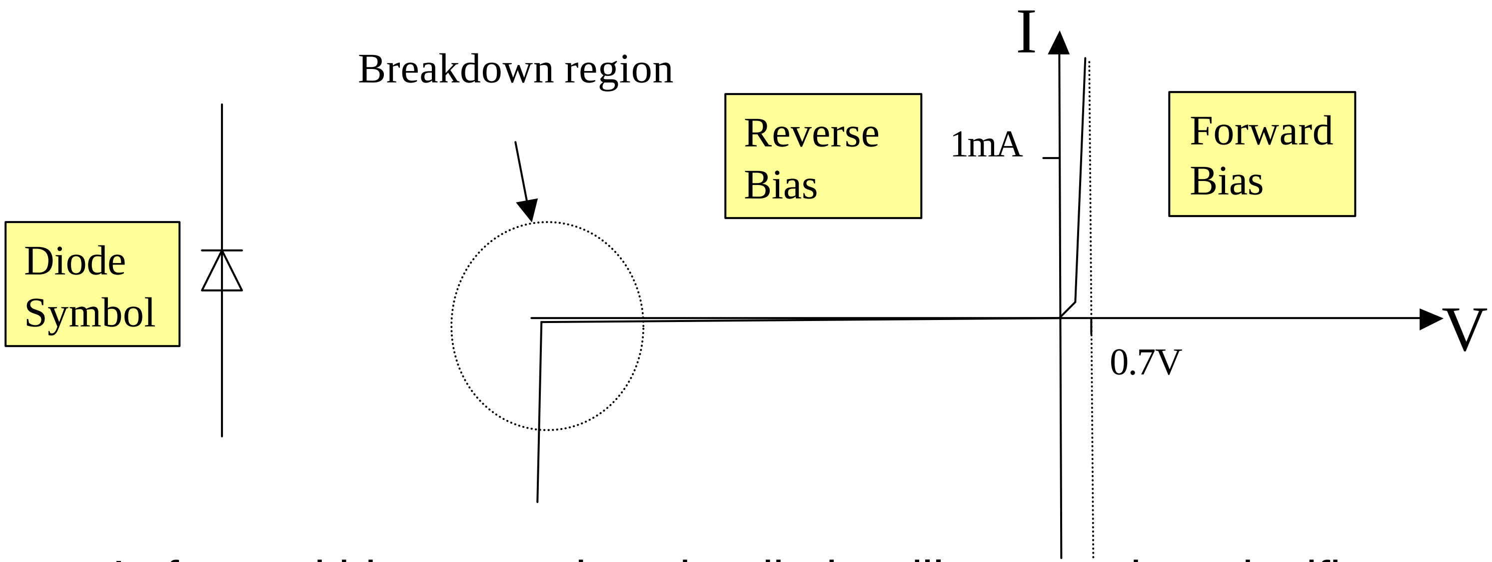
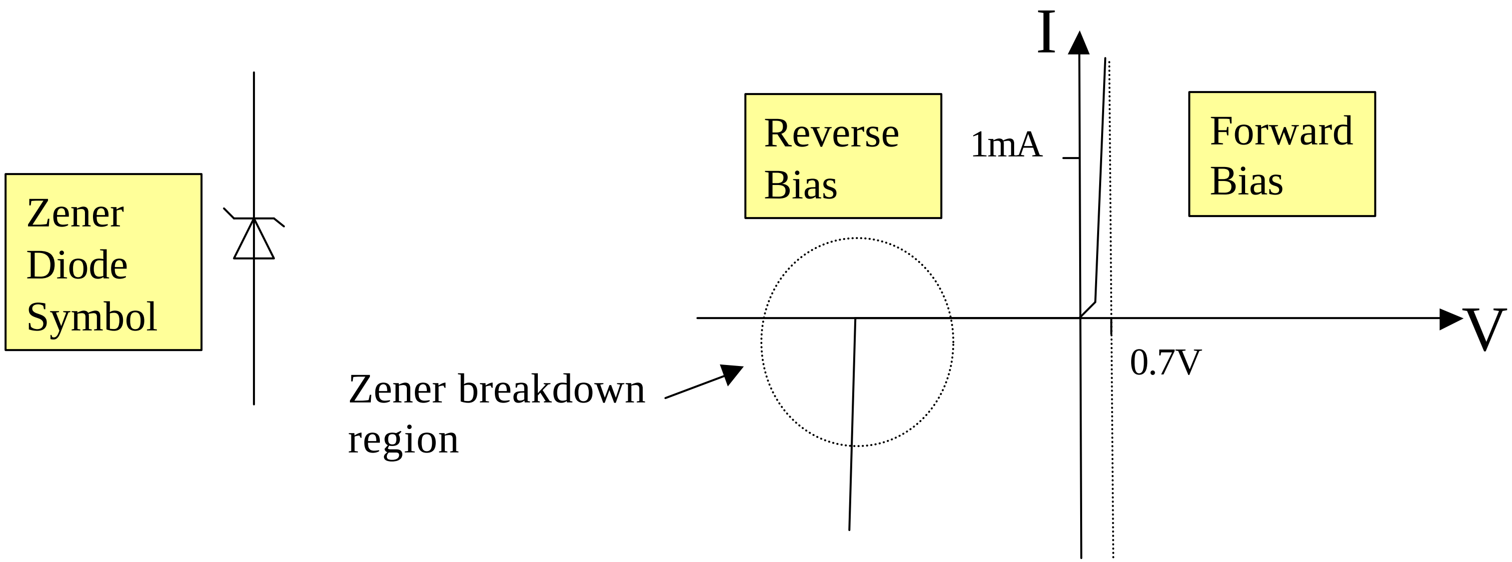
Diode IV Characteristics



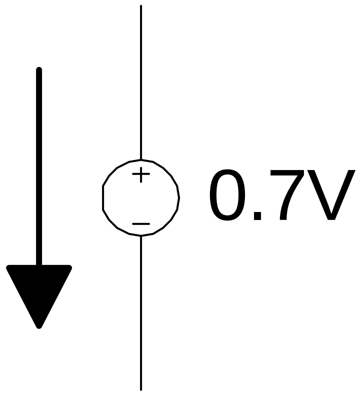
- In forward bias operation, the diode will not conduct significant current until the voltage reaches about 0.7V. After that point large increases in current cause little change in voltage.
- In reverse bias operation, the diode will not conduct significant current until some breakdown threshold voltage which is typically quite large (e.g. 200V). This voltage must be somewhat greater than the peak input voltage (PIV) rating of the diode. (device dependent)

Zener Diode

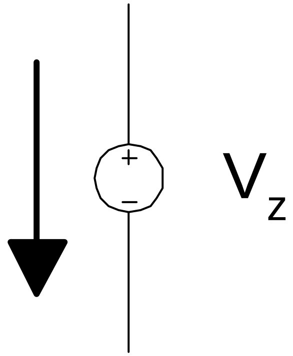


- Zener diodes are manufactured to have a very low reverse bias breakdown voltage
- Since the breakdown at the zener voltage is so sharp, these devices are often used in voltage regulators to provide precise voltage references. The actual zener voltage is device dependent. For example, you can buy a 6V zener diode.

Diode Circuit Models

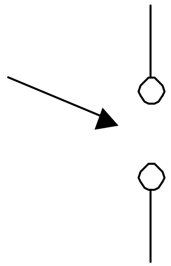


Forward bias model for currents greater than 1 mA



Reverse bias model for zener diode for voltages (just) above zener voltage V_z

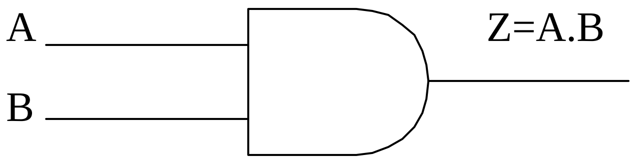
open circuit

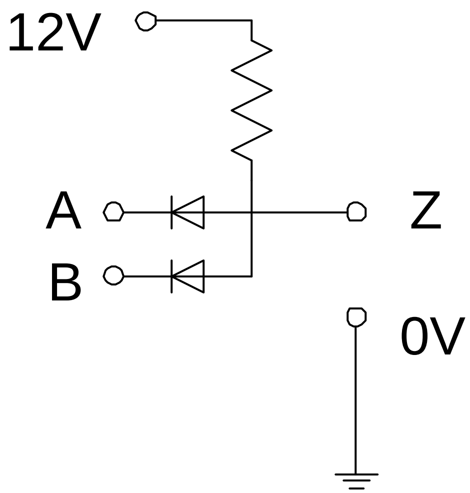


Reverse bias model and model for forward bias with currents less than about 1 mA. (also applies to zener diode in reverse bias below zener voltage)

Logic Circuit

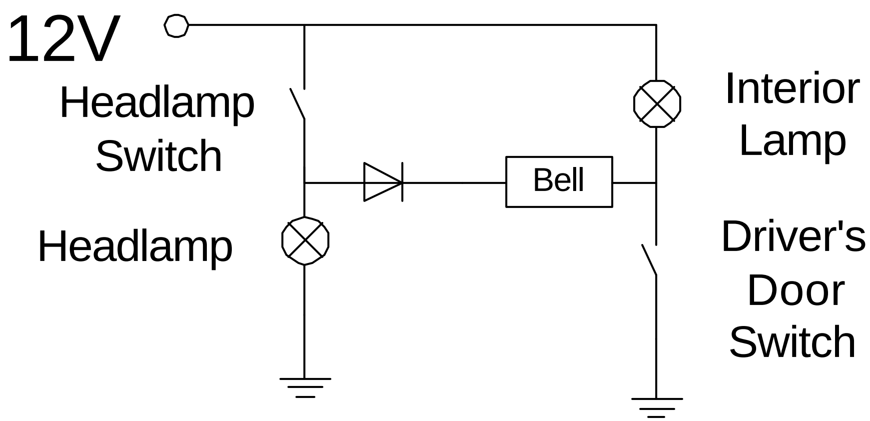
- Diode Resistor Logic (DTL)
- Output Z will be high (12V) if A and B are both connected to 12V (or left open circuit in this case)
- If either A or B is connected to ground (0V) the output will be low (0.7V)
- The diodes are required so A doesn't short out to B.
- This is a very simple Boolean Logic gate implementing the function Z=A.B





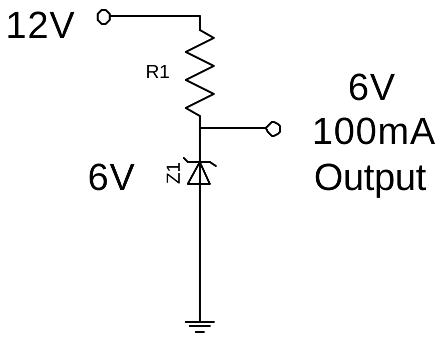
Headlight Reminder

- Bell sounds when headlights are on and driver's door is open
- Diode ensures that the bell does not sound when the door is closed and the headlamps are off



Voltage Shunt Regulator

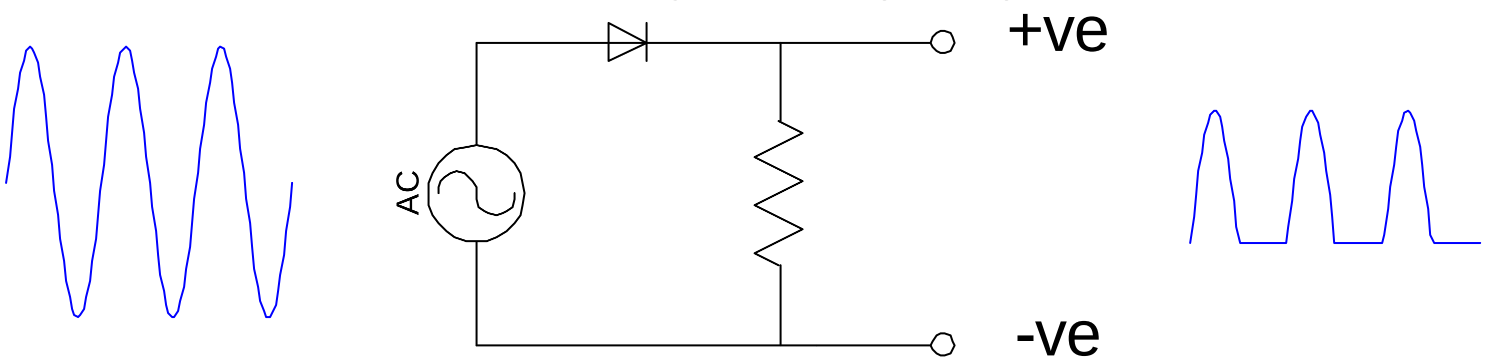
- Power your portable CD player from the car battery
- Problem: When the load is not connected, all the load power must be dissipated by the Zener Diode
- Inefficient, crude, but works fine for small loads
- How do we choose R1?

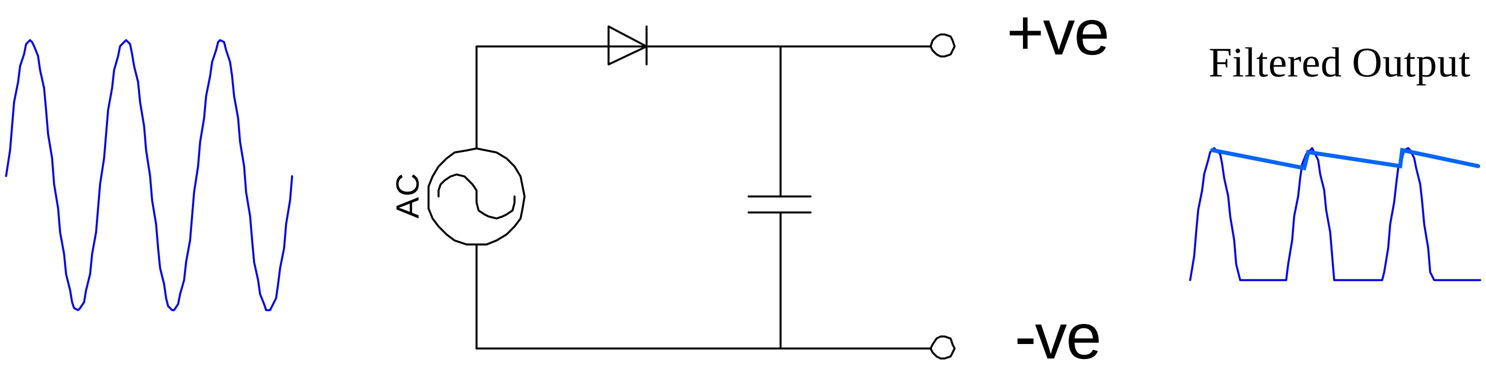


- load current is 100 mA.
- Then R1< 6/.1=60Ω to supply 6V to load.
- Choose R1=47 Ω so that some current flows through Z1 under load
- If load disconnected, all current flows through Z1
- Power dissipated by Z1 = VI=6(6/47)=0.77W
- Need 1W Zener Diode and 1W resistor

Half Wave Rectifier

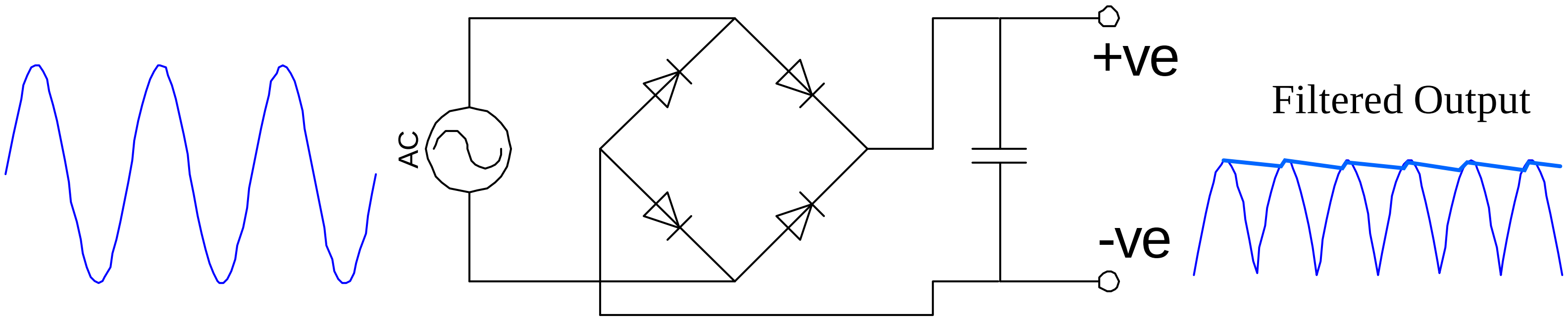
- A Rectifier converts AC to DC
- Usually a capacitor filters out the ripple voltage
- Rectifier is often followed by a voltage regulator





Full Wave Rectifier

- The full wave rectifier uses both halves of the waveform to produce an output with half the ripple voltage for a given load
- It also has twice the ripple frequency



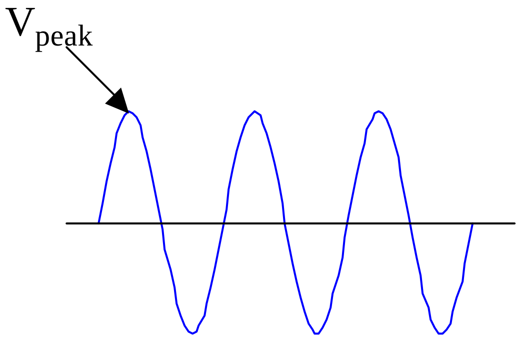
Ripple Voltage Estimate for FWR

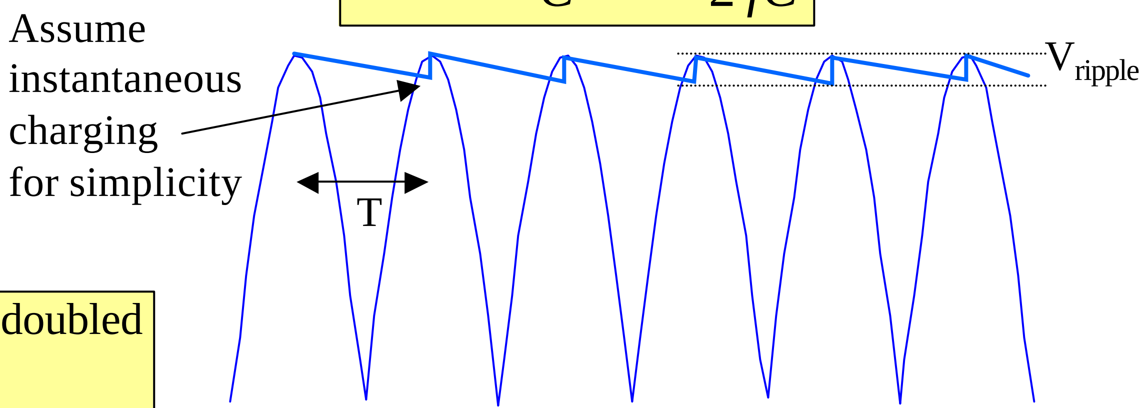
- Let f denote AC frequency and I_{load} denote the load current
- Then time T between peaks after rectifier is 1/2f
- Downward slope of ripple voltage is due to capacitor discharging at the rate

$$I_{load} = C\frac{dV}{dt} \Rightarrow \frac{dV}{dt} = \frac{I_{load}}{C}$$

- Ripple voltage is approximately

$$V_{ripple} = \frac{I_{load}}{C}T = \frac{I_{load}}{2fC}$$





For HWR, ripple voltage is doubled

$$V_{ripple} = \frac{I_{load}}{C}T = \frac{I_{load}}{fC}$$