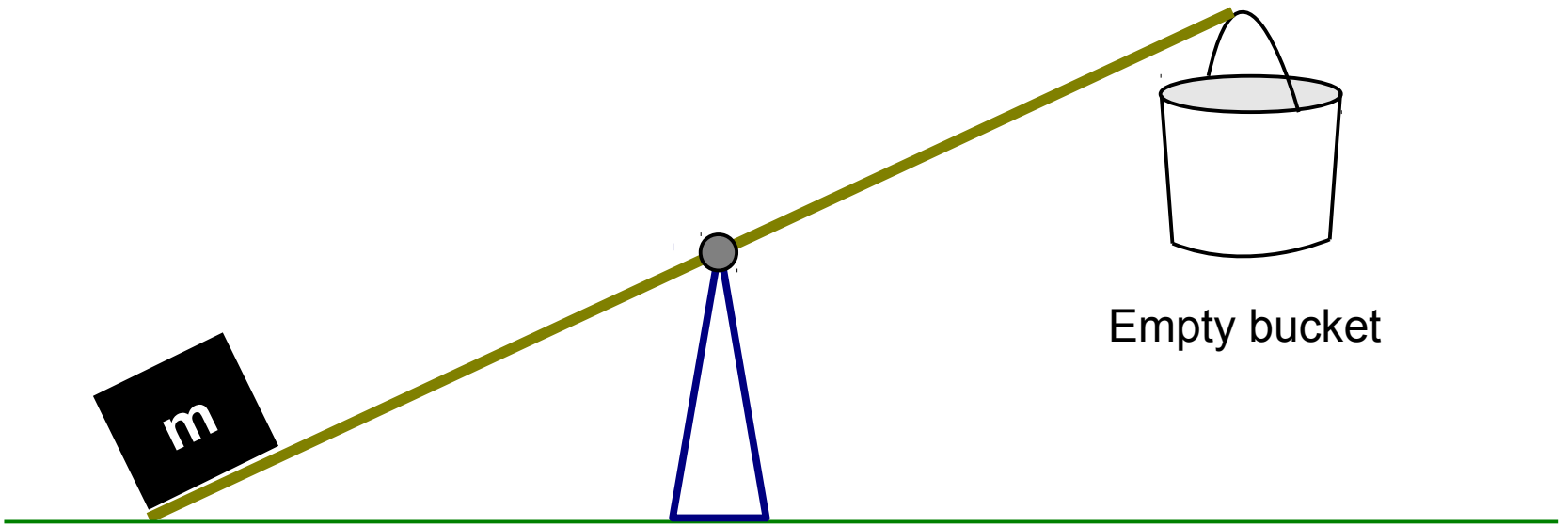
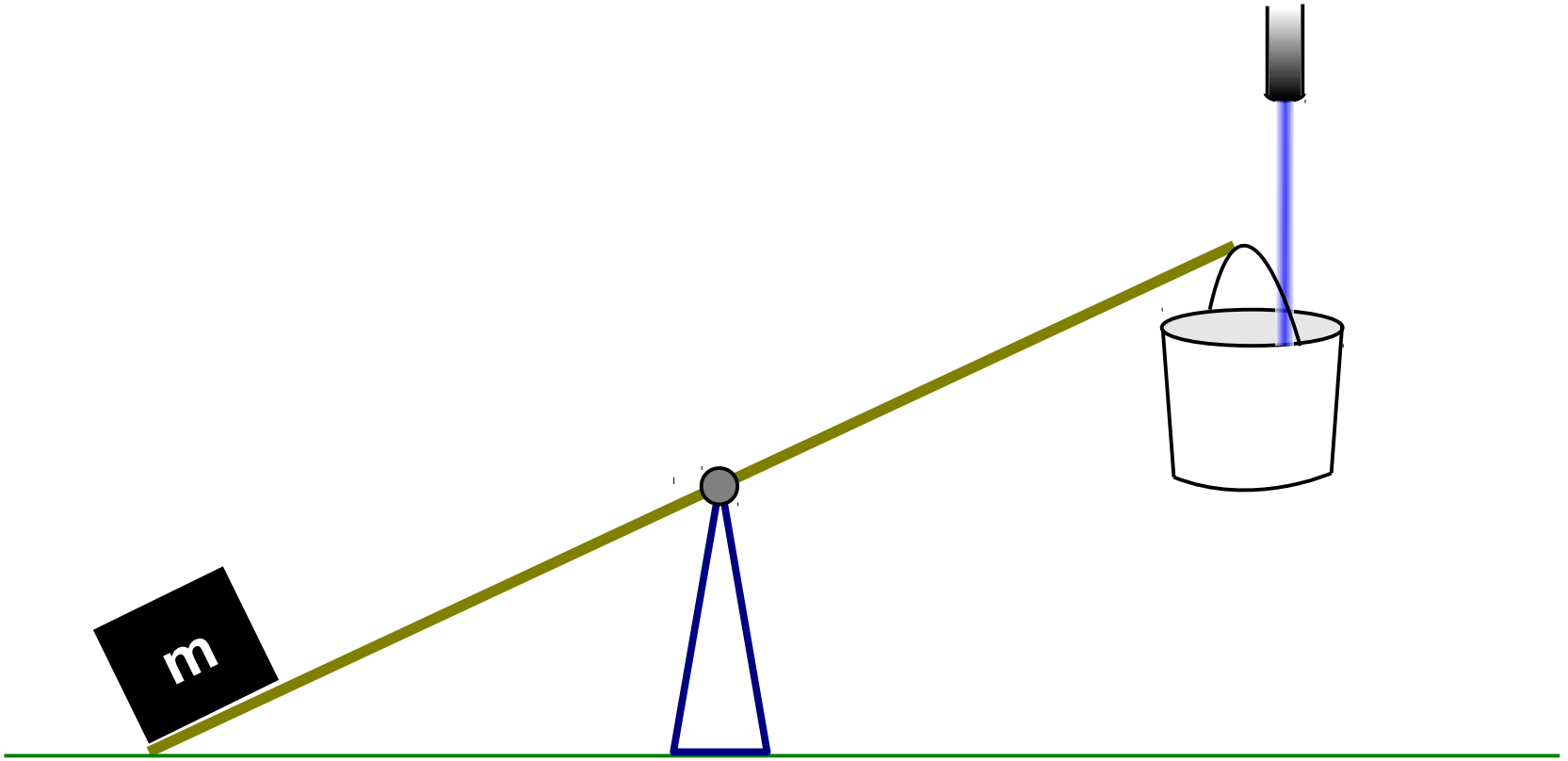
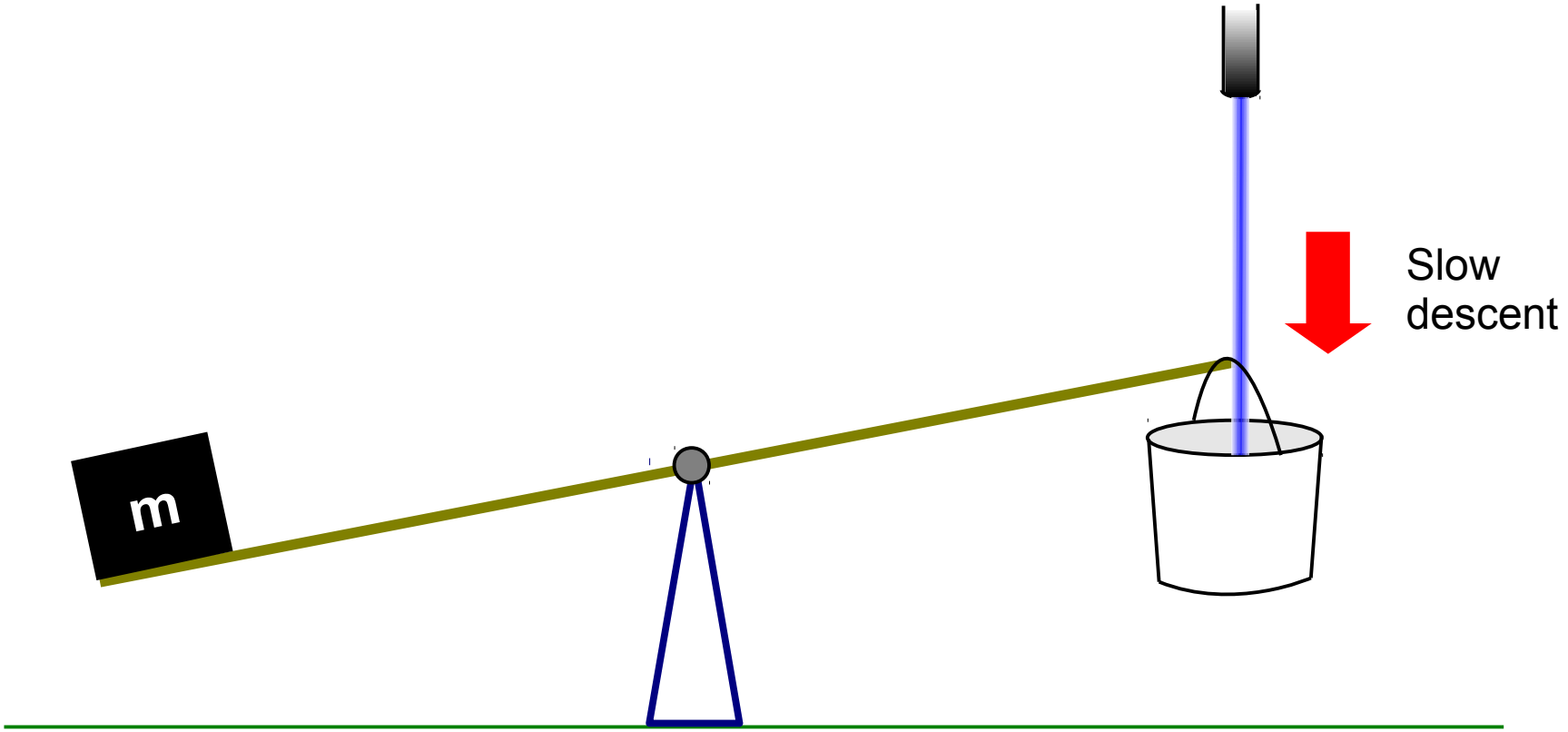
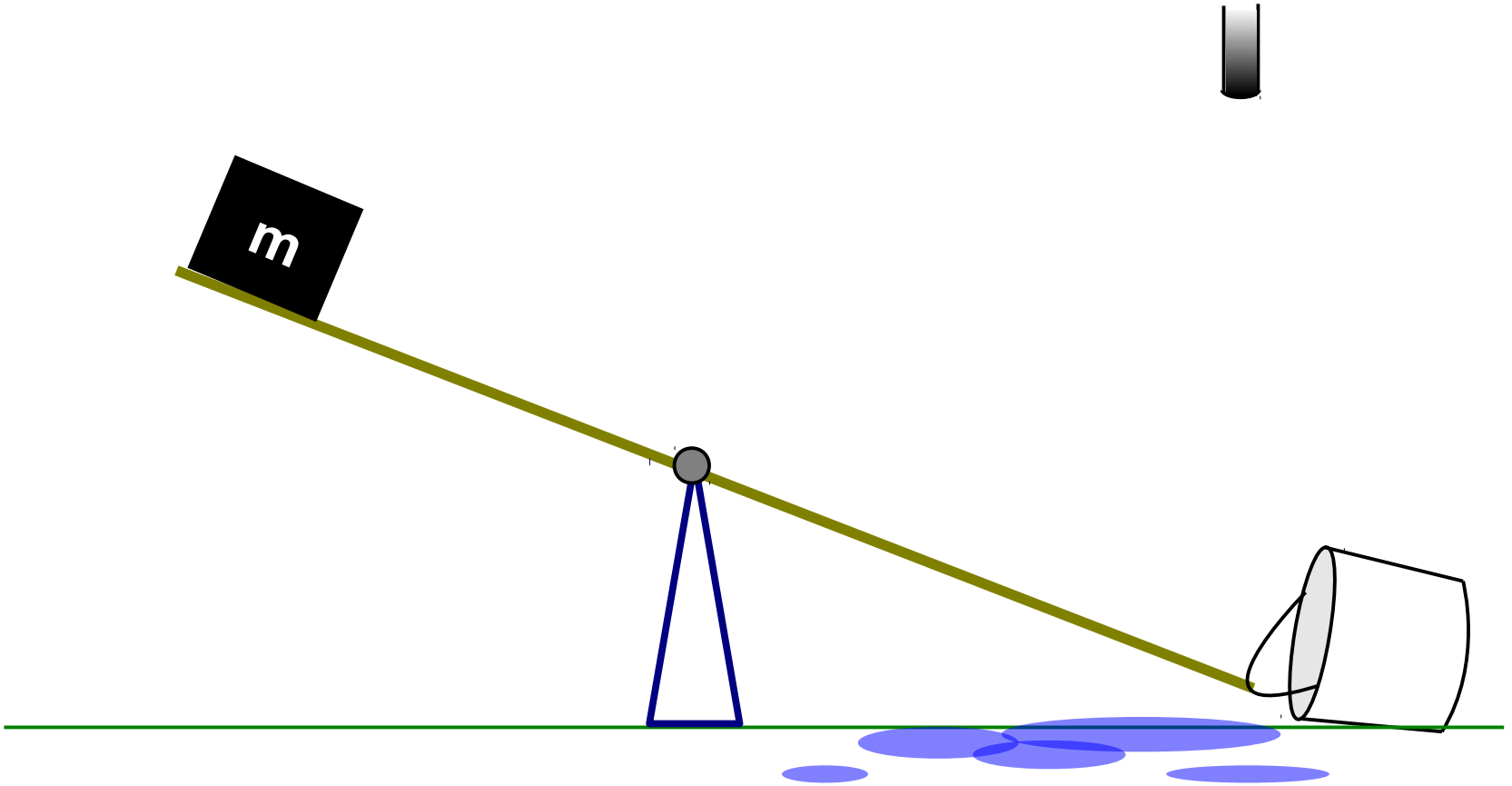
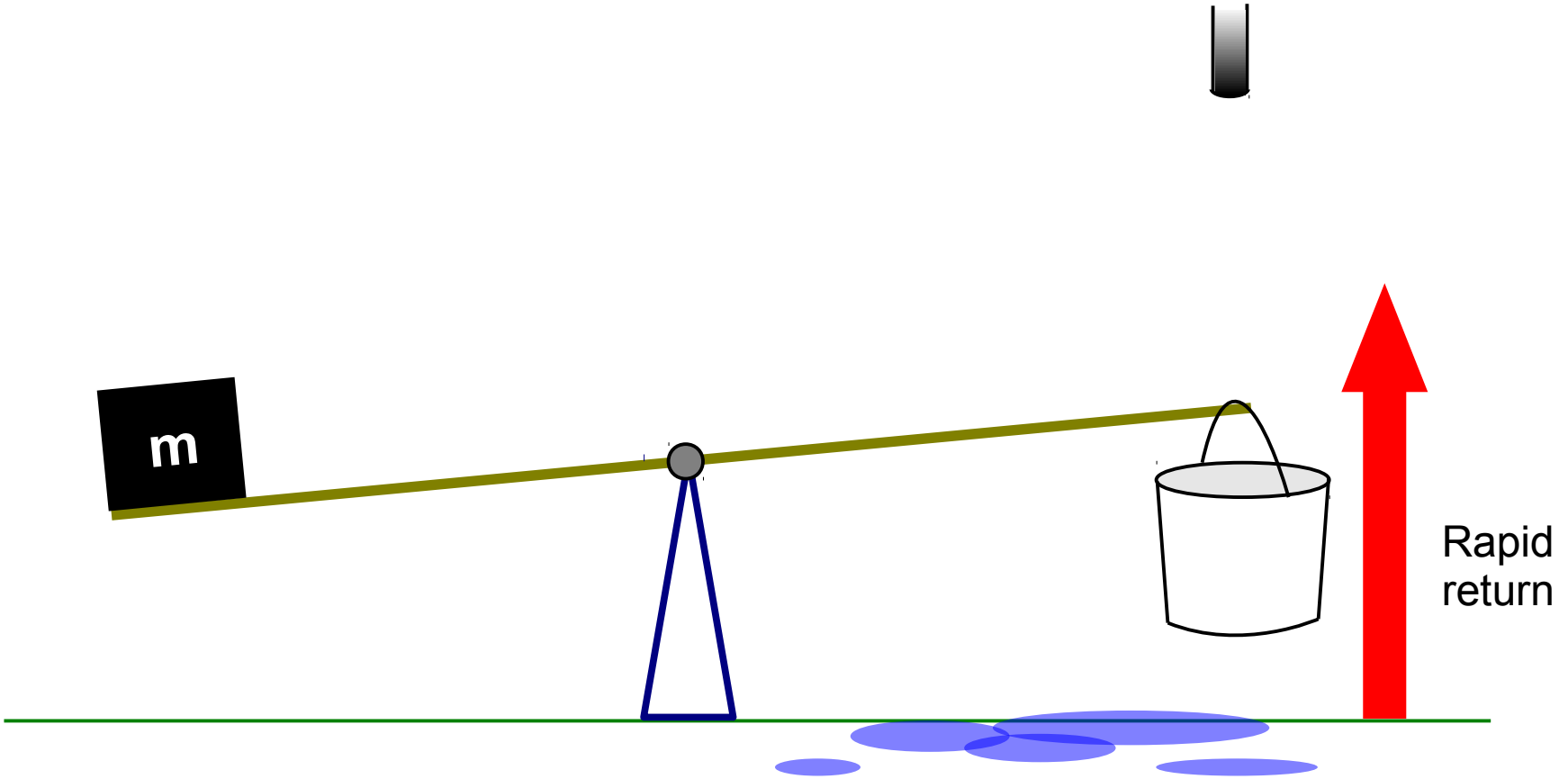
Lab 11: Relaxation oscillators

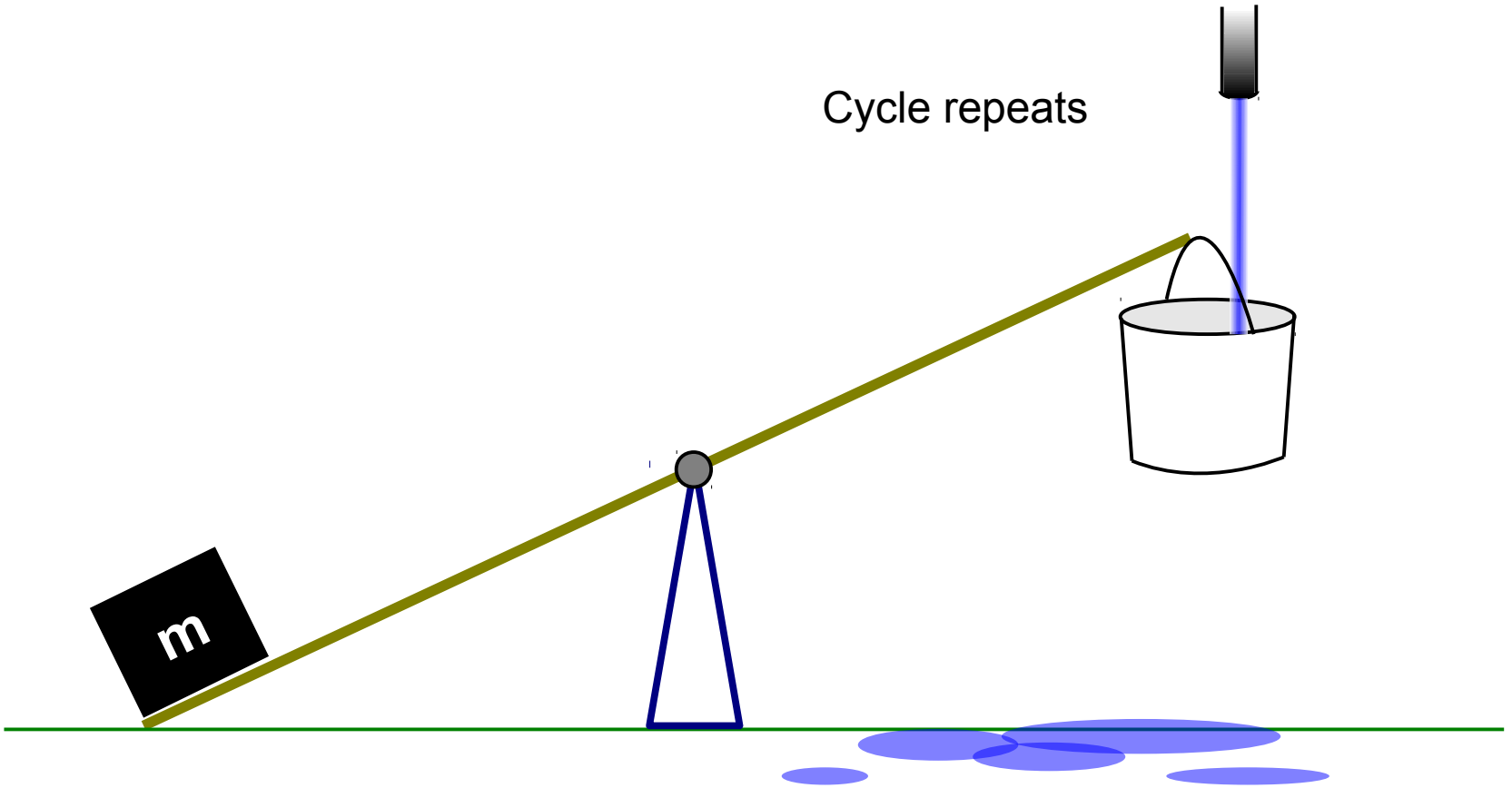

m
Empty bucket


m


m
Slow
descent


m


m
Rapid
return


Cycle repeats
m

Relaxation oscillators:

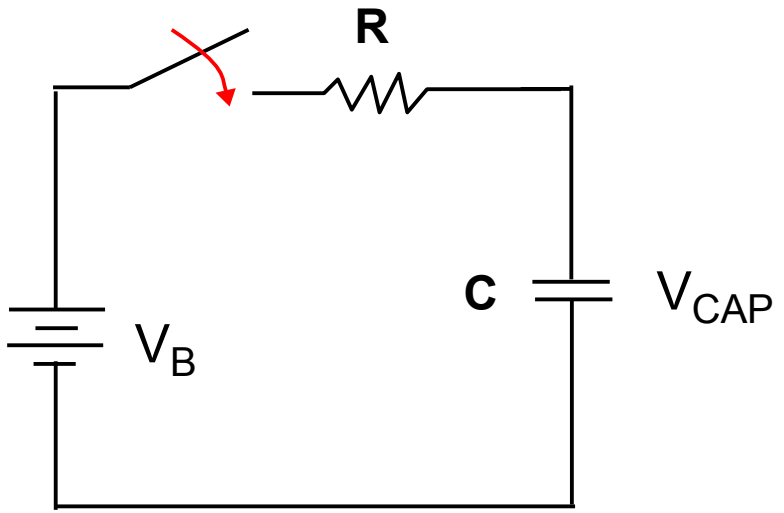
Cycle of adding and dissipating energy

Asymmetric, non-sinusoidal time behavior

Examples:
- Laser physics
- Heart muscle
- Vocal cords
- Predator-prey population cycles

B. van der Pol
(1889-1959)

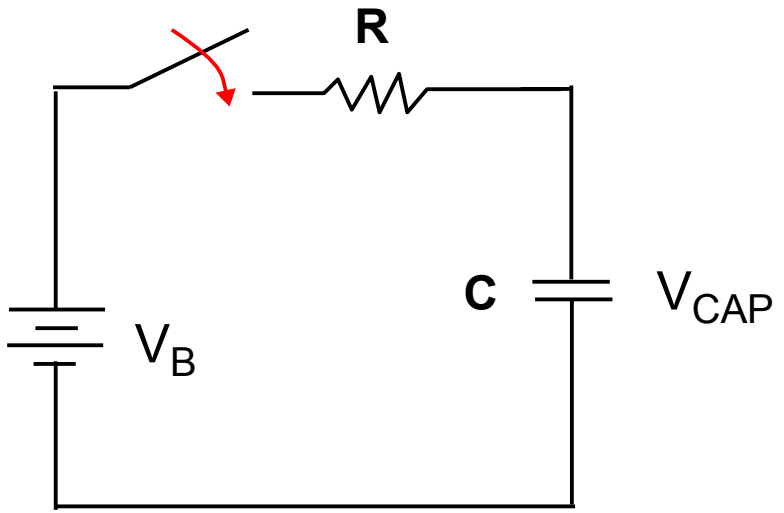
Storing and releasing energy with a capacitor



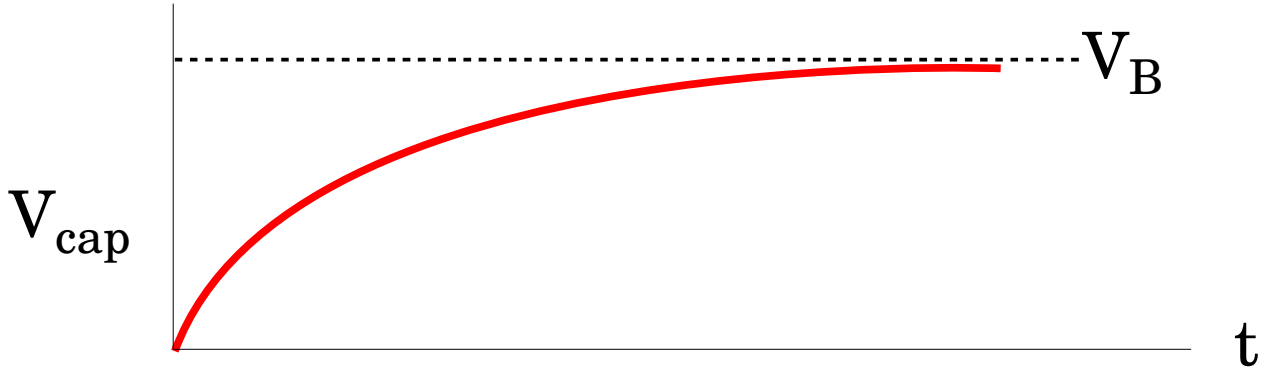
Determine charging rate

Don't use impedance $Z = 1/j\omega C$

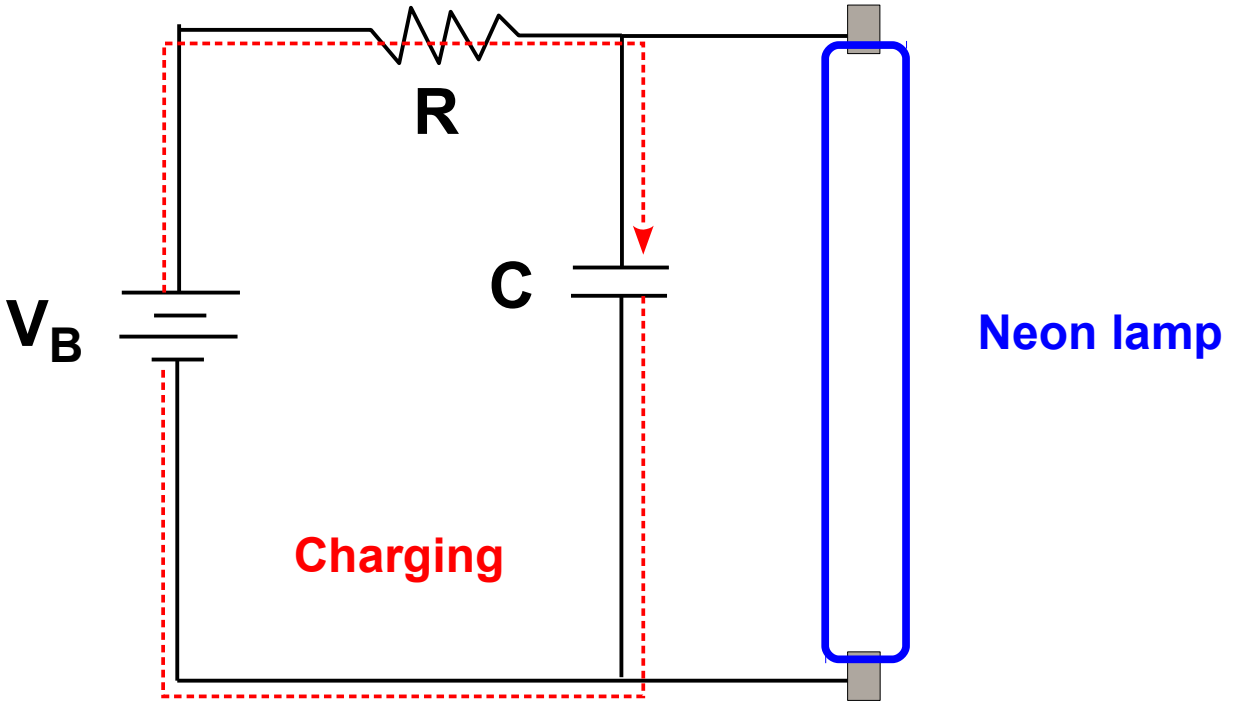
Storing and releasing energy with a capacitor

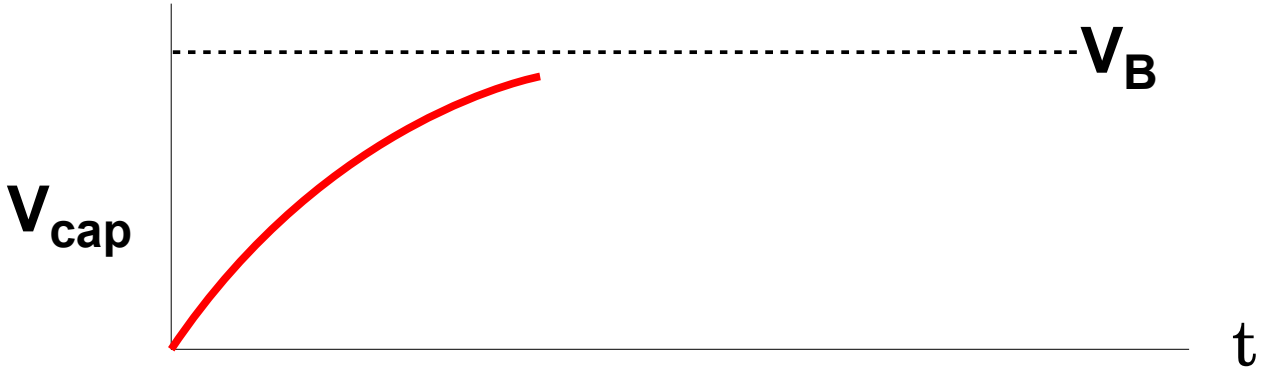


$$V_{\text{cap}} = V_{\text{B}}\left(1 - e^{-t/RC}\right) = V_{\text{B}}\left(1 - e^{-t/\tau}\right)$$

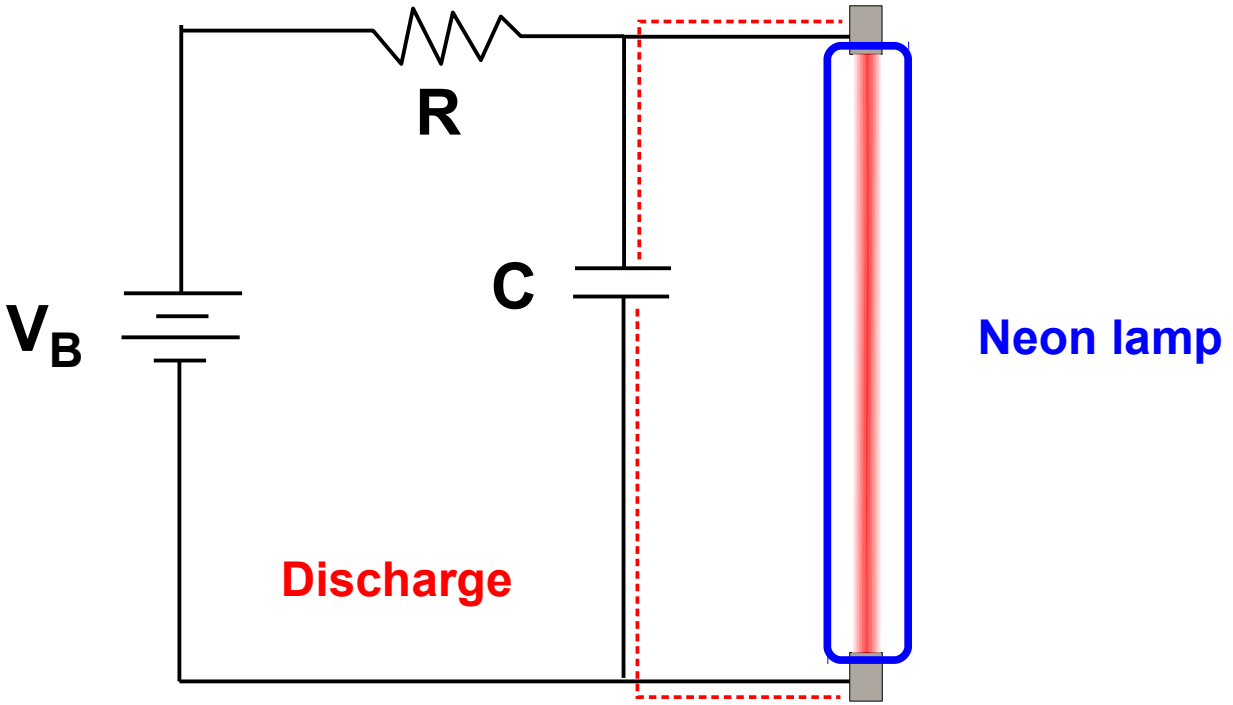


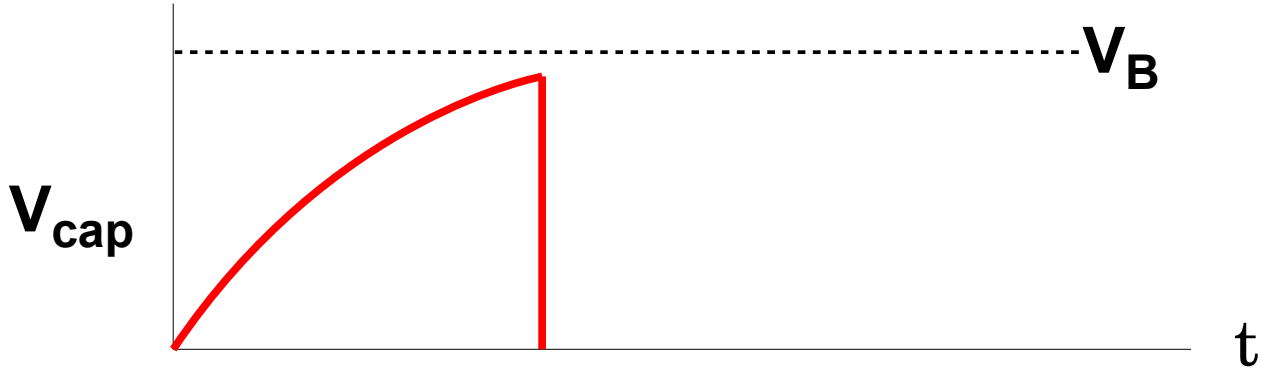
Storing and releasing energy with a capacitor



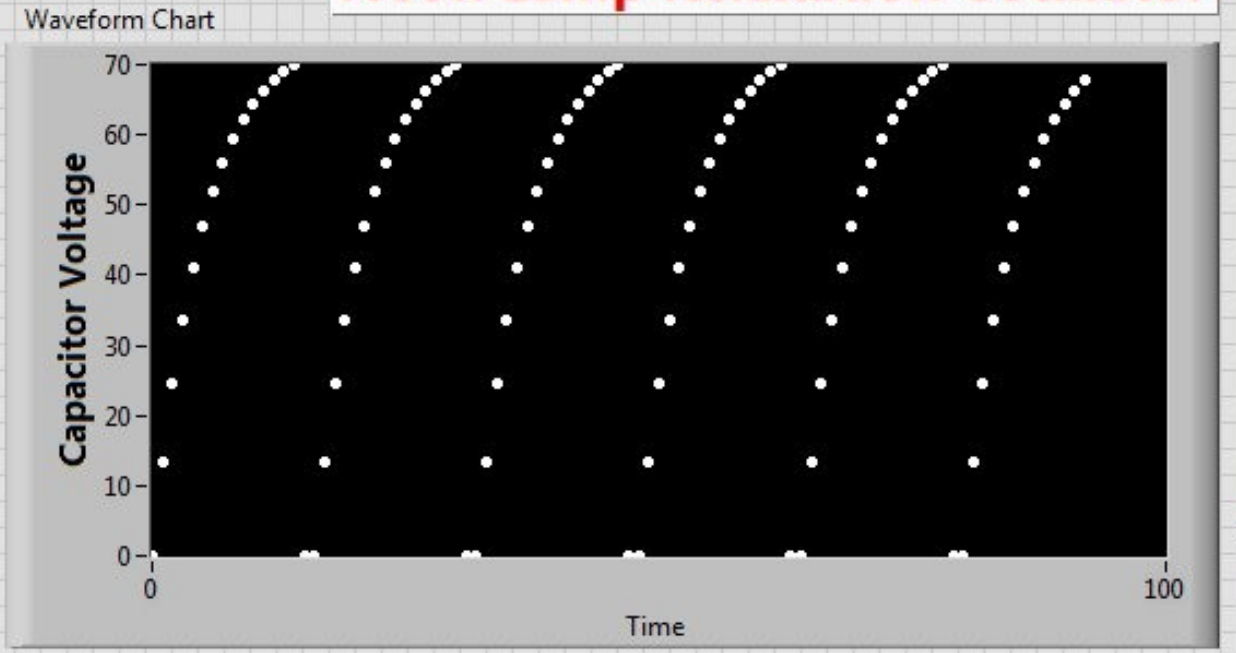


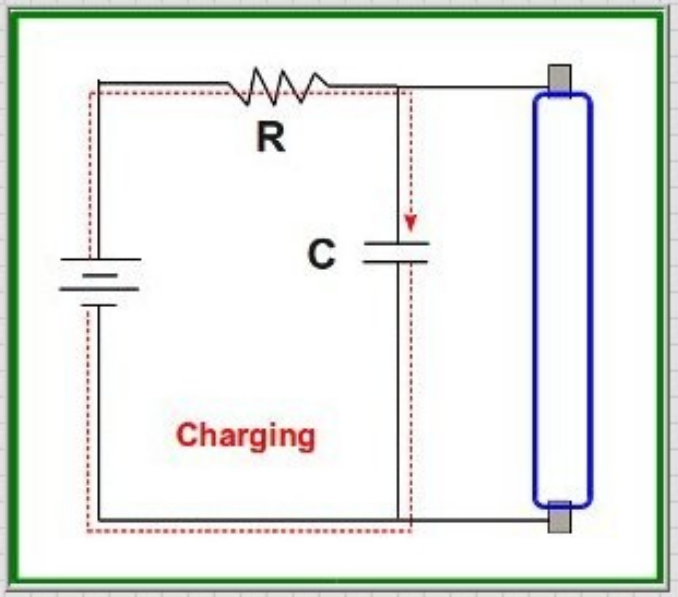
Storing and releasing energy with a capacitor



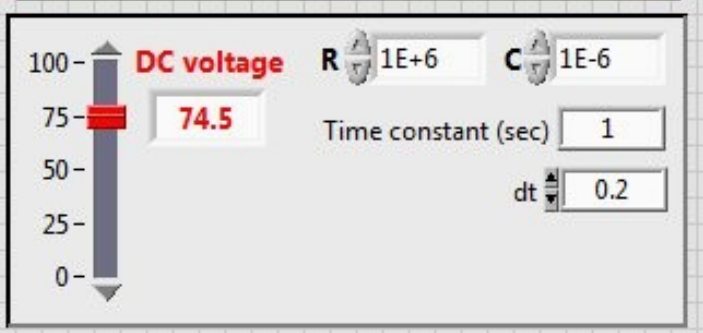


Neon Lamp Relaxation Oscillator

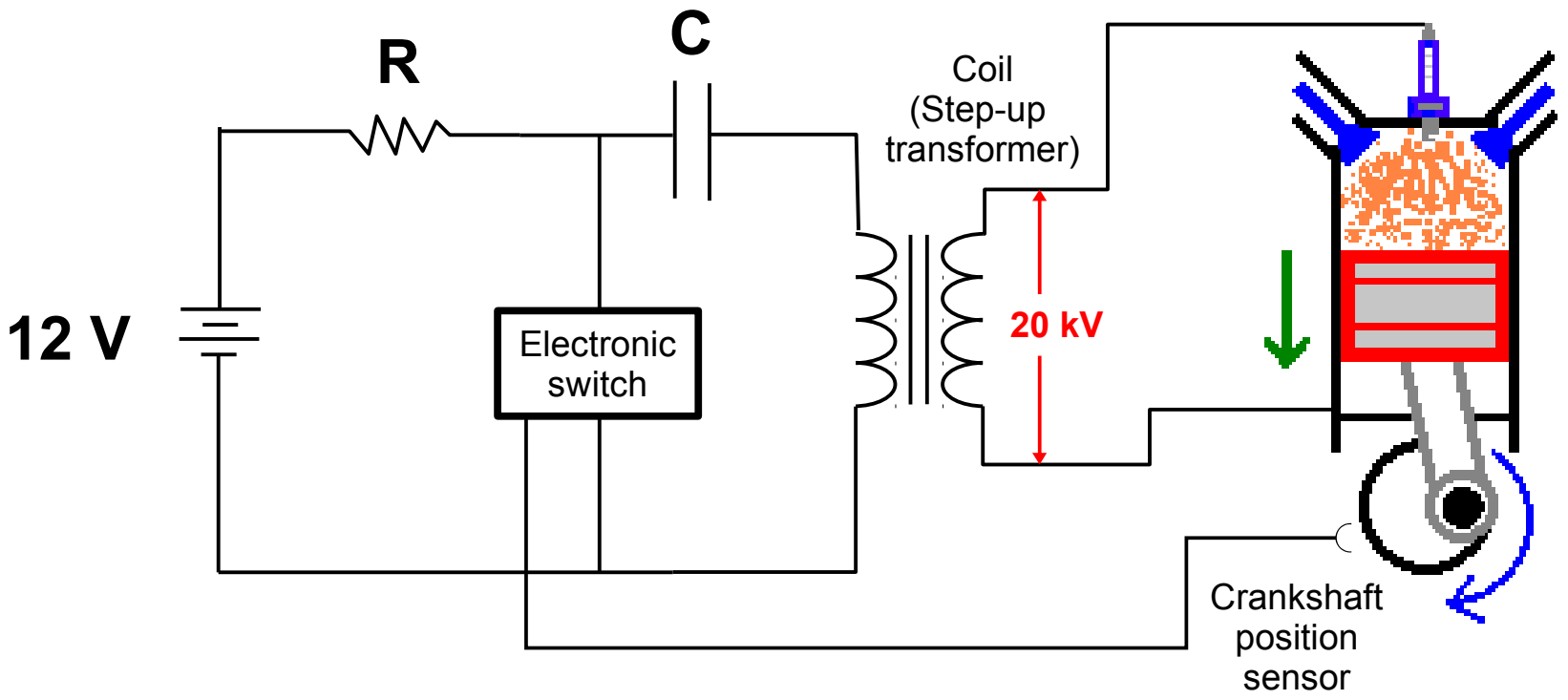




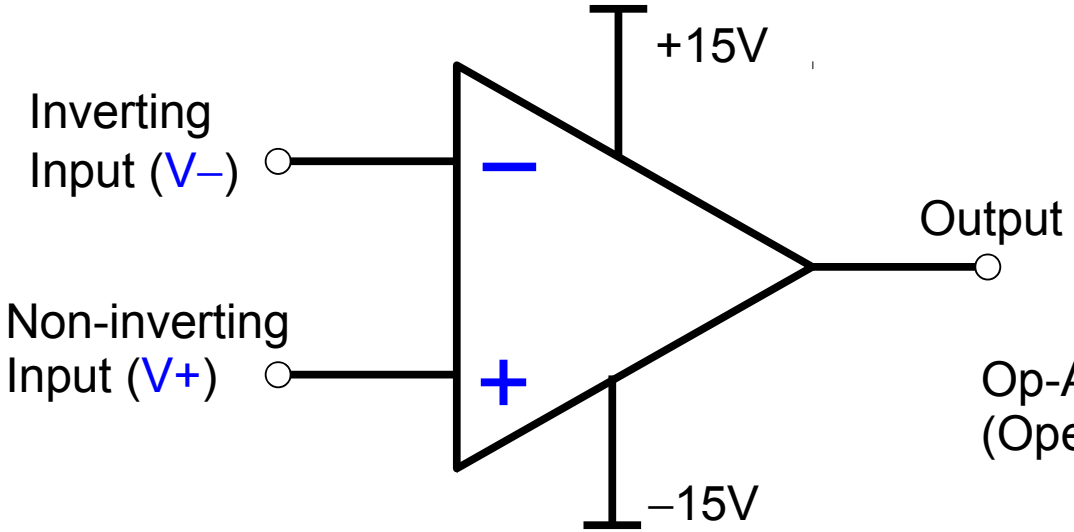
STOP



Storing and releasing energy with a capacitor: Capacitive discharge ignition

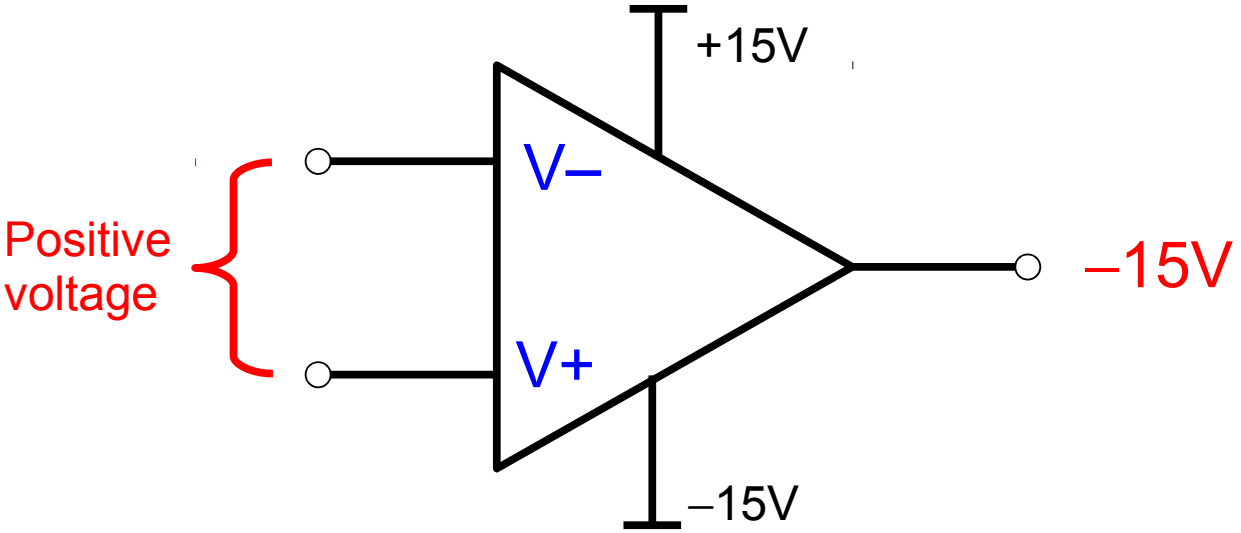


Relaxation oscillator: Implementation with Op-Amp



Op-Amp without feedback: Infinite gain
(Open loop gain of ideal Op-Amp)

Relaxation oscillator: Implementation with Op-Amp

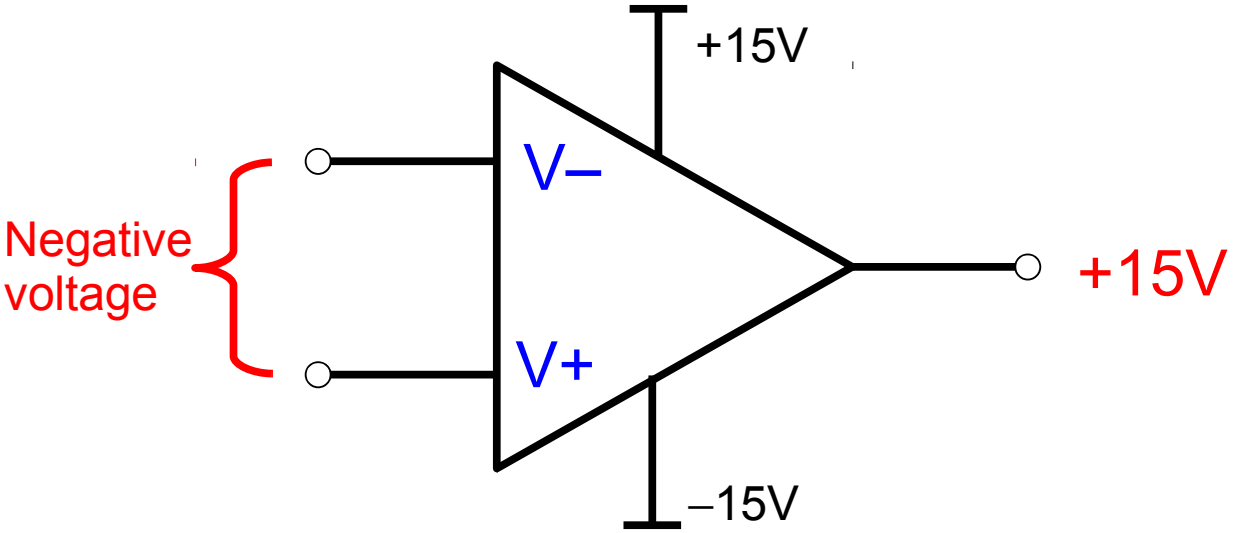


V– greater than V+

Output drives to negative ∞

Clamped at –15V of power supply

Relaxation oscillator: Implementation with Op-Amp

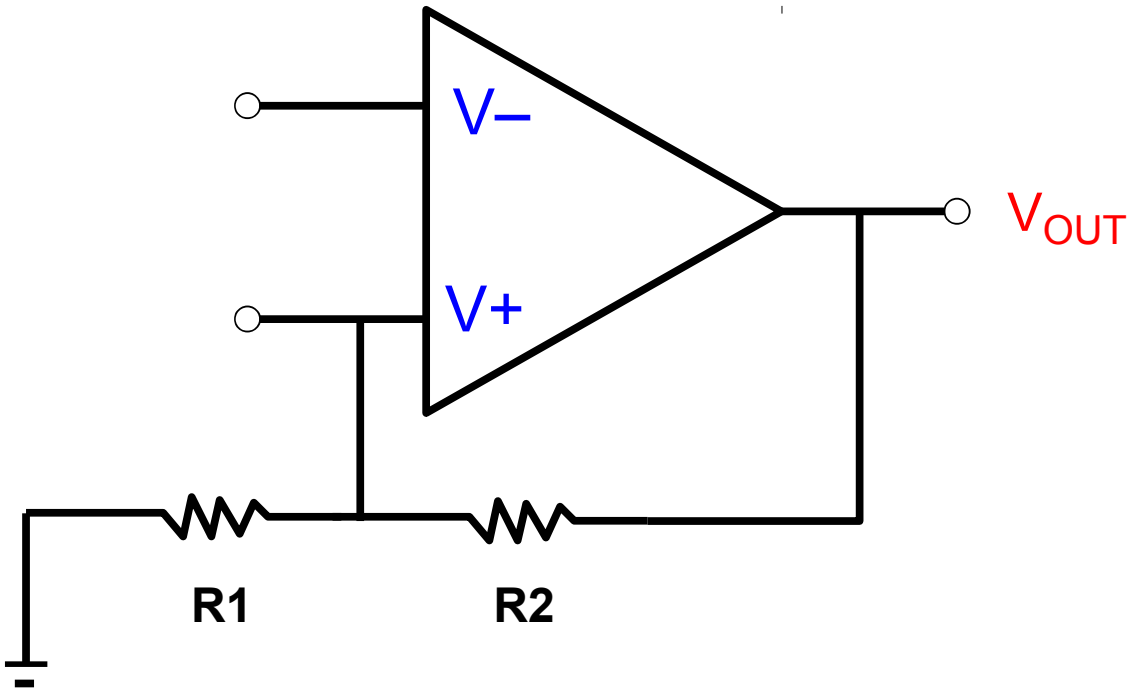


V+ greater than V–

Output drives to positive ∞

Clamped at +15V of power supply

Relaxation oscillator: Implementation with Op-Amp

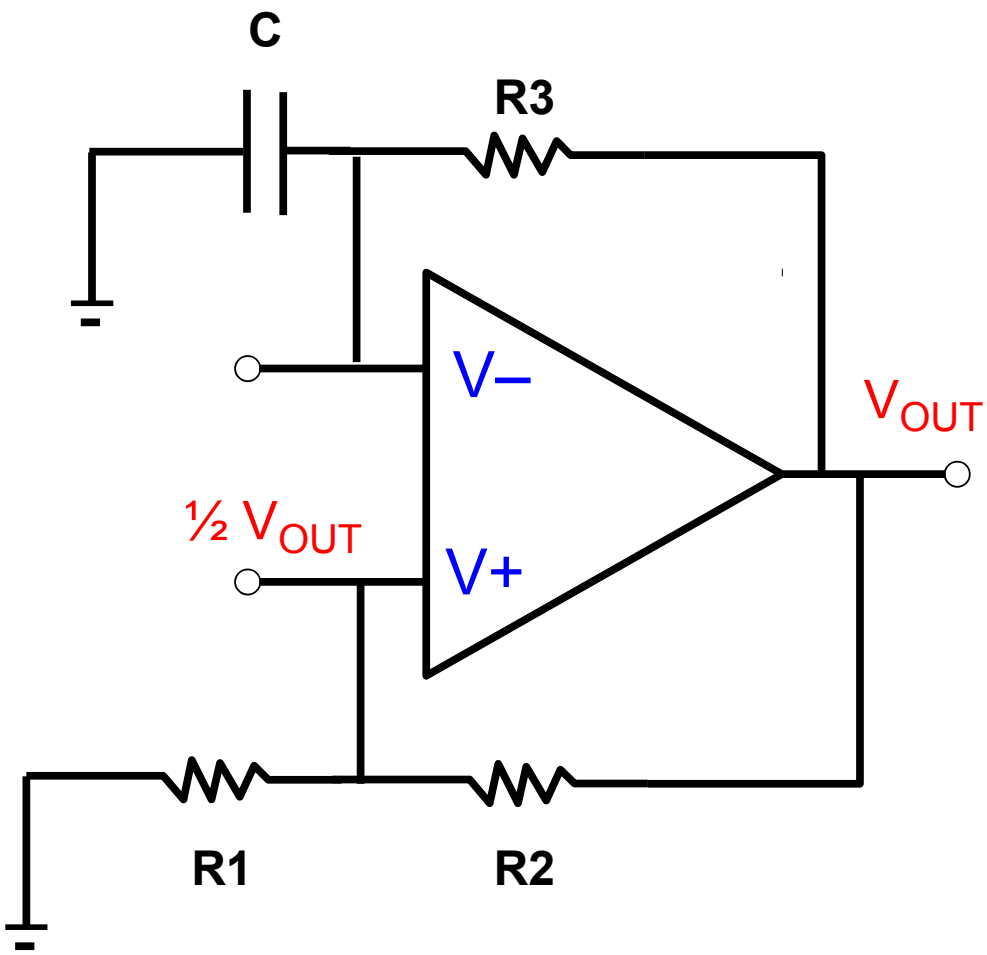


Make V+ a reference voltage

Voltage divider: R1 = R2

V+ = ½ V_{OUT} = +7.5V or –7.5V

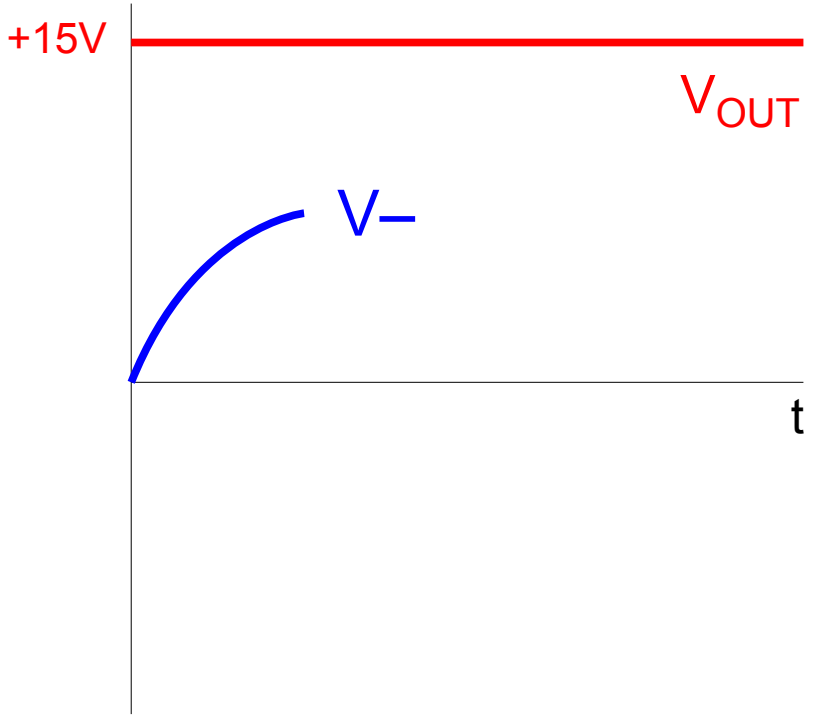
Relaxation oscillator: Implementation with Op-Amp



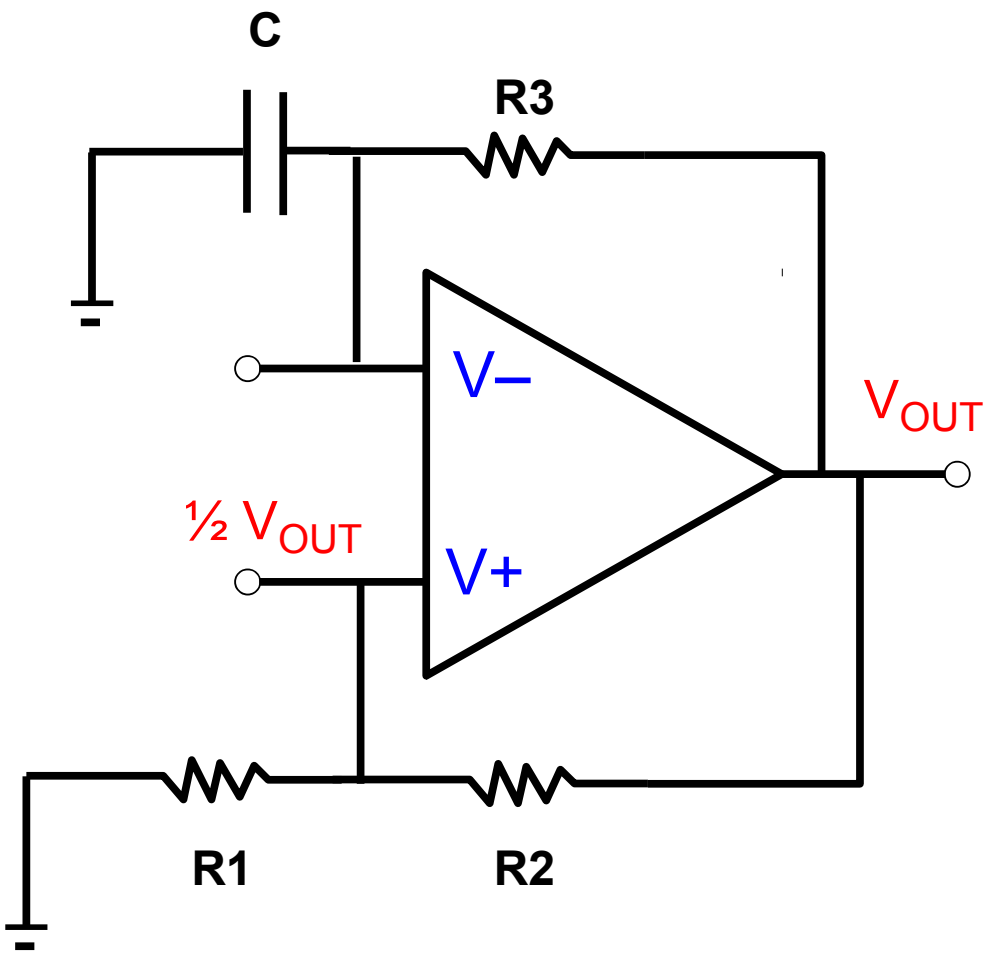
Add RC feedback to inverting input

V– can't follow V_{OUT} instantly

Capacitor charges with $\tau = R3C$



Relaxation oscillator: Implementation with Op-Amp



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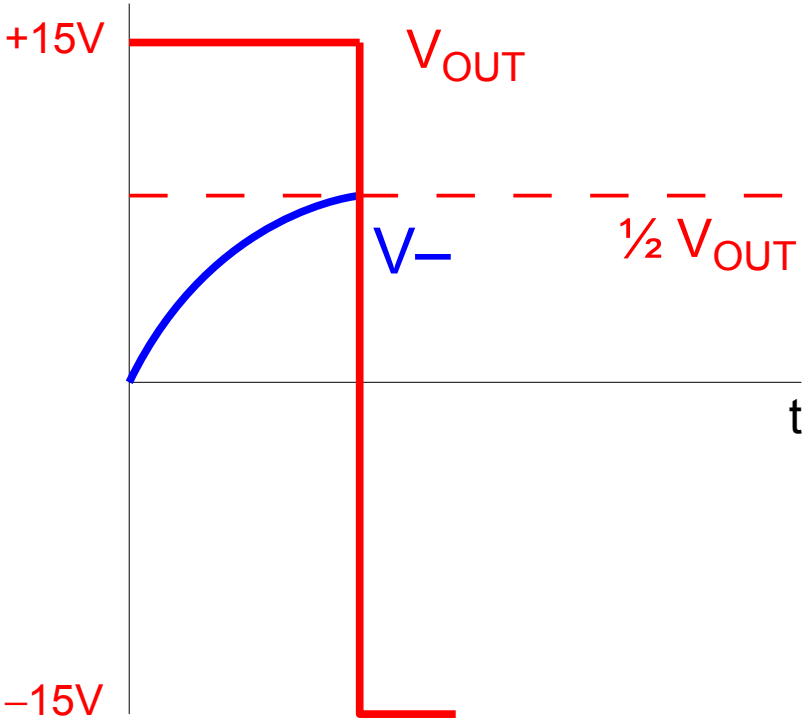
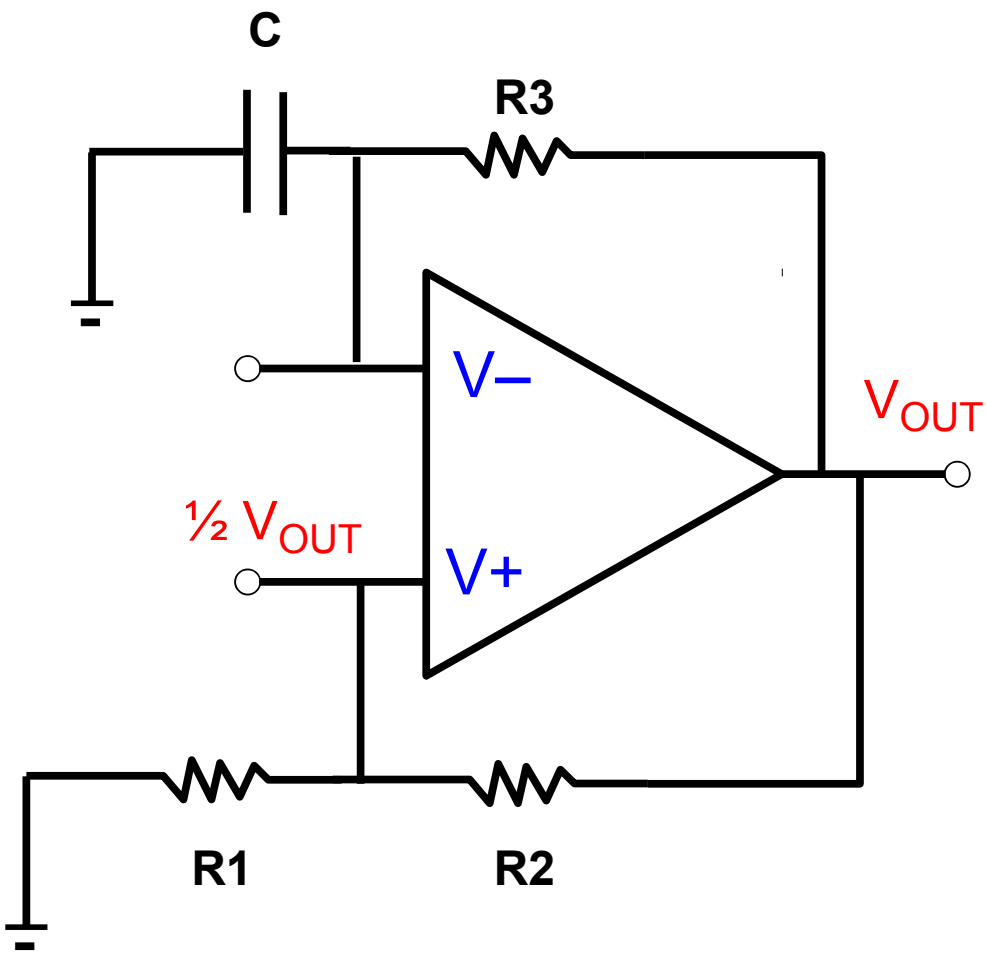


Relaxation oscillator: Implementation with Op-Amp



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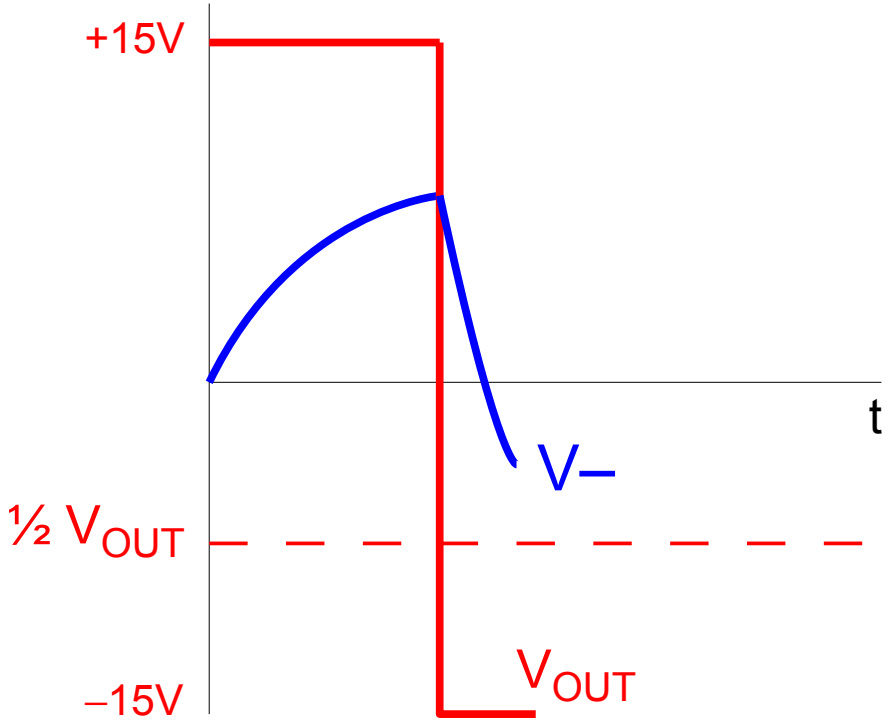
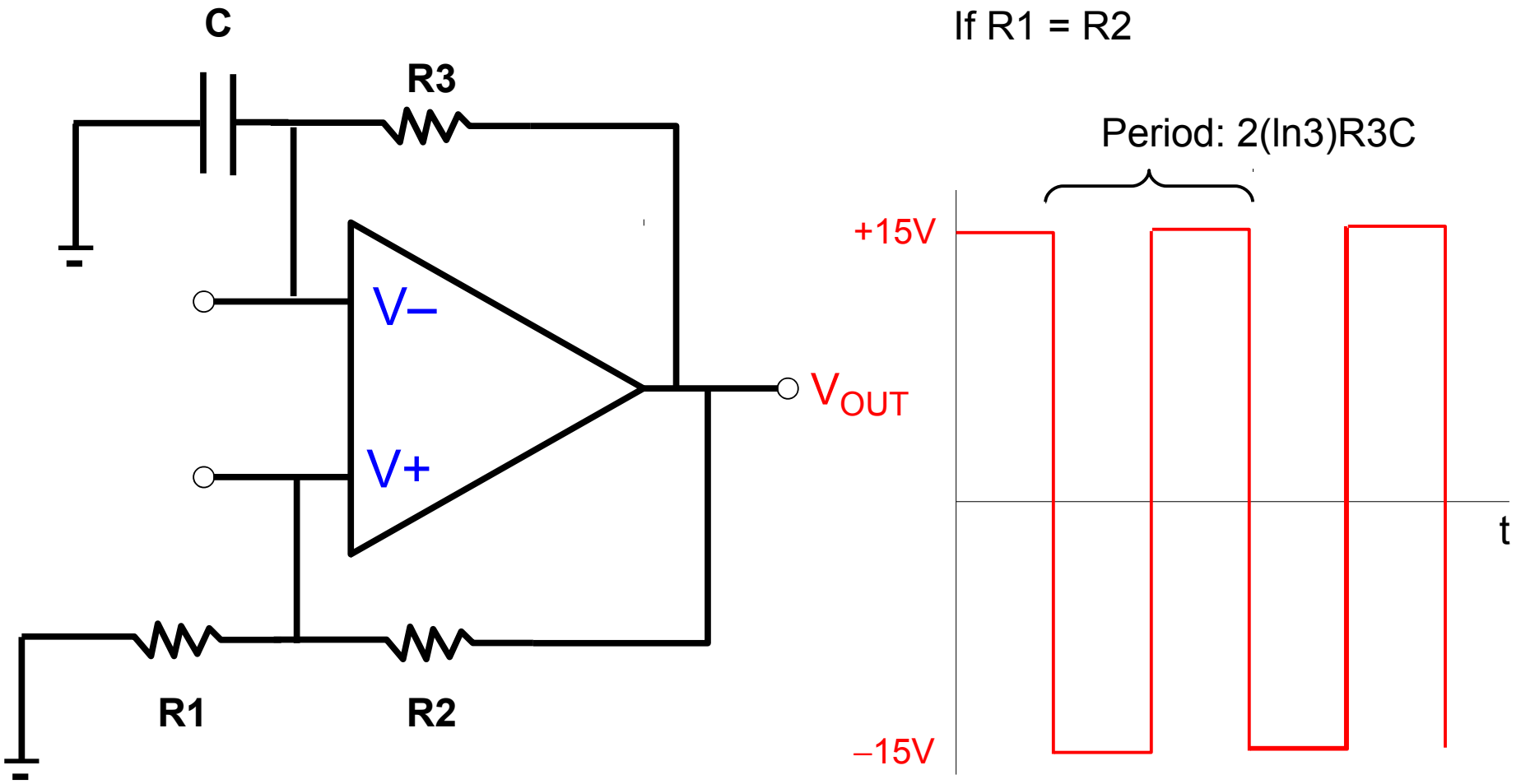
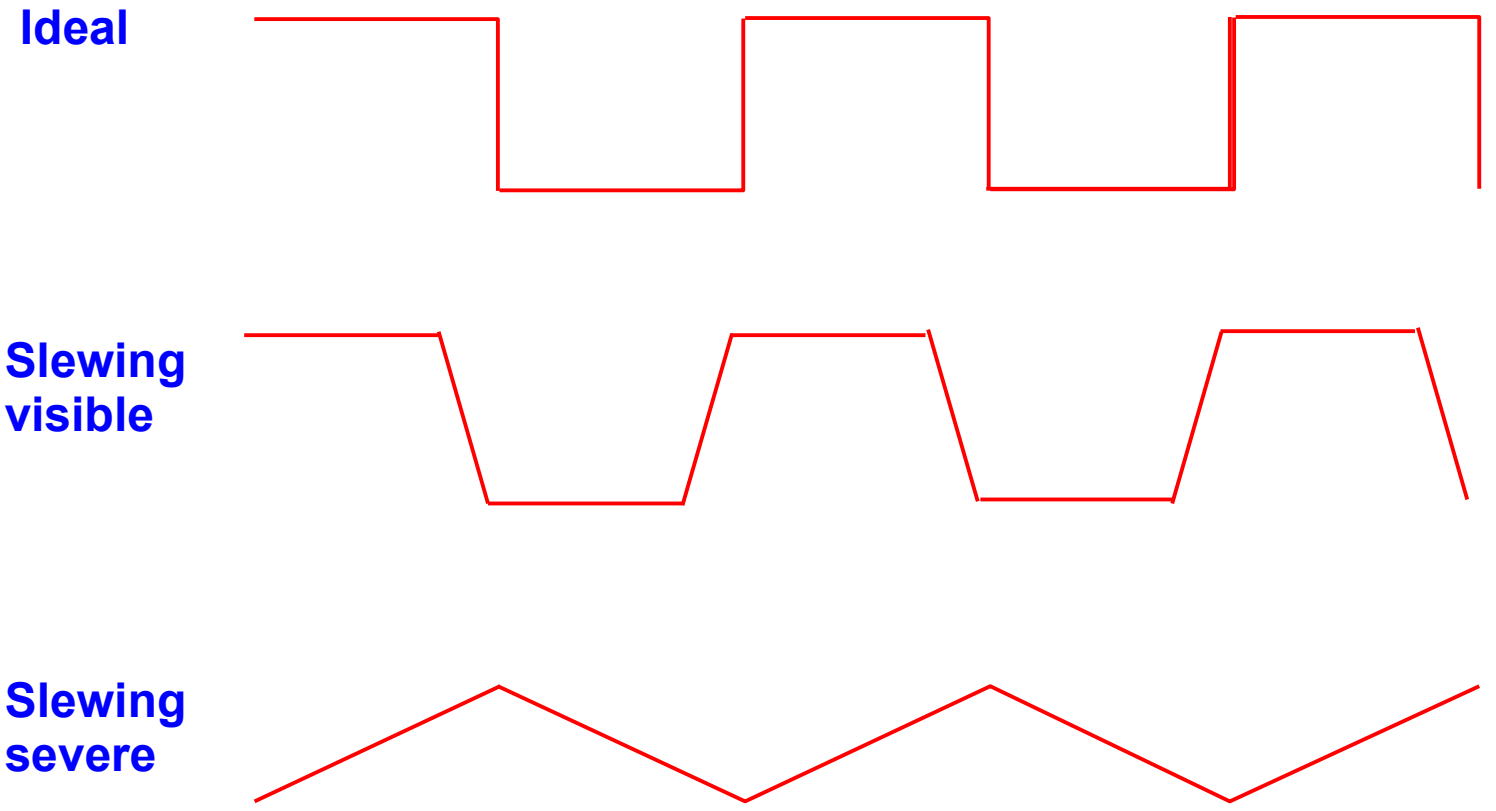


Relaxation oscillator: Implementation with Op-Amp

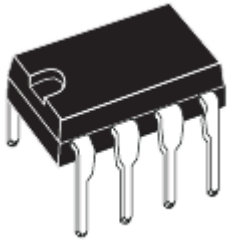


Slewing: Op-Amp cannot switch instantly

Limits the maximum oscillator frequency



555 Timer Chip



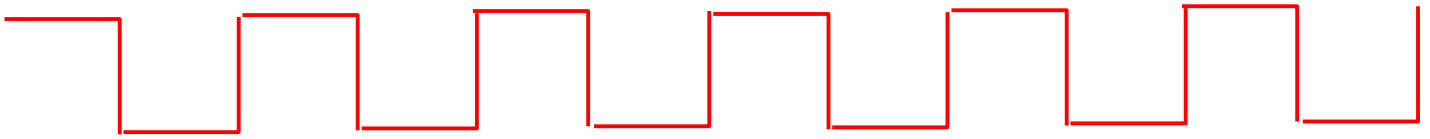
Make rectangular wave relaxation oscillator

Period adjustable with R and C

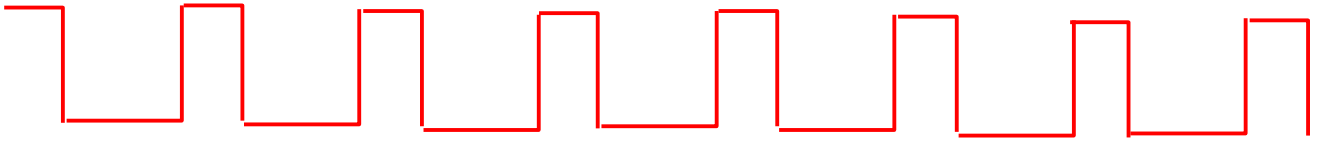
Set from microseconds to hours

Adjustable duty cycle: T_{ON} / Period

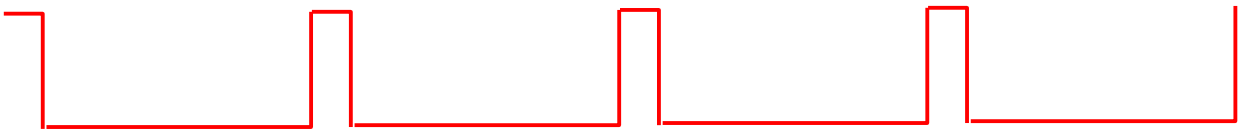
50% duty cycle



33% duty cycle



12.5% duty cycle



VI Server Architecture

– Programatically control Front Panel objects
  [These objects are in the Control Class]

– Programatically edit properties of a running VI
  [These objects are in the VI Class]

Objects have ***PROPERTIES*** and ***METHODS***

PROPERTIES are attributes of an object (eg. color, size, visibility, etc)
METHODS are actions or operations of an object (eg. initializing a control)

PROPERTIES are changed programatically with **PROPERTY NODES**
METHODS are changed programatically with **INVOKE NODES**