

## Audio Amplifiers

### Question:

If you install a pocket radio's batteries backward, it won't work because its

1. speaker will move the wrong direction.
2. parts can only conduct current one way.
3. batteries will absorb power and recharge.

### Speakers

- Sound is produced by a moving surface
- Surface is pushed and pulled magnetically
  - Surface's wire coil carries current → magnetic
  - Coil is attracted/repelled by stationary magnet
- "Sound" current → surface acceleration
- Sound pressure proportional to "sound" current

### Microphones (magnetic)

- Sound is received by a moveable surface
- Surface movement produces electric current
  - Surface's wire coil moves near stationary magnet
  - Electric field pushes current through moving coil
- Sound pressure → surface acceleration
- "Sound" current proportional to sound pressure

### Microphones (electric)

- Surface movement produces electric current
  - Surface's charge moves near stationary wire
  - Electric field pushes current through wire

### Audio Amplifier

- Three circuits:
  - Input circuit: current/voltage represents sound
  - Output circuit: amplified "sound" current/voltage
  - Power circuit: provides power for amplification
- Amplifier produces "enlarged" copy of input

## Amplifier Components

- Resistors – provide voltage drops, limit current
- Capacitors – store charge, shift voltages
- Diodes – one-way devices for current
- Transistors – control current flow

## Resistors

- Simple ohmic devices
  - Voltage drop is proportional to current
  - Resistance is the proportionality constant
  - Many values of resistance are available
- Reduce a current's voltage
- Produce a current proportional to voltage
- Limit current based on voltage drop

## Capacitors

- Two separated conducting surfaces
- Charge (and energy) storage devices
  - One surface is positive, the other negative
  - Charge is proportional to voltage difference
  - Capacitance is proportionality constant
  - Many values of capacitance are available
- Store separated charge and associated energy
- Shift a current's voltage

## Diodes

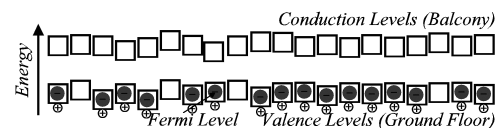
- One-way devices for charge & current
- Usually composed of two semiconductors

## Doped Semiconductors

- Pure semiconductors are insulating
  - Valence levels are filled and can't conduct
  - Conduction levels are empty and can't conduct
- Impure semiconductors can be conducting
  - Extra valence levels → valence band conduction
  - Extra electrons → conduction band conduction

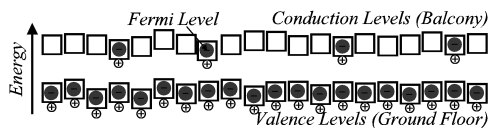
## p-Type Semiconductors

- Substitute atoms with more empty orbitals
- Extra, empty valence levels
- Electrons can move through valence levels



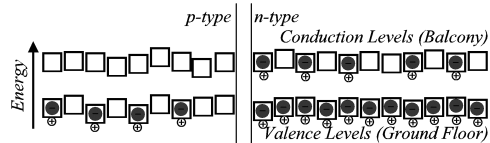
## n-Type Semiconductors

- Substitute atoms with more filled orbitals
- Extra, full conduction levels
- Electrons can move through conduction levels



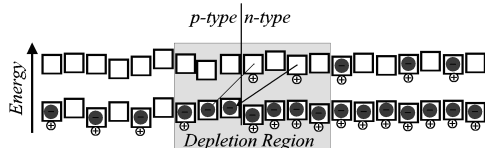
## pn-Junction (before)

- Before p-type meets n-type:
  - Each material can conduct electricity
  - Each material is electrically neutral everywhere



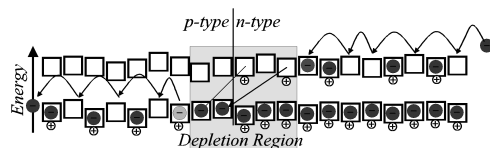
## pn-Junction (after)

- After p-type meets n-type:
  - Insulating depletion region appears at junction
  - Depletion region is electrically polarized



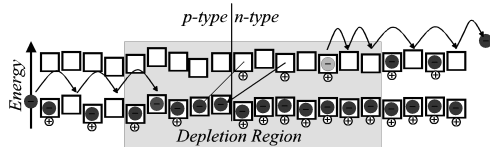
## Forward Conduction

- A diode conducts when electrons arrive at the n-type end and leave at the p-type end
- Depletion region shrinks



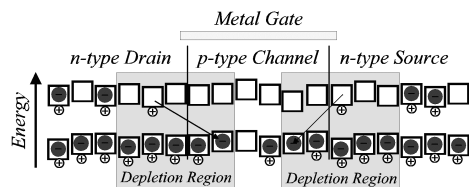
## Reverse Conduction

- A diode doesn't conduct when electrons arrive at the n-type end and leave at the p-type end
- Depletion region enlarges



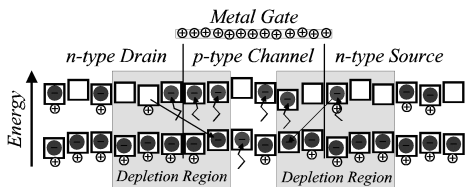
## MOSFET Transistor Off

- Two back-to-back pn-Junctions
- Normally does not conduct electricity at all



## MOSFET Transistor On

- Gate charge can change the channel type
- Entire device becomes one type and conducts

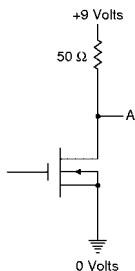


## MOSFET Summary

- An electrically controllable resistor
- A tiny amount of charge alters its resistance
- MOSFET can amplify currents
  - Input circuit controls charge on Gate
  - Output circuit send current through Source/Drain
  - Input circuit controls output circuit

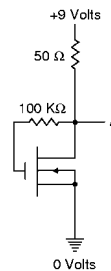
## Amplifier 1

- As resistance of MOSFET drops:
  - Current from +9V to 0V increases
  - Voltage drop of 50Ω resistor increases
  - Voltage at “A” goes down



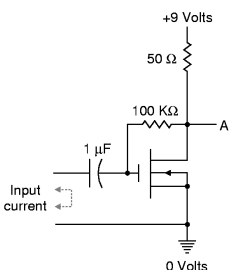
## Amplifier 2

- 100KΩ resistor ensures that MOSFET is partially conducting
  - If it is off, gate becomes more +
  - If it is on, gate becomes less +
  - Balance is struck at partly +
- Voltage at “A” is about 4.5V



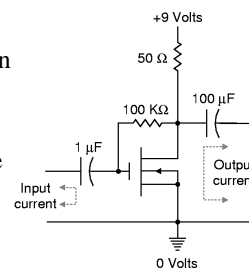
## Amplifier 3

- Any charge flowing through input circuit is placed on the Gate
- Voltage “A” changes
- Input capacitor shifts charge voltage so that it matches gate voltage



## Amplifier 4

- Changes in voltage “A” cause changes in output current
- Output capacitor shifts charge voltage so that it matches speaker voltage



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