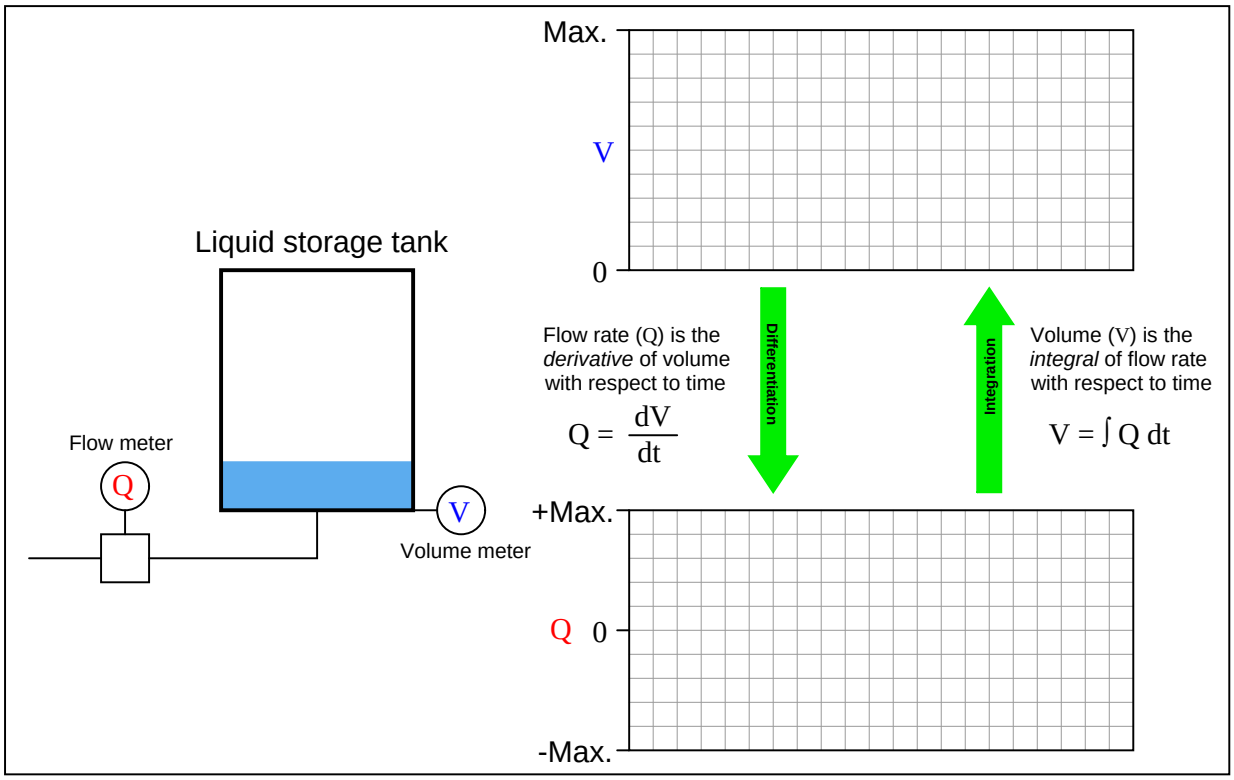
Question 1

**Animation: differentiation and integration (calculus)**

*This question consists of a series of images (one per page) that form an animation. Flip the pages with your fingers to view this animation (or click on the "next" button on your viewer) frame-by-frame.*

The following animation shows two variables graphed over time, one being the derivative of the other and the other being the integral of the first.


Liquid storage tank
Flow meter
Q
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Volume meter
Max.
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Flow rate (Q) is the *derivative* of volume with respect to time
$Q = \frac{dV}{dt}$
Differentiation
Integration
Volume (V) is the *integral* of flow rate with respect to time
$V = \int Q\,dt$
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Q 0
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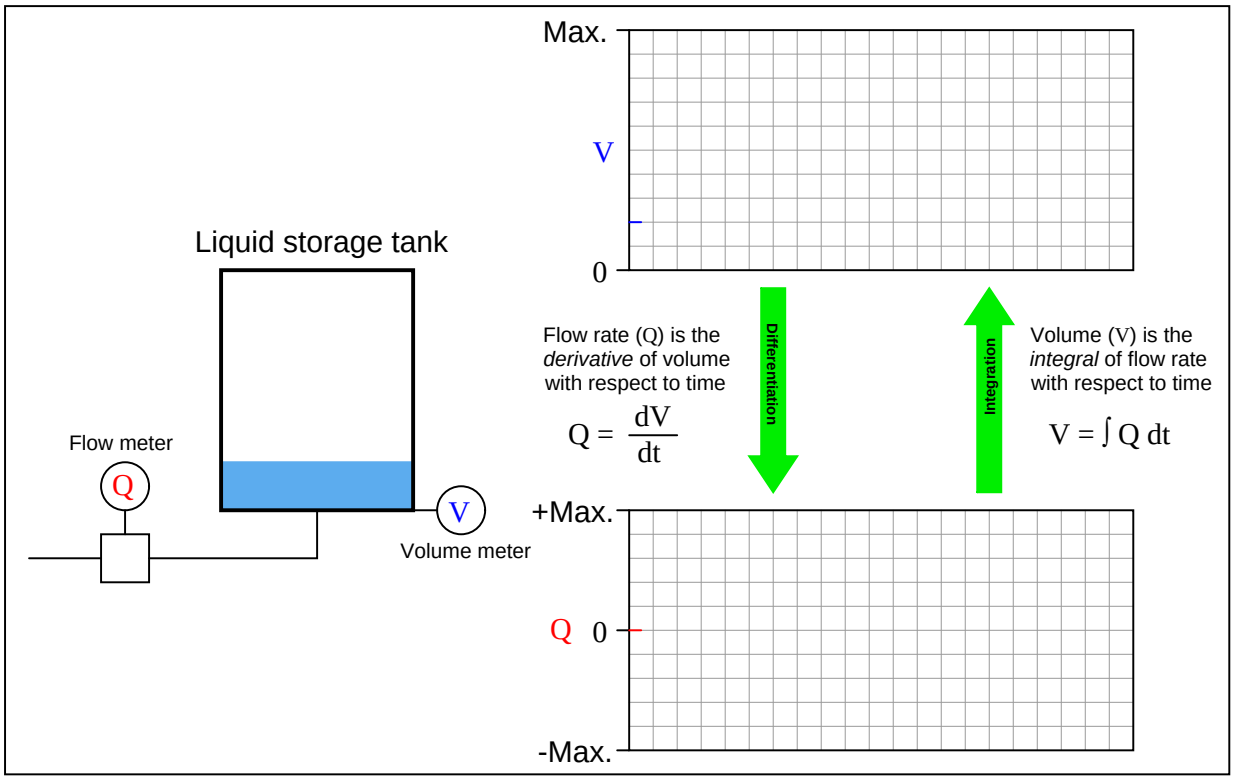
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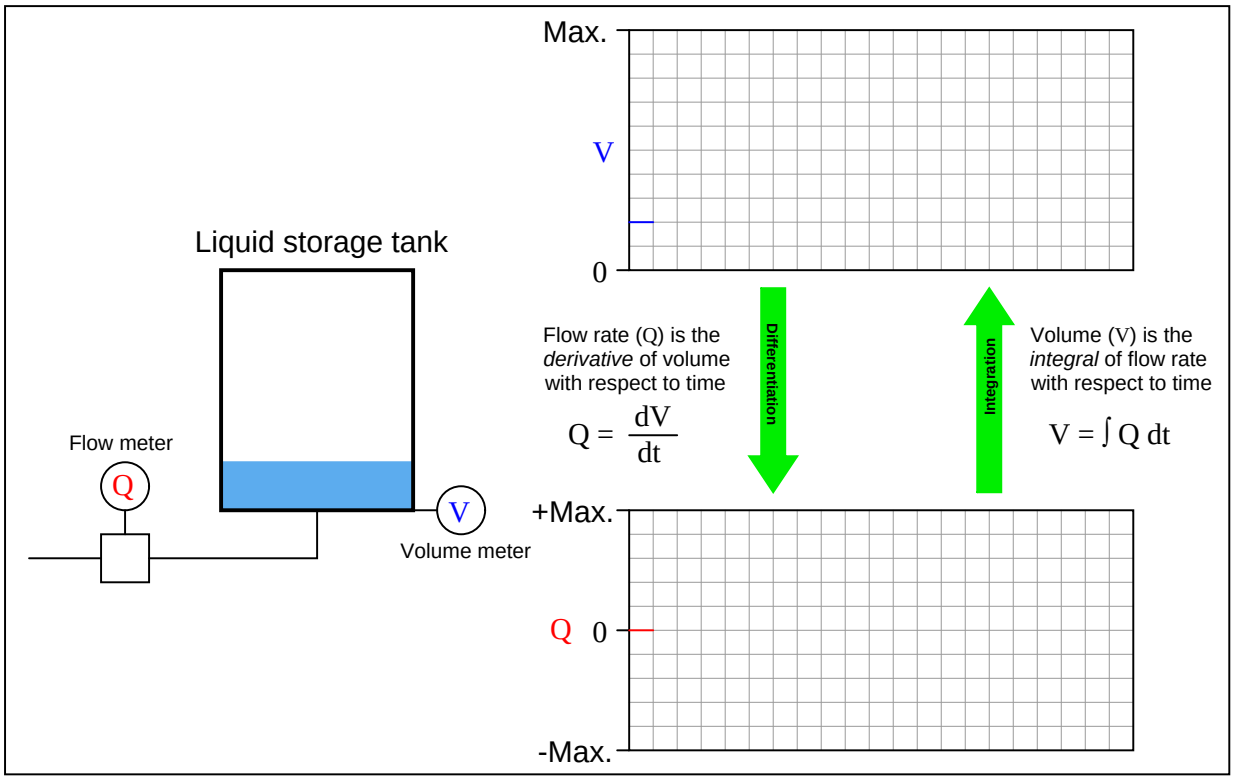
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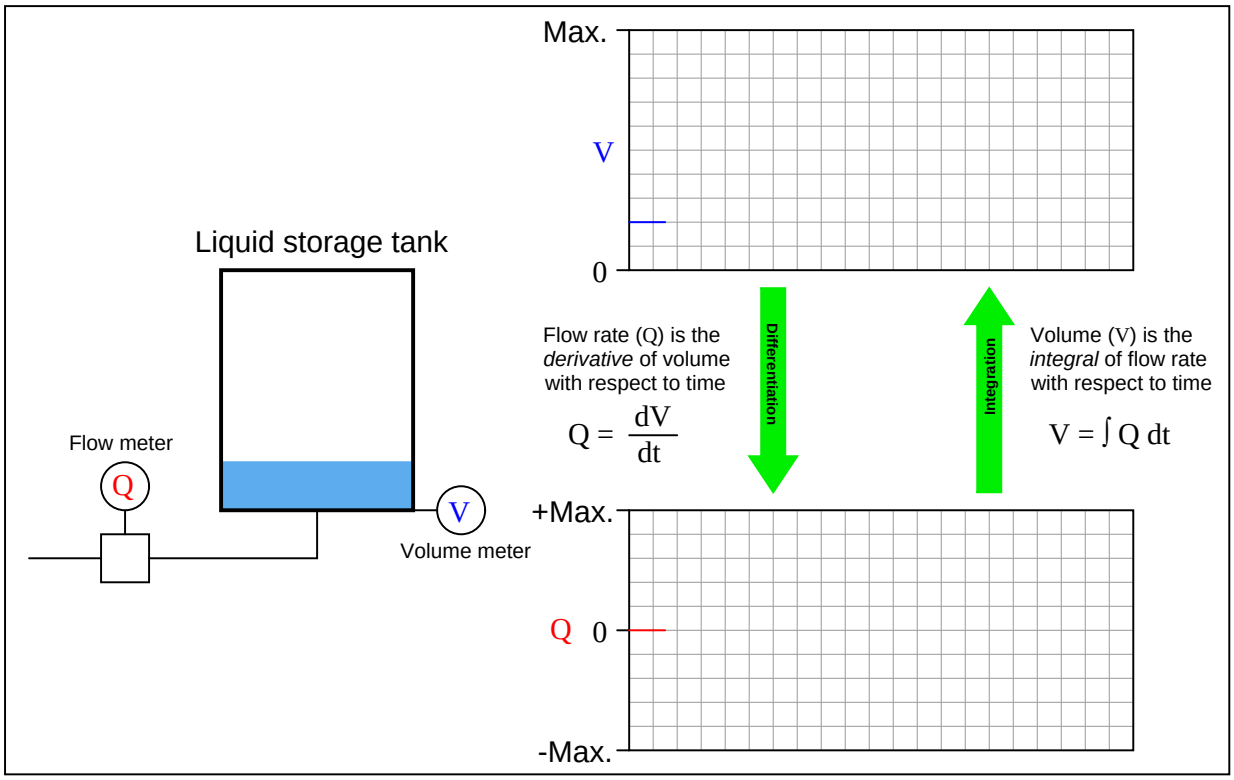
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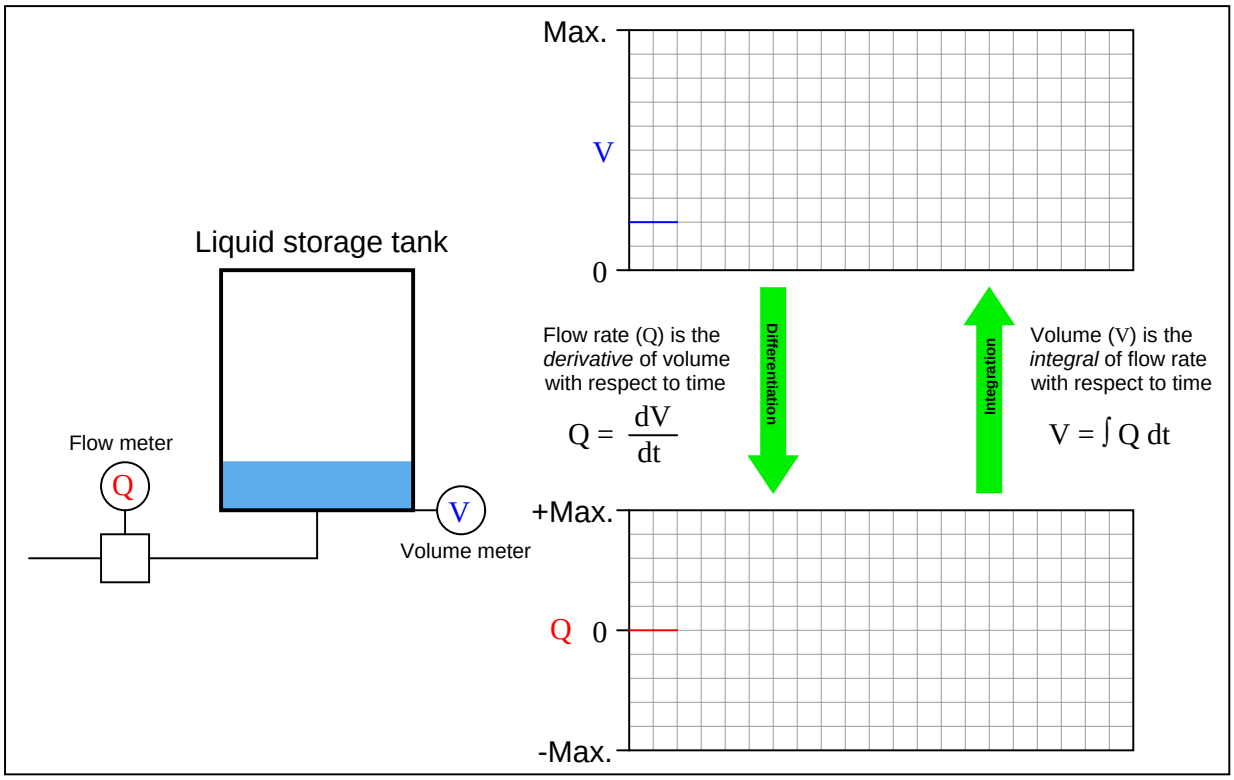
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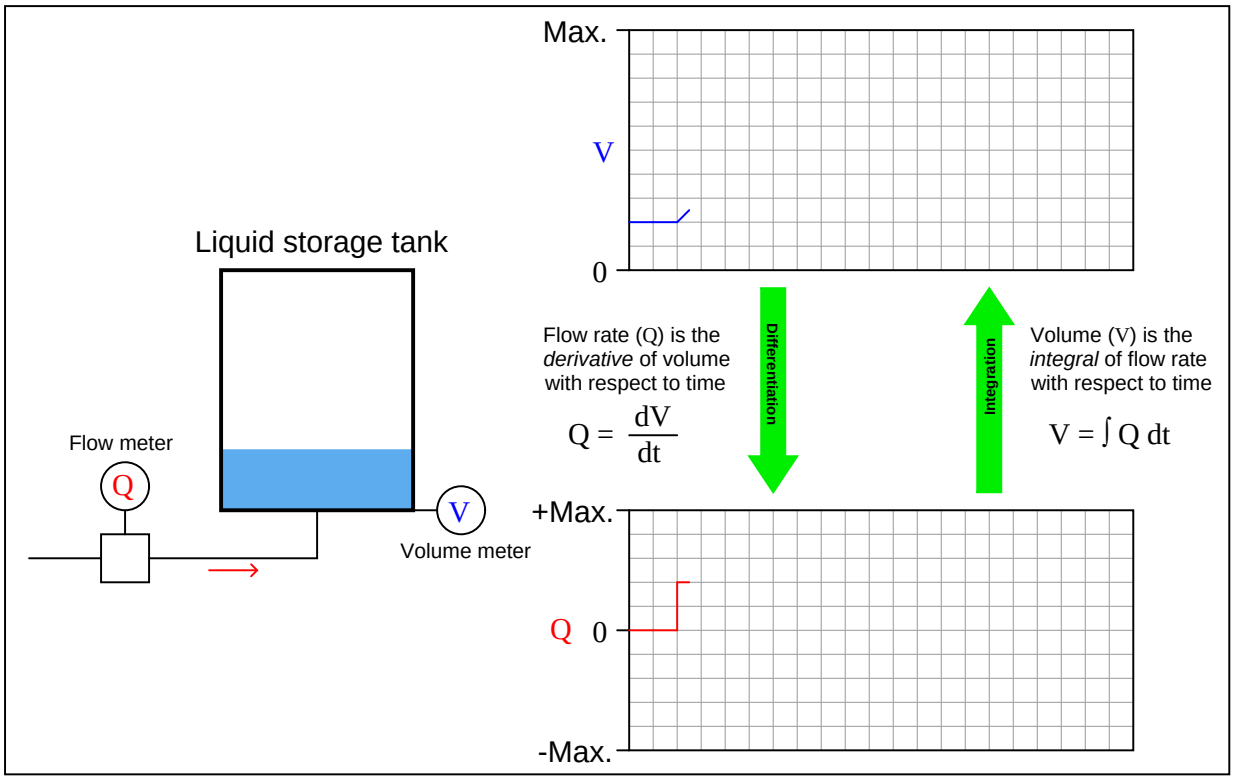
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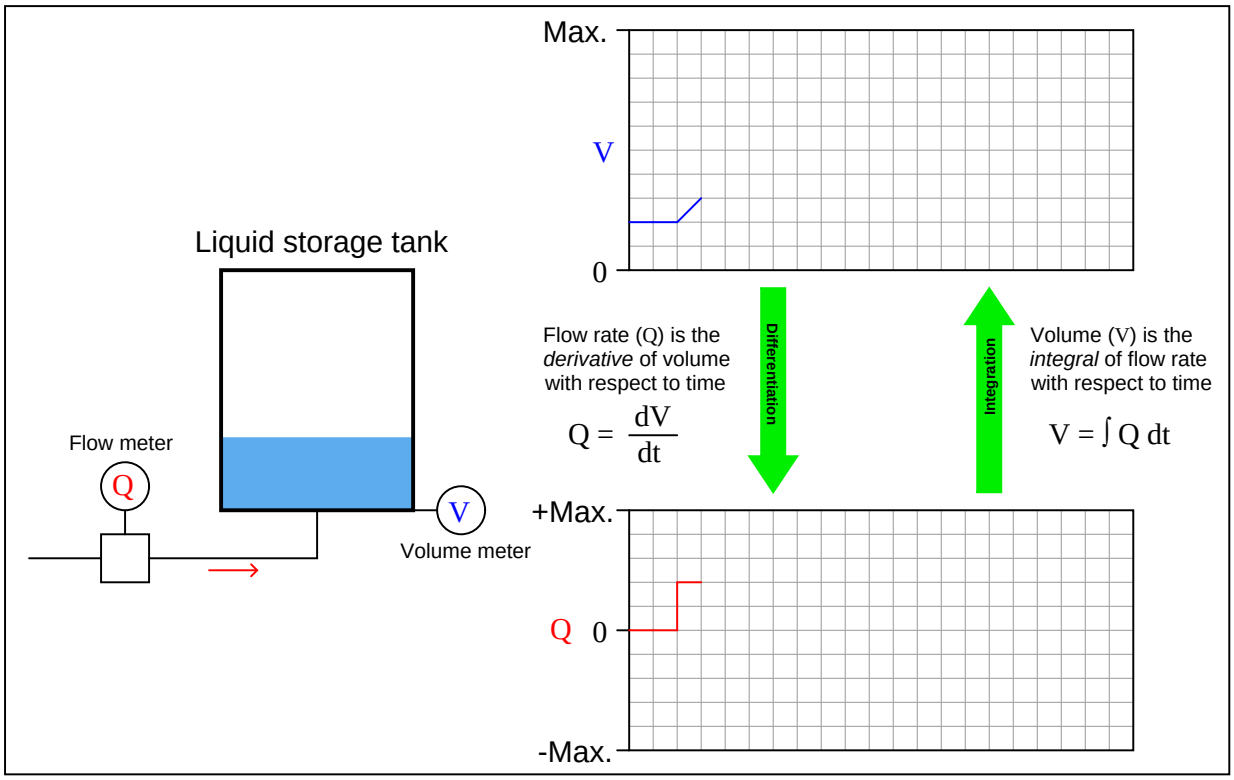
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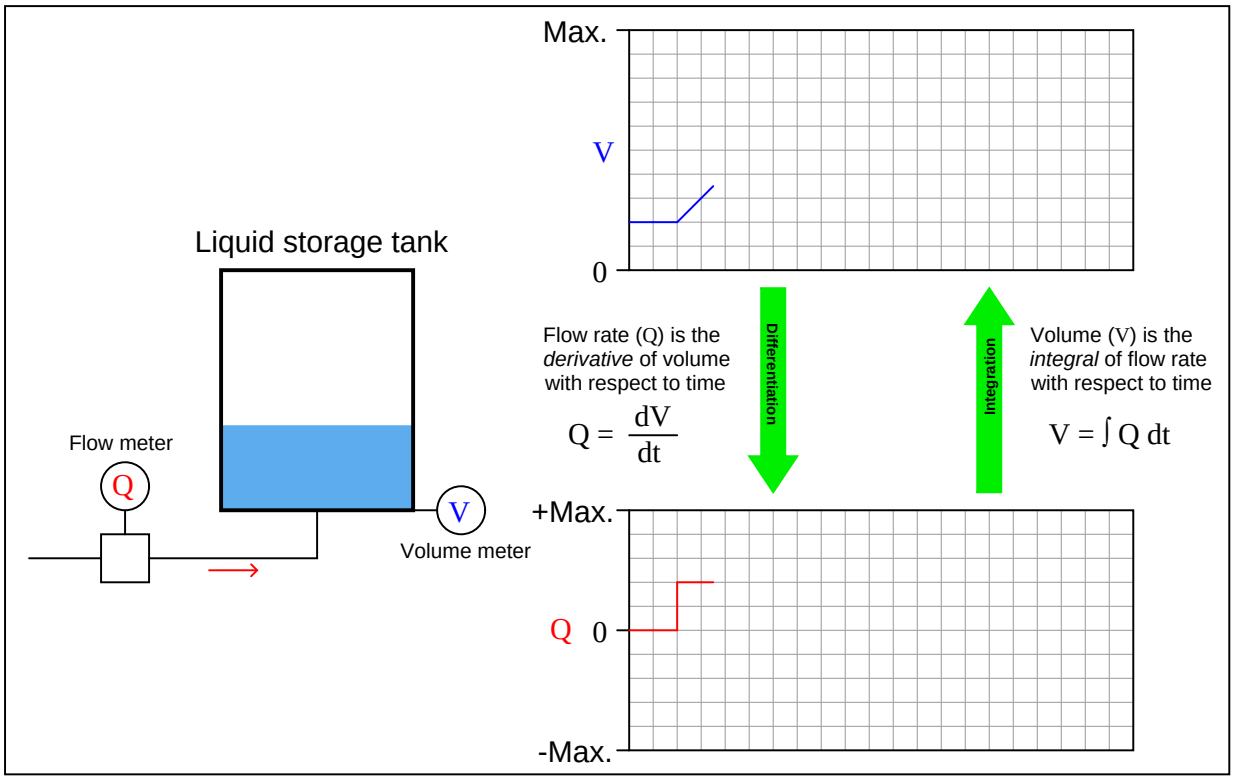
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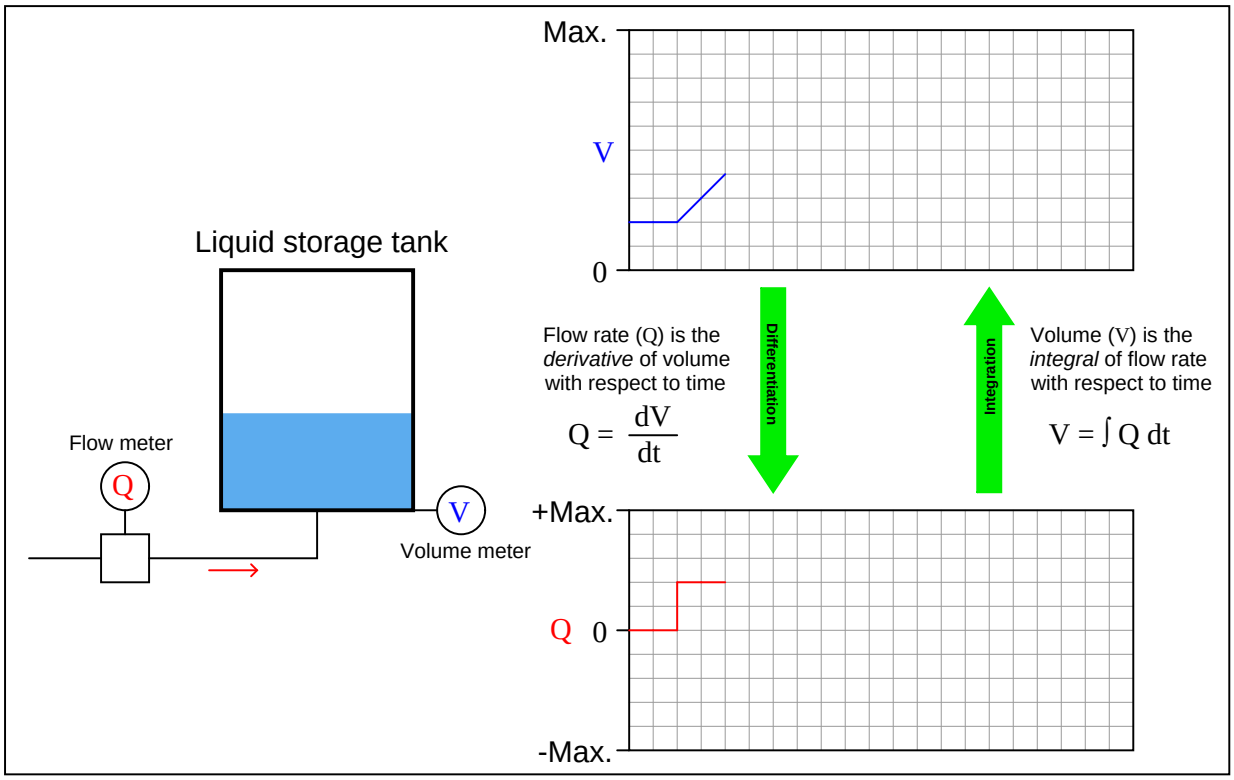
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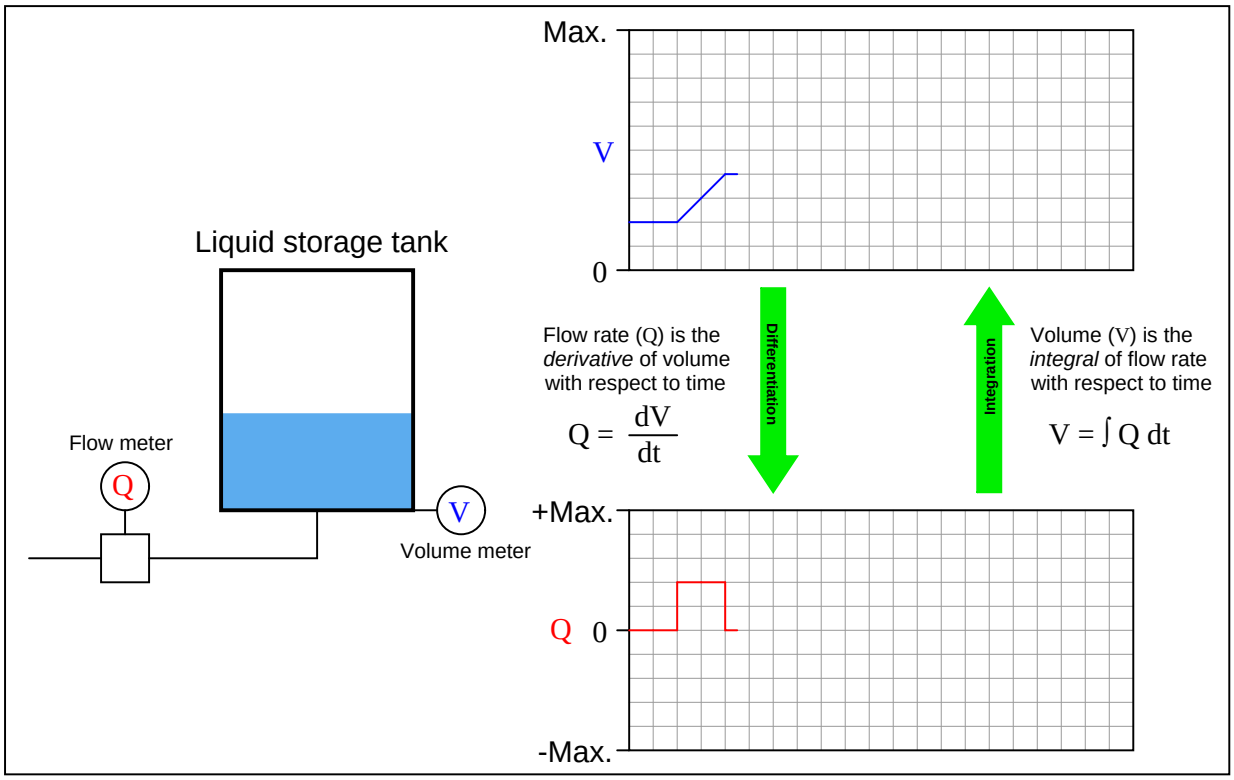
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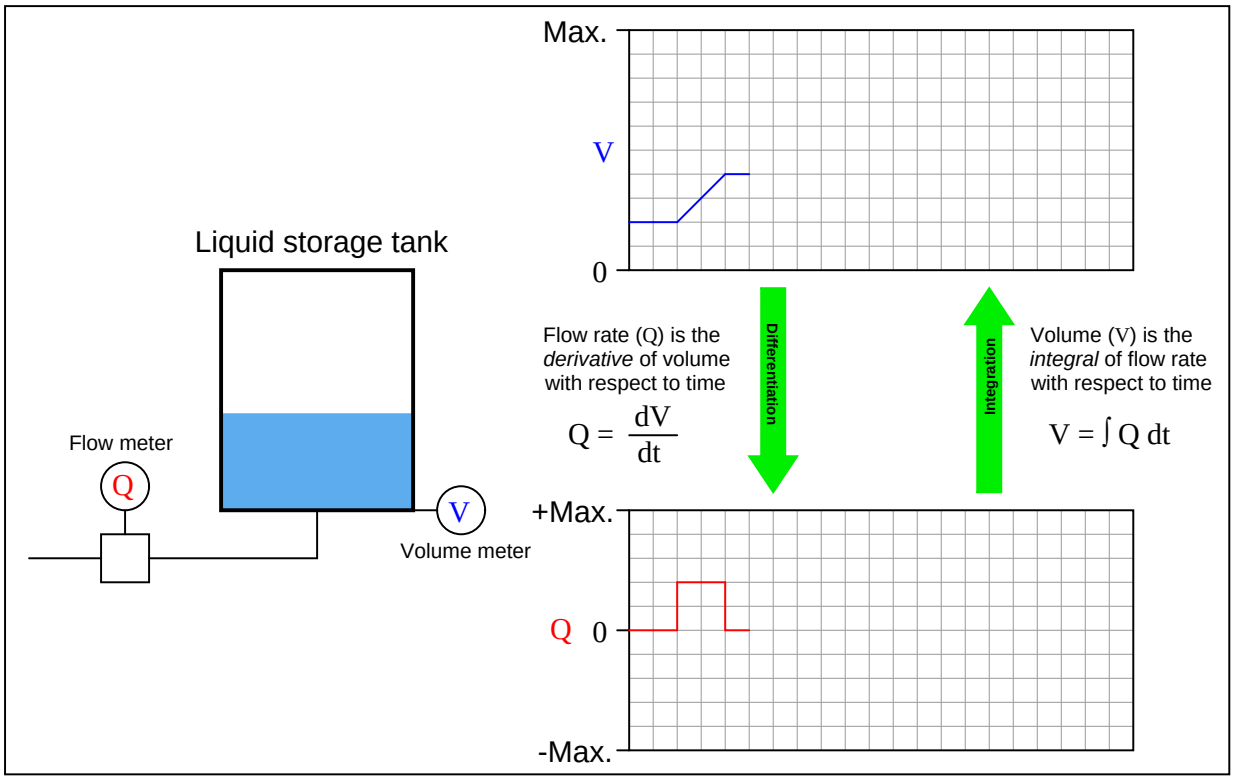
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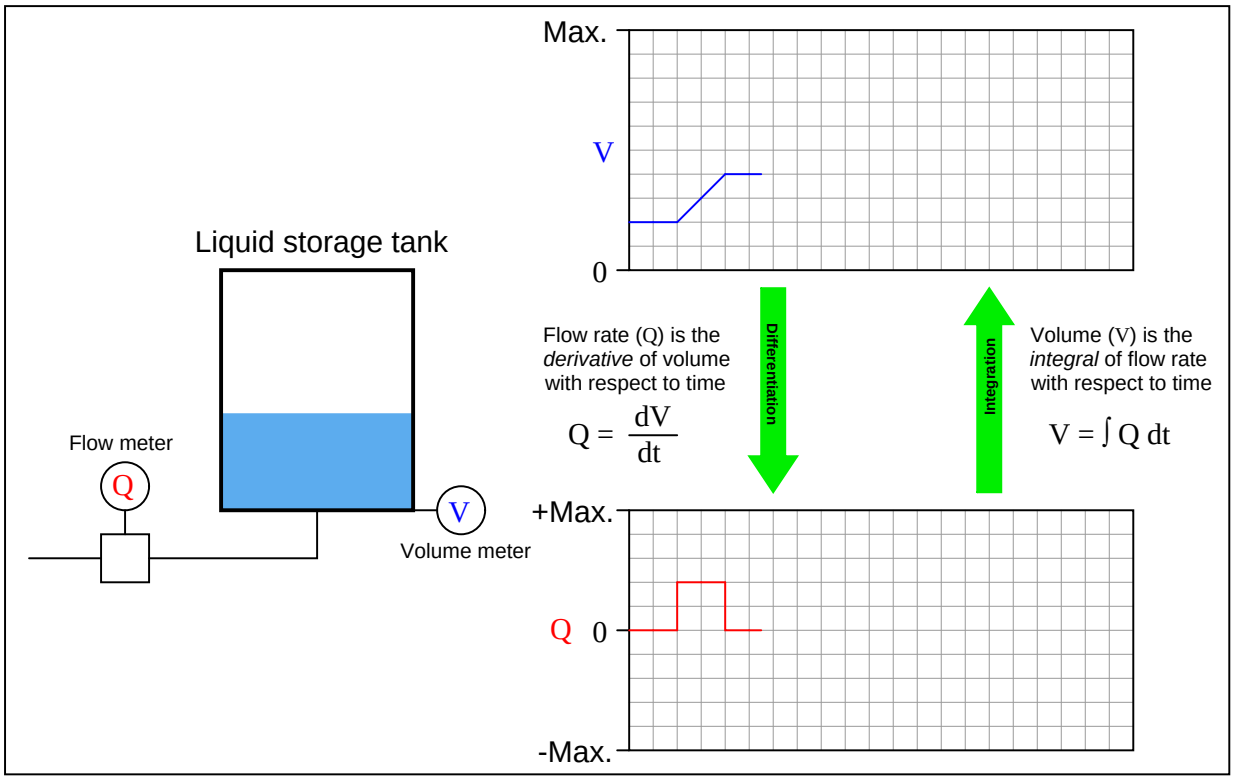
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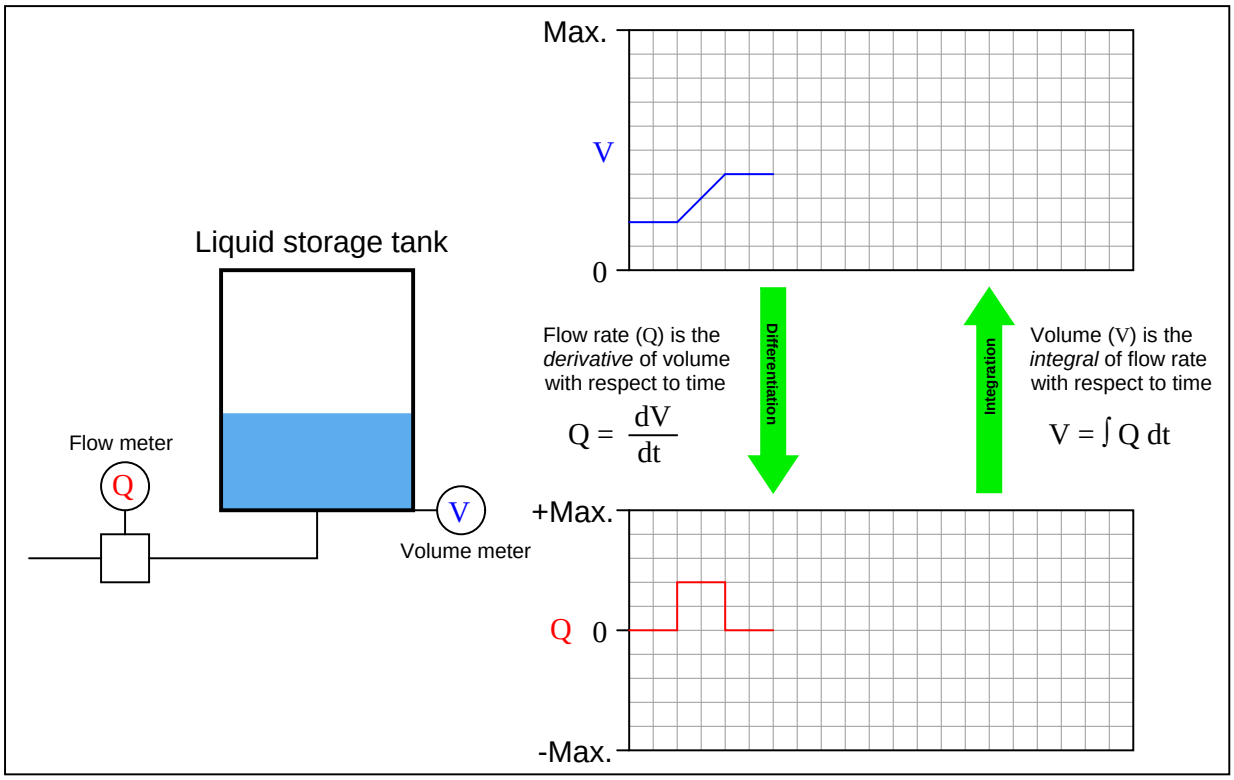
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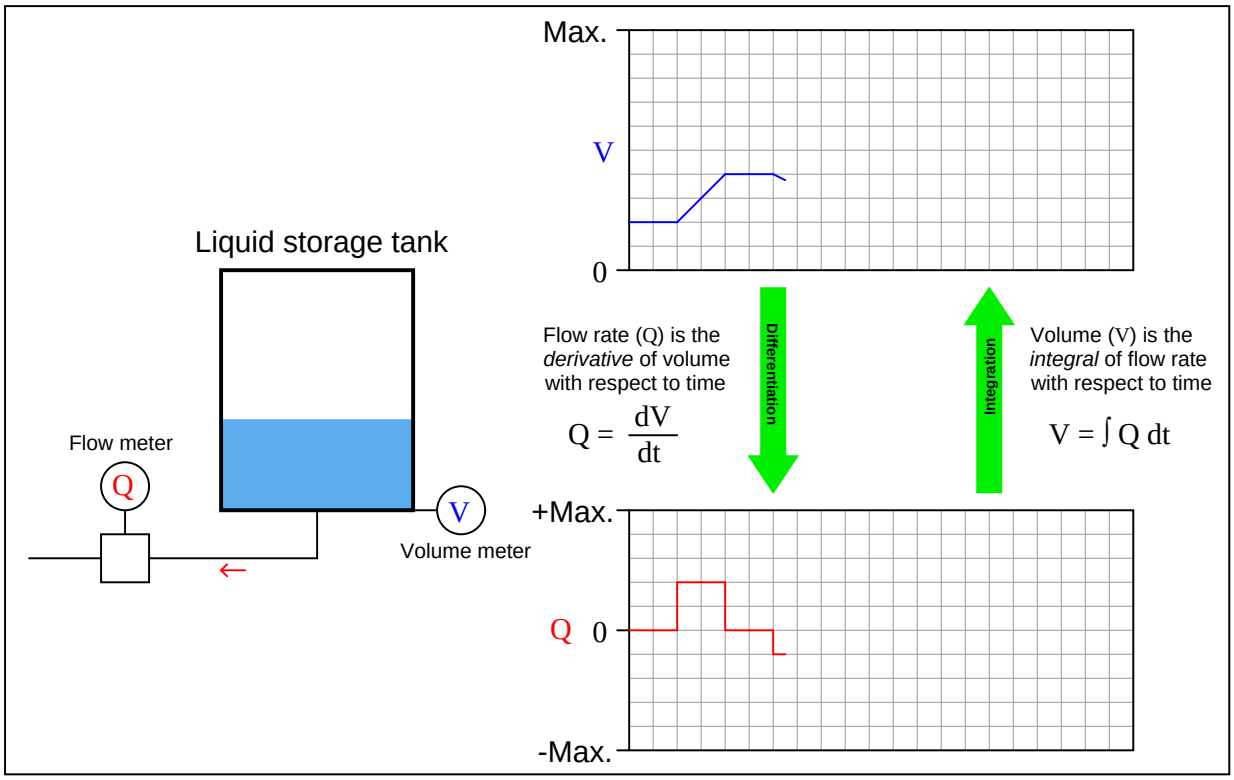
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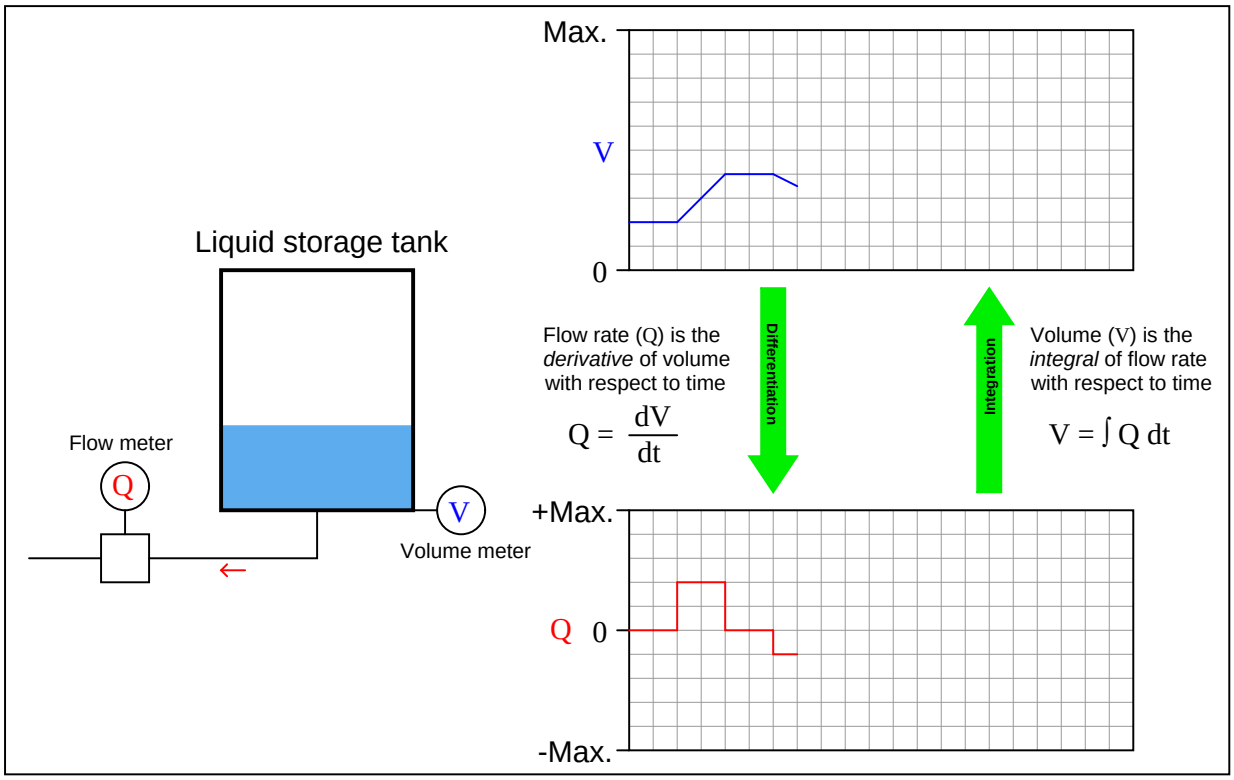
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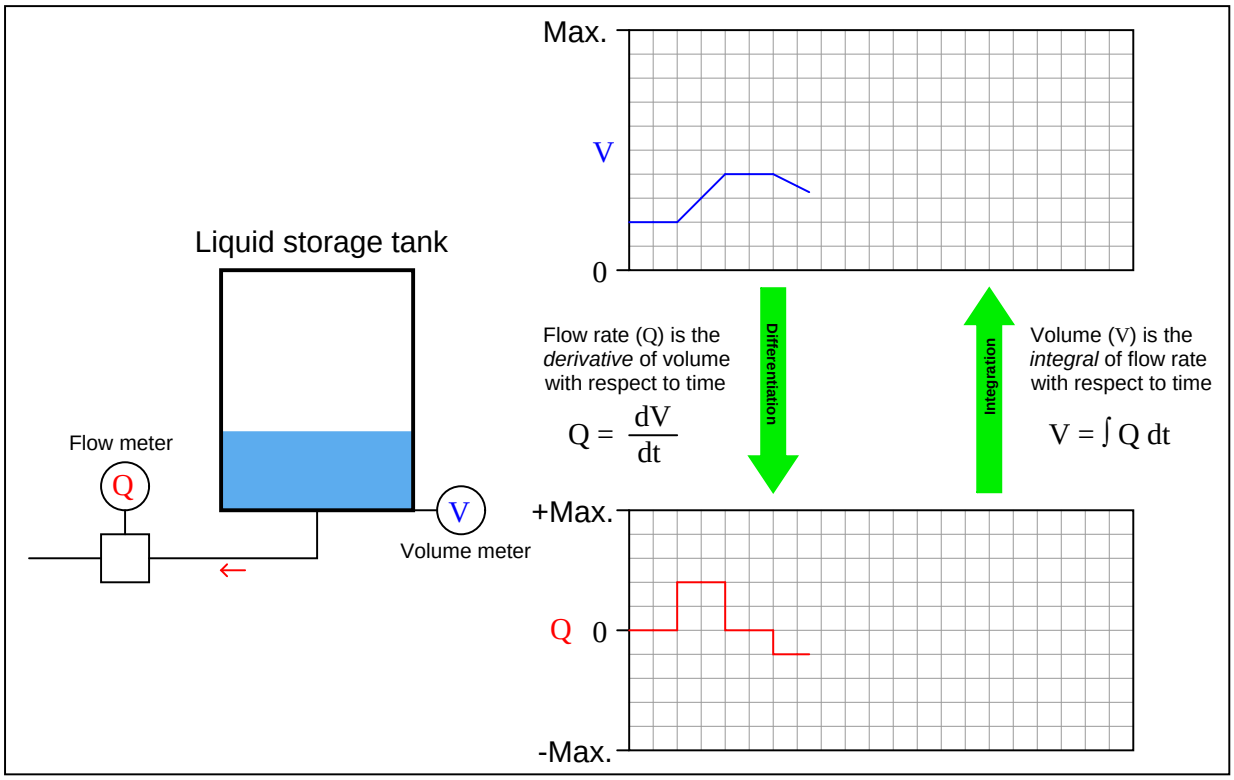
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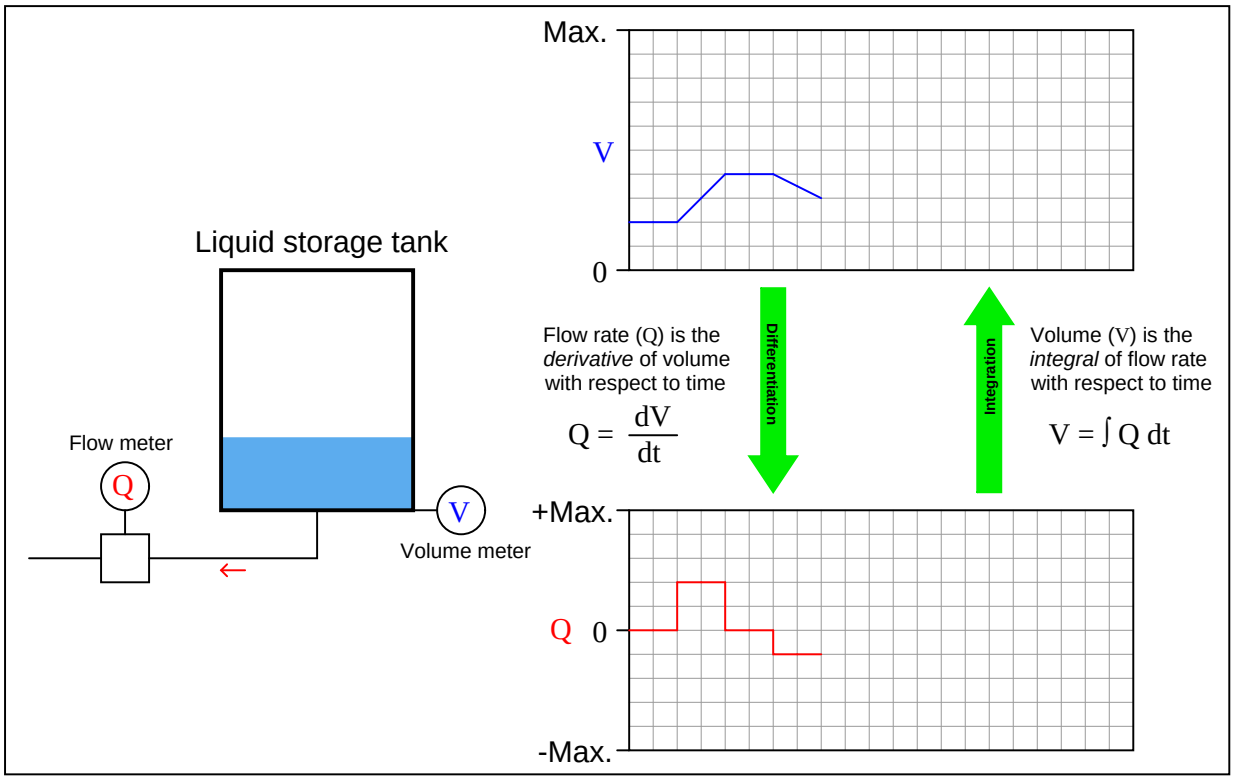
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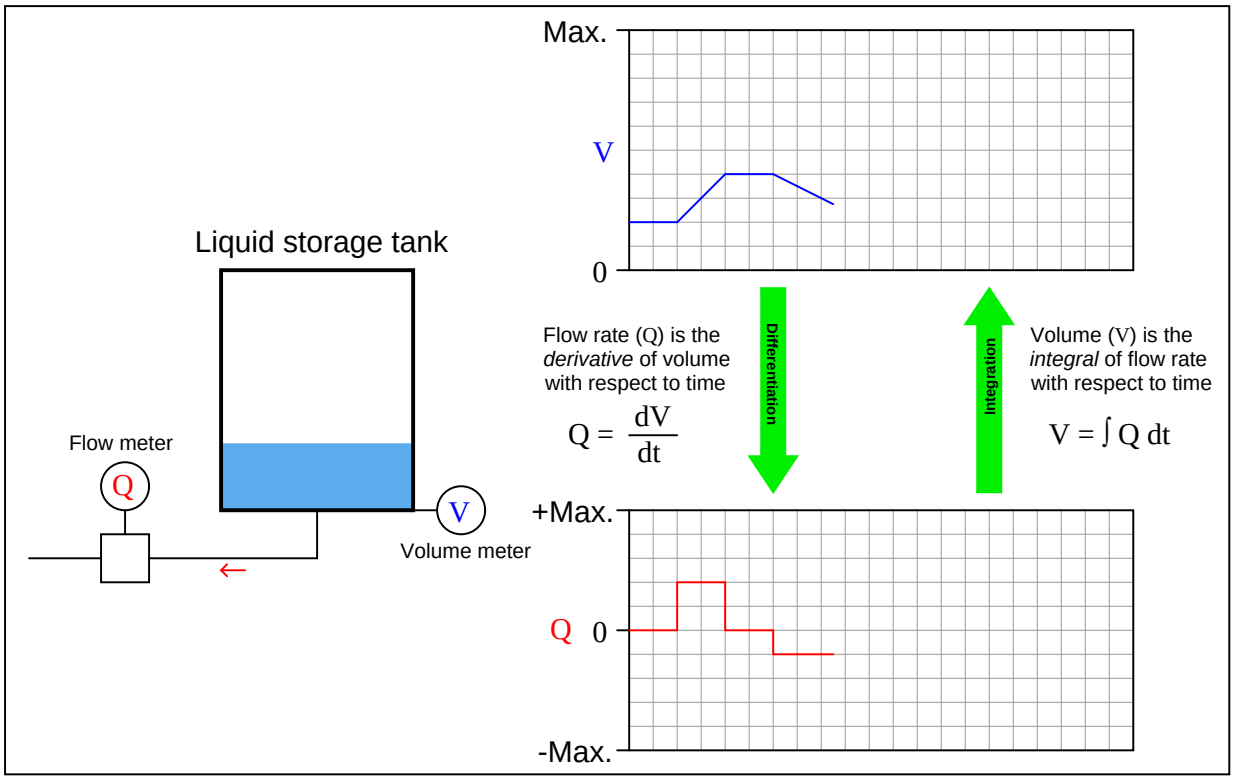
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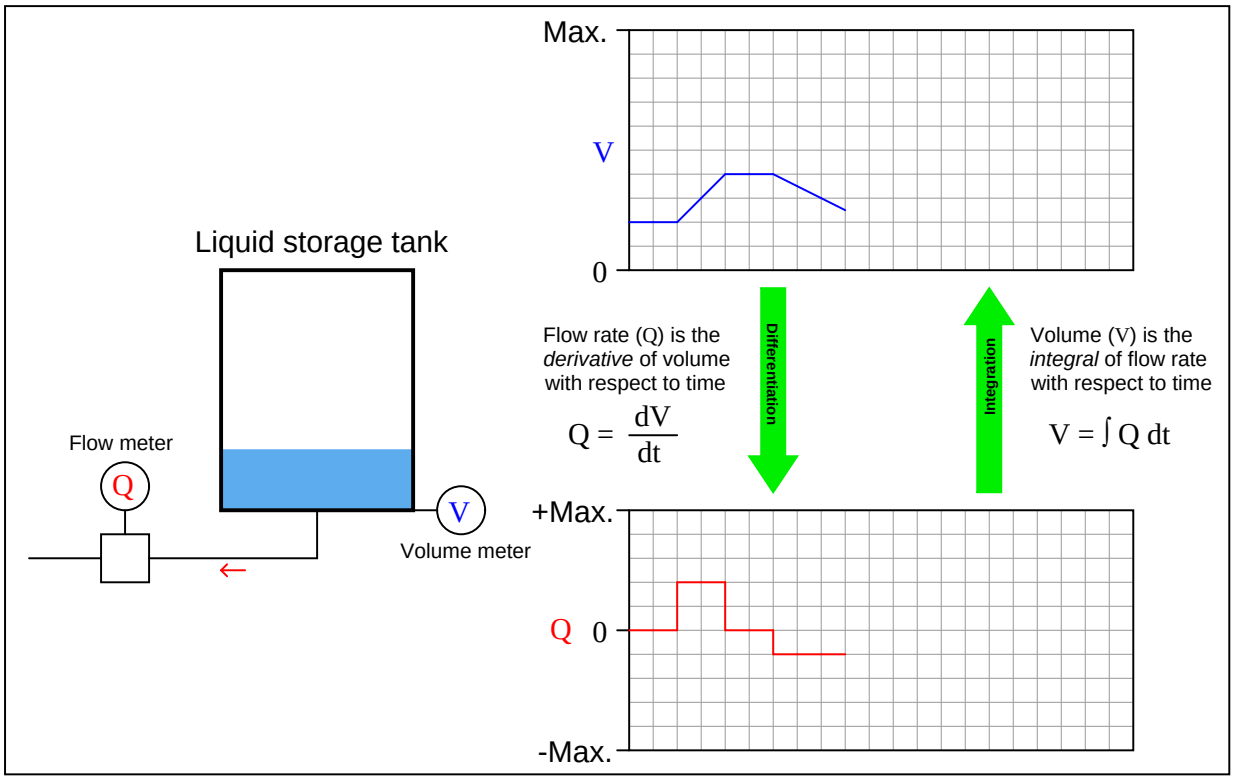
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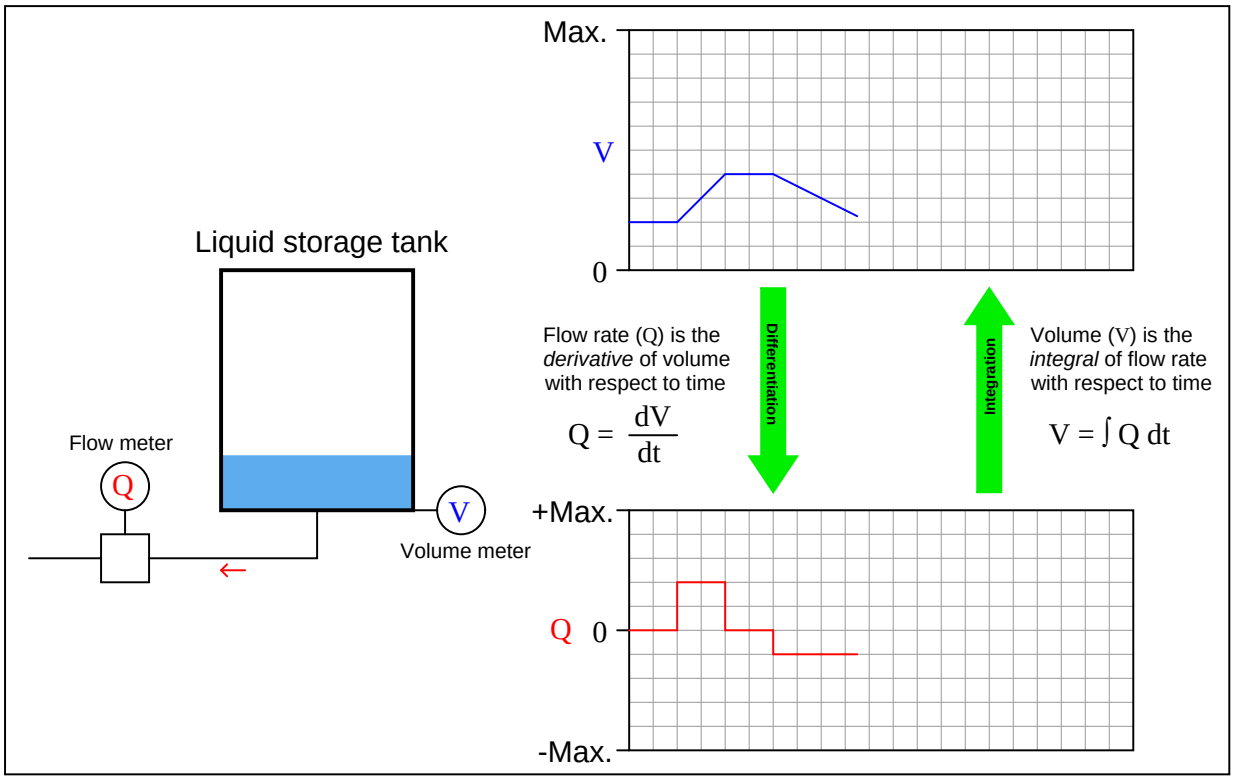
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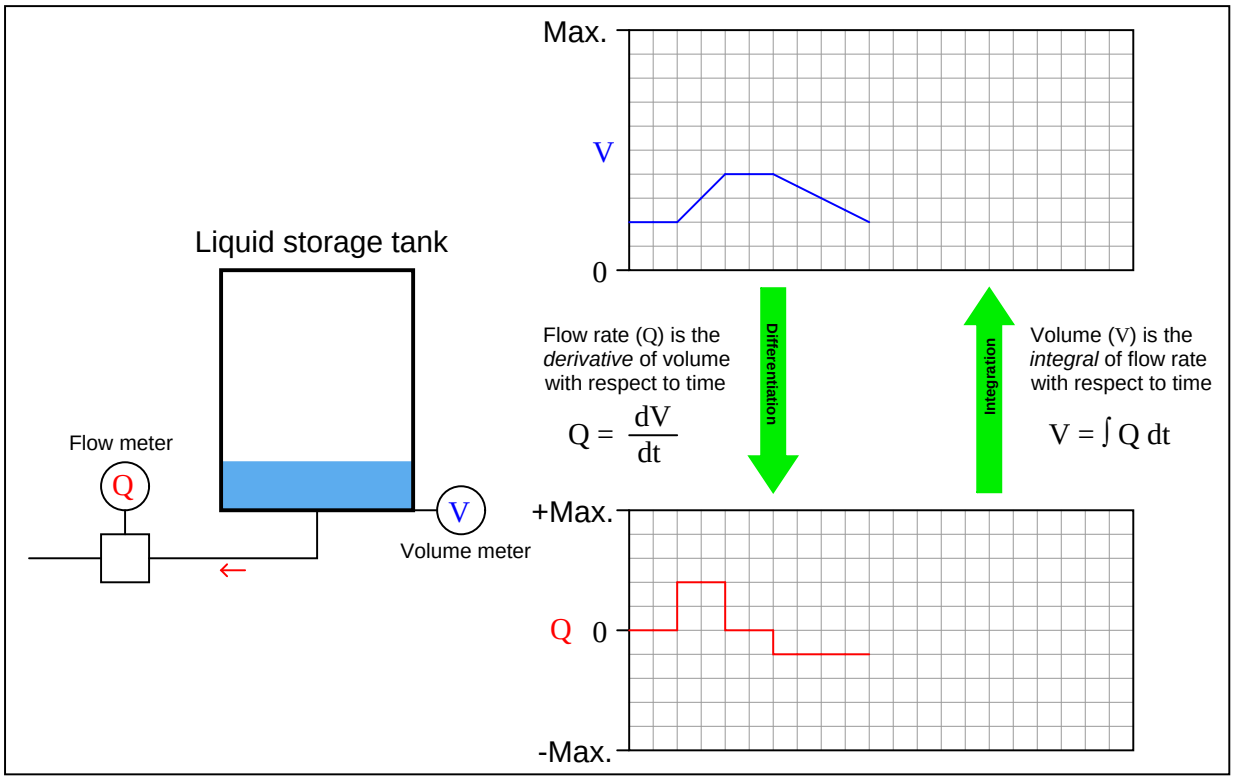
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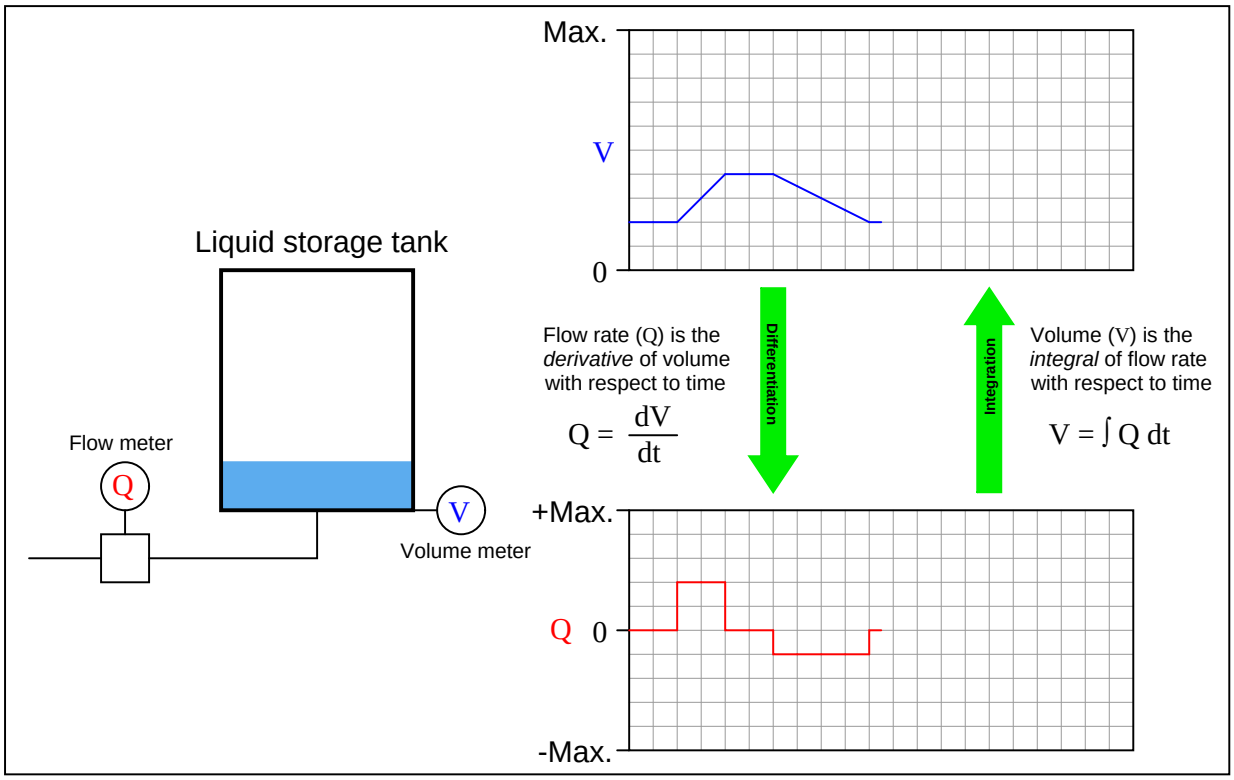
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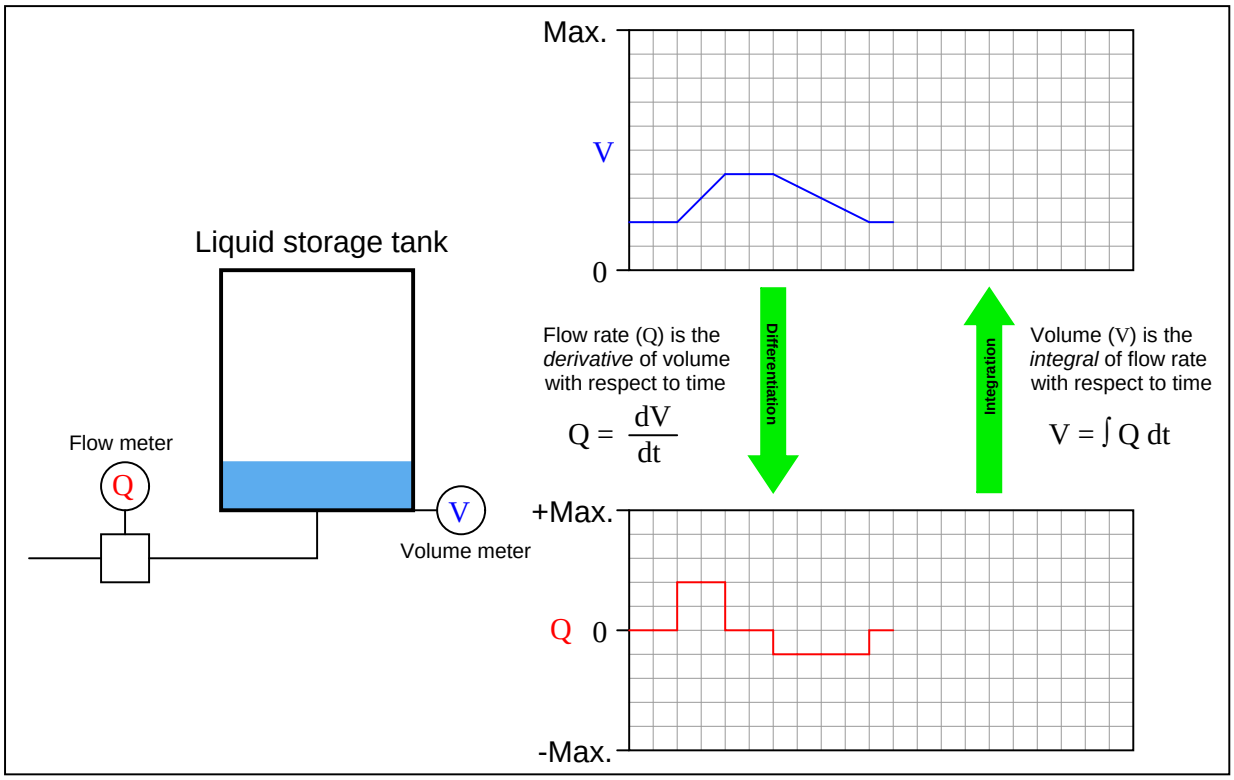
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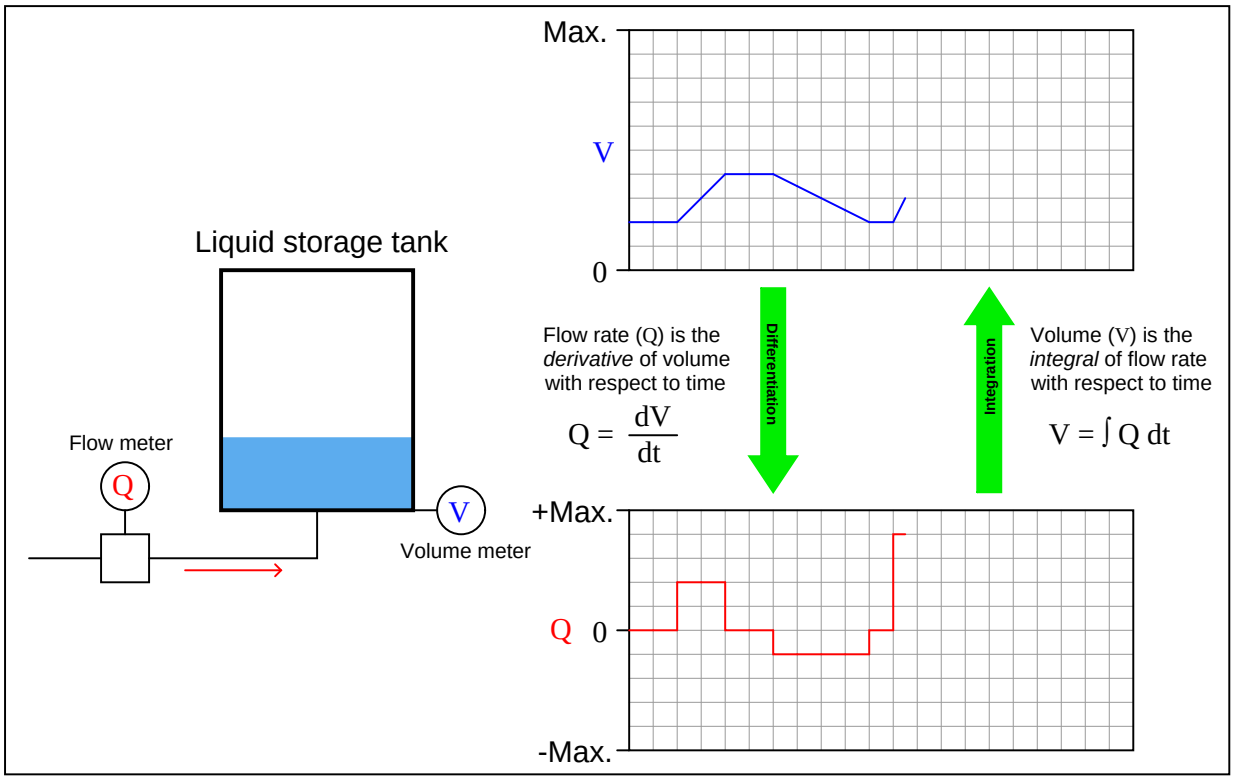
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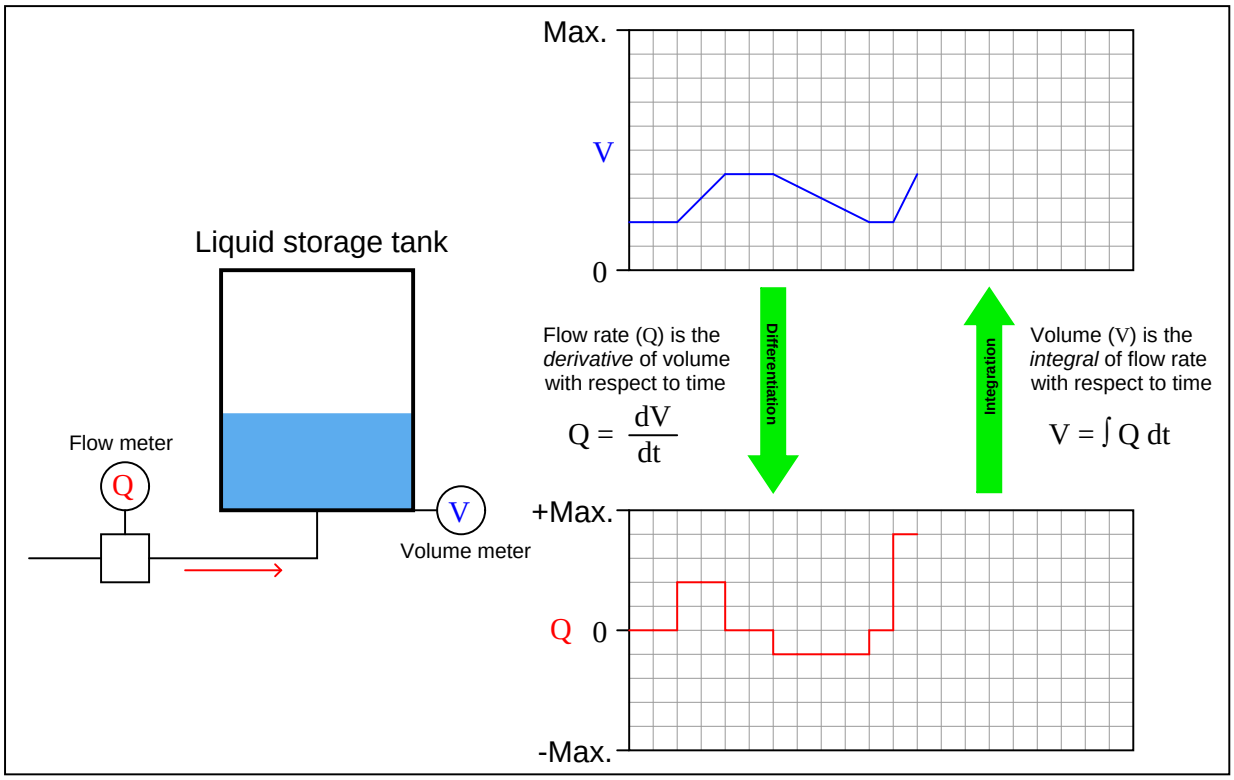
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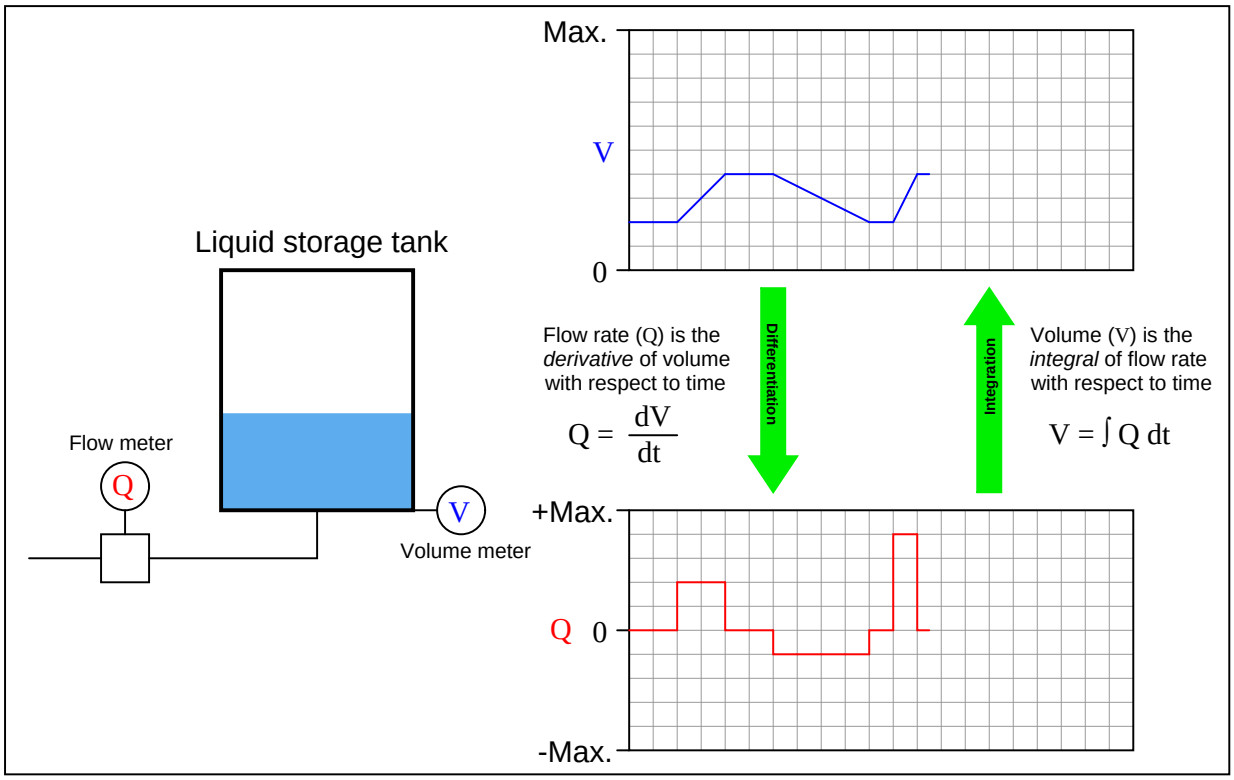
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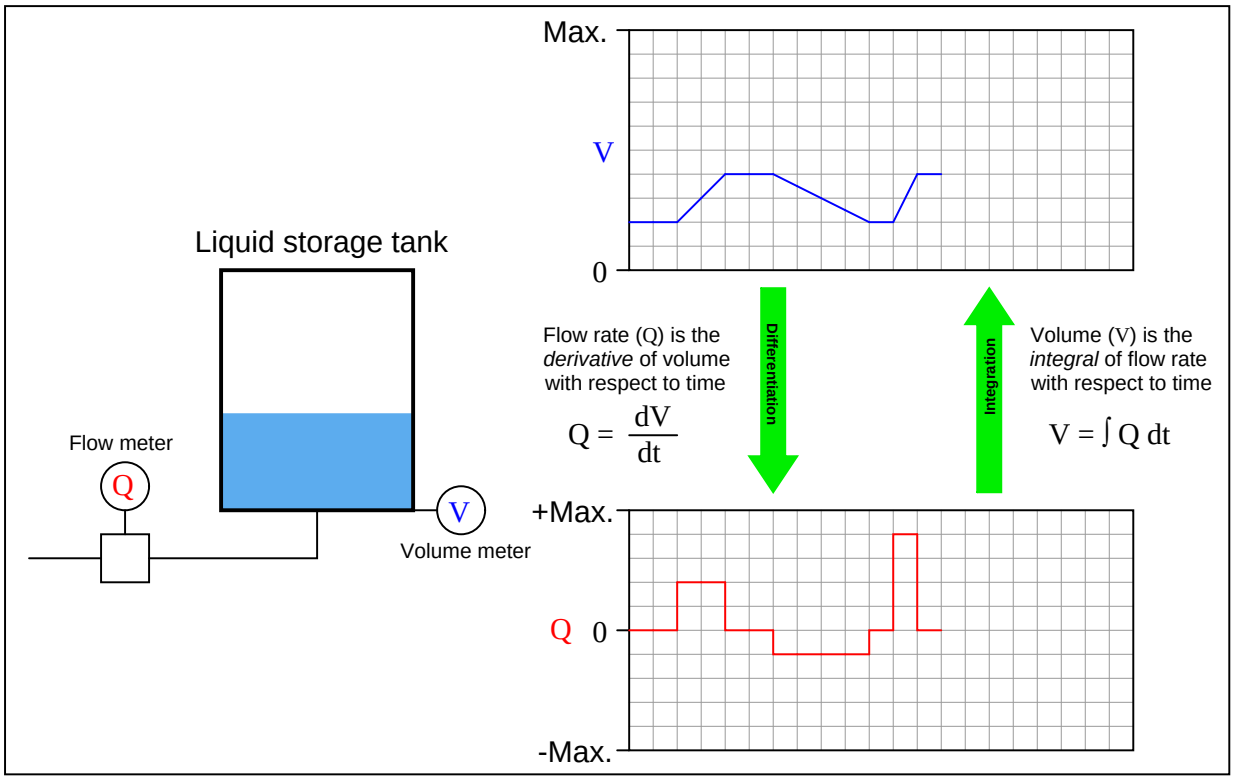
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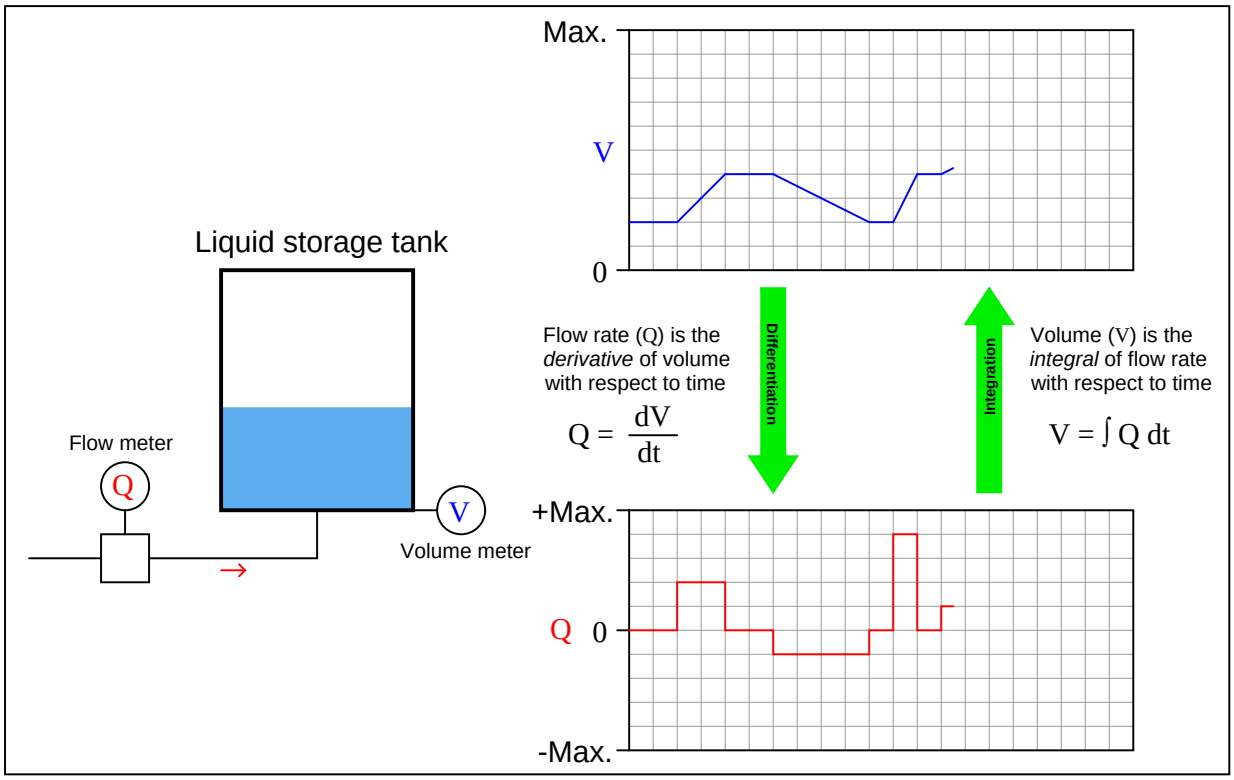
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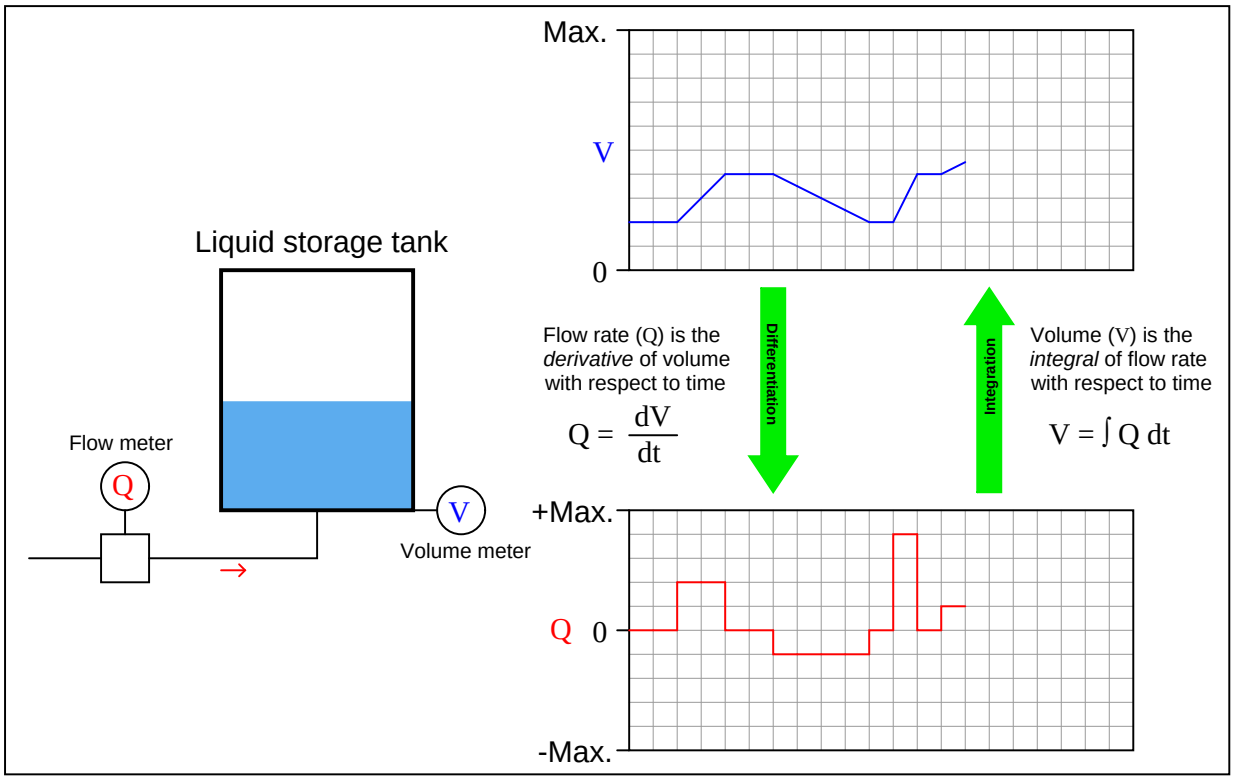
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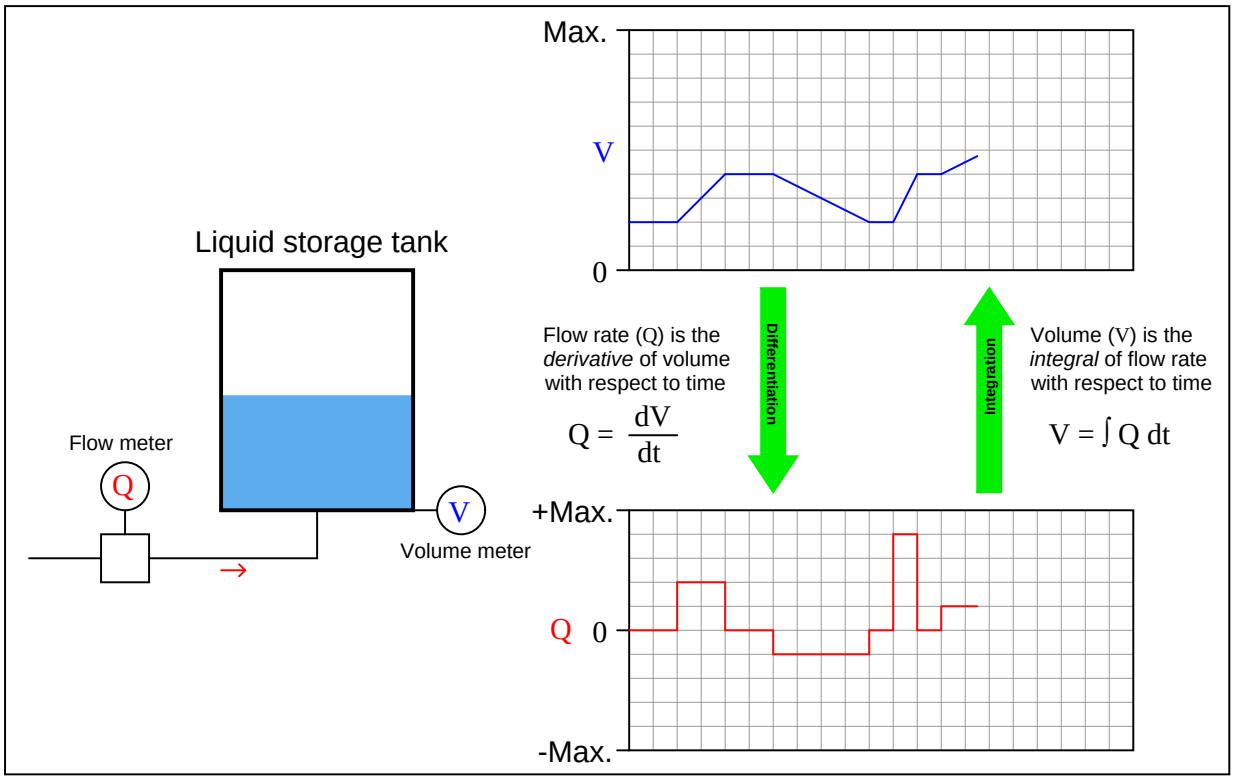
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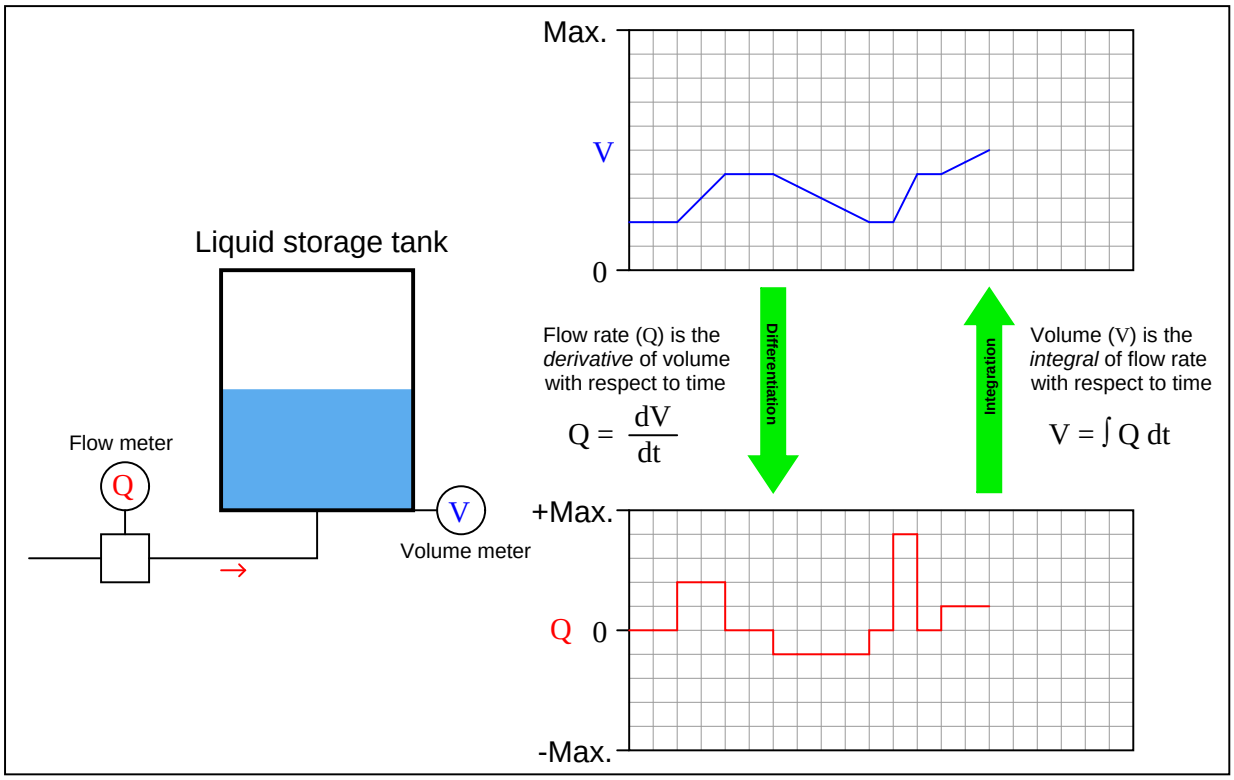
Liquid storage tank
Flow meter
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V
Volume meter
Max.
V
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Flow rate (Q) is the *derivative* of volume with respect to time
Q = dV/dt
Differentiation
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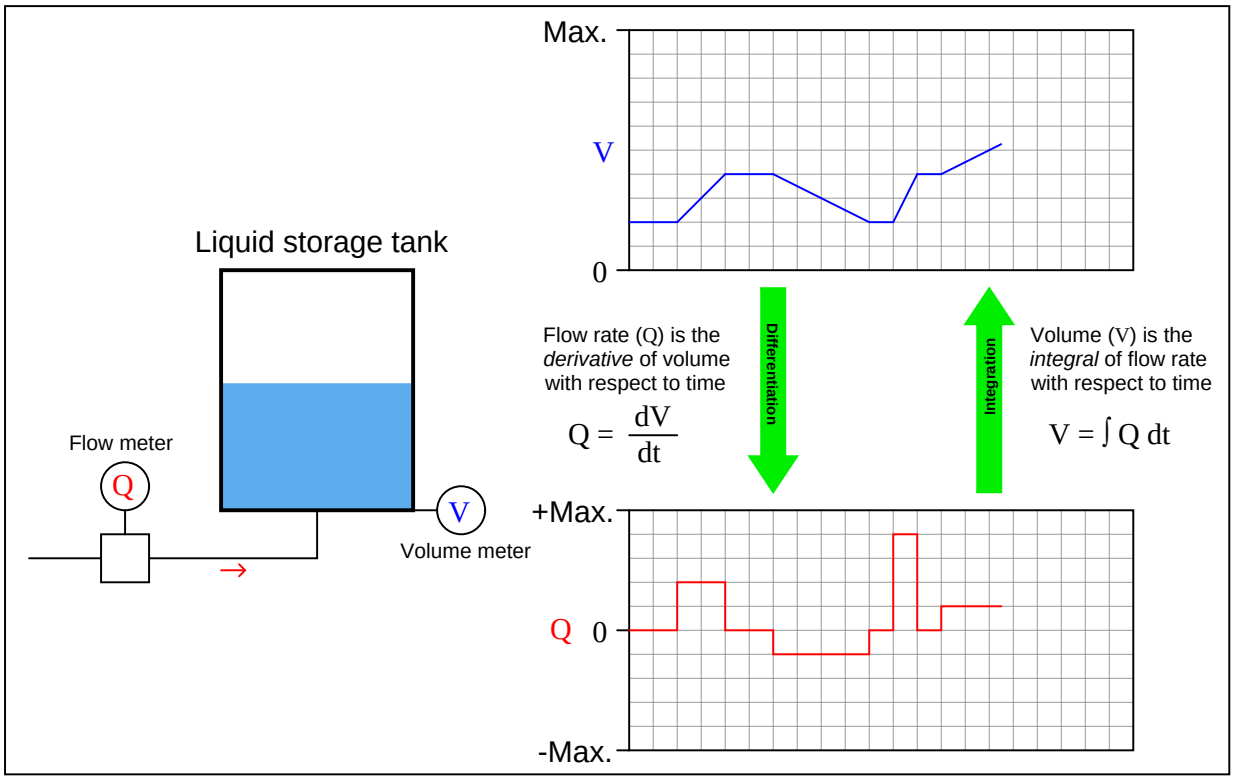
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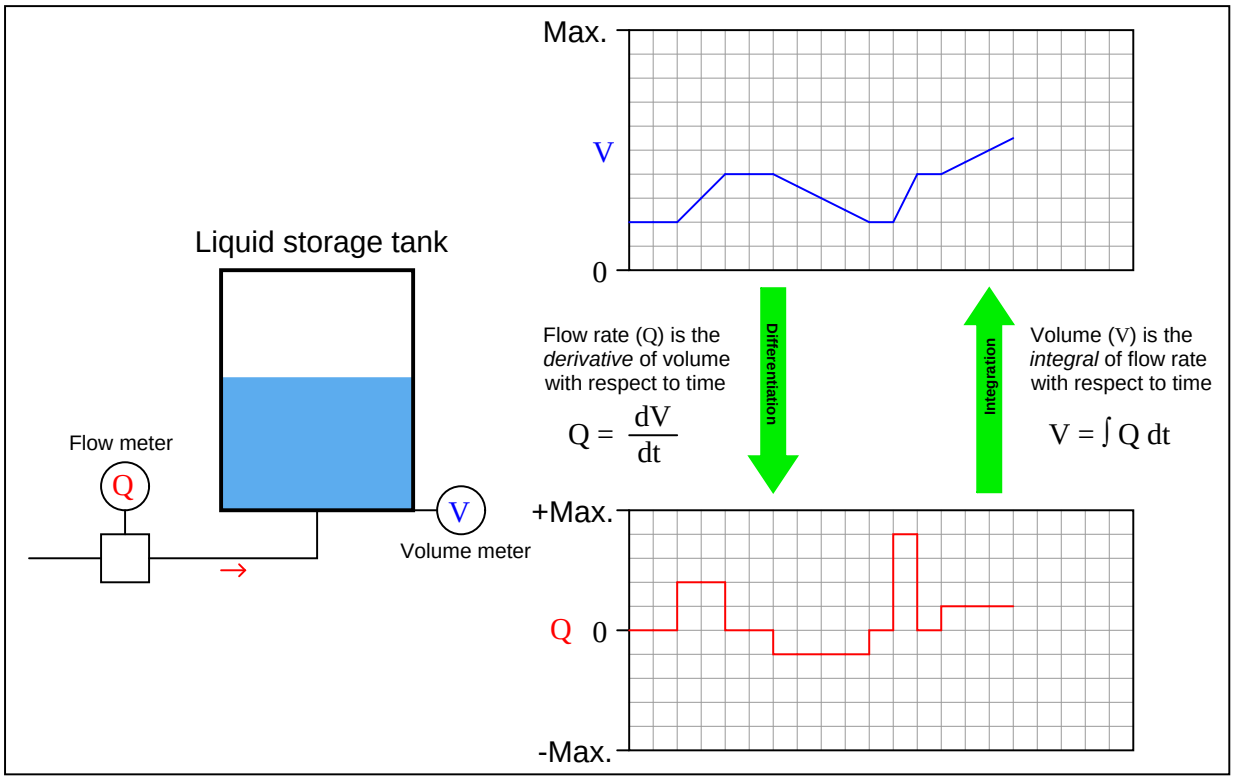
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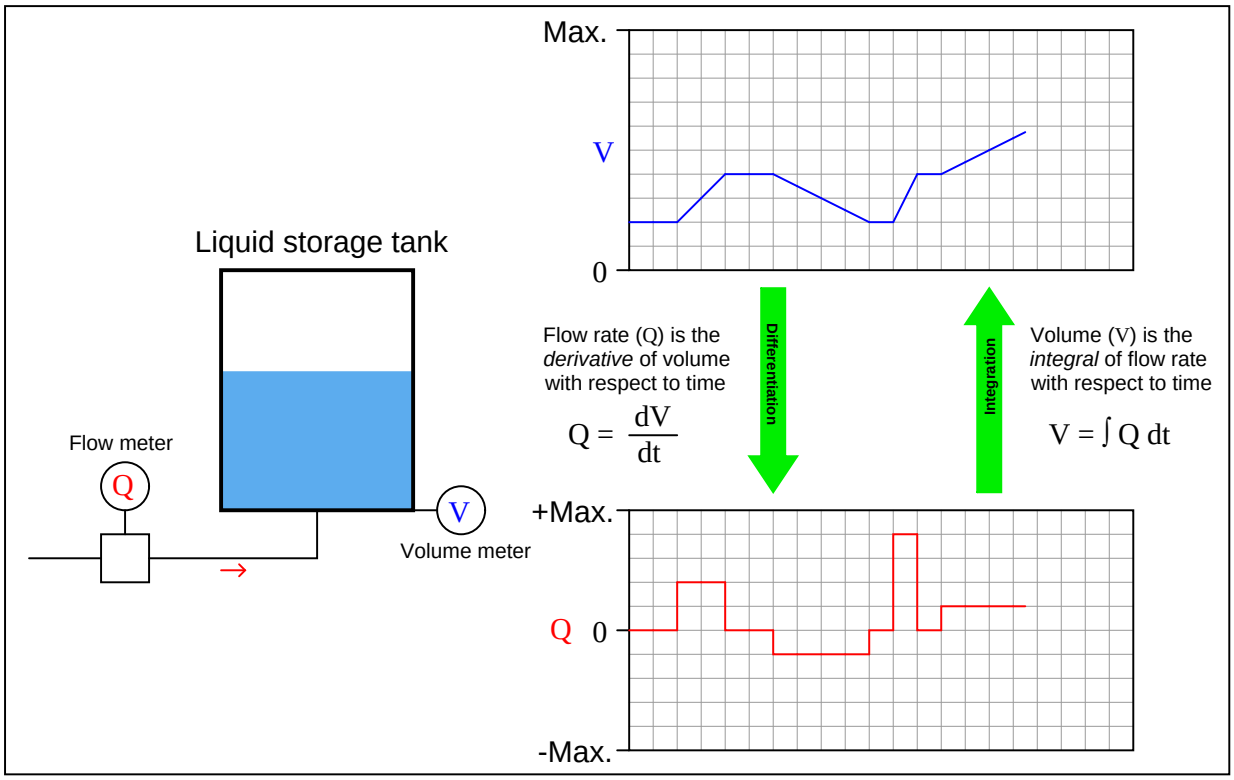
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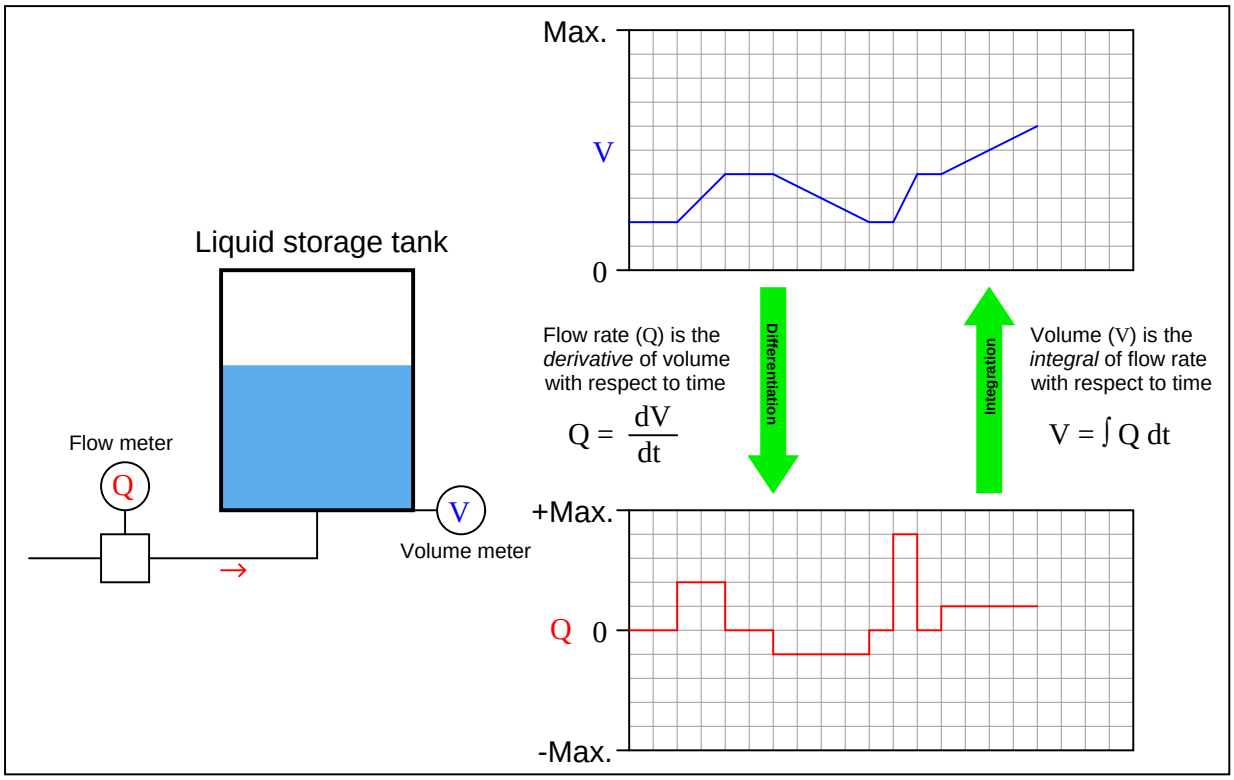
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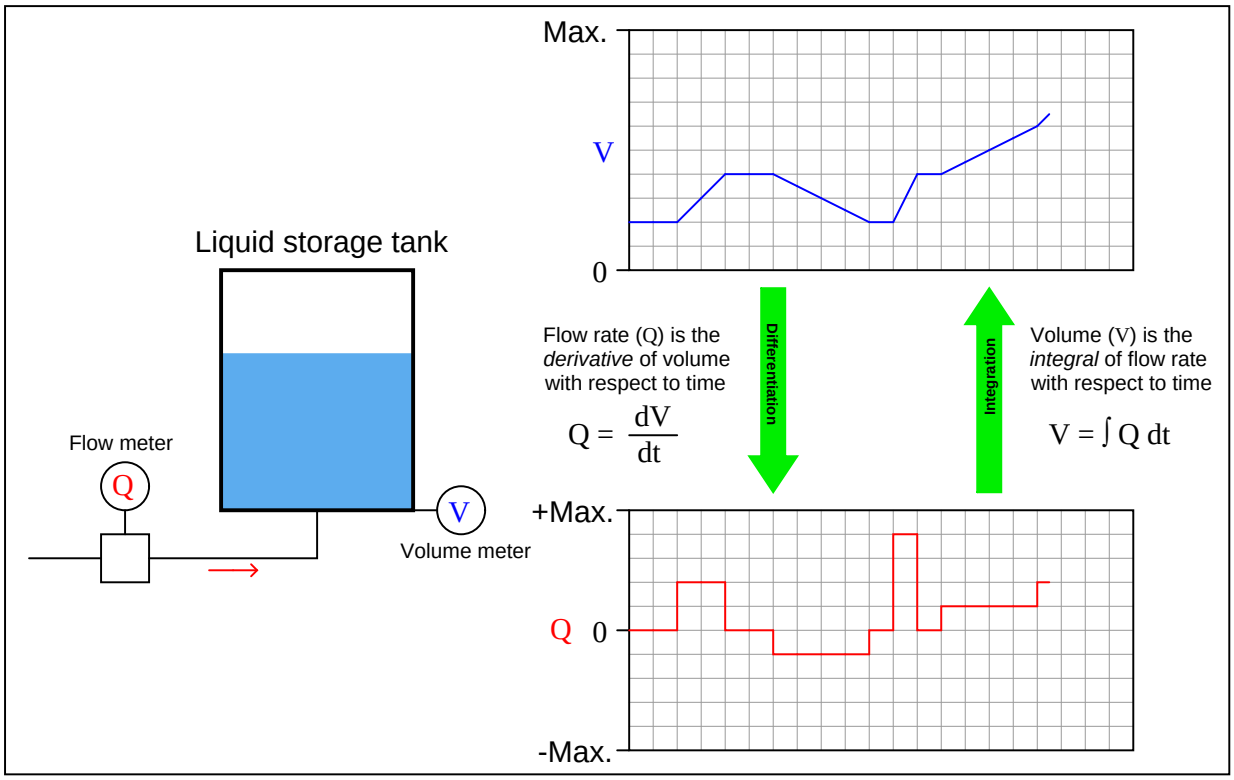
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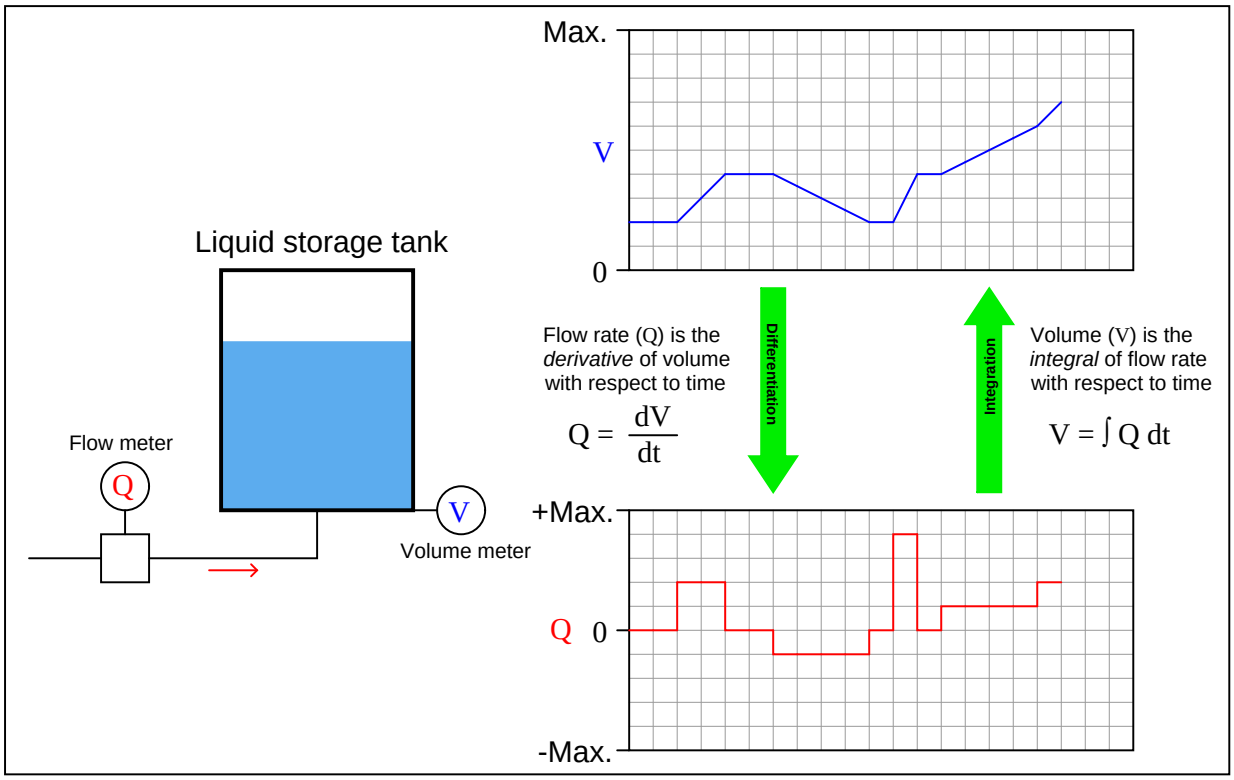
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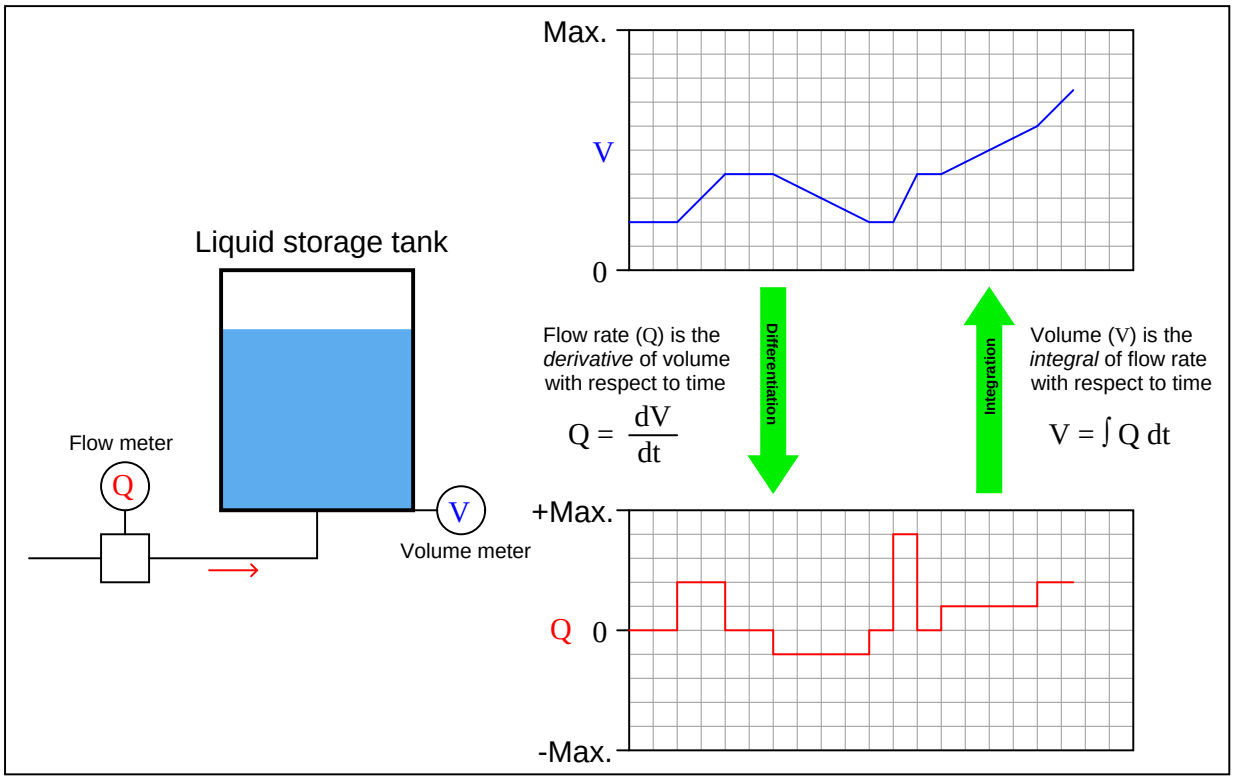
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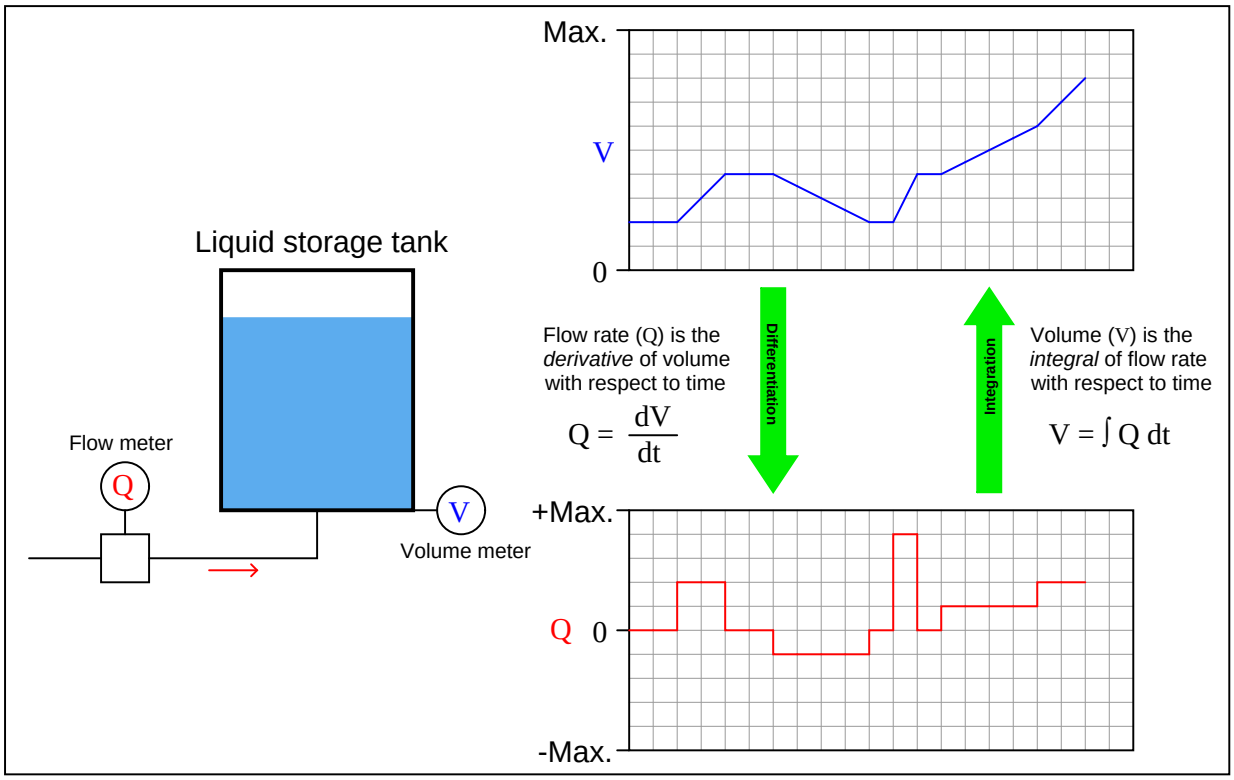
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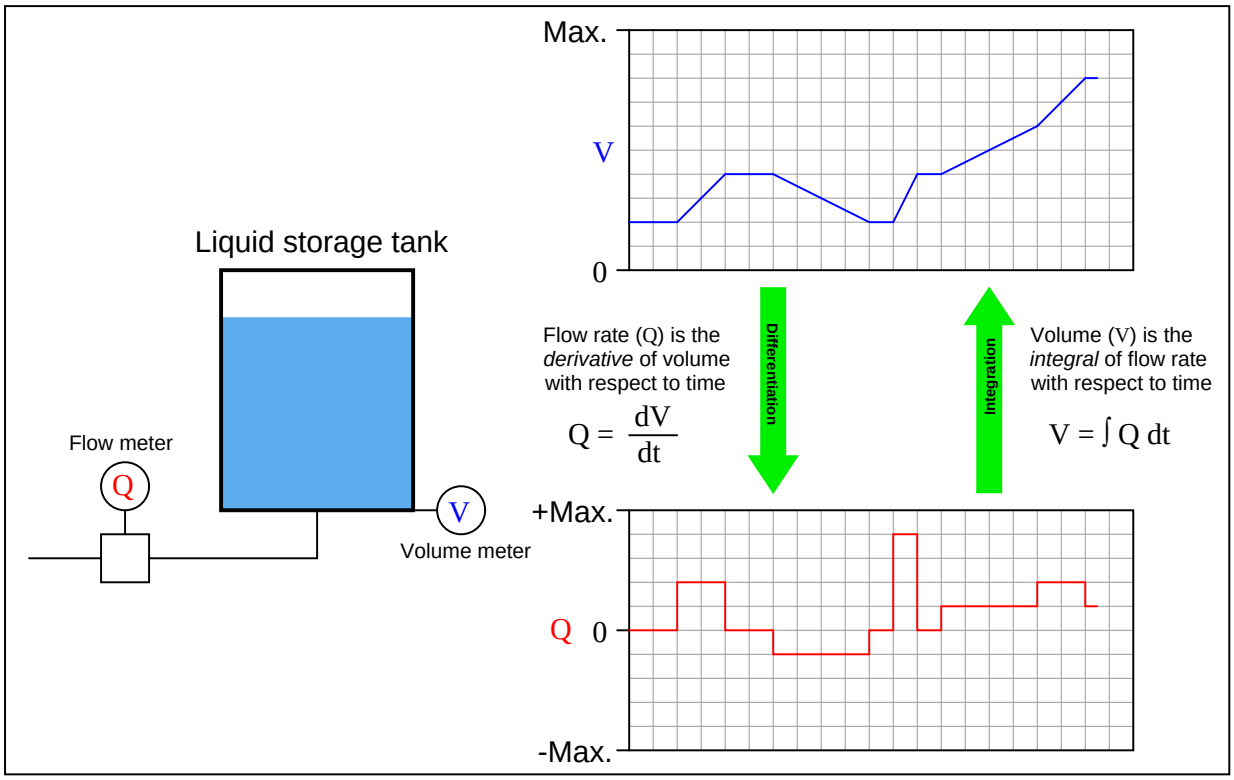
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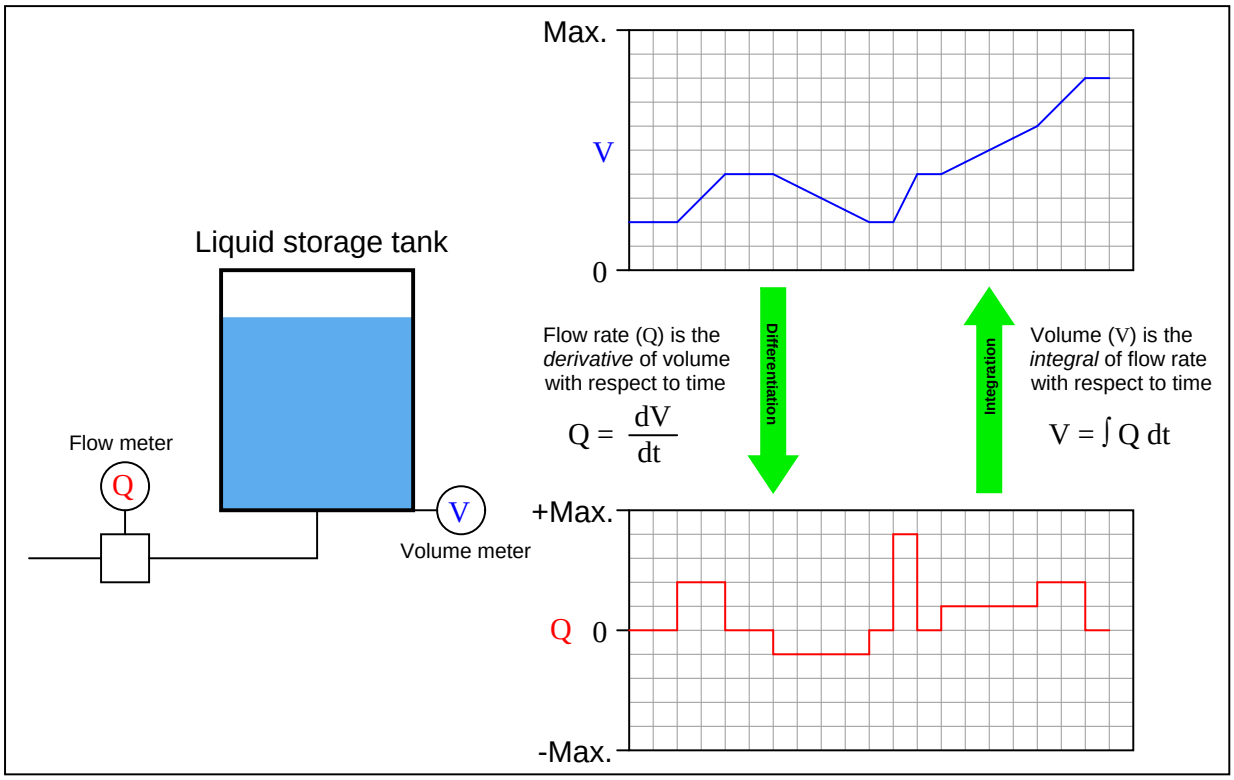
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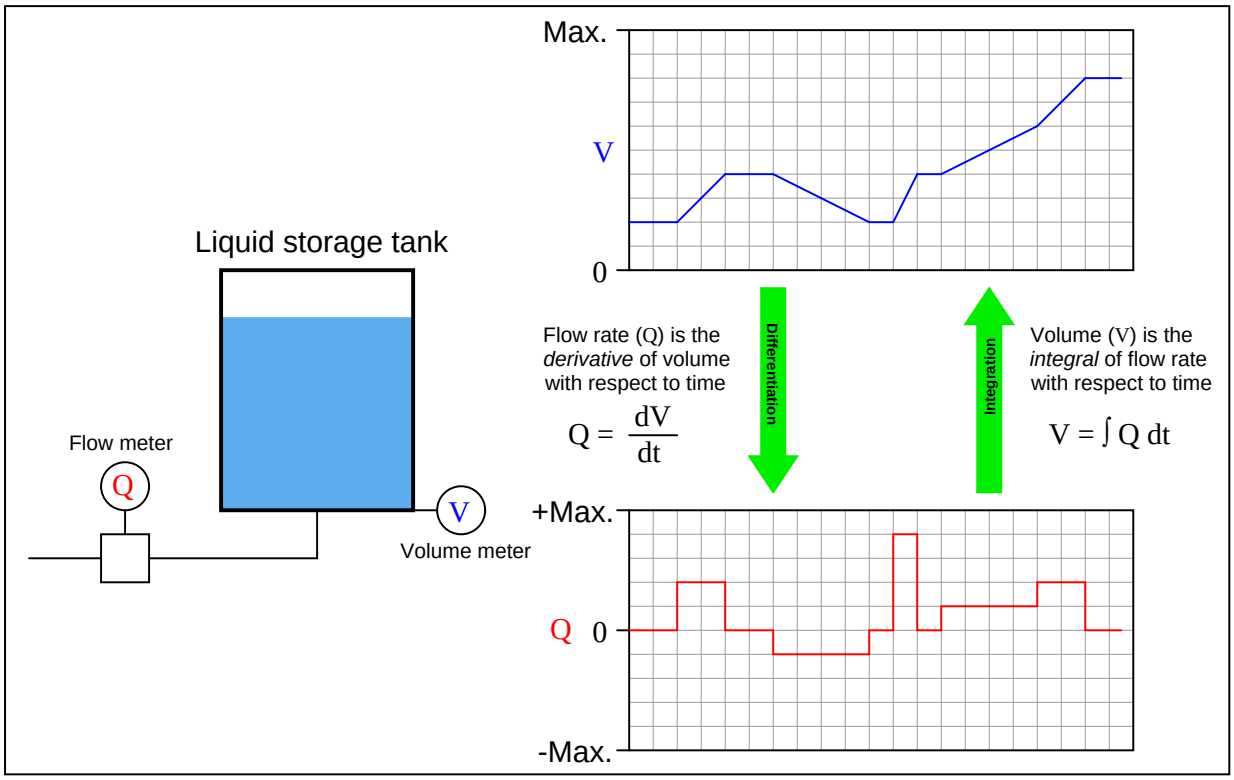
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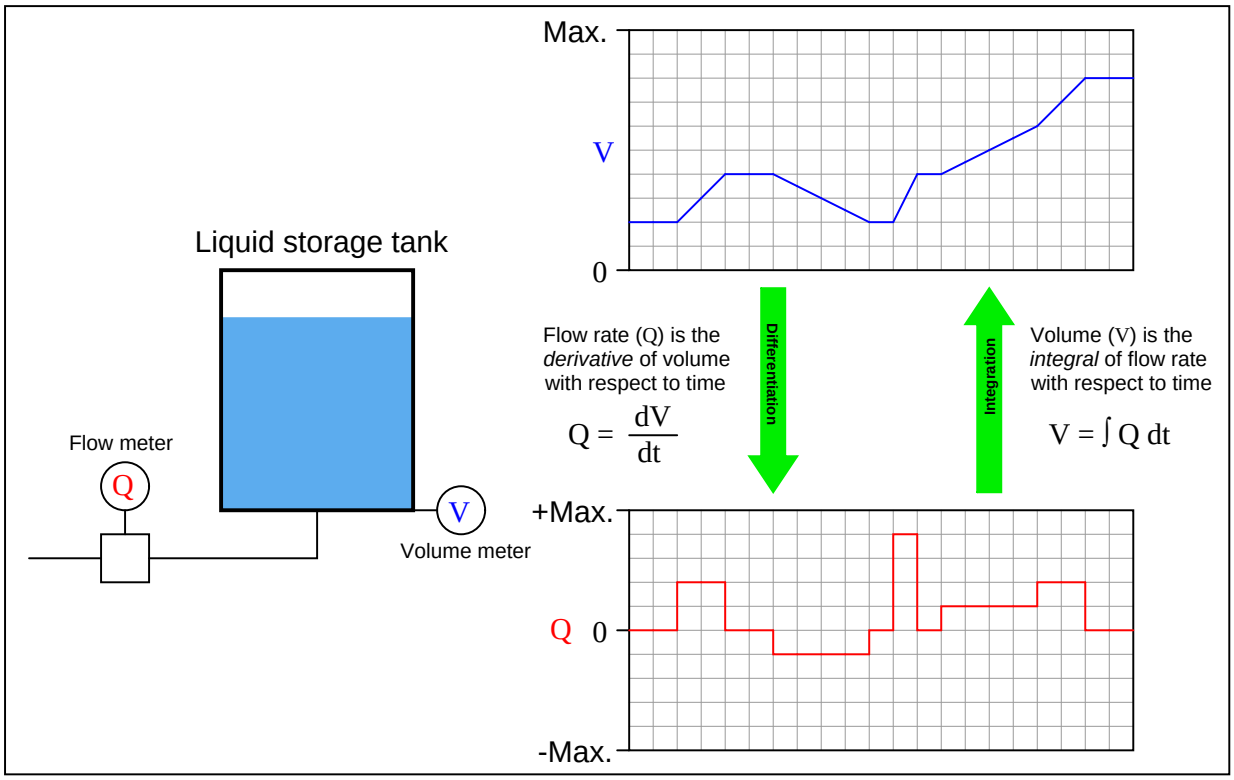
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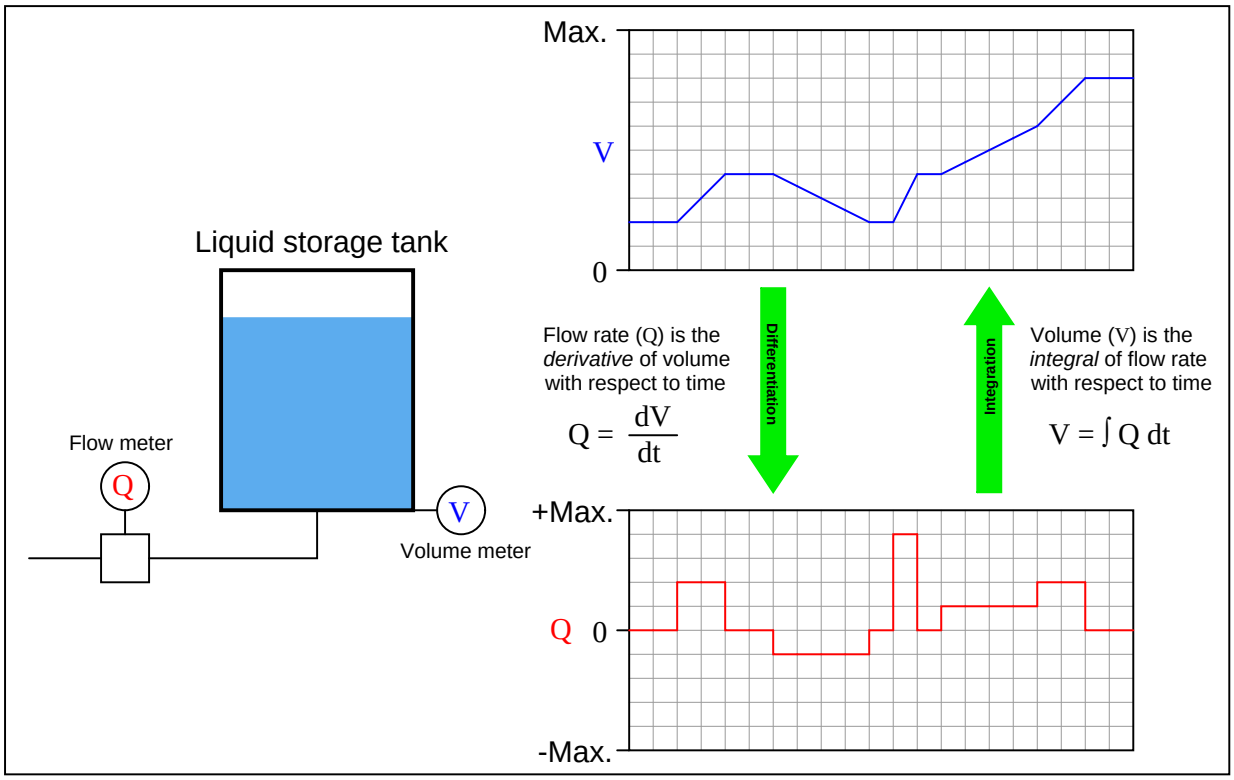
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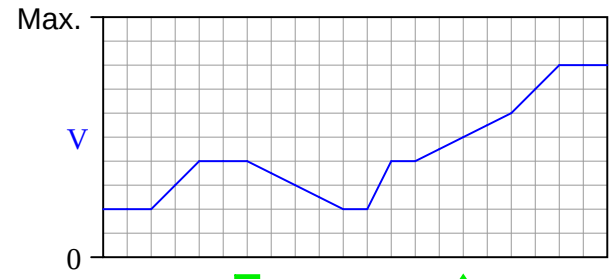
*Note how the **height** of the flow graph directly relates to the **slope** of the volume graph . . .*




Flow rate (Q) is the *derivative* of volume with respect to time

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Integration

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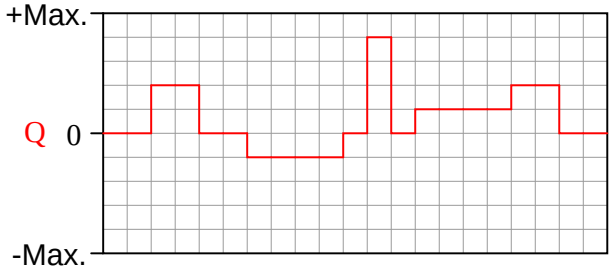

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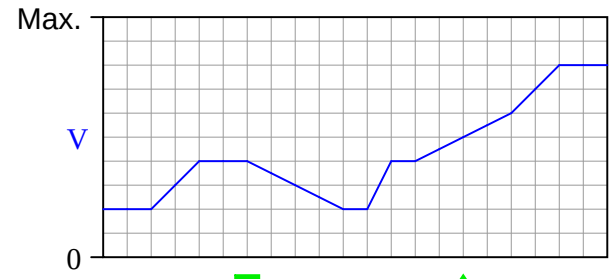


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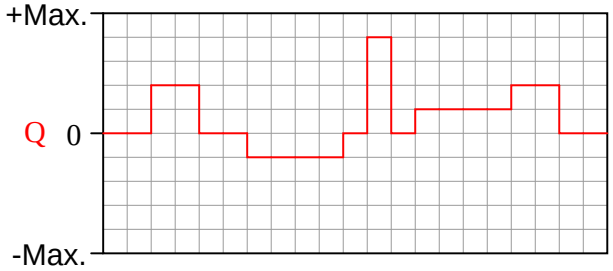

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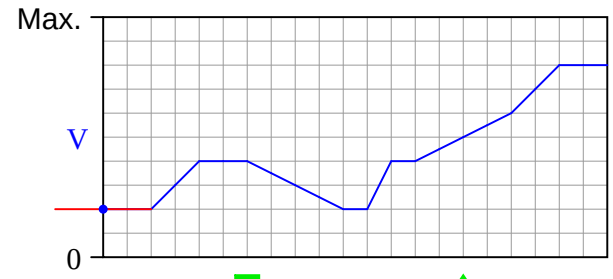


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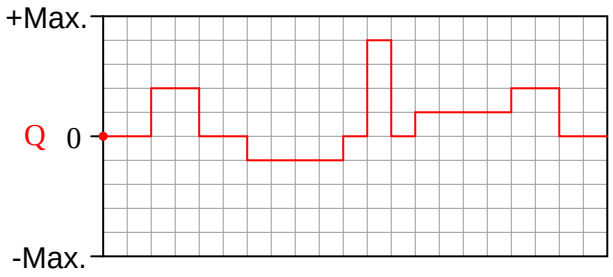

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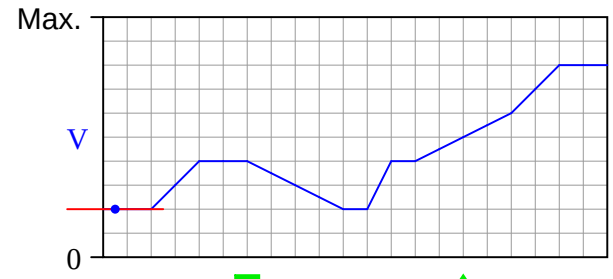


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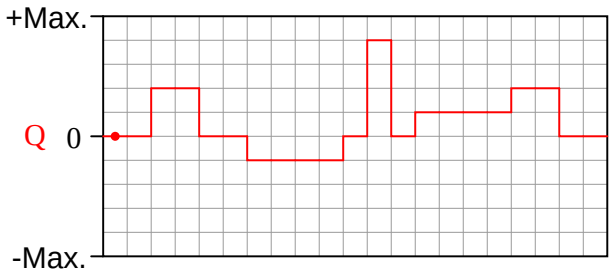

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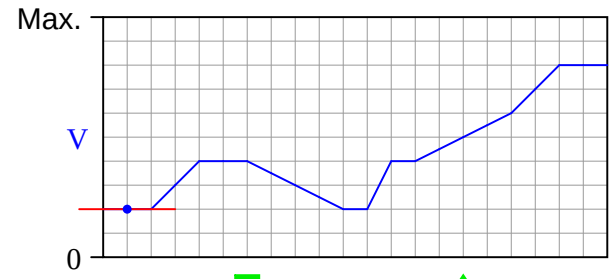


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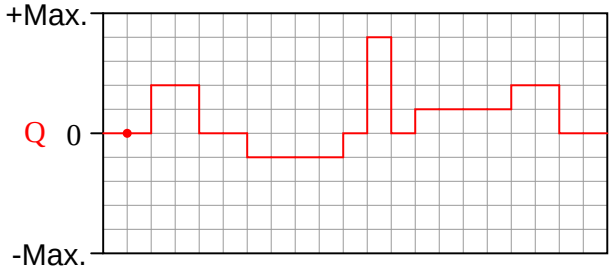

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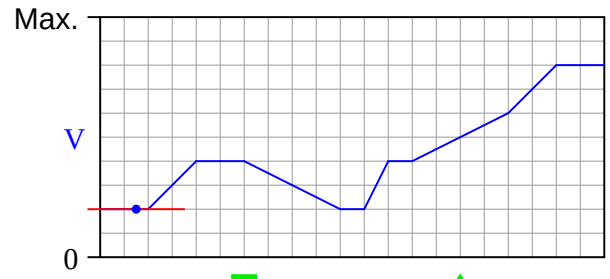


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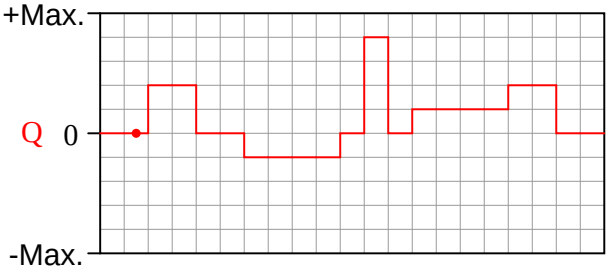

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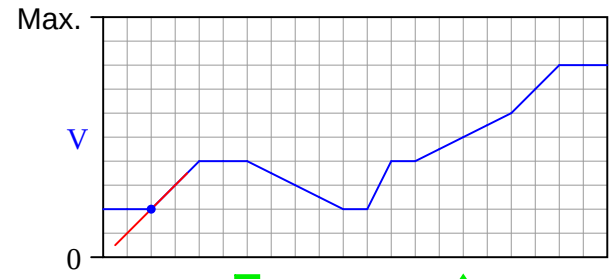


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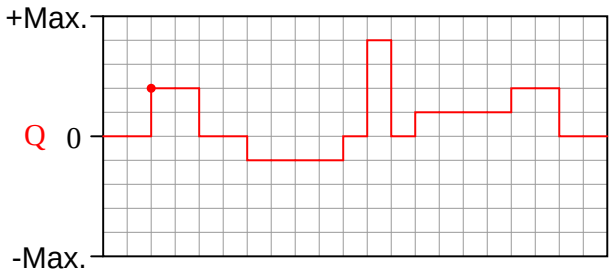

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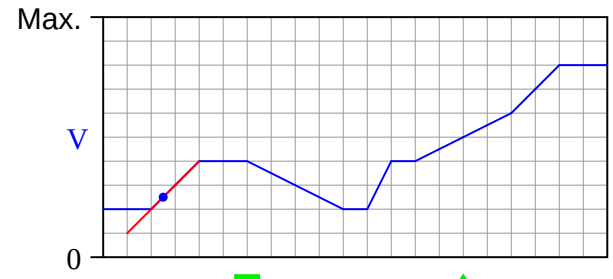


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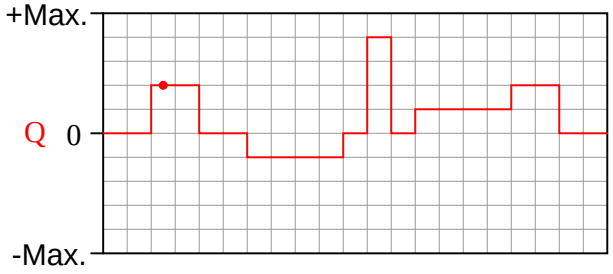

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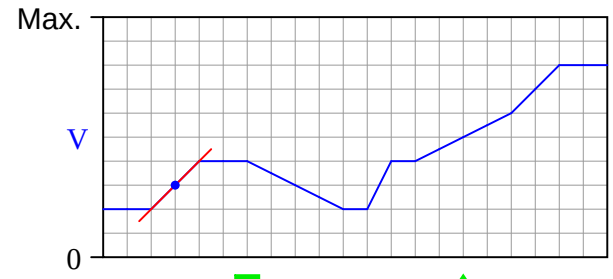


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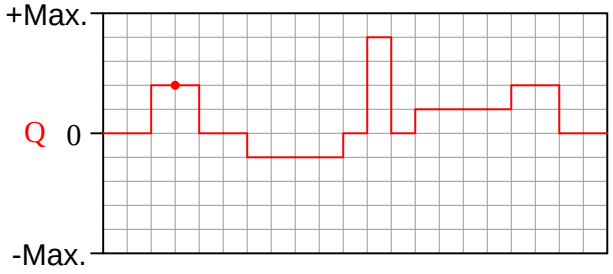

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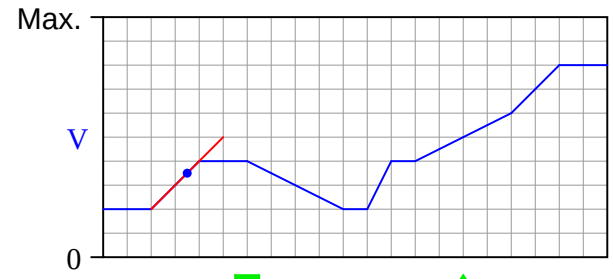


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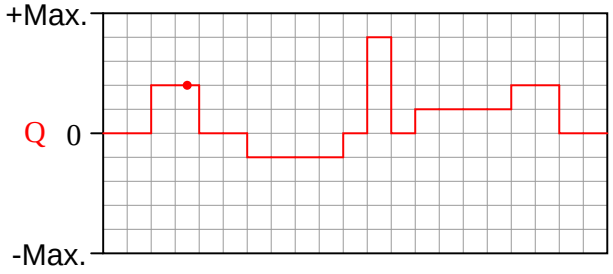

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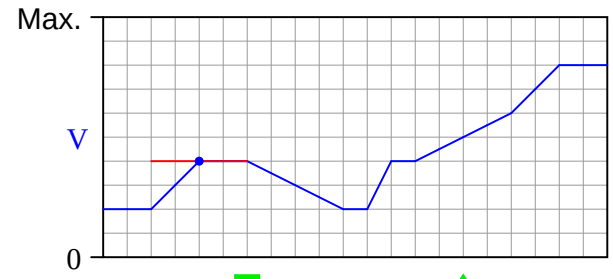


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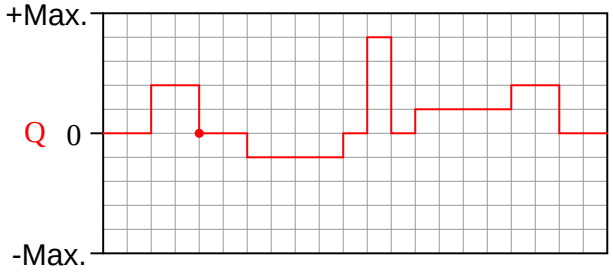
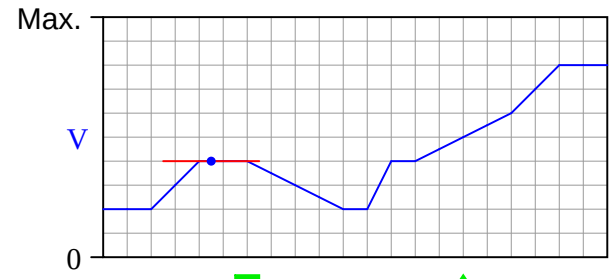


*Note how the **height** of the flow graph directly relates to the **slope** of the volume graph . . .*




Flow rate (Q) is the *derivative* of volume with respect to time

$$Q = \frac{dV}{dt}$$

Differentiation

Integration

Volume (V) is the *integral* of flow rate with respect to time

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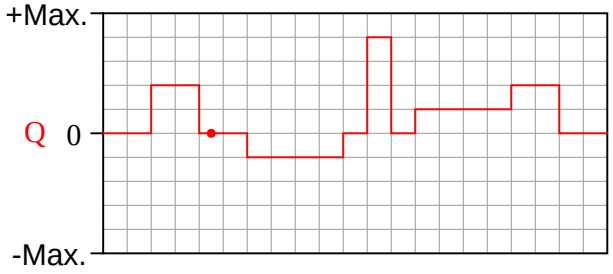

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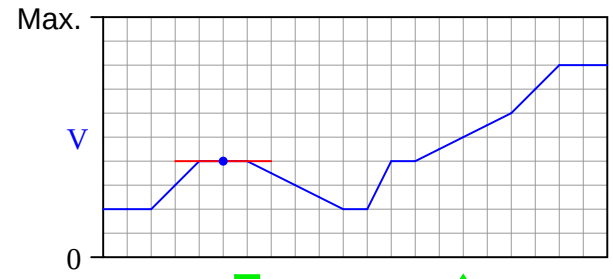


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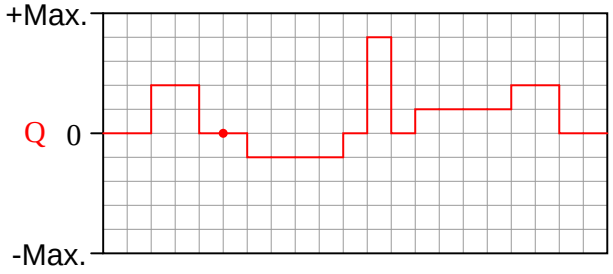

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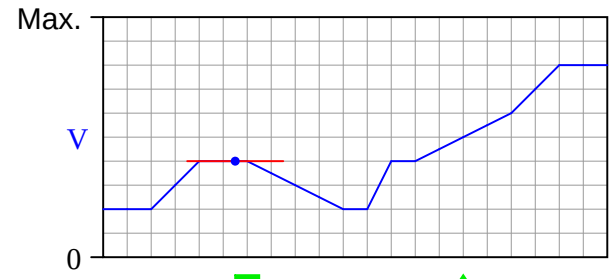


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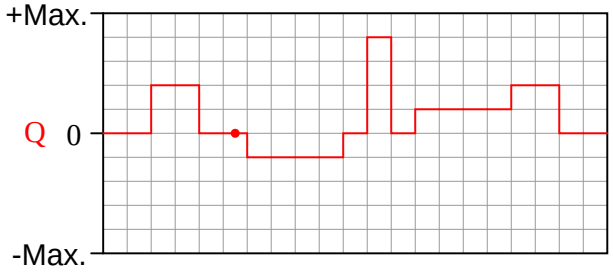

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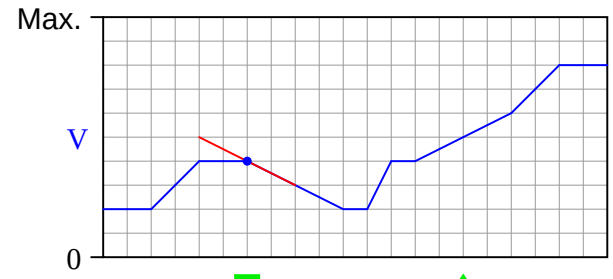


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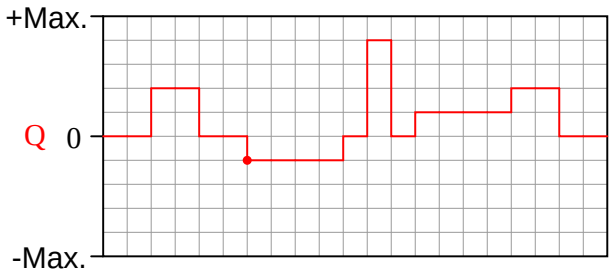

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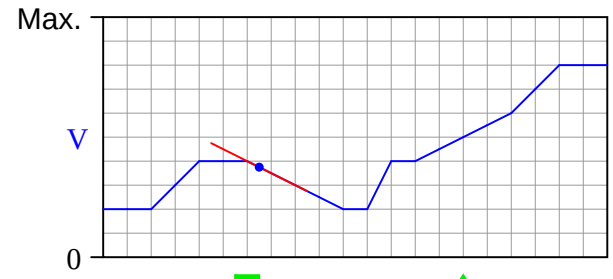


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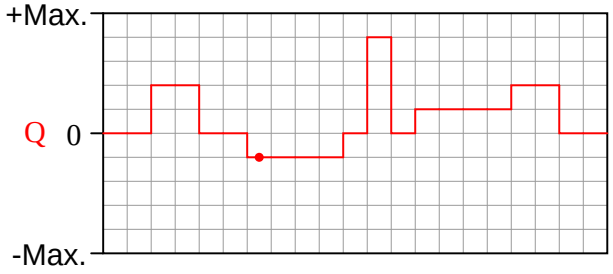

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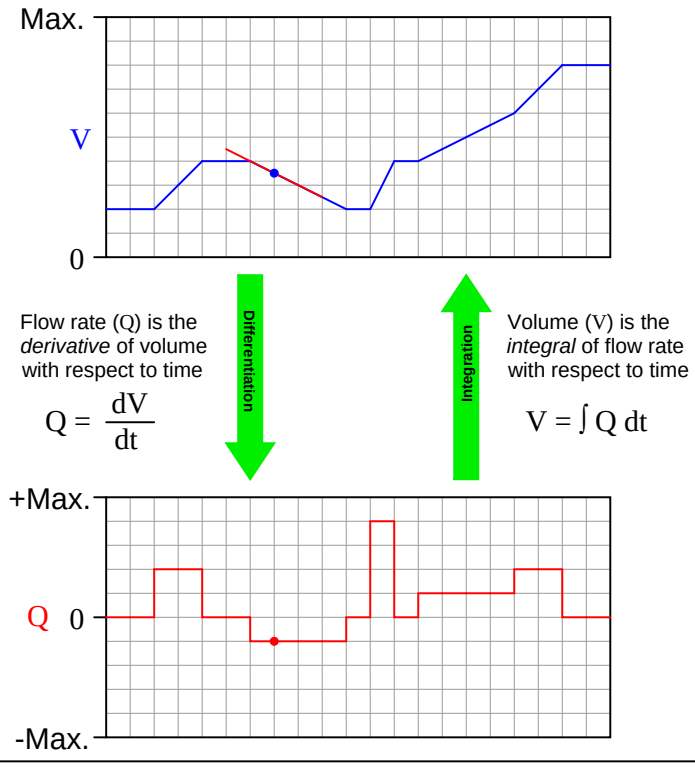

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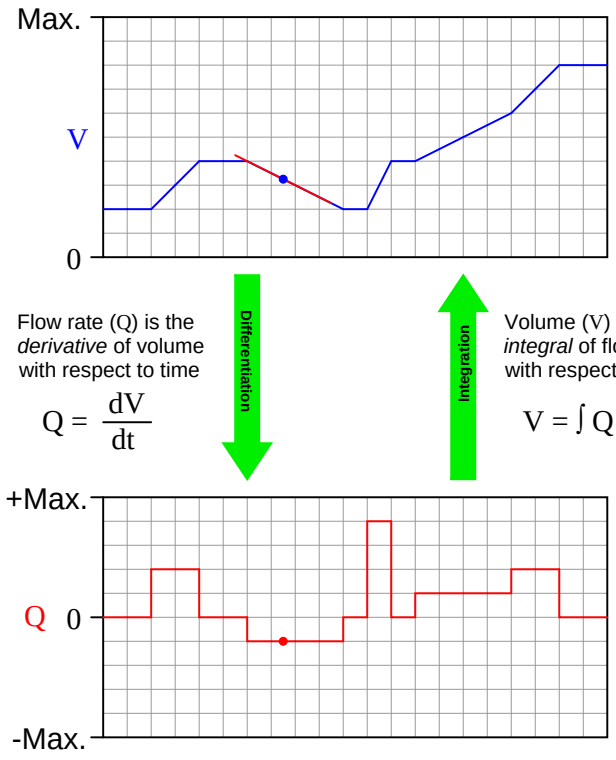

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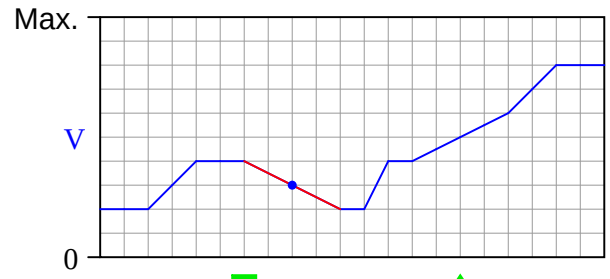


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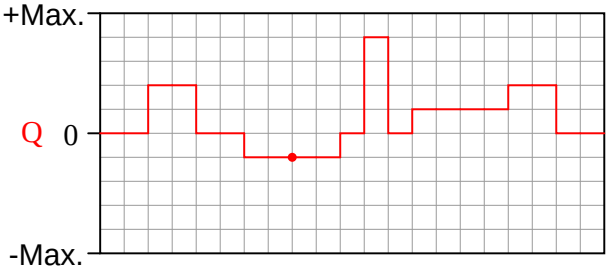

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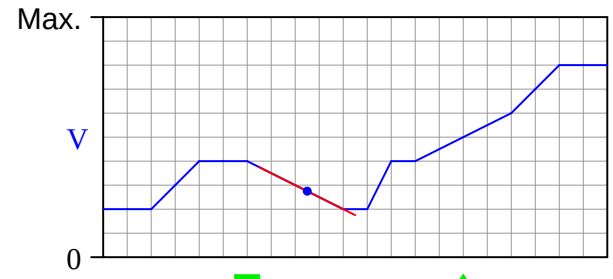


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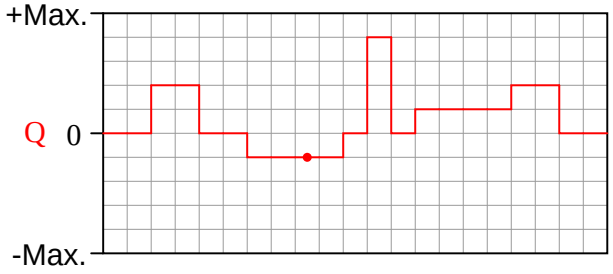

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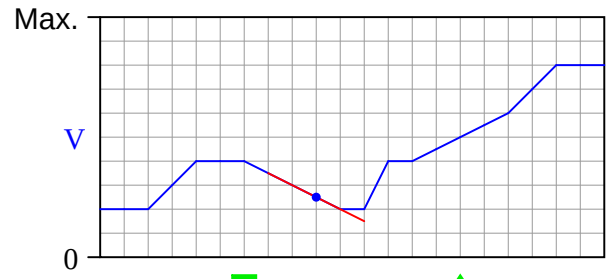


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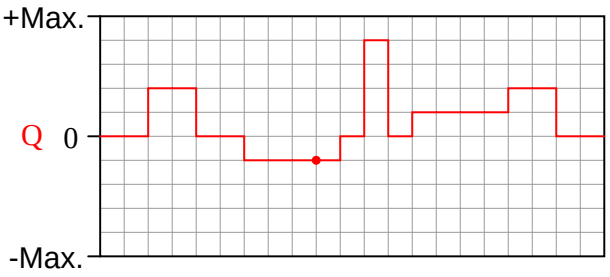

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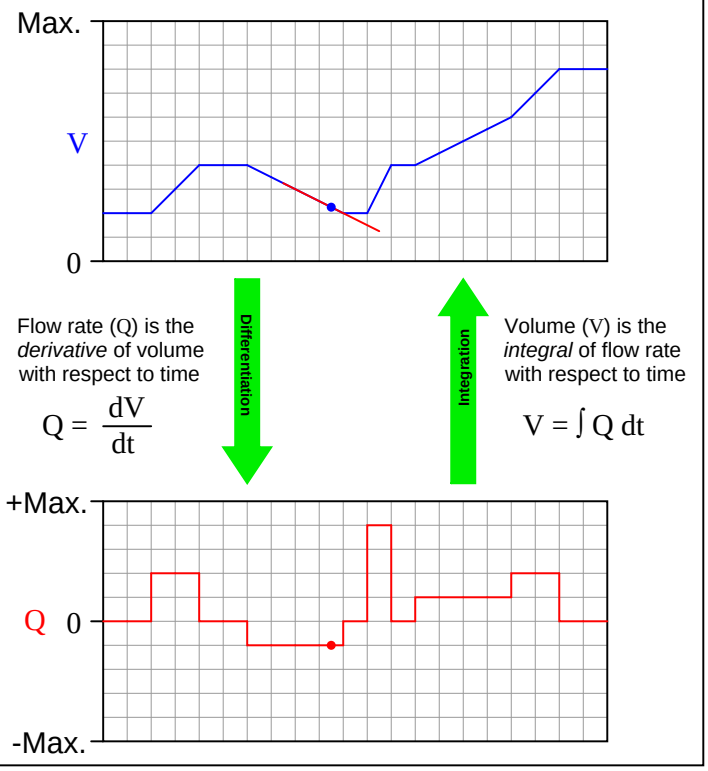

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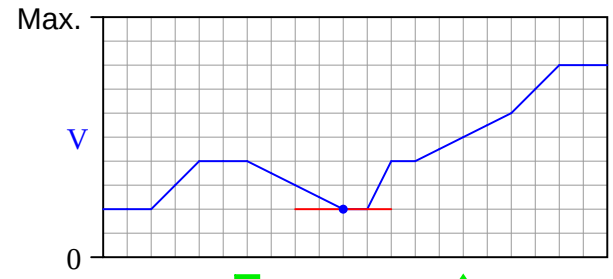


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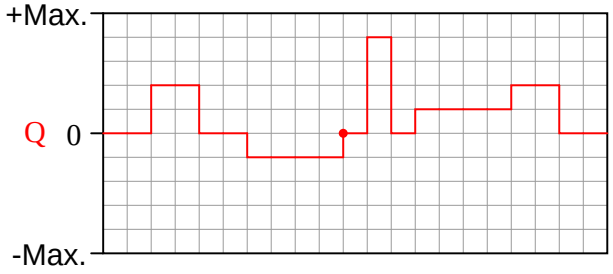

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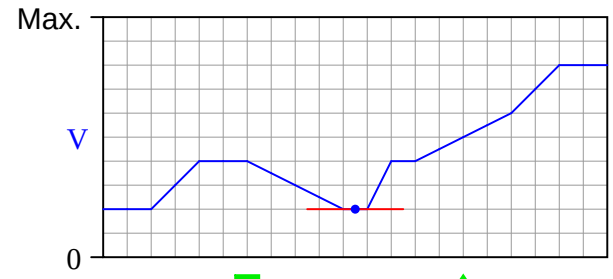


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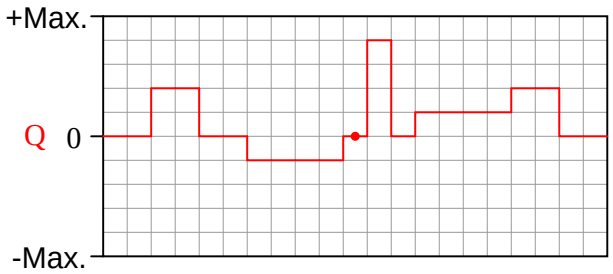

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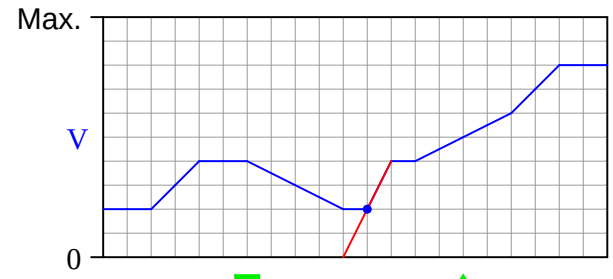


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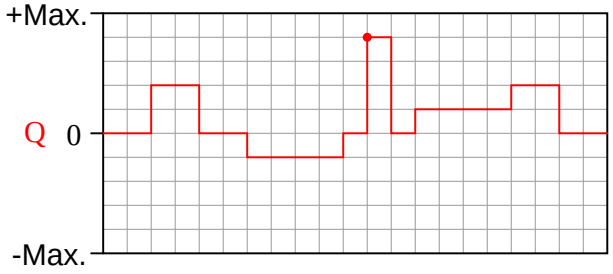

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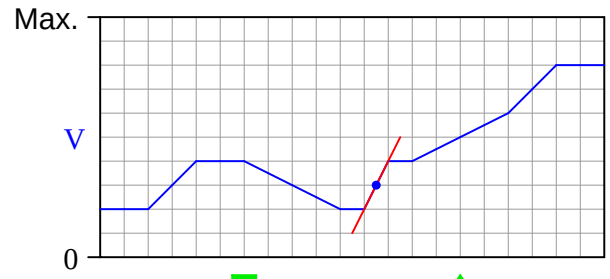


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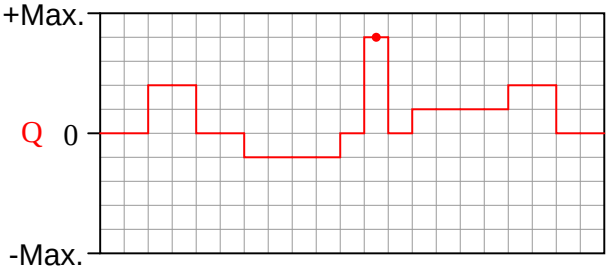

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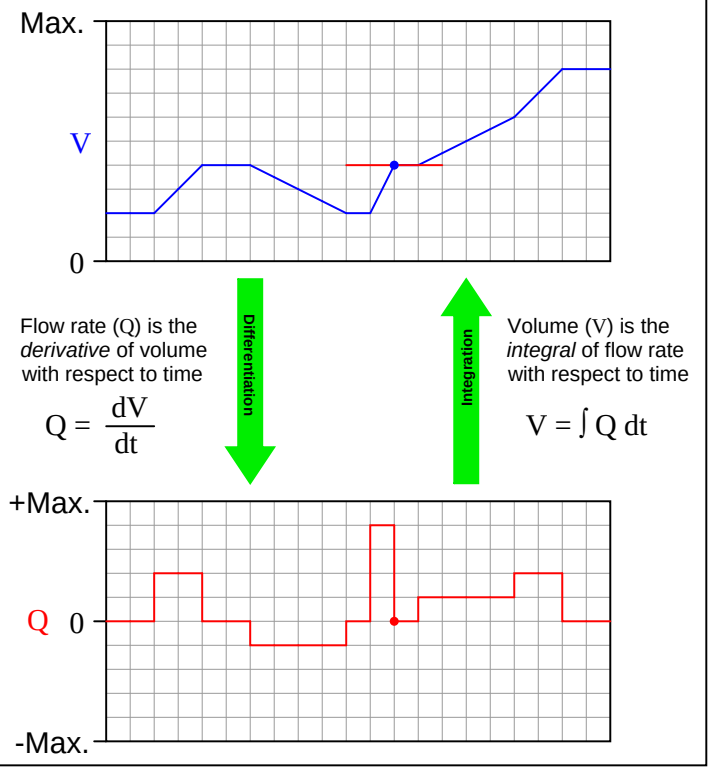

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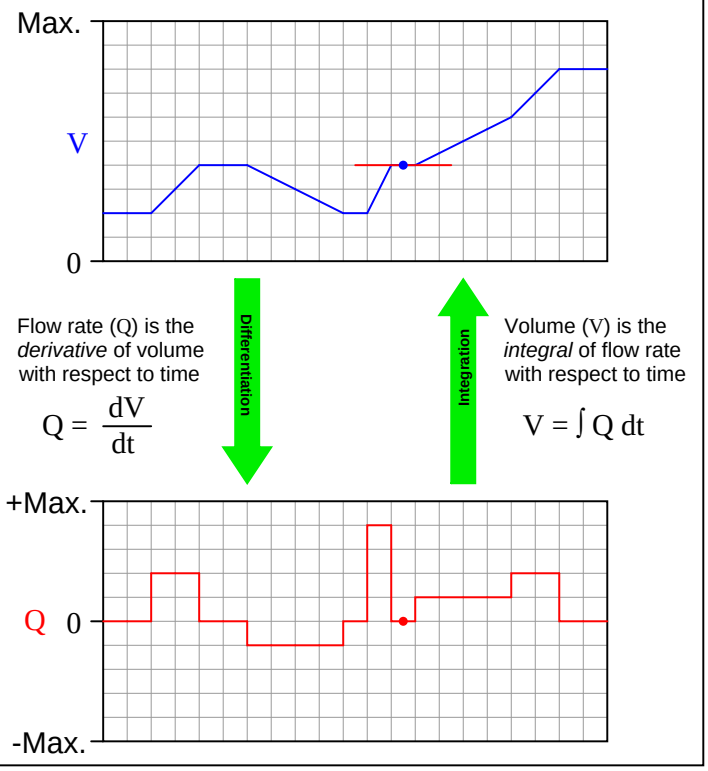

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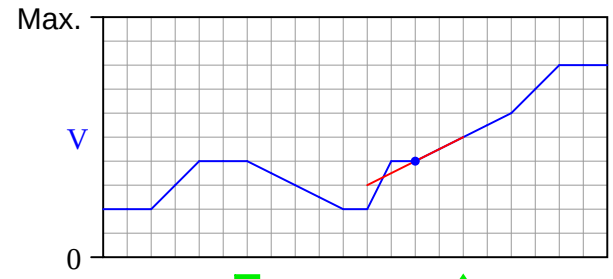


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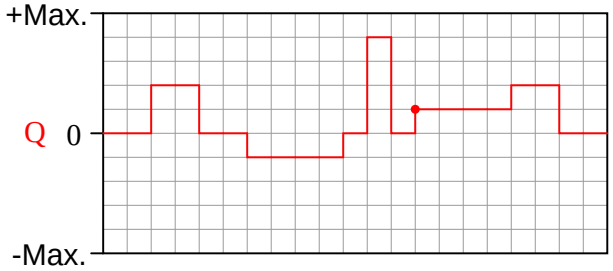

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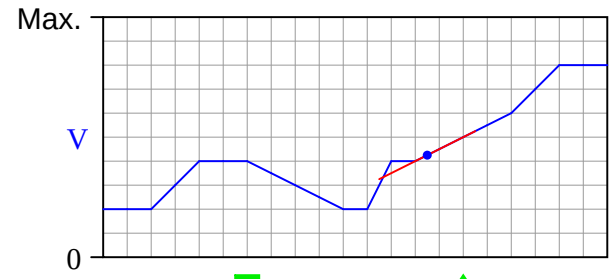


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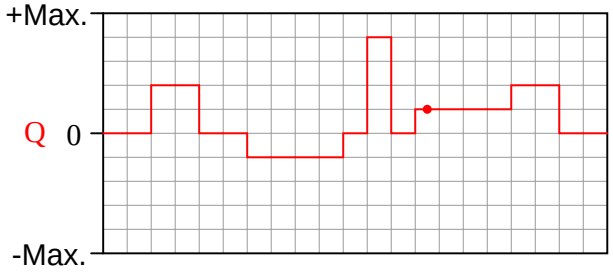

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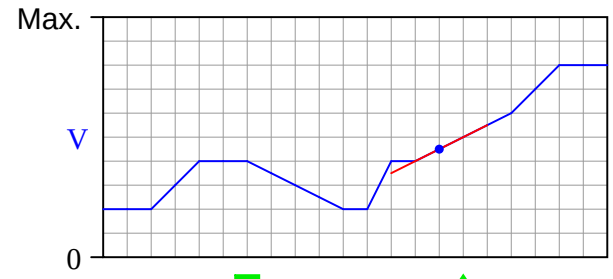


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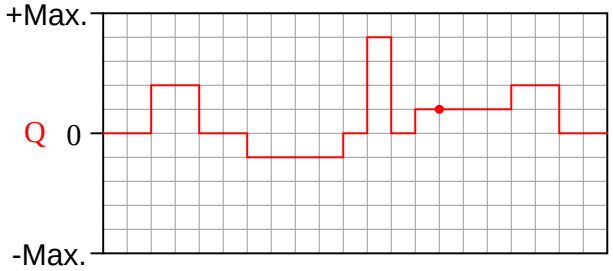

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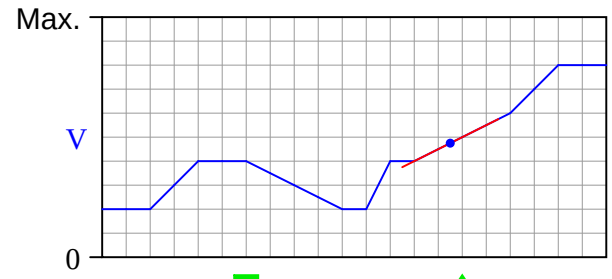


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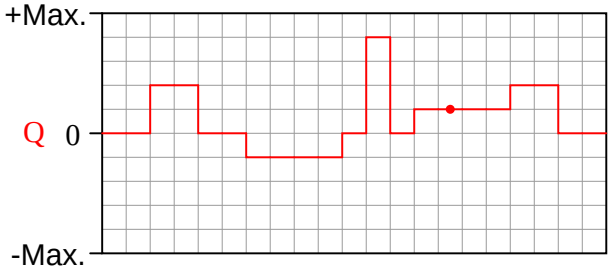

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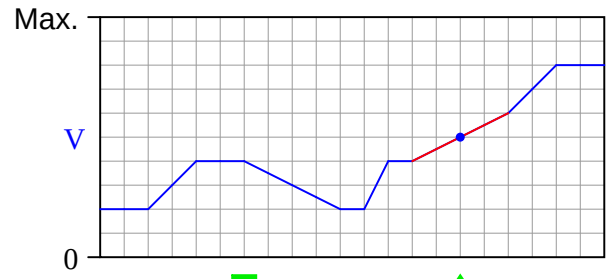


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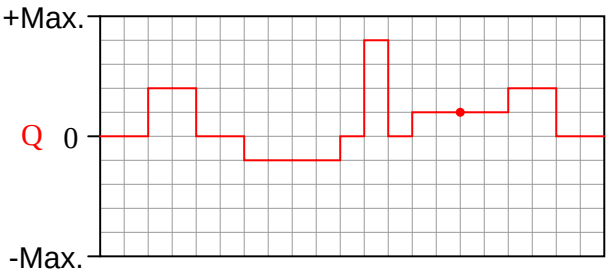

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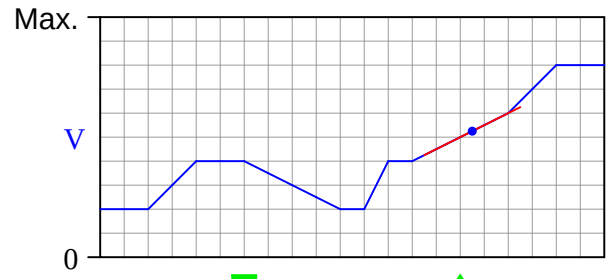



Flow rate (Q) is the *derivative* of volume with respect to time

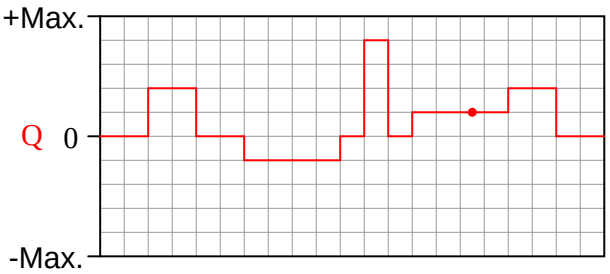
$$Q = \frac{dV}{dt}$$

Differentiation

Integration

Volume (V) is the *integral* of flow rate with respect to time

$$V = \int Q\, dt$$



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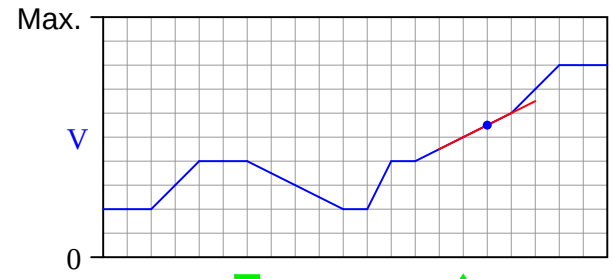


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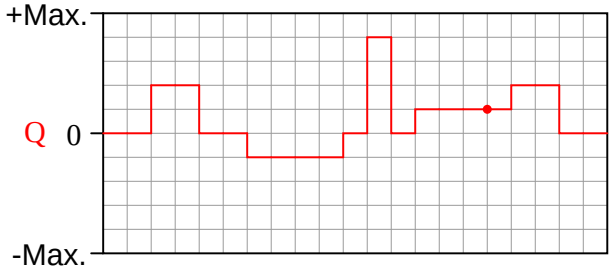

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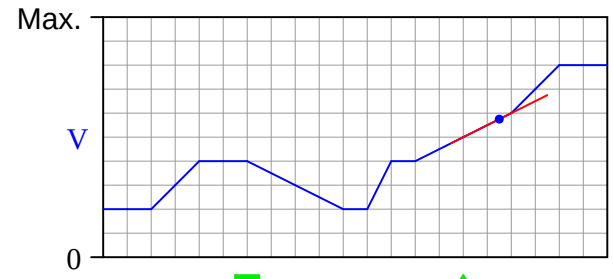


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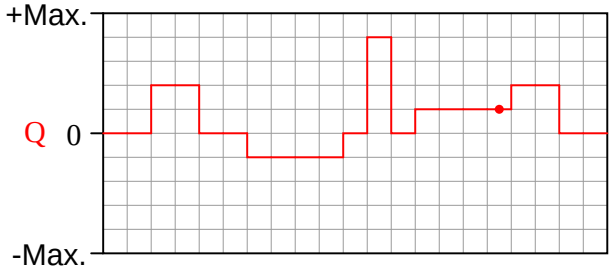

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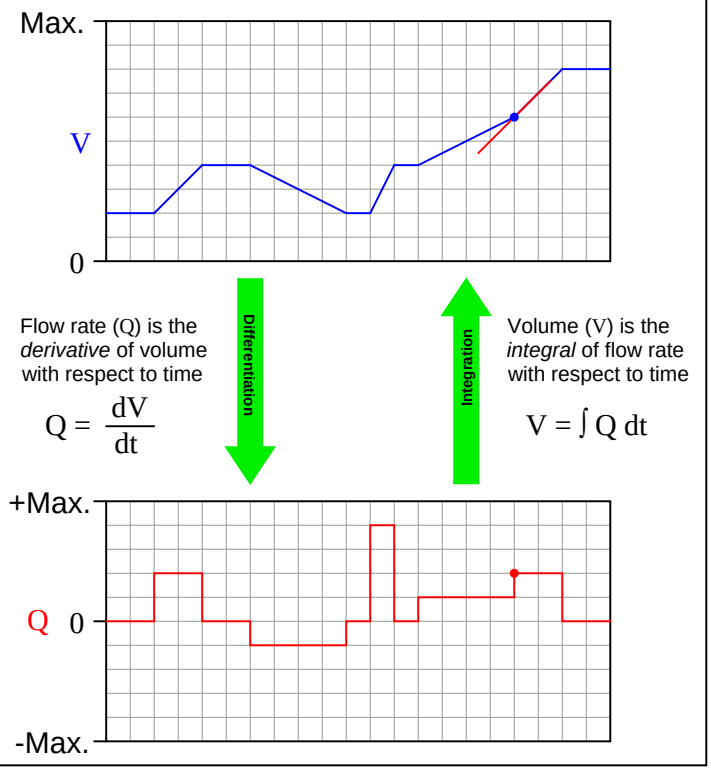

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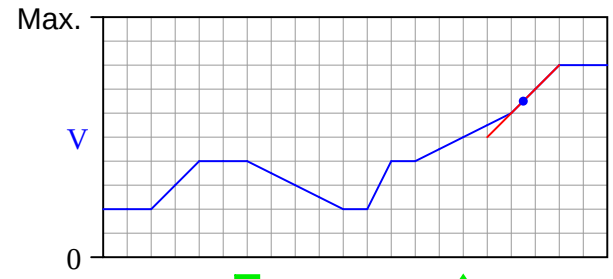


Flow rate (Q) is the *derivative* of volume with respect to time

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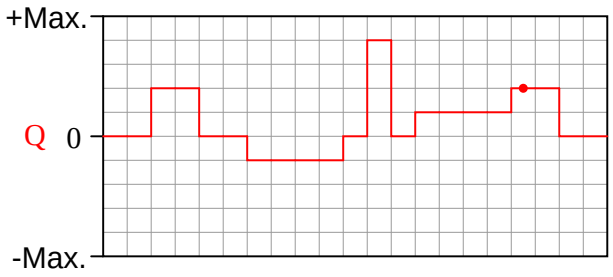

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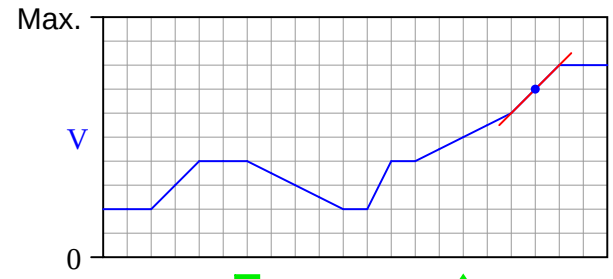


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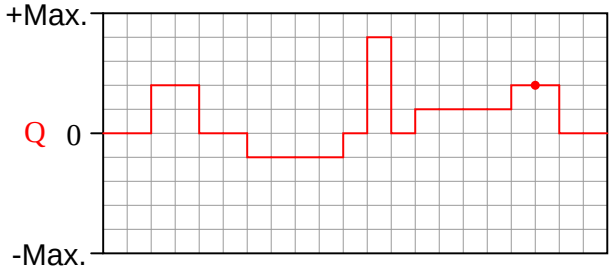

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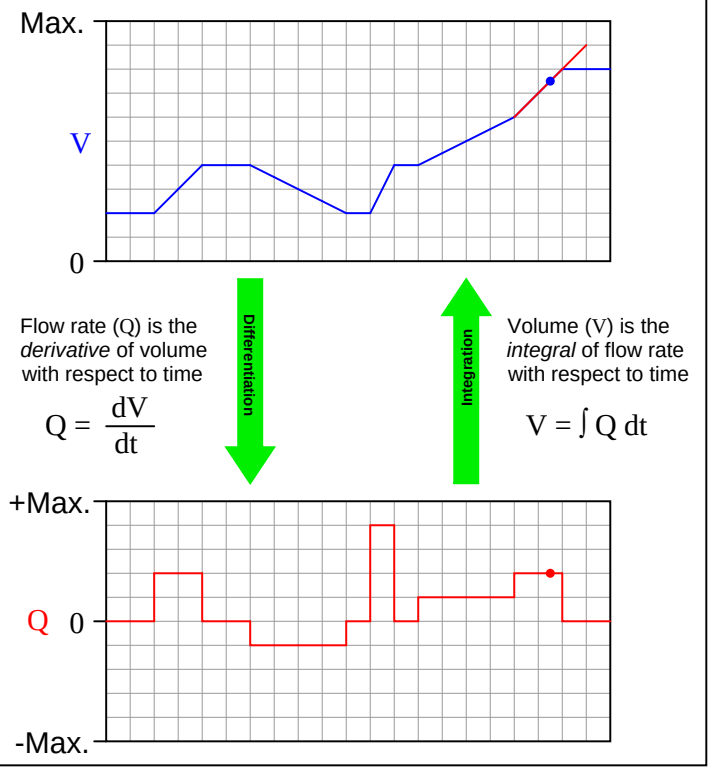

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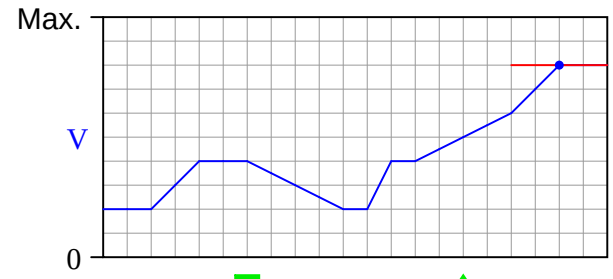


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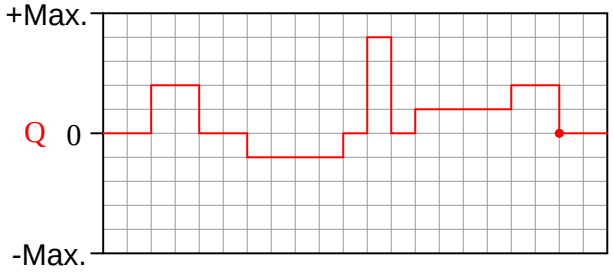

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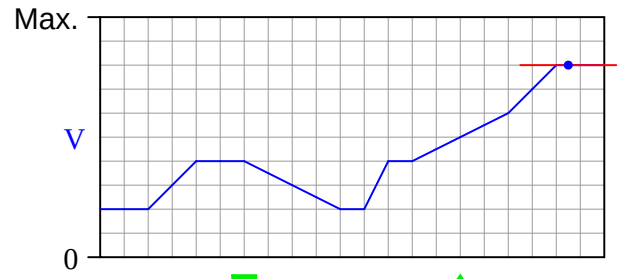


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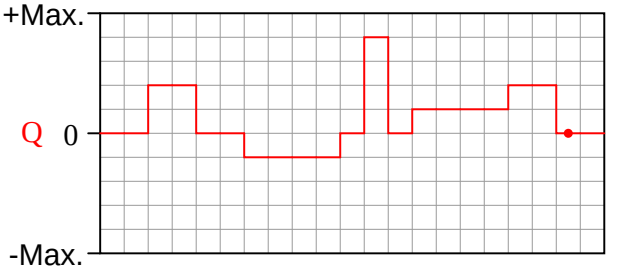

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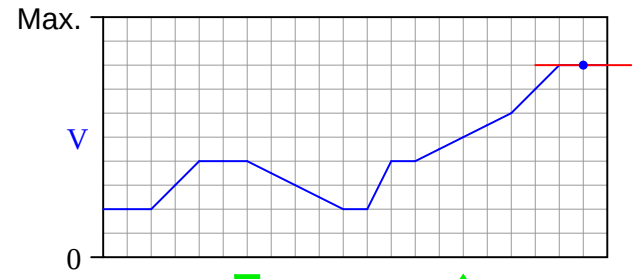


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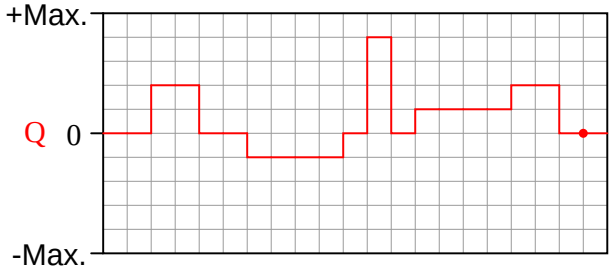

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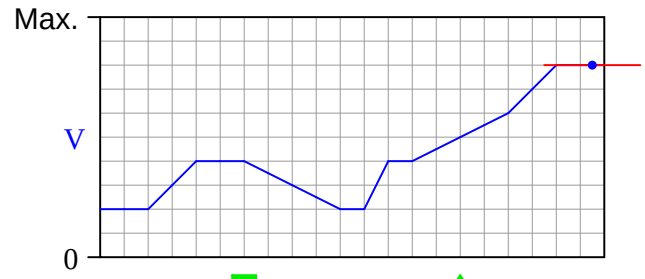


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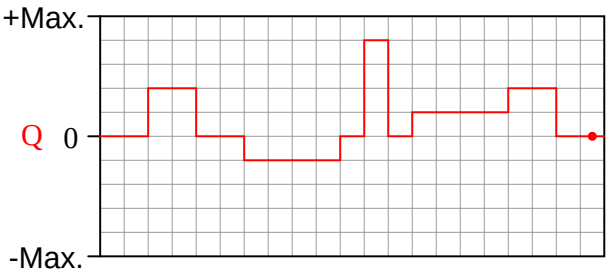

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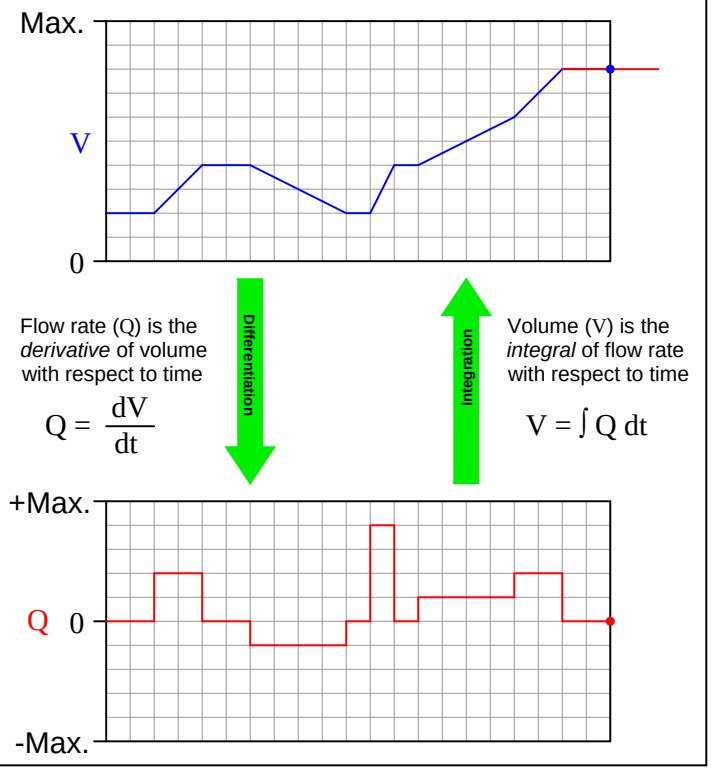

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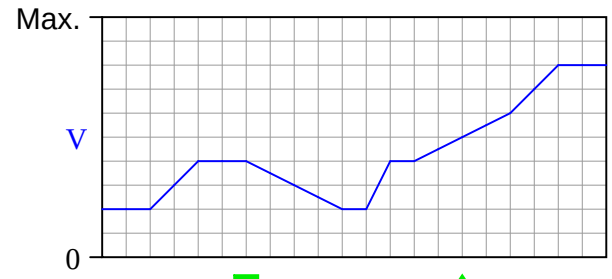


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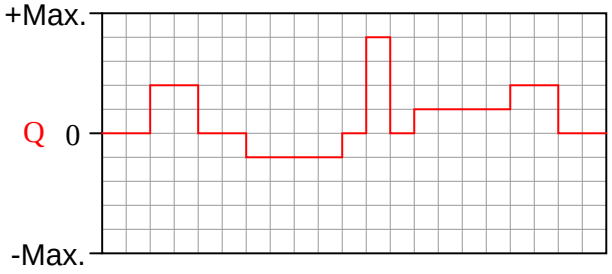

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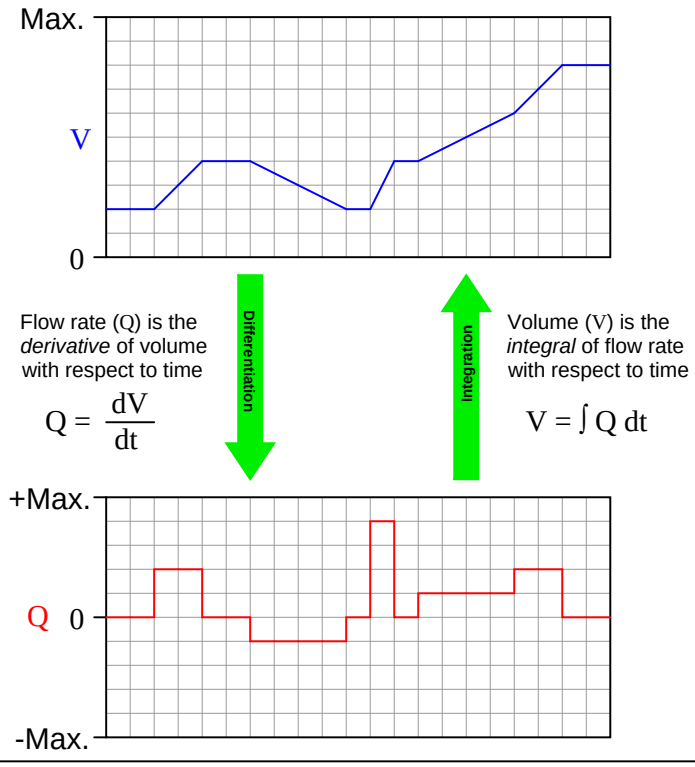

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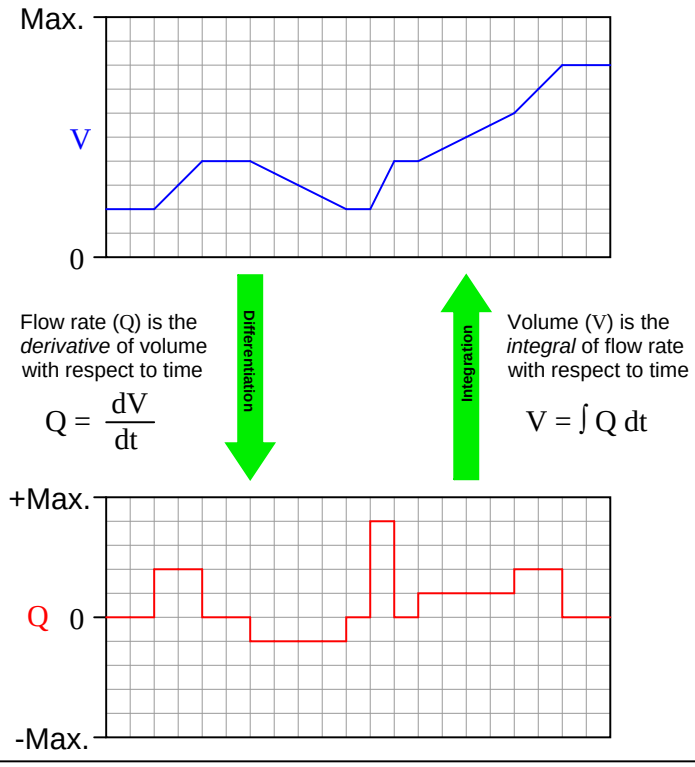

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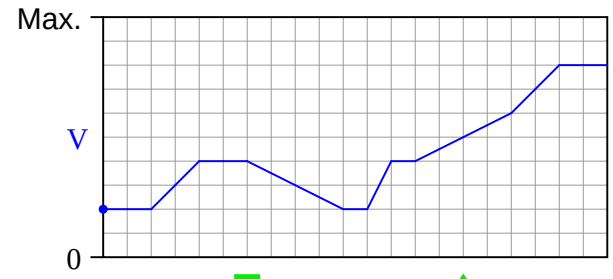


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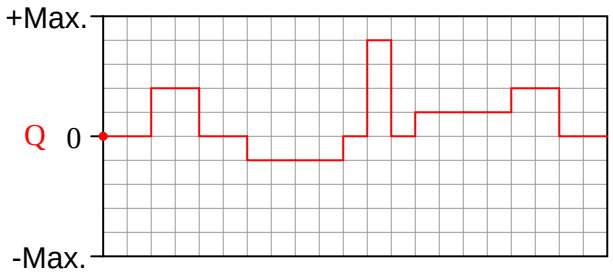

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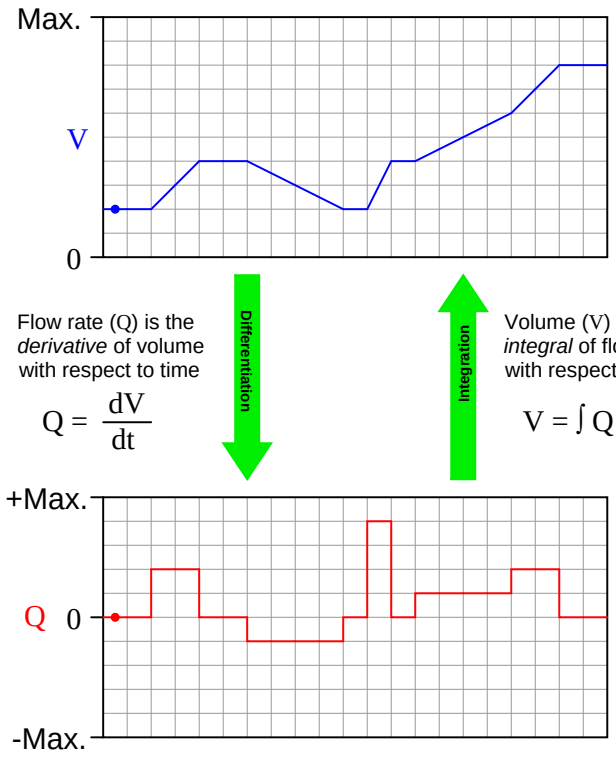

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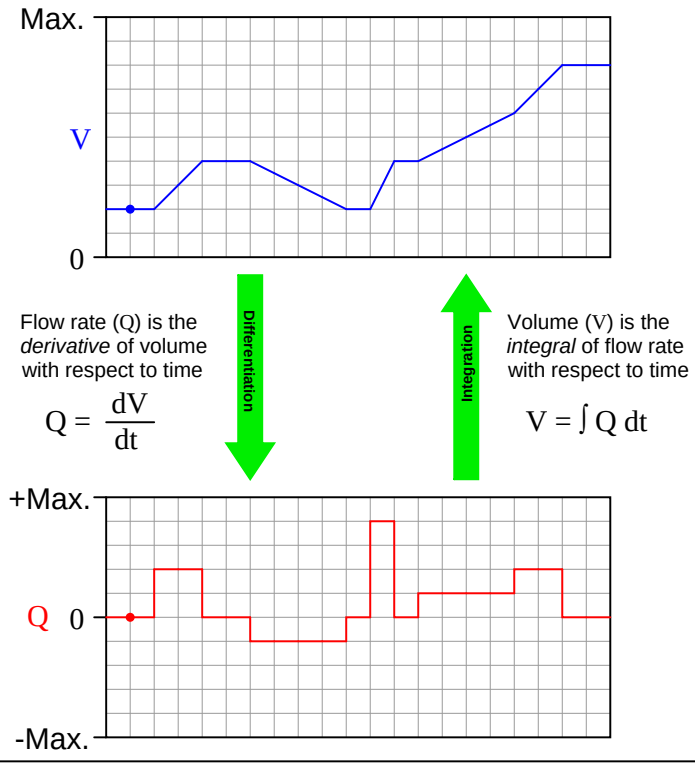

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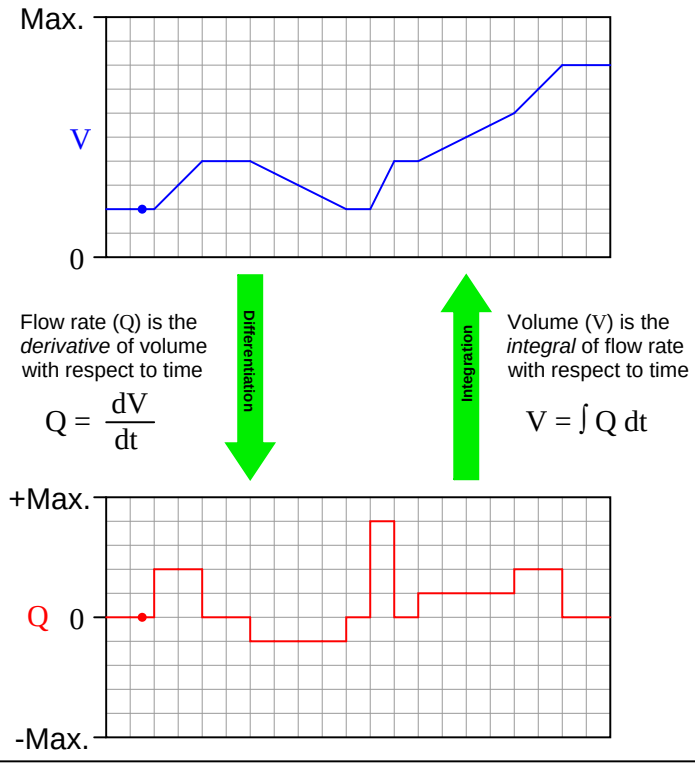

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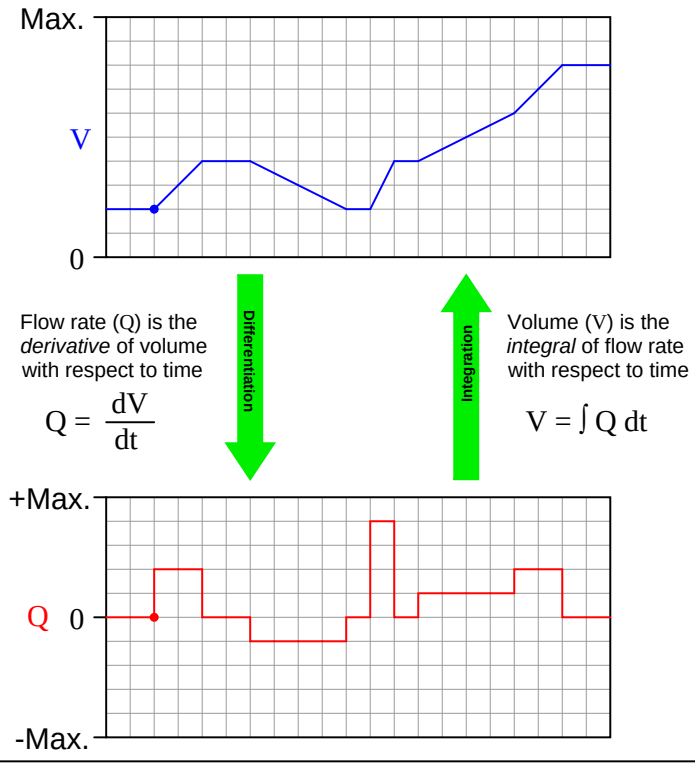

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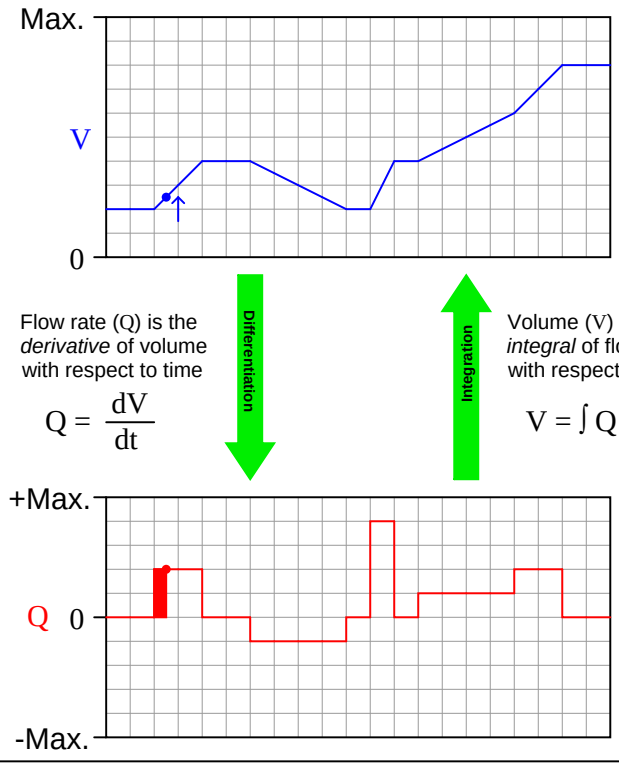

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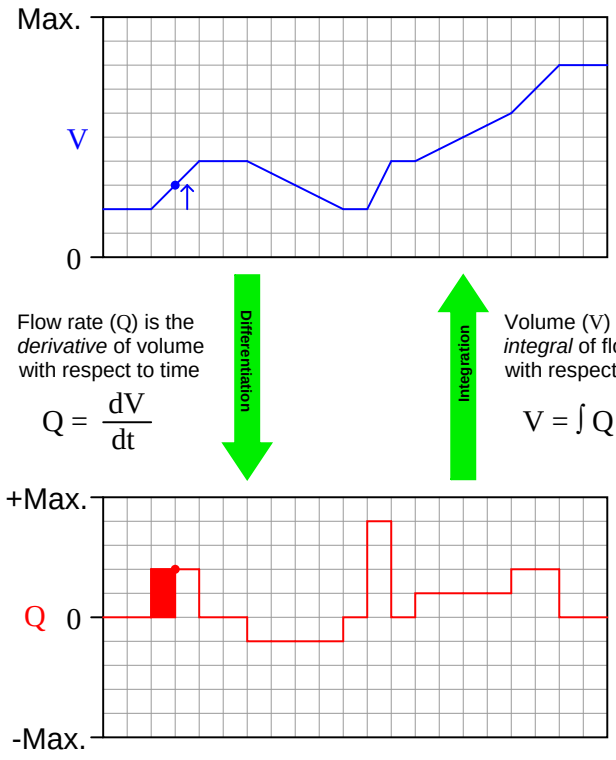

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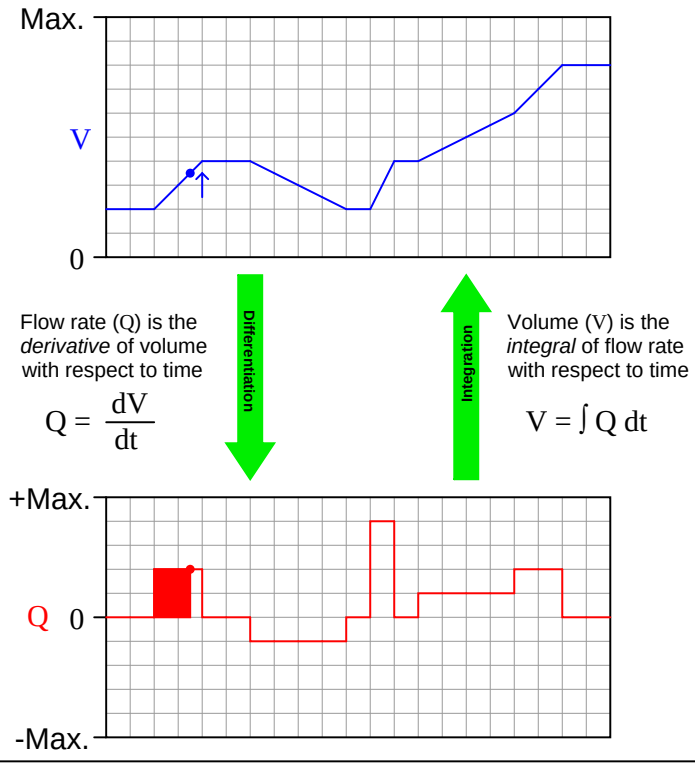

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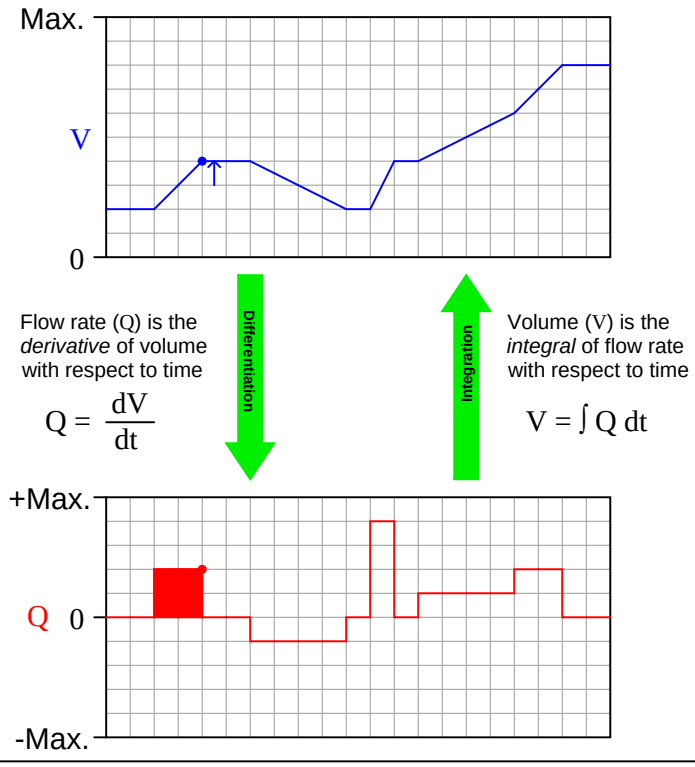

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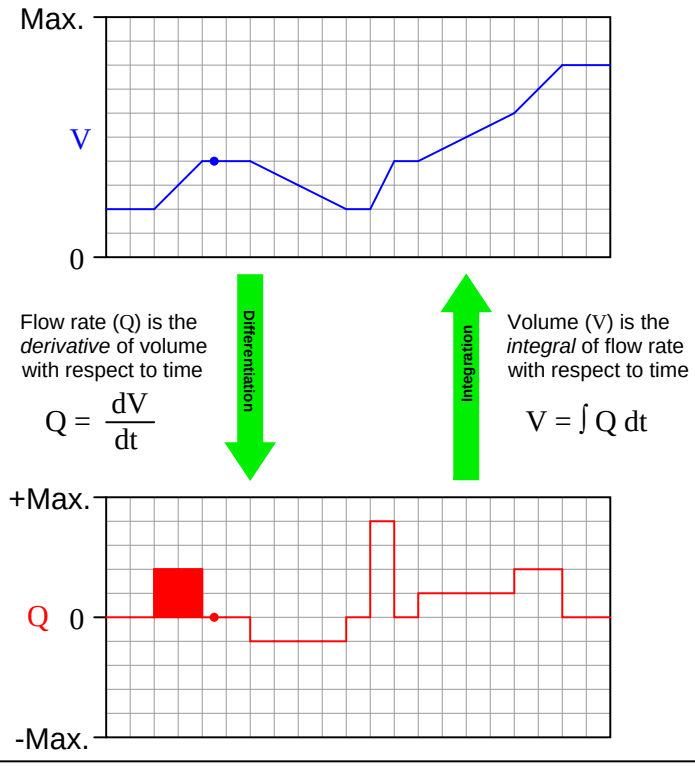

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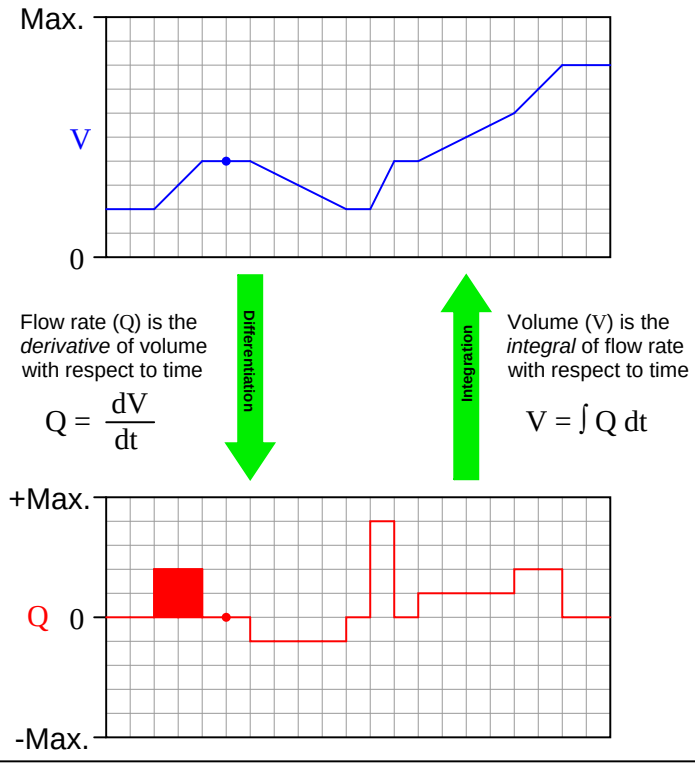

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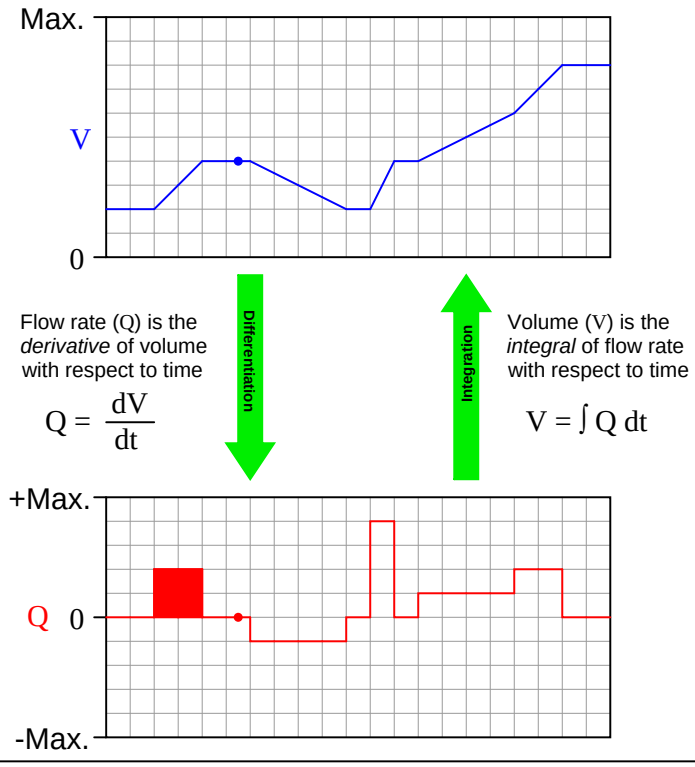

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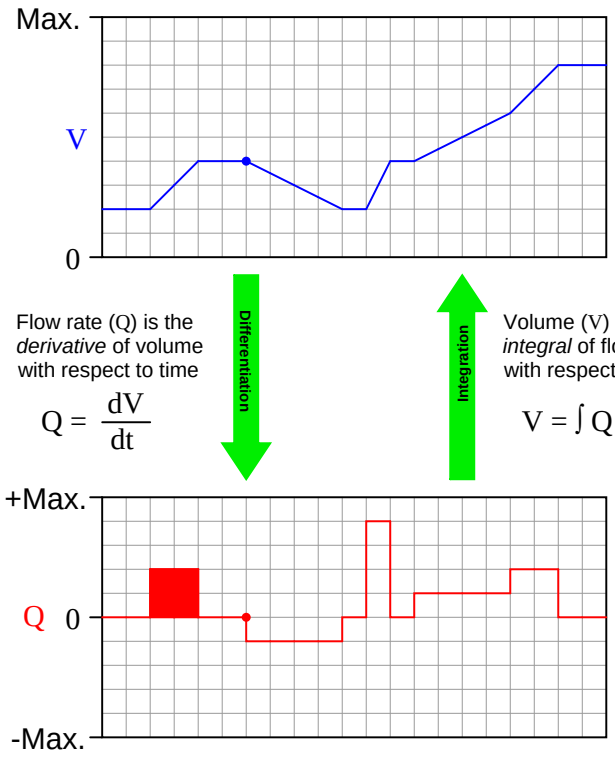

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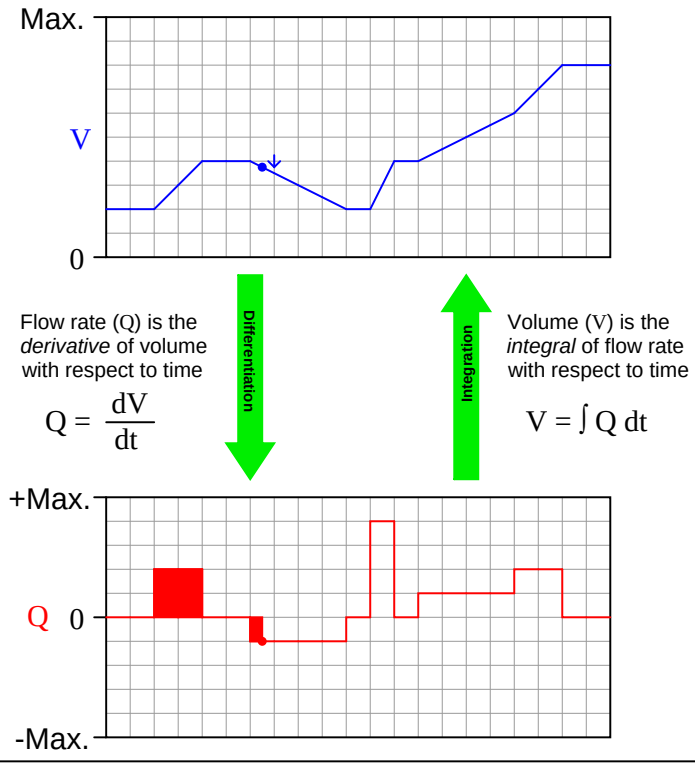

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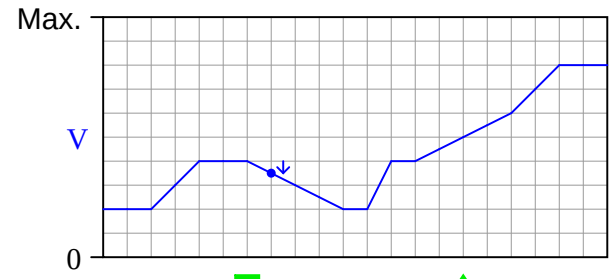


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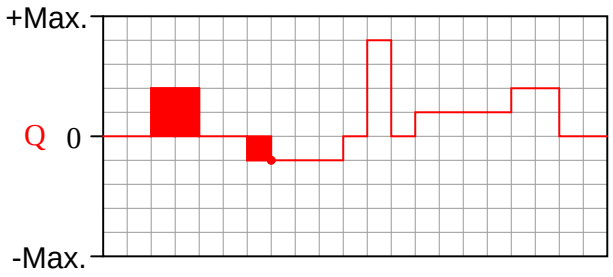
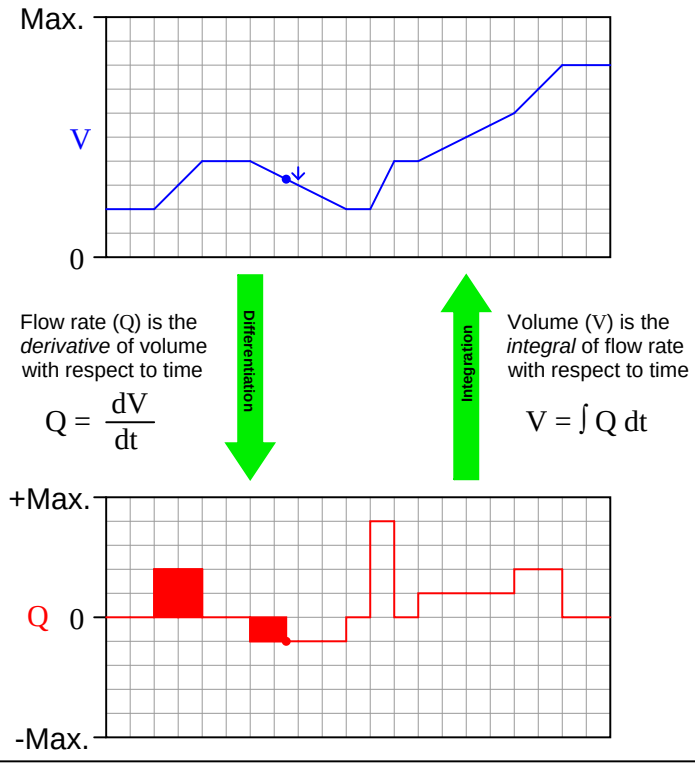
Integration

Volume (V) is the *integral* of flow rate with respect to time

$$V = \int Q\, dt$$



*Note how the **height increase** of the volume graph directly relates to the **area accumulated** by the flow graph . . .*



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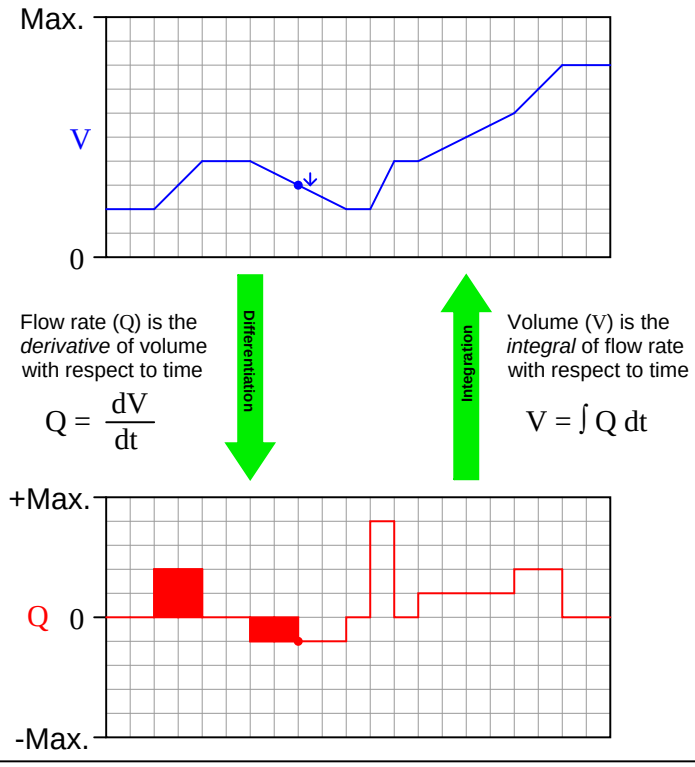

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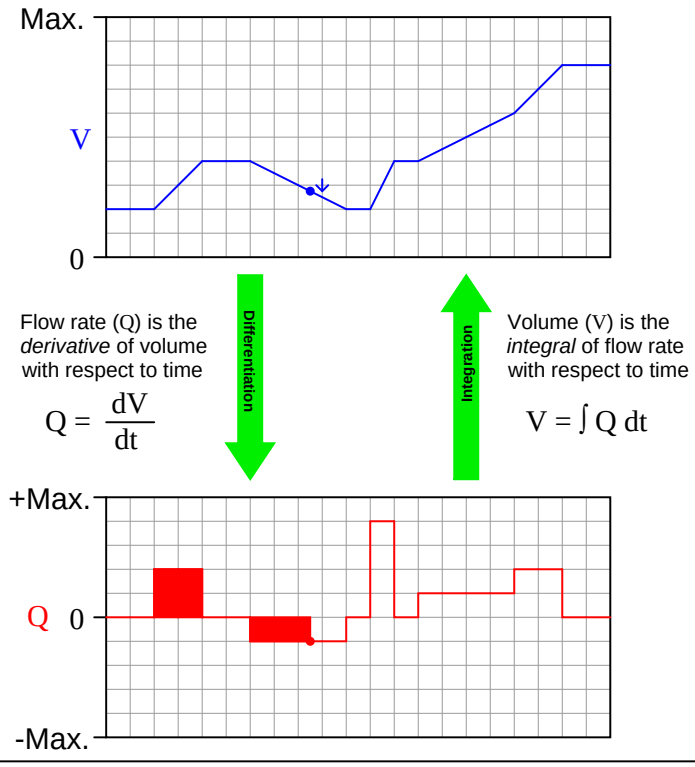

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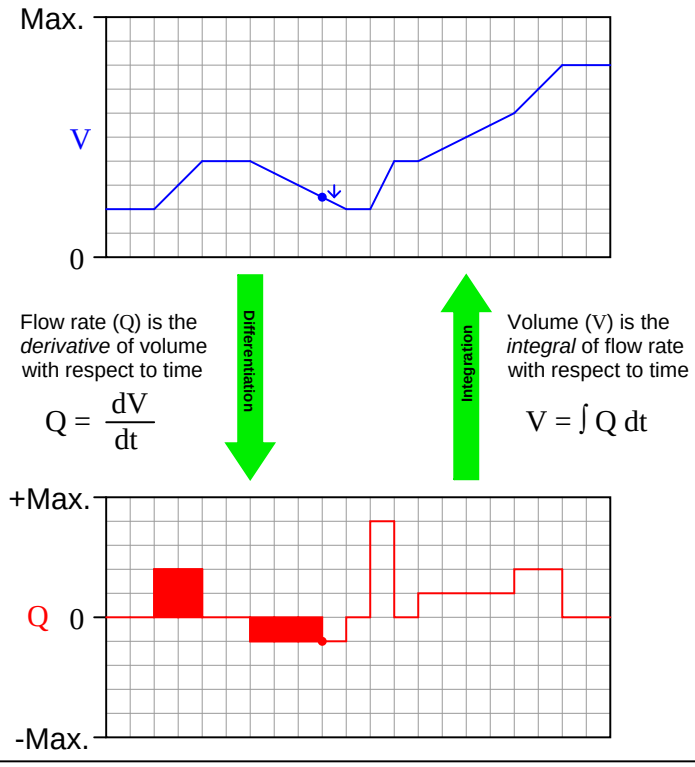

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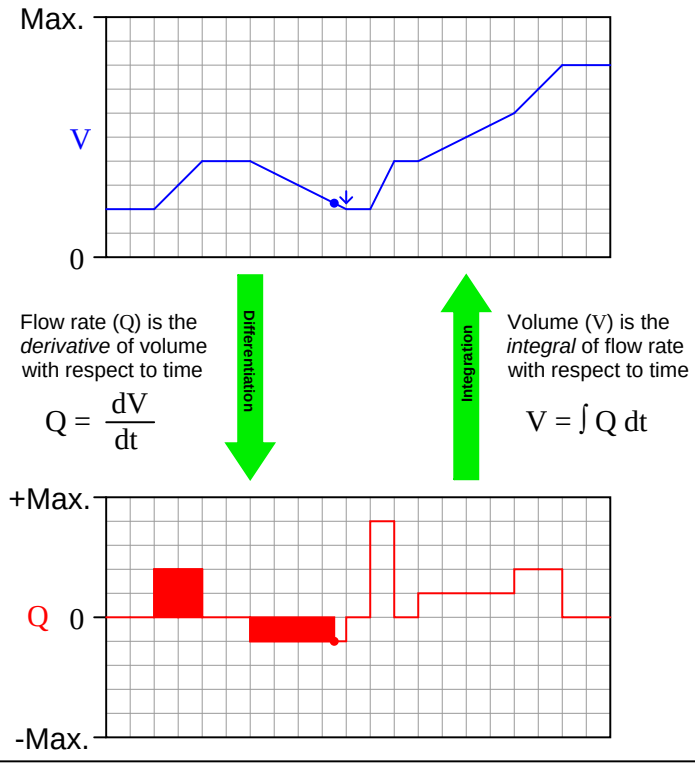

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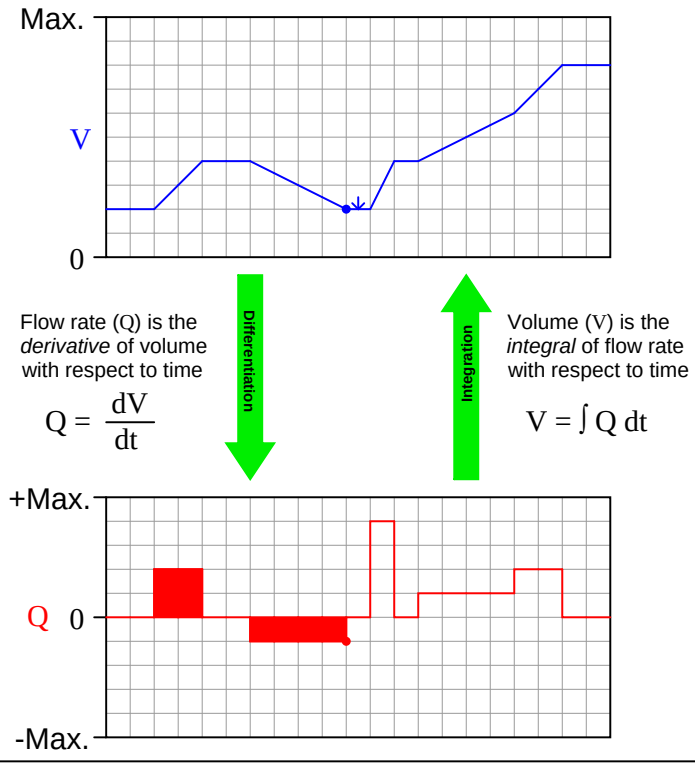

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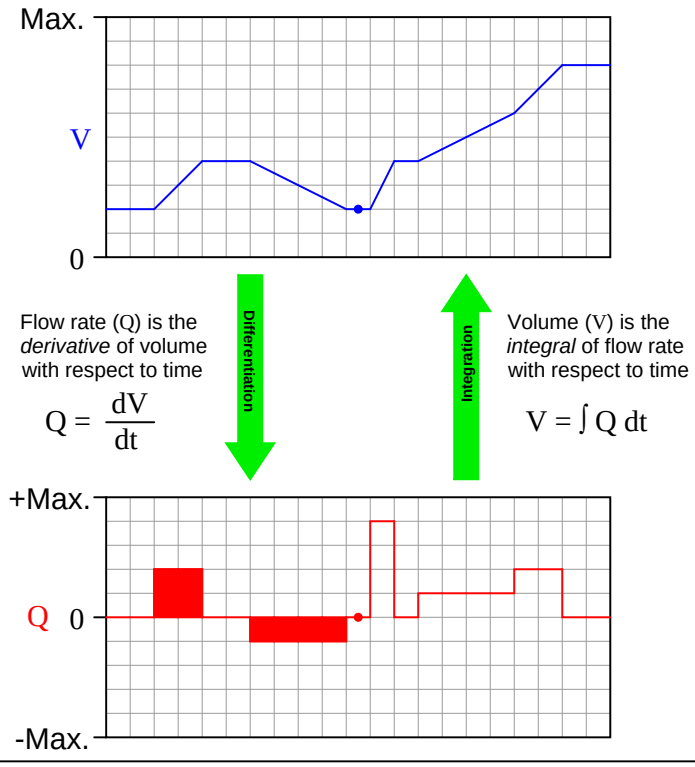

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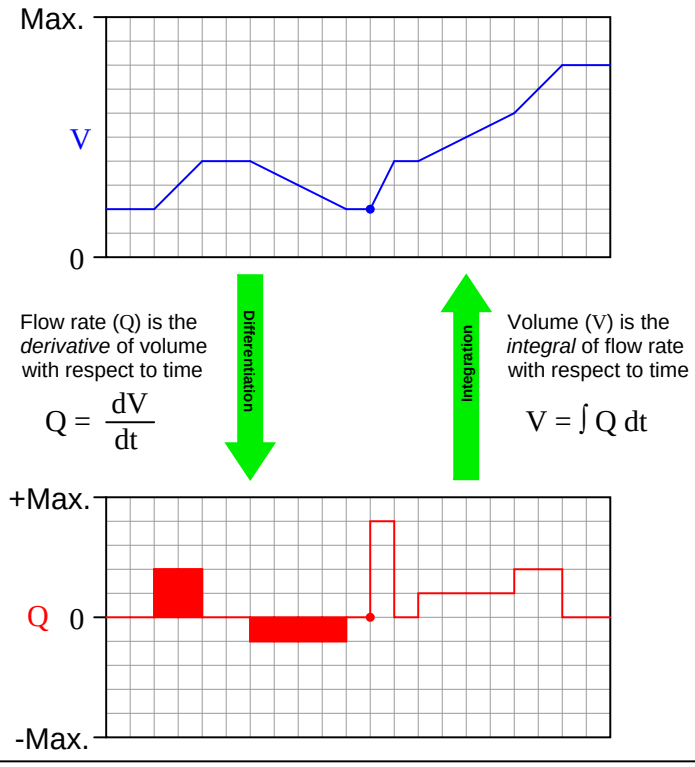

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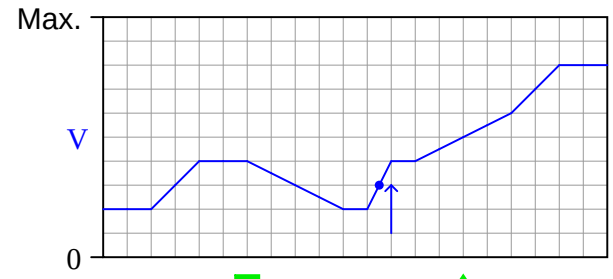


Flow rate (Q) is the *derivative* of volume with respect to time

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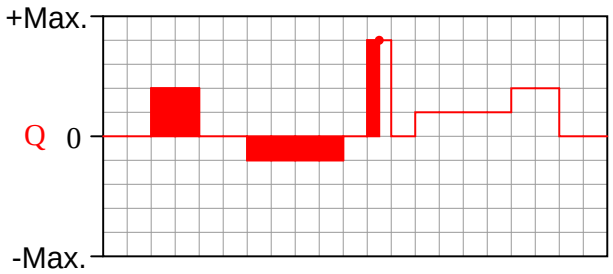

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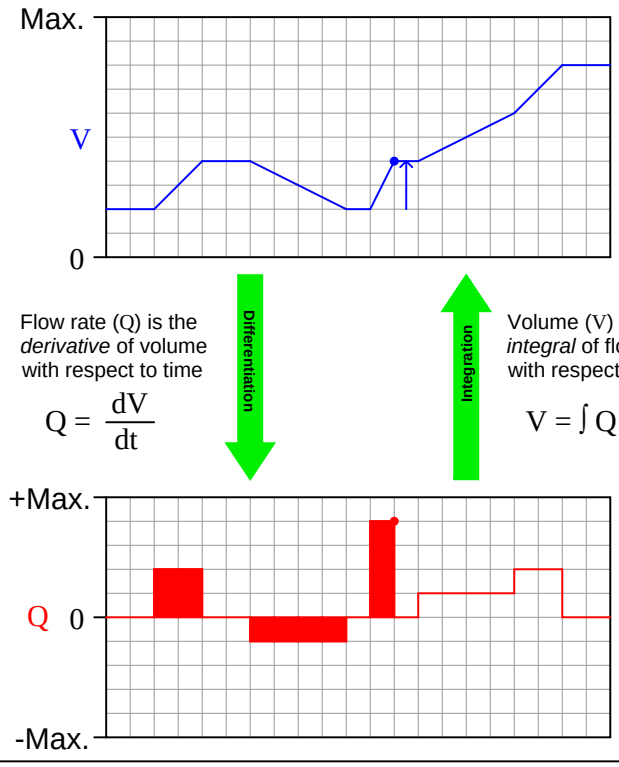

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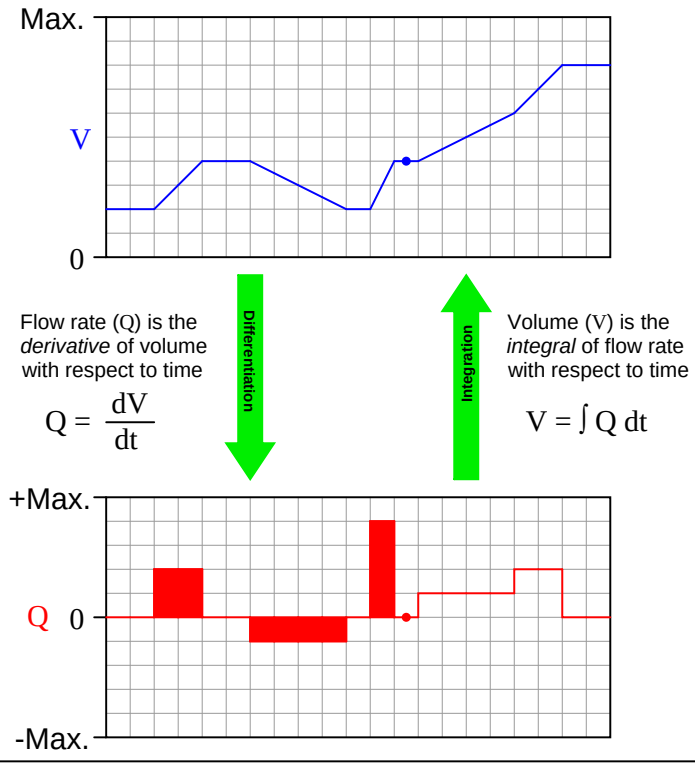

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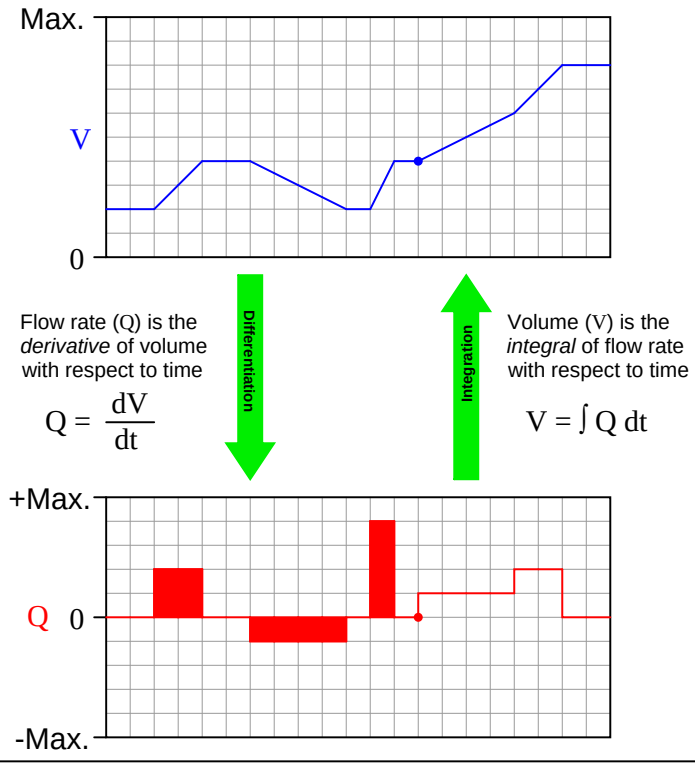

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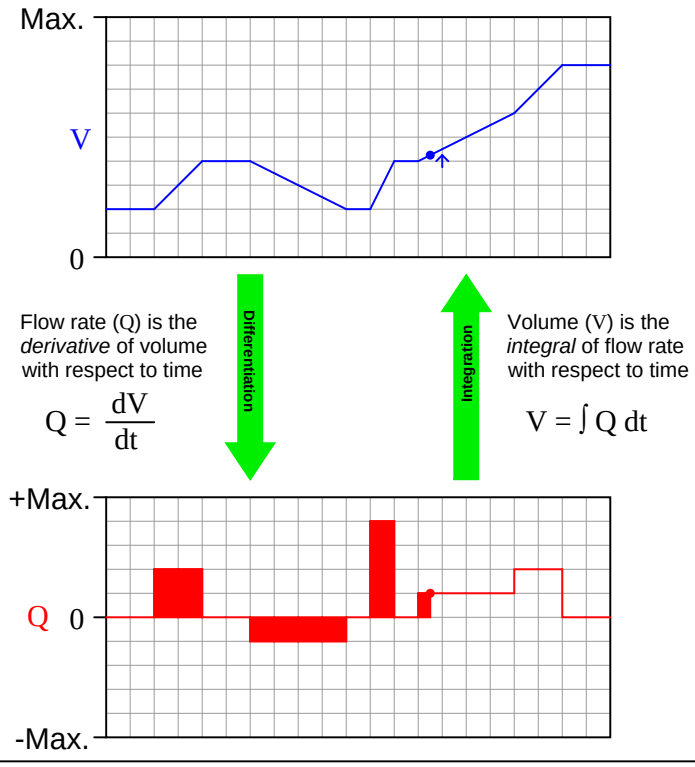

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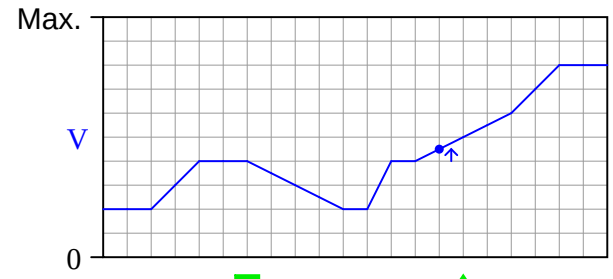


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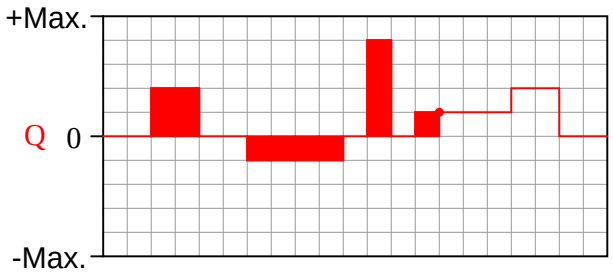

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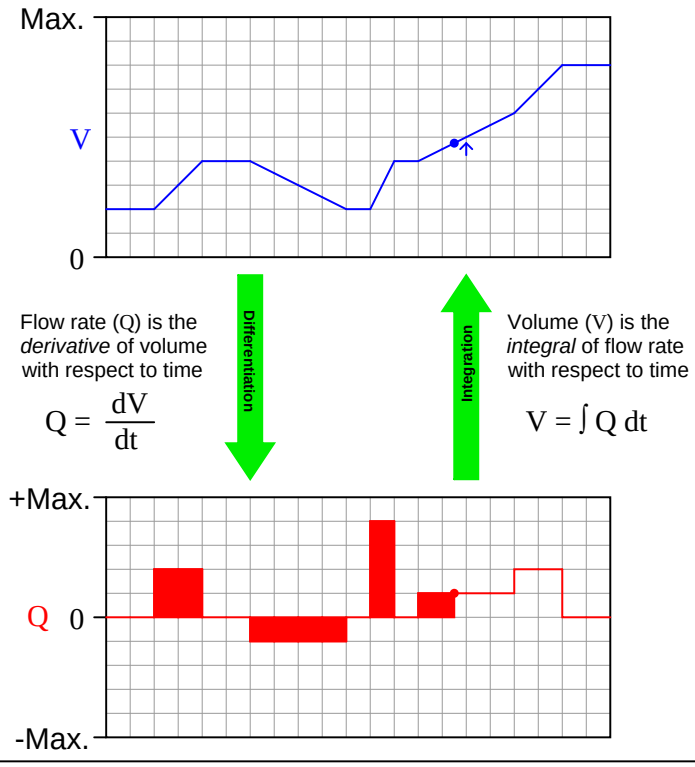

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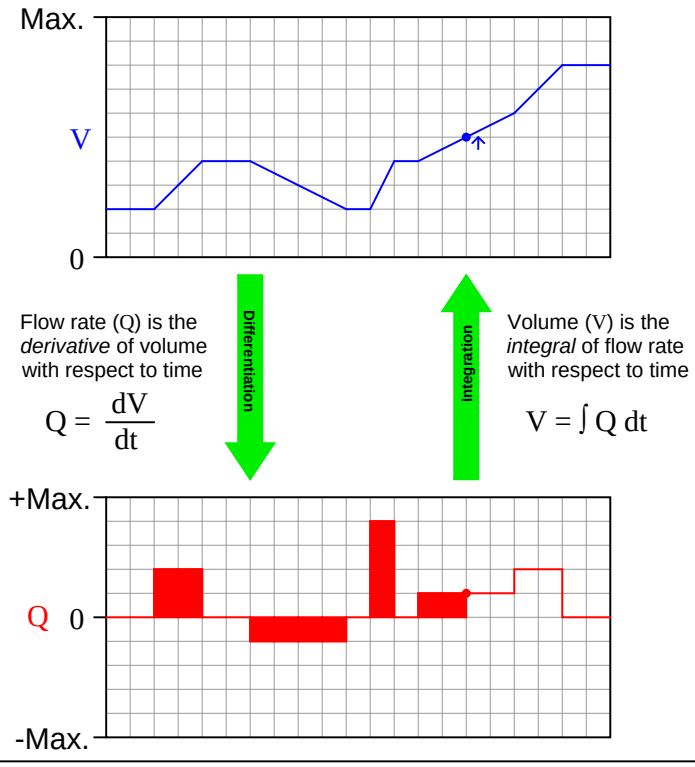

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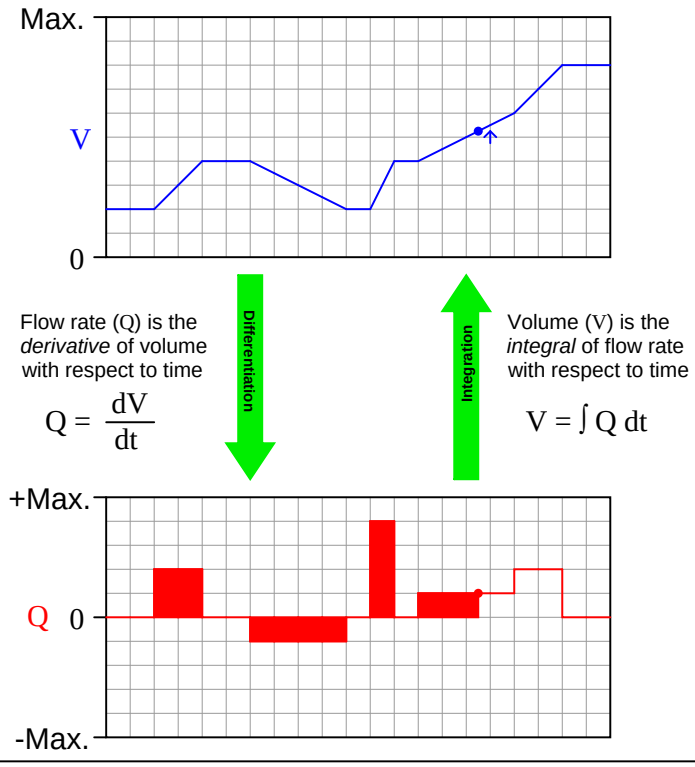

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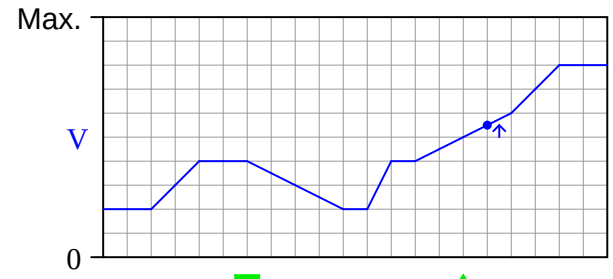


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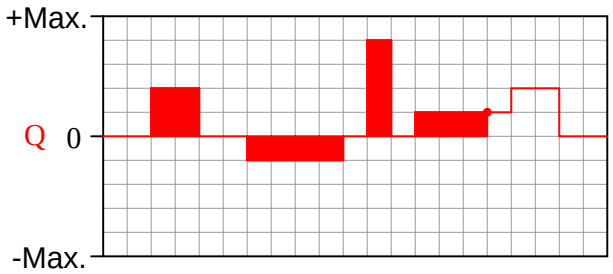

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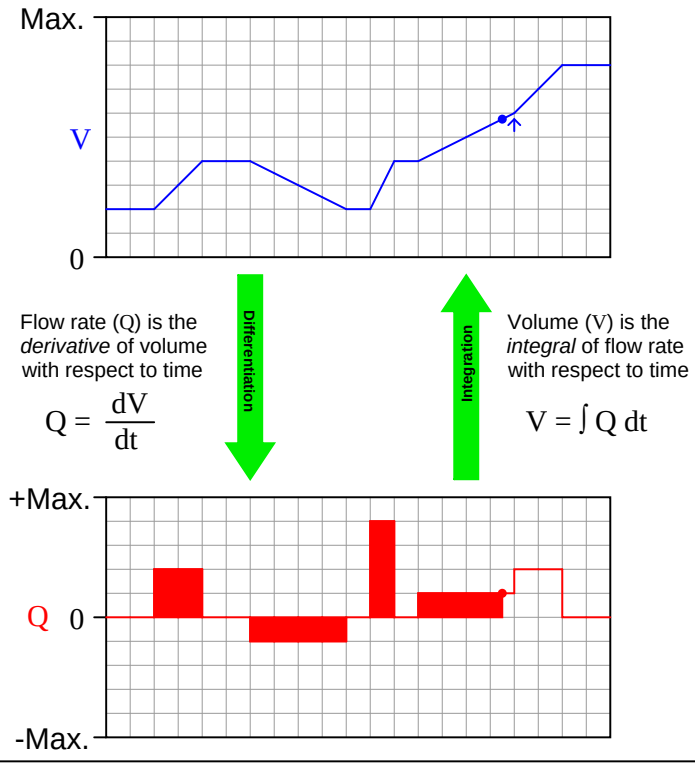

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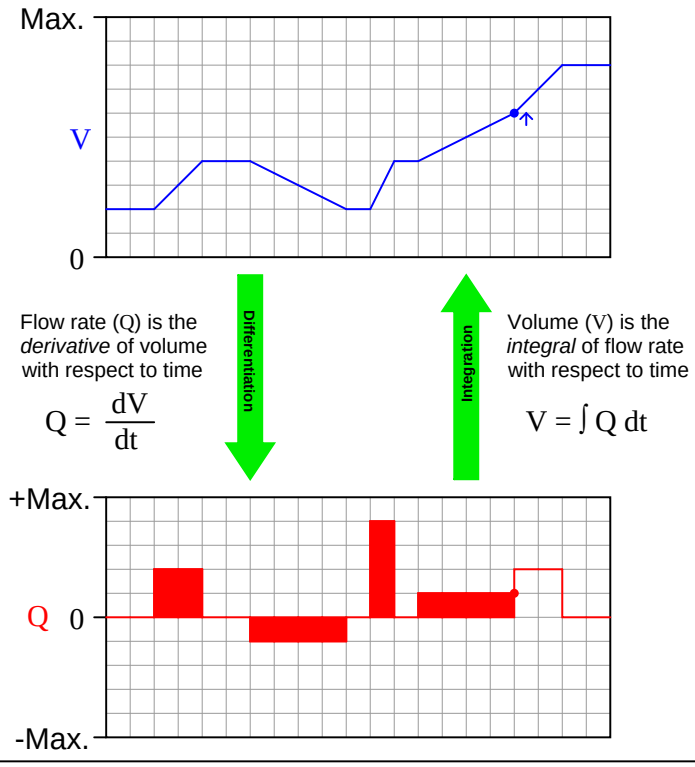

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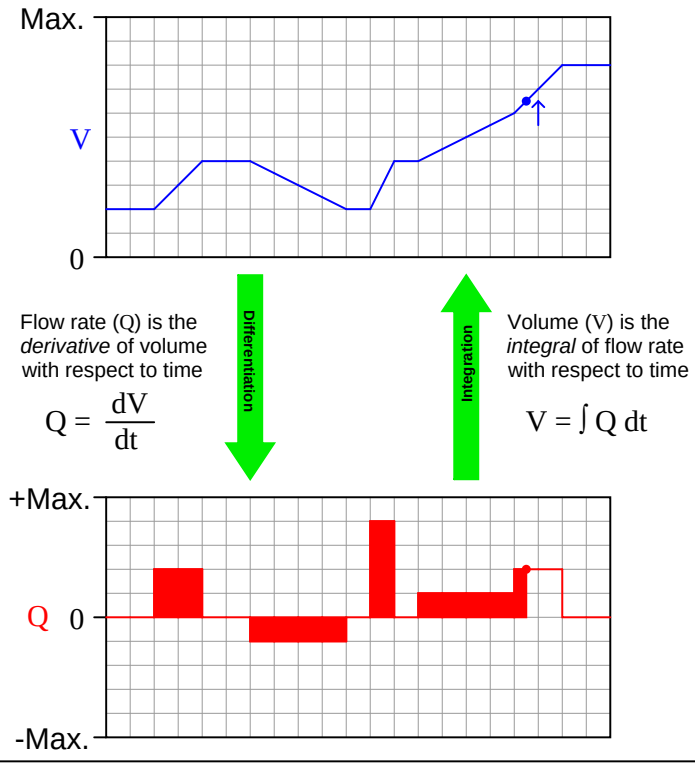

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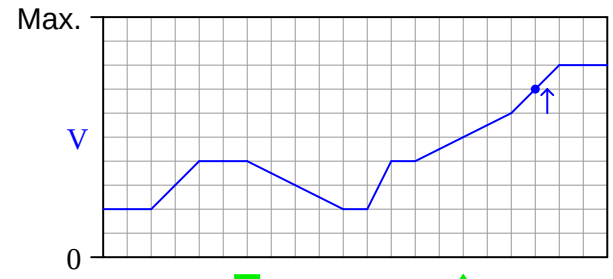


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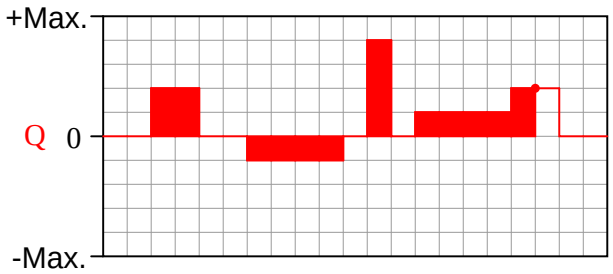

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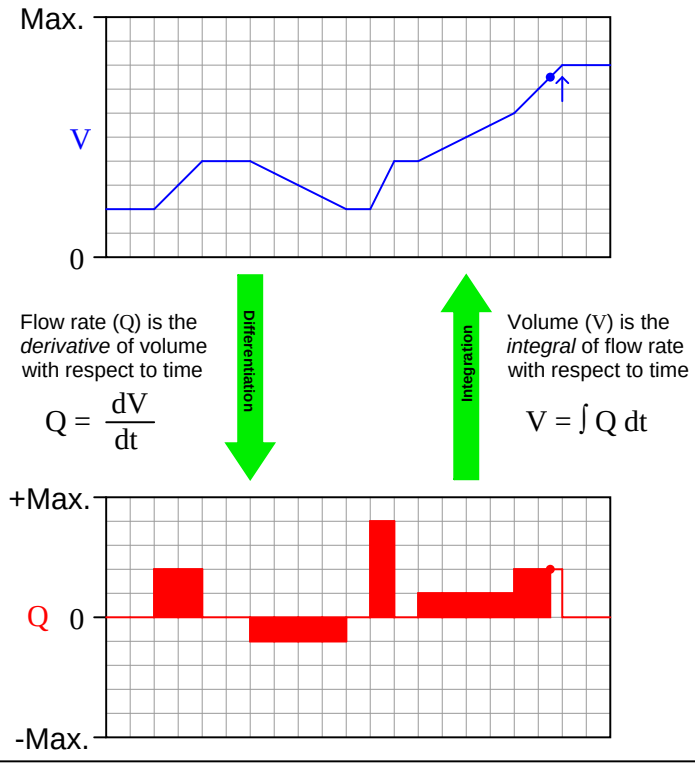

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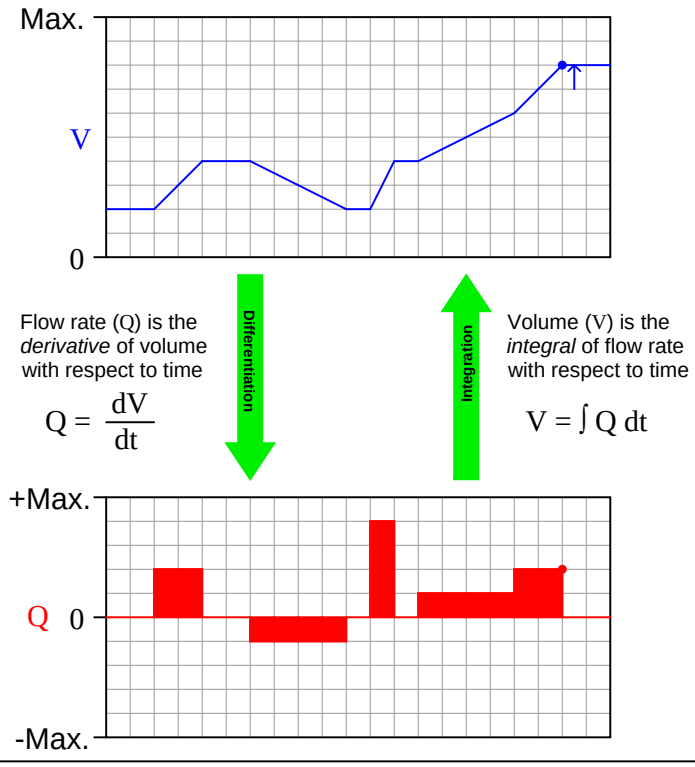

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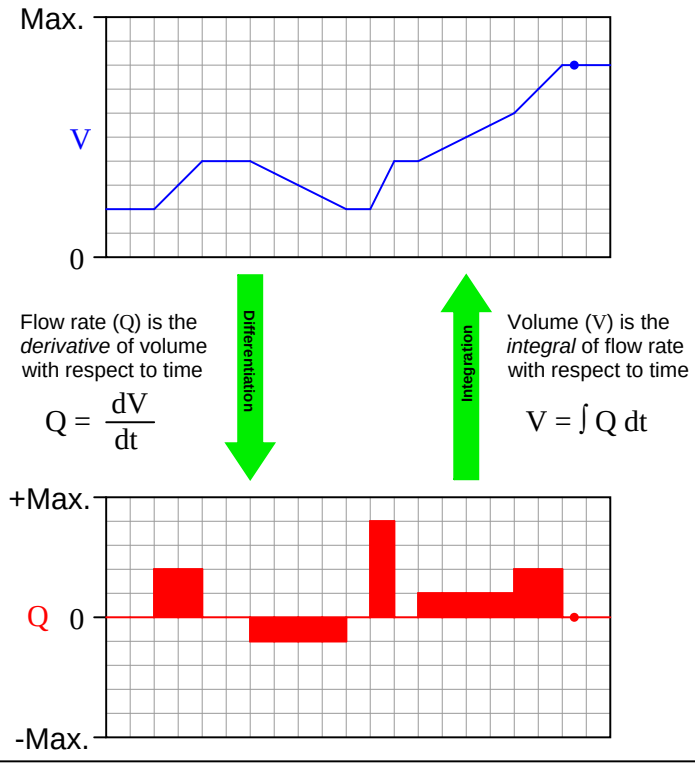

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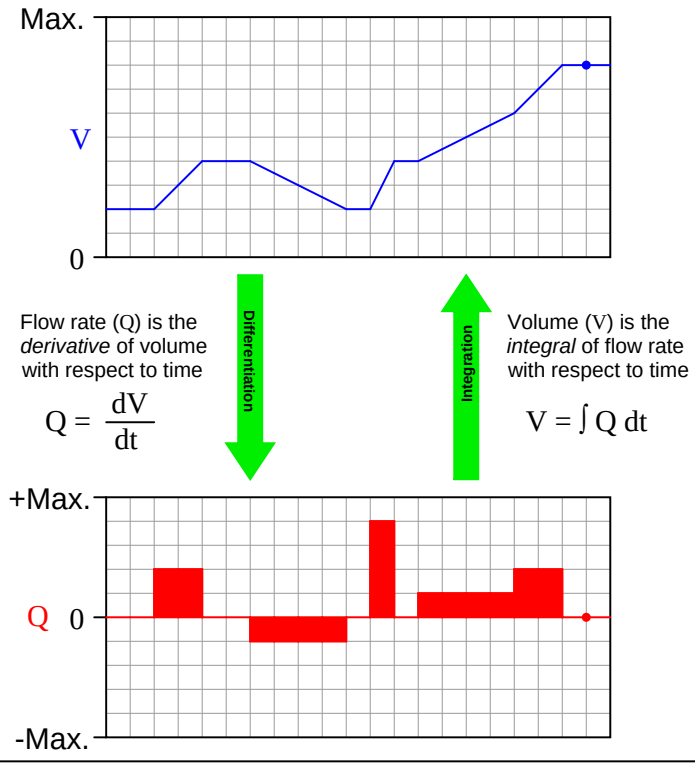

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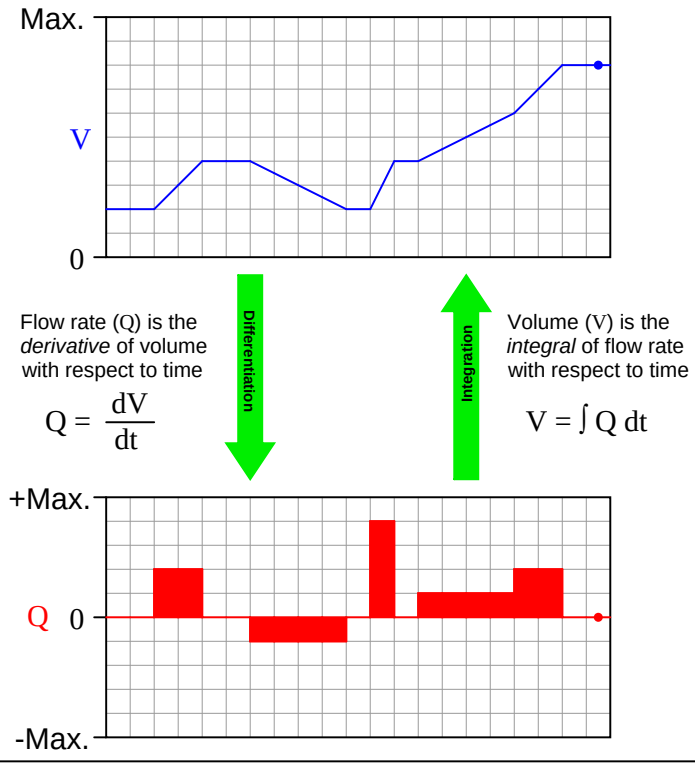

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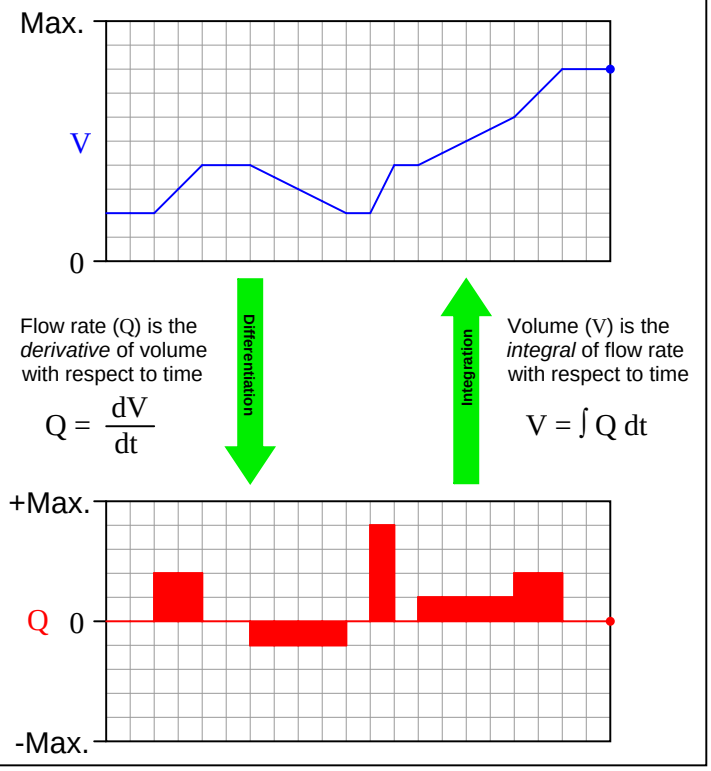

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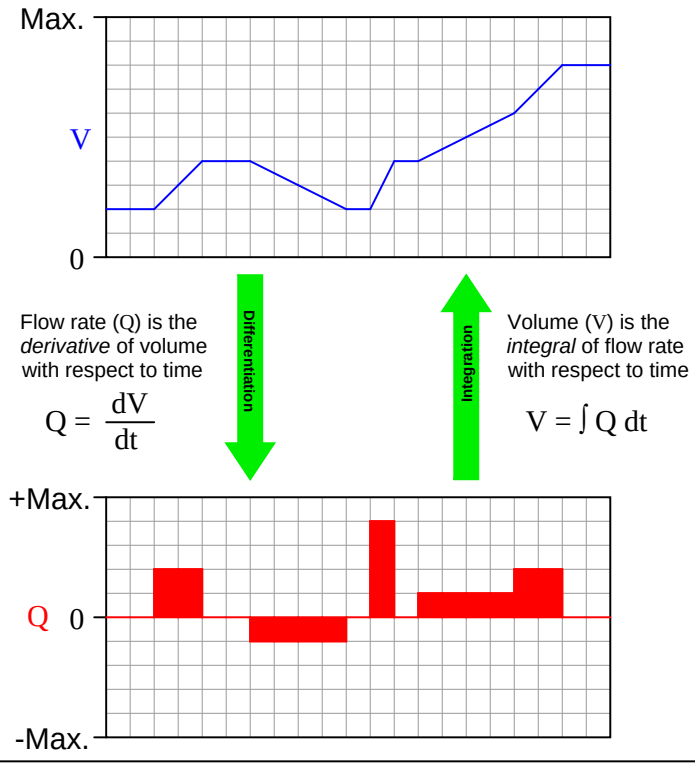


file 04090

Answer 1

Nothing to note here.

Notes 1

The purpose of this animation is to let students study the generation of characteristic curves and reach their own conclusions. Similar to experimentation in the lab, except that here all the data collection is done visually rather than through the use of test equipment, and the students are able to "see" things that are invisible in real life.