as Datum

Open Calculator

fx $$d_f = E_{total} - \left( \left( \frac{V_{mean}^2}{2 \cdot [g]} \right) \right)$$

ex $$3.398937\text{m} = 8.6\text{J} - \left( \left( \frac{(10.1\text{m/s})^2}{2 \cdot [g]} \right) \right)$$

## 7) Depth of Flow given Total Energy per Unit Weight of Water in Flow Section

Open Calculator

fx $$d_f = E_{total} - \left( \left( \frac{V_{mean}^2}{2 \cdot [g]} \right) + y \right)$$

ex $$3.358937\text{m} = 8.6\text{J} - \left( \left( \frac{(10.1\text{m/s})^2}{2 \cdot [g]} \right) + 40\text{mm} \right)$$

## 8) Diameter of Section given Froude Number

Open Calculator

fx $$d_{section} = \frac{\left( \frac{V_{FN}}{Fr} \right)^2}{[g]}$$

ex $$4.996609\text{m} = \frac{\left( \frac{70\text{m/s}}{10} \right)^2}{[g]}$$

## 9) Diameter of Section through Section Considering Condition of Minimum Specific Energy

Open Calculator

fx $$d_{section} = \frac{V_{mean}^2}{[g]}$$

ex $$10.40213m = \frac{(10.1m/s)^2}{[g]}$$

## 10) Discharge through Area

Open Calculator

fx $$Q = \sqrt{2 \cdot [g] \cdot A_{cs}^2 \cdot (E_{total} - d_f)}$$

ex $$34.66508m^3/s = \sqrt{2 \cdot [g] \cdot (3.4m^2)^2 \cdot (8.6J - 3.3m)}$$

## 11) Discharge through Section Considering Condition of Maximum Discharge

Open Calculator

fx $$Q = \sqrt{(A_{cs}^3) \cdot \frac{[g]}{T}}$$

ex $$13.54781m^3/s = \sqrt{\left((3.4m^2)^3\right) \cdot \frac{[g]}{2.1m}}$$

## 12) Discharge through Section Considering Condition of Minimum Specific Energy

Open Calculator

fx $$Q = \sqrt{\left(A_{cs}^3\right) \cdot \frac{[g]}{T}}$$

ex $$13.54781\text{m}^3/\text{s} = \sqrt{\left((3.4\text{m}^2)^3\right) \cdot \frac{[g]}{2.1\text{m}}}$$

## 13) Froude Number given Velocity

Open Calculator

fx $$Fr = \frac{V_{FN}}{\sqrt{[g] \cdot d_{section}}}$$

ex $$9.996609 = \frac{70\text{m/s}}{\sqrt{[g] \cdot 5\text{m}}}$$

## 14) Mean Velocity of Flow for Total Energy per Unit Weight of Water in Flow Section

Open Calculator

fx $$V_{mean} = \sqrt{(E_{total} - (d_f + y)) \cdot 2 \cdot [g]}$$

ex $$10.15706\text{m/s} = \sqrt{(8.6\text{J} - (3.3\text{m} + 40\text{mm})) \cdot 2 \cdot [g]}$$

## 15) Mean Velocity of Flow given Froude Number

Open Calculator

fx $$V_{FN} = Fr \cdot \sqrt{d_{section} \cdot [g]}$$

ex $$70.02375\text{m/s} = 10 \cdot \sqrt{5\text{m} \cdot [g]}$$

## 16) Mean Velocity of flow given Total Energy in flow section taking Bed Slope as Datum

Open Calculator

fx $$V_{mean} = \sqrt{(E_{total} - (d_f)) \cdot 2 \cdot [g]}$$

ex $$10.19561\text{m/s} = \sqrt{(8.6\text{J} - (3.3\text{m})) \cdot 2 \cdot [g]}$$

## 17) Mean Velocity of Flow through Section Considering Condition of Minimum Specific Energy

Open Calculator

fx $$V_{mean} = \sqrt{[g] \cdot d_{section}}$$

ex $$7.002375\text{m/s} = \sqrt{[g] \cdot 5\text{m}}$$

## 18) Top Width of Section Considering Condition of Maximum Discharge

Open Calculator

fx $$T = \sqrt{\left(A_{cs}^3\right) \cdot \frac{[g]}{Q}}$$

ex $$5.247044\text{m} = \sqrt{\left(\left(3.4\text{m}^2\right)^3\right) \cdot \frac{[g]}{14\text{m}^3/\text{s}}}$$

## 19) Top Width of Section through Section Considering Condition of Minimum Specific Energy

Open Calculator

fx $$T = \left(\left(A_{cs}^3\right) \cdot \frac{[g]}{Q}\right)$$

ex $$27.53147\text{m} = \left(\left(\left(3.4\text{m}^2\right)^3\right) \cdot \frac{[g]}{14\text{m}^3/\text{s}}\right)$$

## 20) Total Energy per unit Weight of Water in Flow Section

Open Calculator

fx $$E_{total} = \left(\frac{V_{mean}^2}{2 \cdot [g]}\right) + d_f + y$$

ex $$8.541063\text{J} = \left(\frac{\left(10.1\text{m/s}\right)^2}{2 \cdot [g]}\right) + 3.3\text{m} + 40\text{mm}$$

## 21) Total Energy per unit Weight of Water in Flow Section considering Bed Slope as Datum

Open Calculator

fx $$E_{total} = \left(\frac{V_{FN}^2}{2 \cdot [g]}\right) + d_f$$

ex $$253.1305\text{J} = \left(\frac{(70\text{m/s})^2}{2 \cdot [g]}\right) + 3.3\text{m}$$

## 22) Total Energy per unit Weight of Water in Flow Section given Discharge

Open Calculator

fx $$E_{total} = d_f + \left(\frac{\left(\frac{Q}{A_{cs}}\right)^2}{2 \cdot [g]}\right)$$

ex $$4.164465\text{J} = 3.3\text{m} + \left(\frac{\left(\frac{14\text{m}^3/\text{s}}{3.4\text{m}^2}\right)^2}{2 \cdot [g]}\right)$$

## 23) Volume of Liquid Considering Condition of Maximum Discharge

Open Calculator

fx $$Vw = \sqrt{\left(A_{cs}^3\right) \cdot \frac{[g]}{T}} \cdot \Delta t$$

ex $$16.93476\text{m}^3 = \sqrt{\left((3.4\text{m}^2)^3\right) \cdot \frac{[g]}{2.1\text{m}}} \cdot 1.25\text{s}$$

# Variables Used

- $A_{cs}$ Cross-Sectional Area of Channel *(Square Meter)*
- $d_f$ Depth of Flow *(Meter)*
- $d_{section}$ Diameter of Section *(Meter)*
- $E_{total}$ Total Energy *(Joule)*
- **Fr** Froude Number
- **Q** Discharge of Channel *(Cubic Meter per Second)*
- **T** Top Width *(Meter)*
- $V_{FN}$ Mean Velocity for Froude Number *(Meter per Second)*
- $V_{mean}$ Mean Velocity *(Meter per Second)*
- **Vw** Volume of Water *(Cubic Meter)*
- **y** Height above Datum *(Millimeter)*
- **Δt** Time Interval *(Second)*

# Constants, Functions, Measurements used

- 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), Millimeter (mm)
  *Length Unit Conversion*
- Measurement: **Time** in Second (s)
  *Time Unit Conversion*
- Measurement: **Volume** in Cubic Meter ($m^3$)
  *Volume Unit Conversion*
- Measurement: **Area** in Square Meter ($m^2$)
  *Area Unit Conversion*
- Measurement: **Speed** in Meter per Second (m/s)
  *Speed Unit Conversion*
- Measurement: **Energy** in Joule (J)
  *Energy Unit Conversion*
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second ($m^3/s$)
  *Volumetric Flow Rate Unit Conversion*

# Check other formula lists

- **Computation of Uniform Flow Formulas**
- **Critical Flow and its Computation Formulas**
- **Geometrical Properties of Channel Section Formulas**
- **Metering Flumes and Momentum in Open Channel Flow Specific Force Formulas**
- **Specific Energy and Critical Depth Formulas**