OP Amp (1A)

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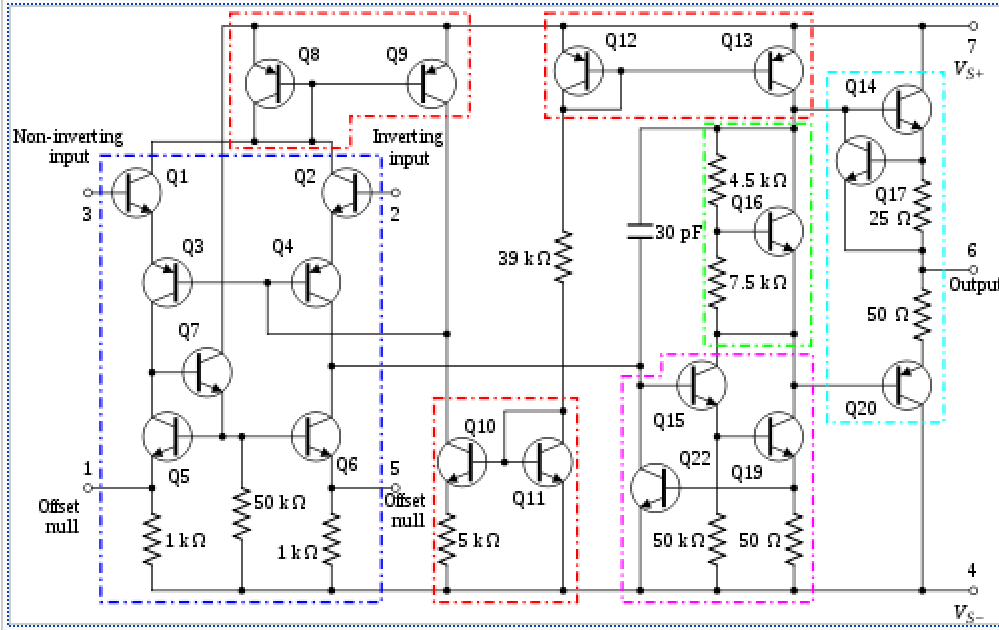
741 op-amp

A µA741 integrated circuit, one of the most successful operational amplifiers.

Type	Discrete circuit Integrated circuit
Invented	Karl D. Swartzel Jr.
First production	1941
Pin configuration	• V+: non-inverting input • V−: inverting input • Vout: output • VS+: positive power supply • VS−: negative power supply



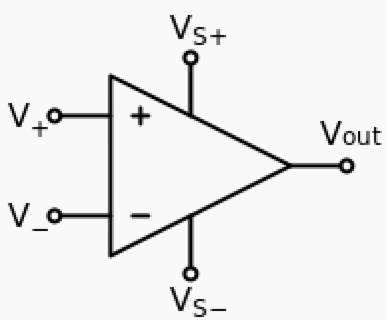
A component-level diagram of the common 741 op-amp. Dotted lines outline: current mirrors (red); differential amplifier (blue); class A gain stage (magenta); voltage level shifter (green); output stage (cyan).

https://en.wikipedia.org/wiki/Operational_amplifier

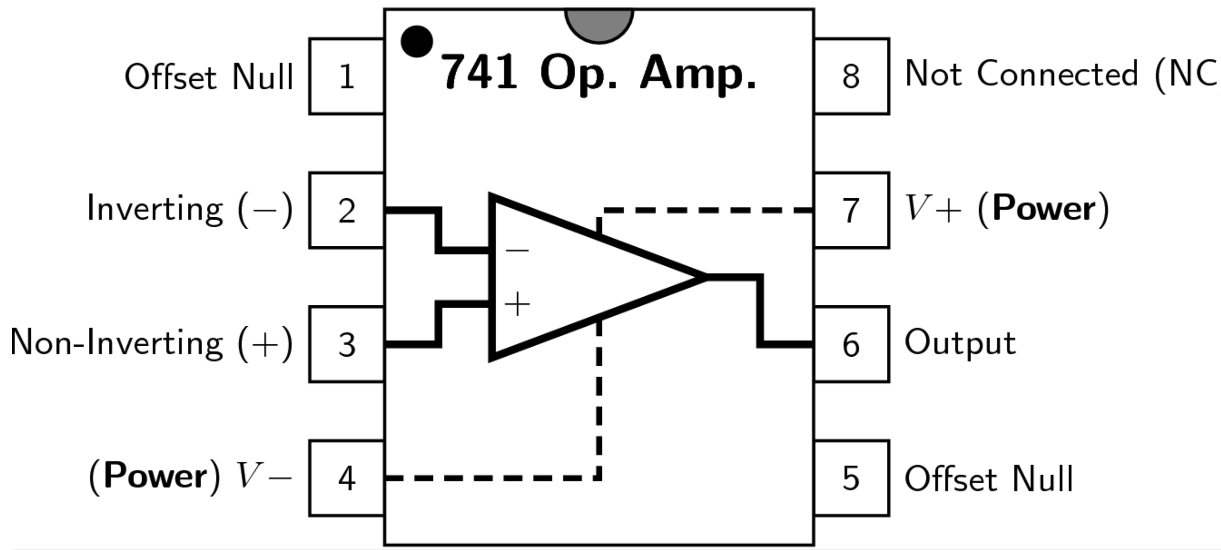
Power Supply

The power supply pins (V_{S+} and V_{S-}) can be labeled in different ways (*See IC power supply pins*). Often these pins are left out of the diagram for clarity, and the power configuration is described or assumed from the circuit.

Electronic symbol



Circuit diagram symbol for an op-amp. Pins are labeled as listed above.



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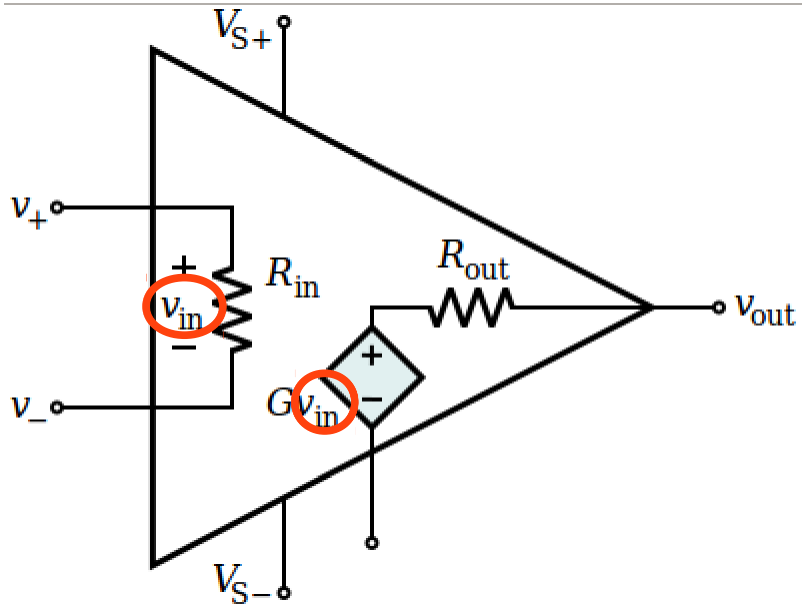
Ideal OP-Amps



$R_{in} = \infty$

$R_{out} = 0$

- Infinite open-loop gain $G = v_{out} / v_{in}$
- Infinite input impedance R_{in}
- Zero input current
- Zero output impedance R_{out}

- Zero input offset voltage
- Zero noise
- Infinite voltage range available at the output
- Infinite bandwidth
  with zero phase shift and infinite slew rate

- Infinite Common-mode rejection ratio (CMRR)
- Infinite Power supply rejection ratio.

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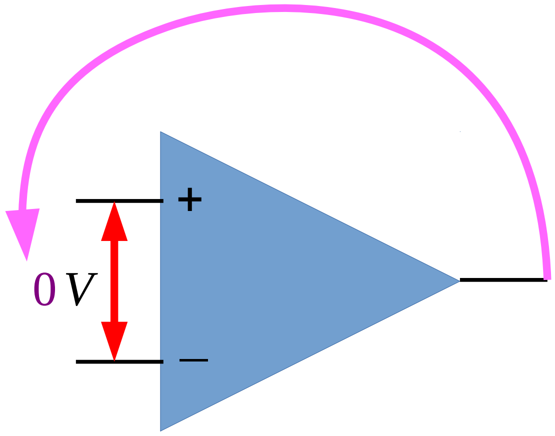
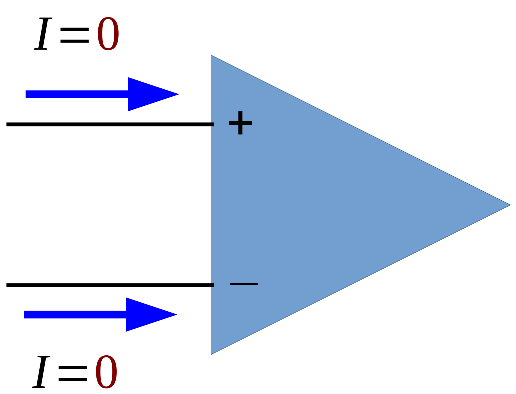
The Op-amp golden rule



1. The Voltage Rule

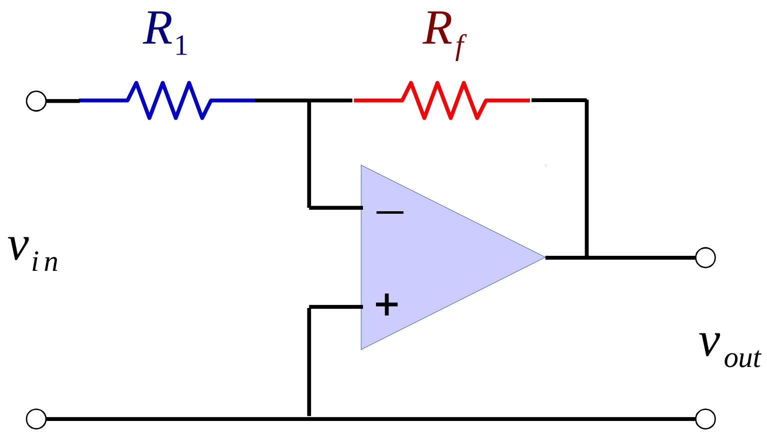
The output attempts to do whatever is necessary to make the voltage difference between the inputs **zero**.

II. The Current Rule
IThe inputs draw no current.



http://hyperphysics.phy-astr.gsu.edu/hbase/electronic/opampi.html#c1

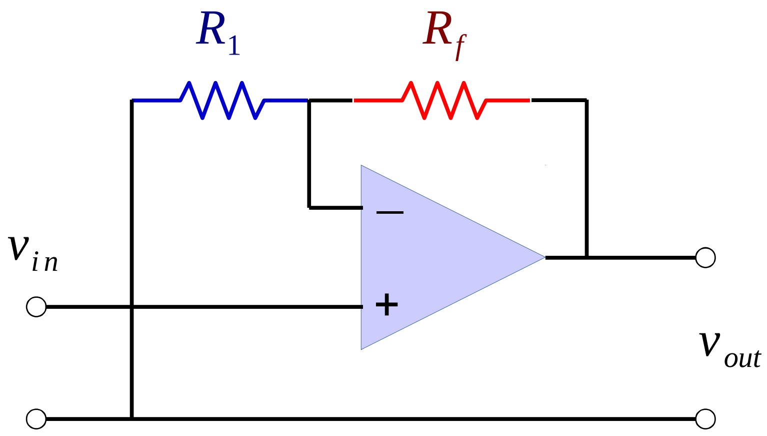
Inverting Amplifier



$$\frac{v_{out}}{v_{in}} = -\frac{R_f}{R_1}$$

http://hyperphysics.phy-astr.gsu.edu/hbase/electronic/opampi.html#c1

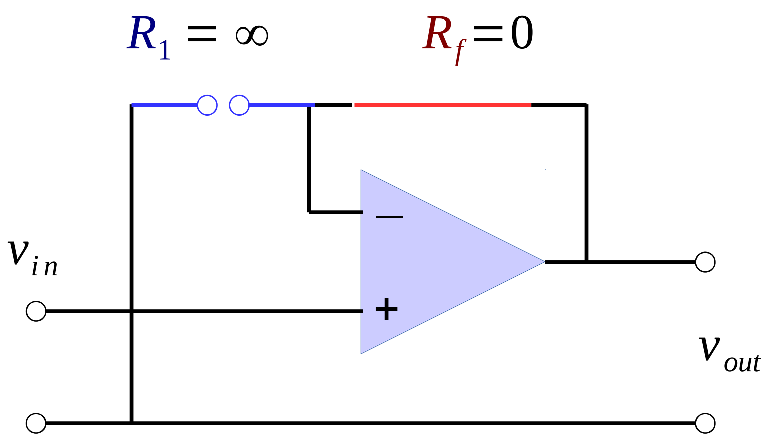
Non-Inverting Amplifier



$$\frac{v_{out}}{v_{in}} = 1 + \frac{R_f}{R_1}$$

http://hyperphysics.phy-astr.gsu.edu/hbase/electronic/opampi.html#c1

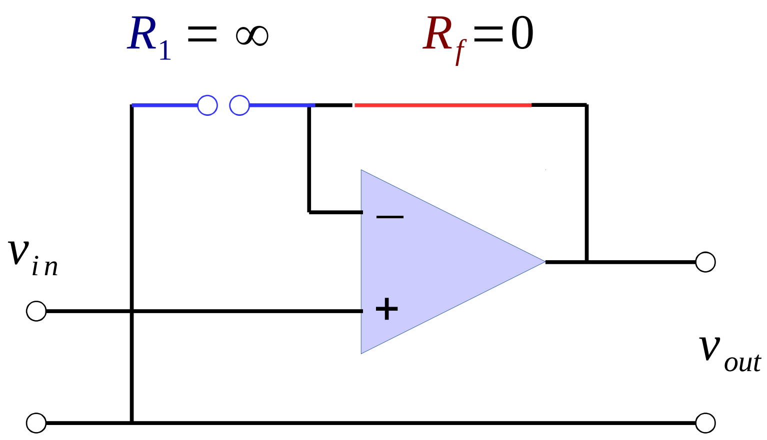
Voltage Follower



$$\frac{v_{out}}{v_{in}} = 1$$

http://hyperphysics.phy-astr.gsu.edu/hbase/electronic/opampi.html#c1

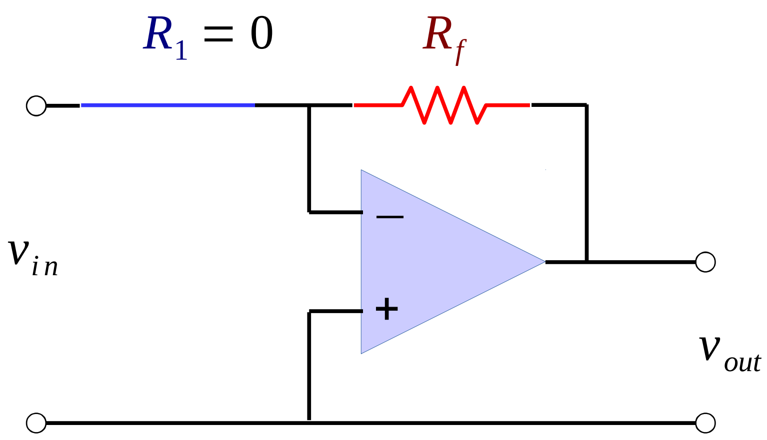
Voltage Follower



$$\frac{v_{out}}{v_{in}} = 1$$

http://hyperphysics.phy-astr.gsu.edu/hbase/electronic/opampi.html#c1

I → V Amplifier



$$v_{out} = -i_{in} R_f$$

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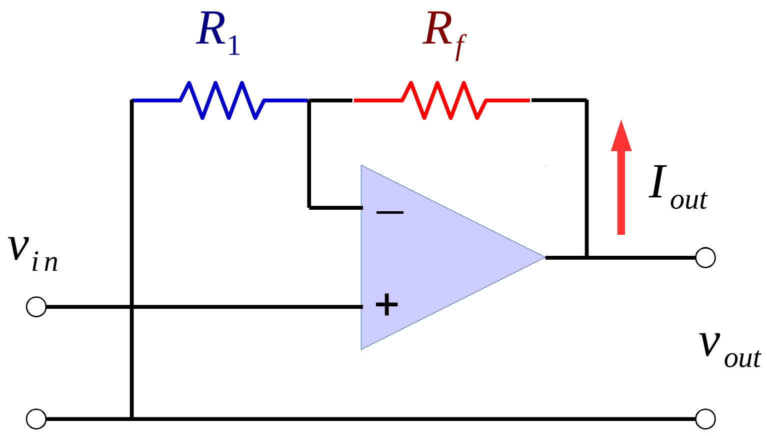
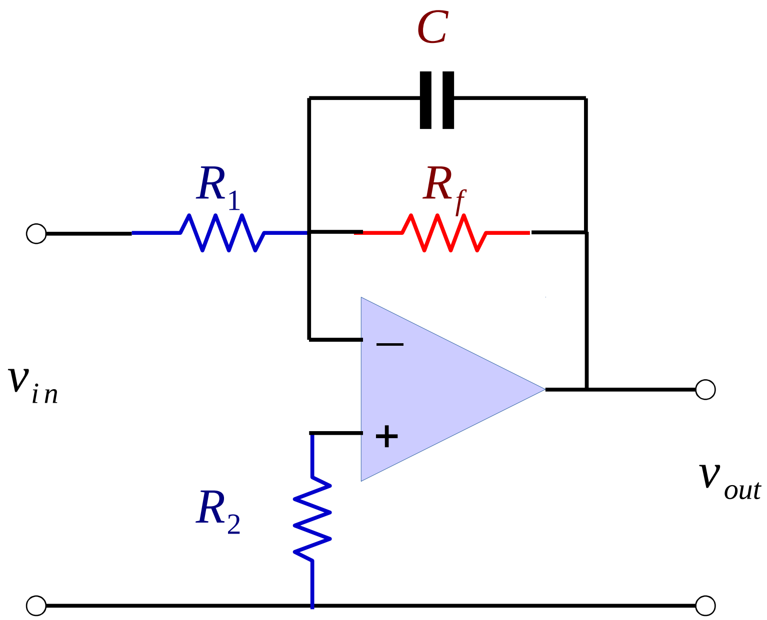
V → I Amplifier



$$I_{out} = \frac{v_{in}}{R_1}$$

http://hyperphysics.phy-astr.gsu.edu/hbase/electronic/opampi.html#c1

Integrator



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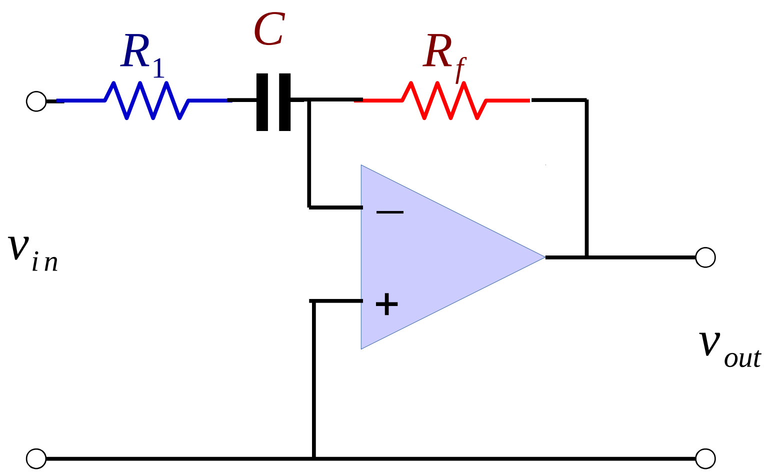
Differentiator



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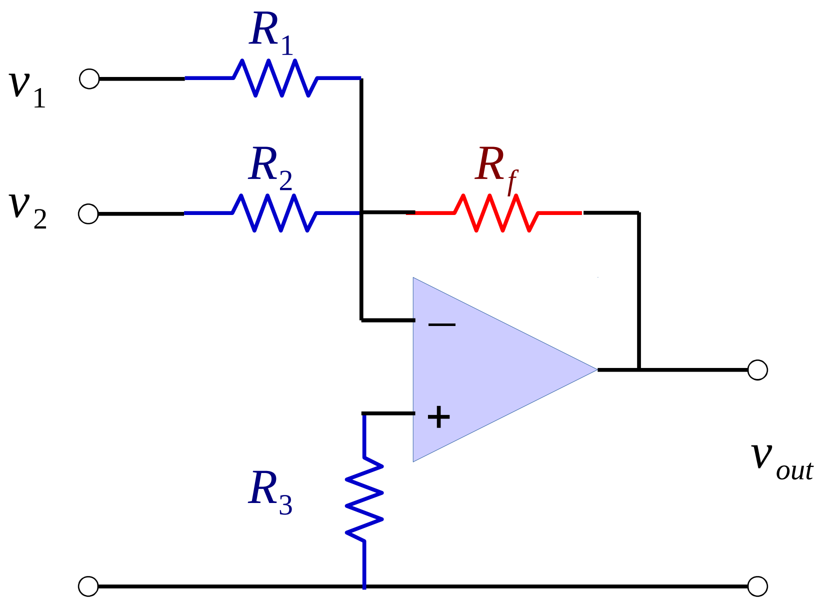
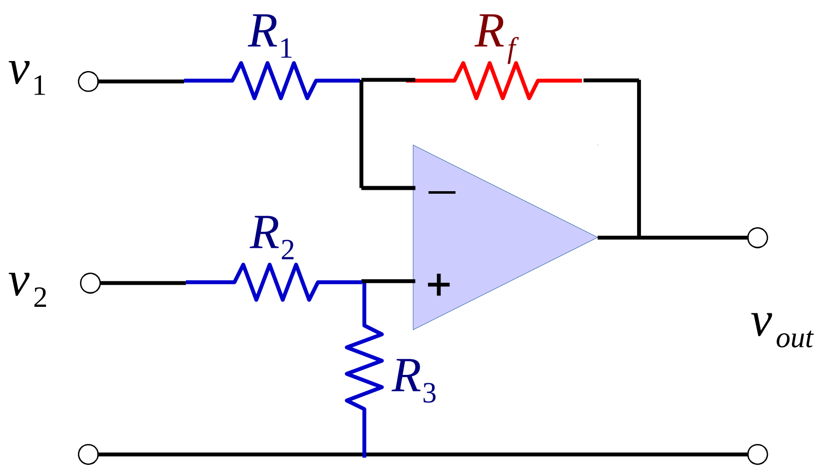
Summing Amplifier



$$v_{out} = -[V_1 + V_2]$$

http://hyperphysics.phy-astr.gsu.edu/hbase/electronic/opampi.html#c1

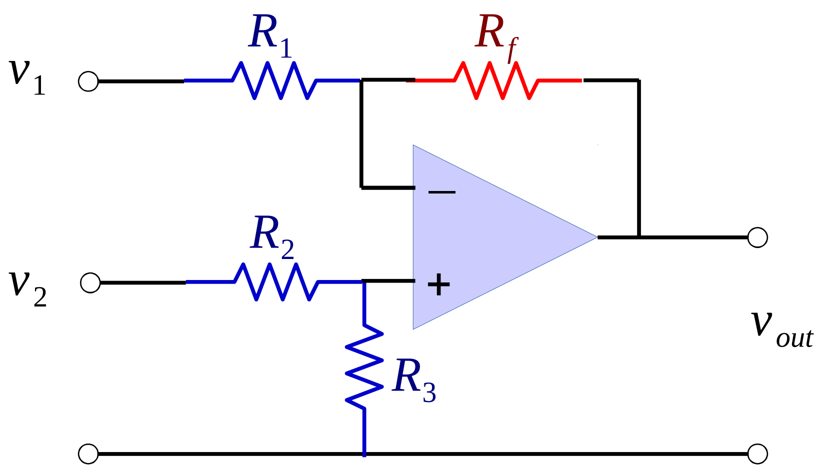
Difference Amplifier



$$v_{out} = -[v_1 - v_2]$$

http://hyperphysics.phy-astr.gsu.edu/hbase/electronic/opampi.html#c1

Differential Amplifier



$$v_{out} = v_2 \frac{(R_f + R_1)}{(R_3 + R_2)} - v_1 \frac{R_f}{R_1}$$

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References

[1] en.wikipedia.org
[2] http://hyperphysics.phy-astr.gsu.edu/