ComOrg

Chapter 1
Basic computer knowledge and computer evolution

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Objectives

- To tell the computer development from mechanical calculator to the computer system.
- to tell difference between microprocess and microcontroller.
- To express electronic devices and electronic measurement tools
- Be able to describe the concept of data transferring and detection errors in the computer system.
- Be able to tell mechanical protection and safety in the computer system and IoT

Topic

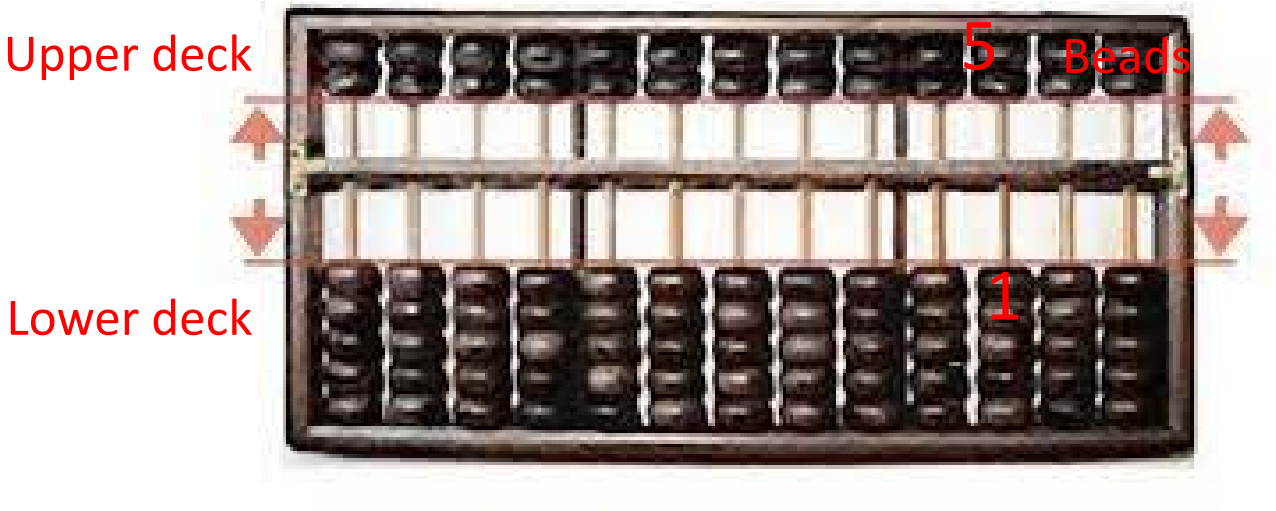
- From Mechanical machine to Computer
  - Mechanical
  - Vacuum tube
  - Silicon Transistor
- Microprocessor, microcontroller, DSP, GPU
- Quiz (5 points)

MECHANICAL COMPUTER

1st Era

1.1.1 Mechanical computer

- Abacus
  - Used in China, Europa and Russia

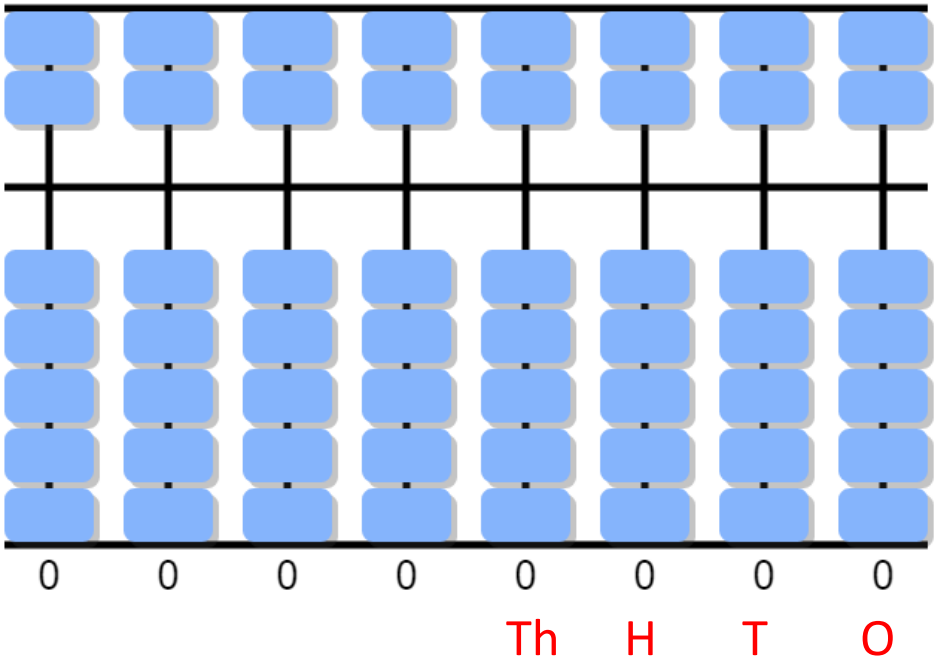


Chinese abacus

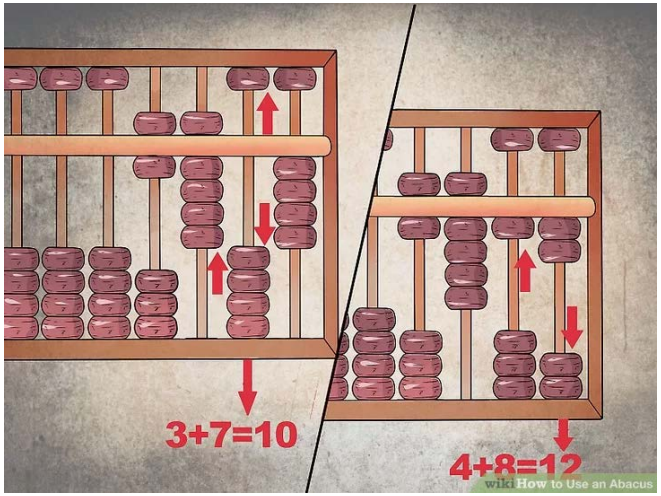
Activity 1.1 Play abacus

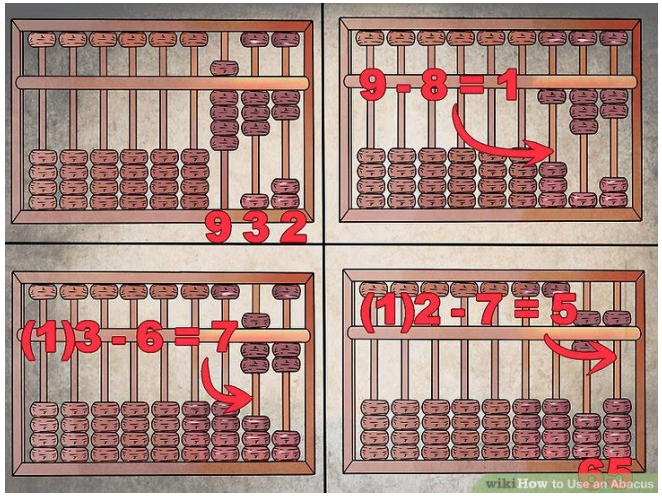
- Click on https://www.mathematik.uni-marburg.de/~thormae/lectures/ti1/code/abacus/sanpan.html

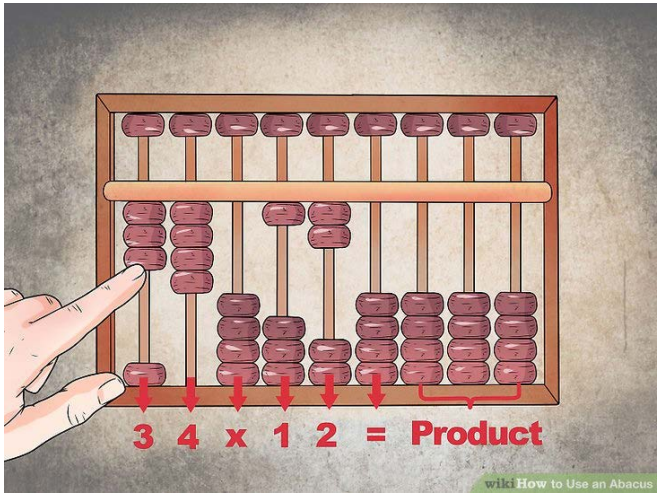
- Calculate
  - 83 + 12 = ?
  - 112 + 12 = ?

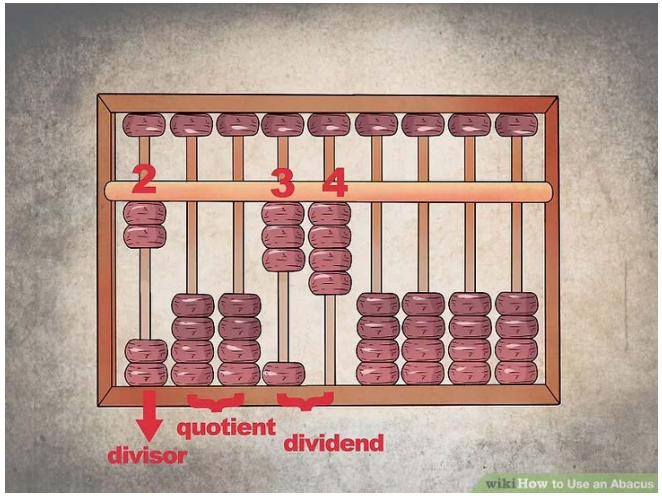


More functions in Abacus



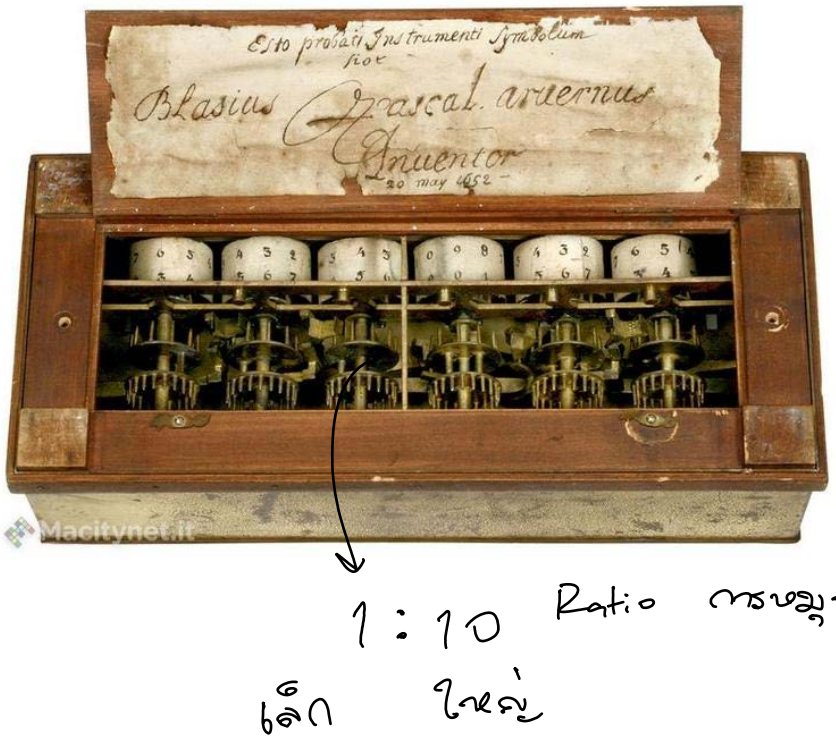






https://www.wikihow.com/Use-an-Abacus

1.1.1 Mechanical computer



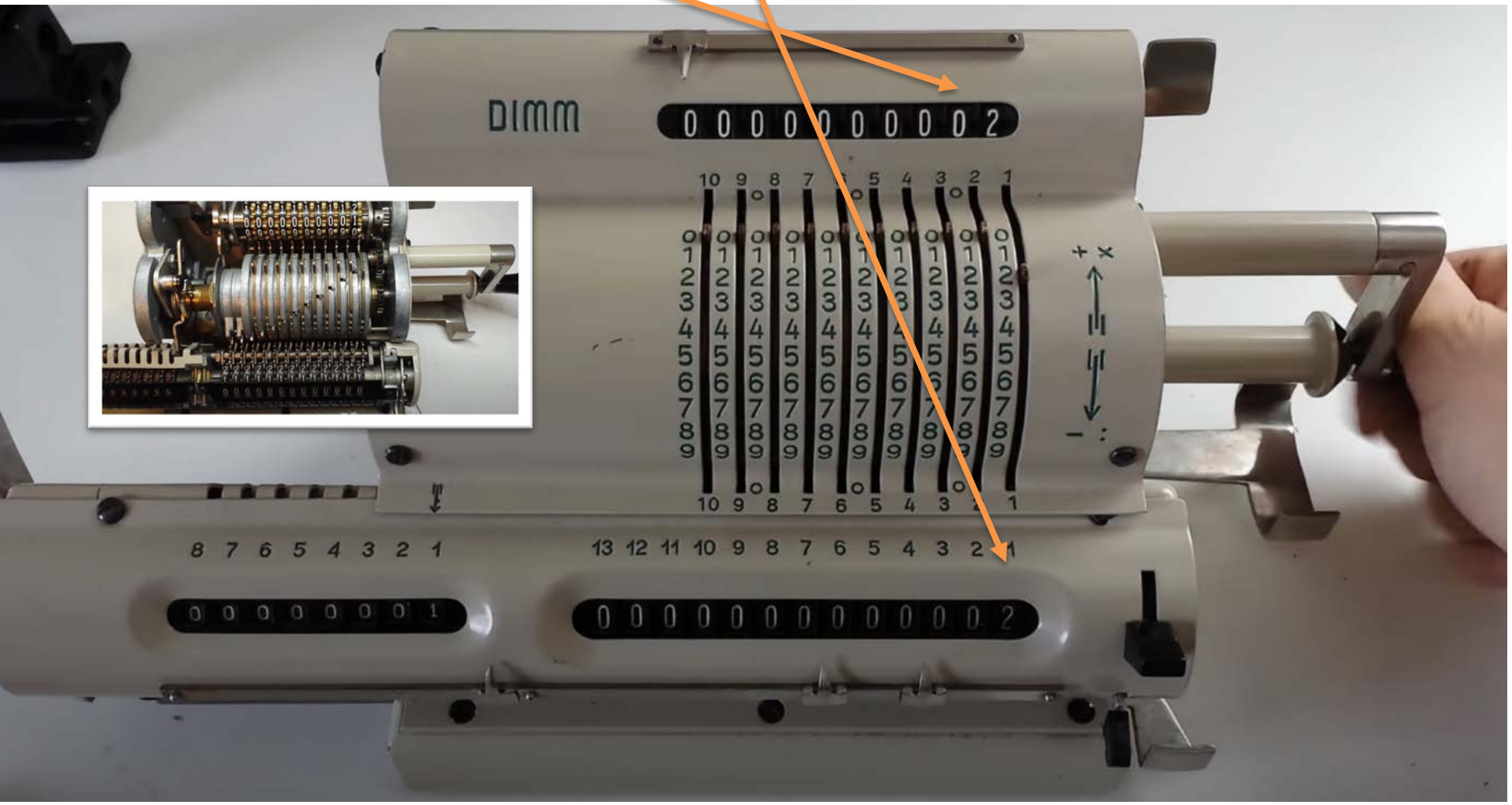
1 : 10 Ratio การหมุน

เล็ก ใหญ่

- Mechanical calculator
  - Blaise Pascal (1642) developed a machine to help his father working in the shop.
  - Working only function of the addition and subtraction.

2nd Era - เหล็ก

2+2 = 4



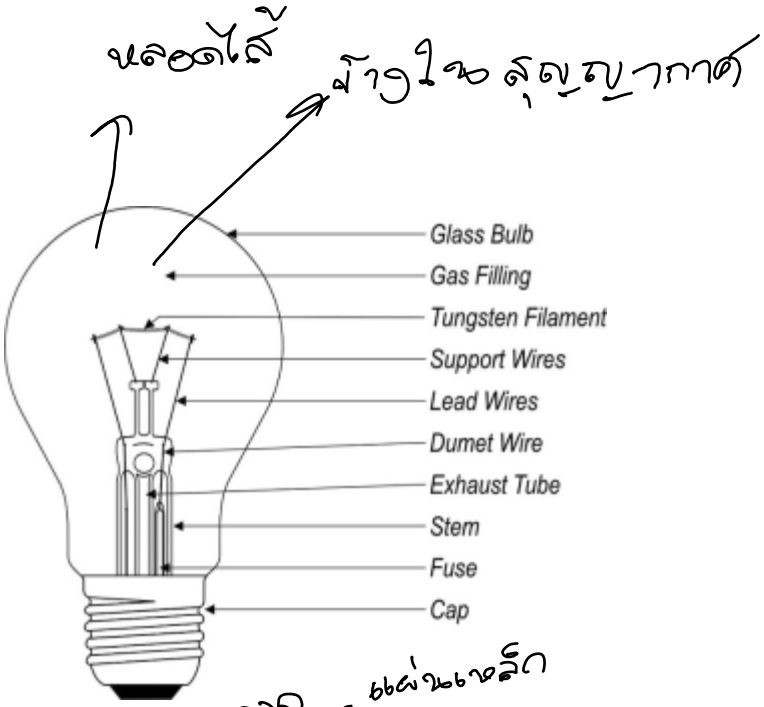
https://youtu.be/aDN4s8ElxqE?t=144

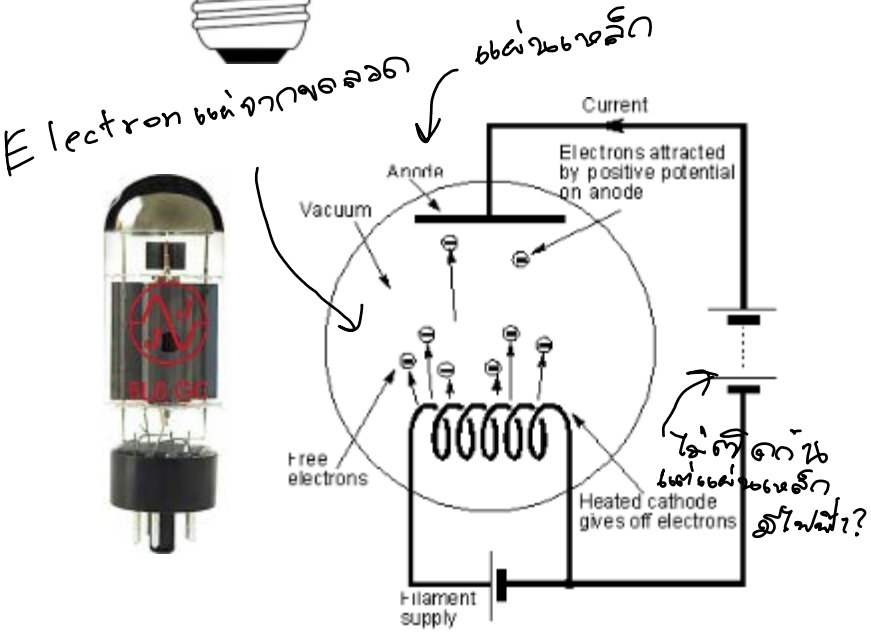
3rd Era ಎಲೆಕ್ಟ್ರಾನ್

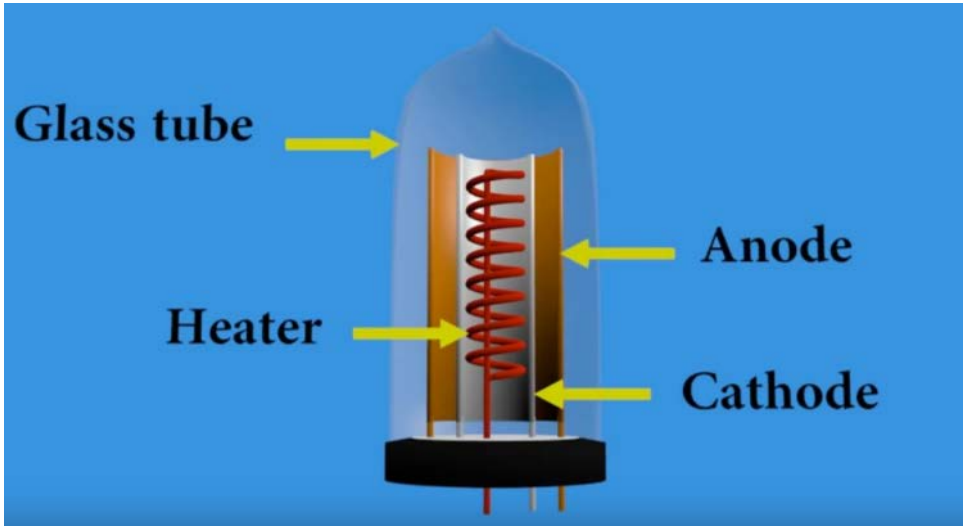
ELECTRICITY
VACUUM TUBE

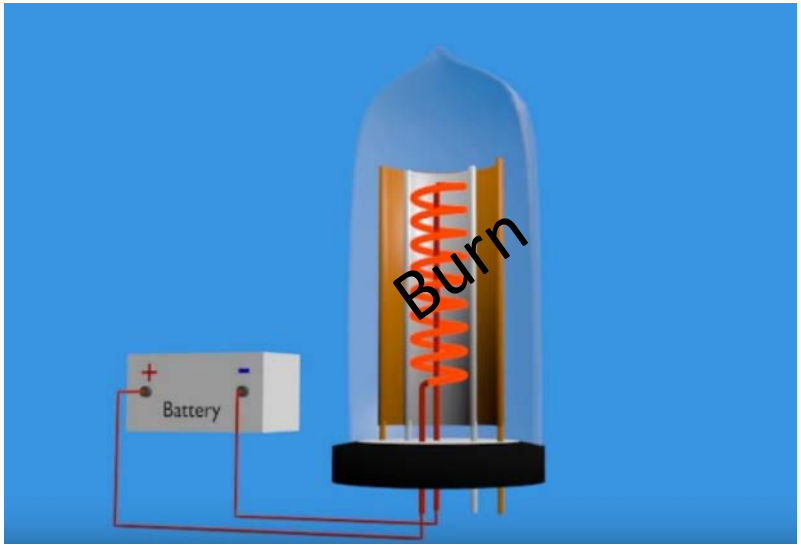
1.1.2 Vacuum Tube

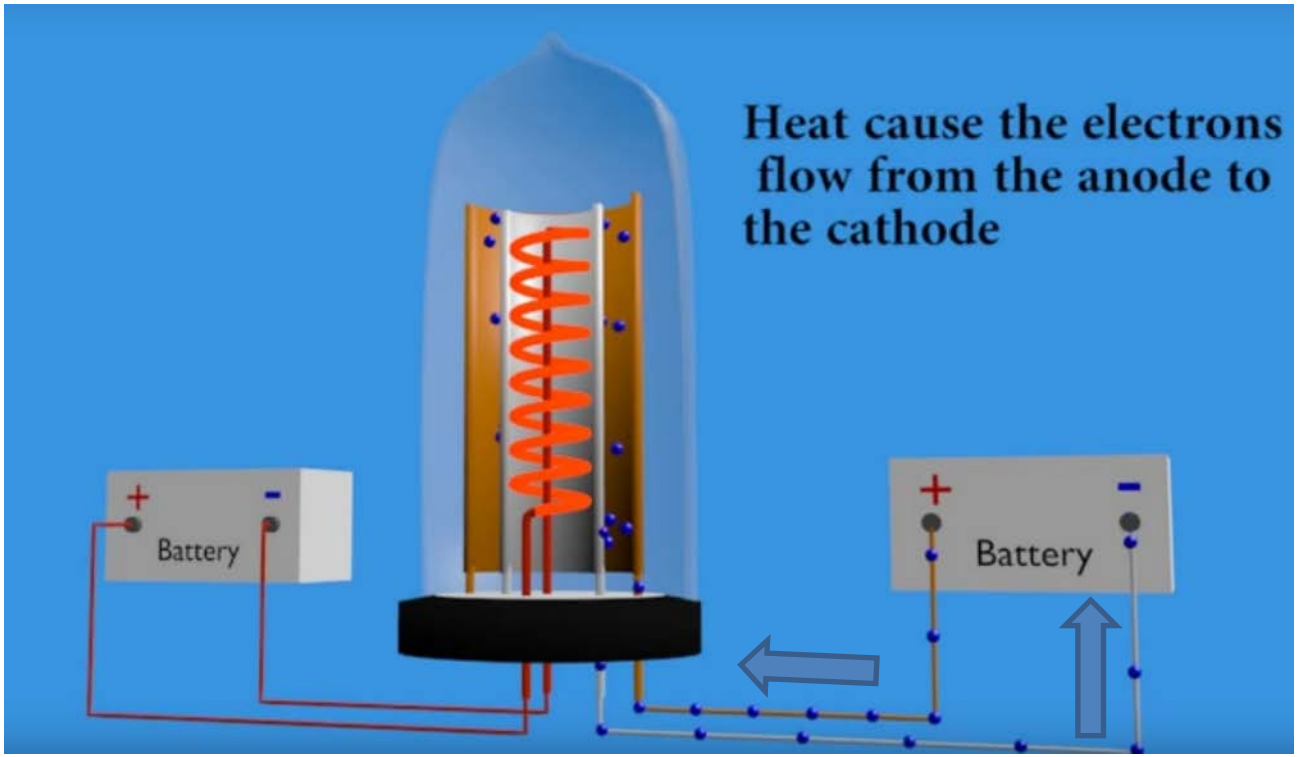
- Vacuum Tube was developed from *Incandescent lamp*.
- When *a tungsten*[74] *lead* gets heat, it spreads electron by moving to an anode plate.
- A grid plate uses controls number of electron moving from the tungsten lead to an anode plate.







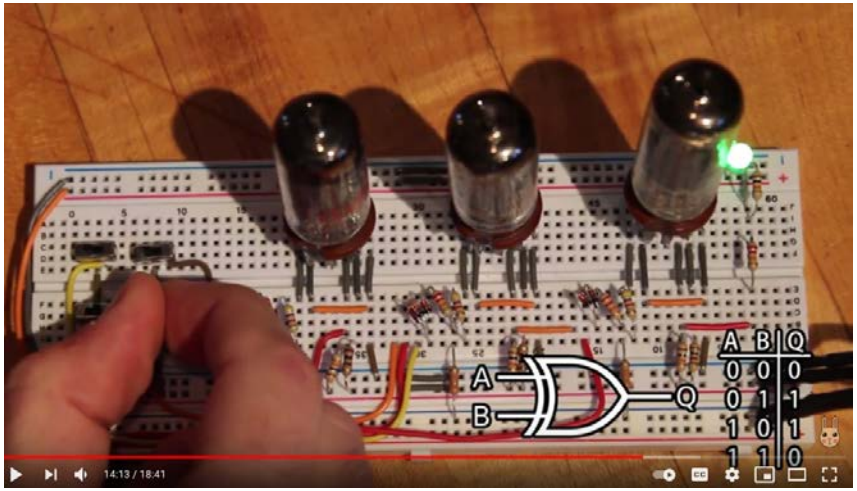




https://www.youtube.com/watch?v=K6BgZ8s1Vuw

XOR

Vacuum tube and future



https://youtu.be/N-Sc6k_rlTM?t=853

ใช้ vacuum tubes 3 หลอด สำหรับ XOR Gate 1 หลอด

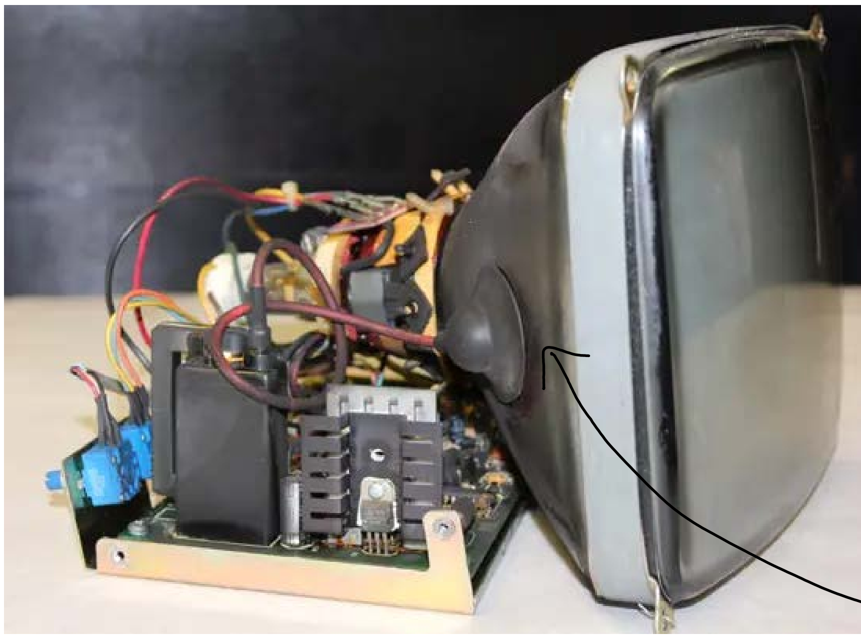
4.) Future: The Nano Vacuum Tube

Vacuum tubes may make a comeback and replace standard microchips. Engineers have been able to build a structure in phosphorus doped silicon and use nanotubes to build a switch. These devices can operate 10 times faster than silicon transistors.

vacuum tube ในยุคสุดท้าย

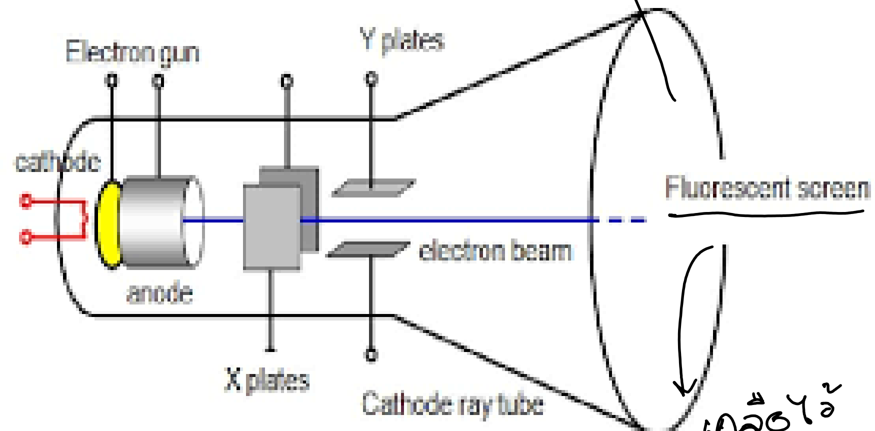
Cathod Ray Tube (CRT)

มาสร้างเป็น TV



≈ 25k Volt

ถ้าอยู่ใกล้จะโดนแต่รังสี สายตาเสีย

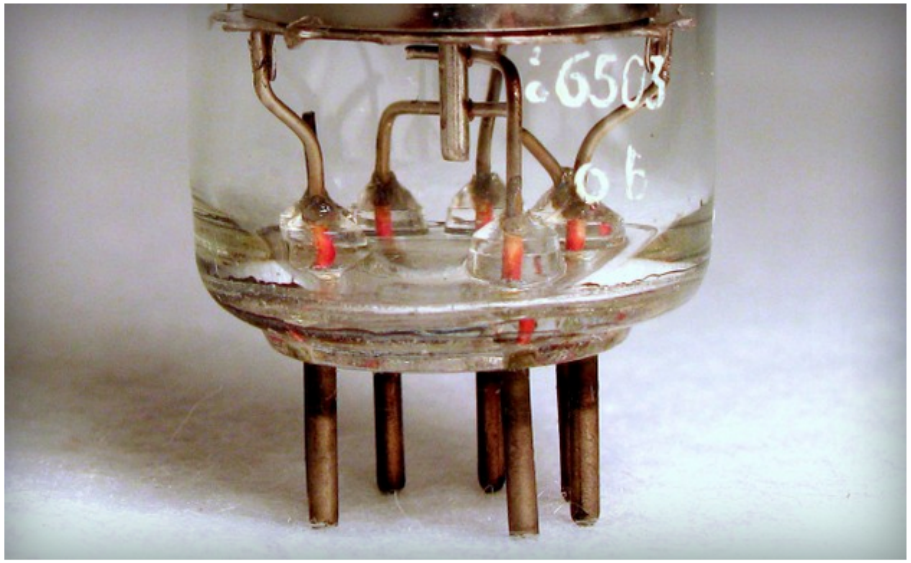


เคลือบไว้ (สารที่กระทบ e^- จะเปล่งแสง)

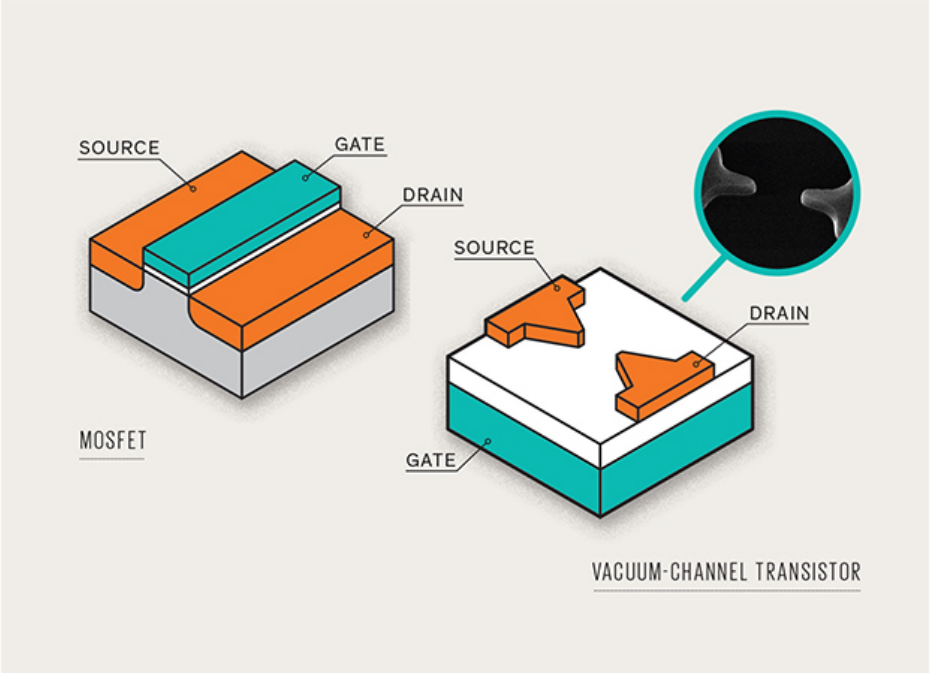
The vacuum tube strikes back: NASA's tiny 460GHz vacuum transistor that could one day replace silicon FETs

By Sebastian Anthony on June 24, 2014 at 8:12 am | Comments

92 SHARES



Way back in the salad days of digital computing (the 1940s and '50s), computers were made of vacuum tubes — big, hot, clunky devices that, when you got right down to it, were essentially glorified light bulbs. This is why early computers like the ENIAC weighed more than 27 tons and consumed more power than a small town. Later, obviously, vacuum tubes would be replaced by probably the greatest invention of all time — the solid-state transistor — which would allow for the creation of smaller, faster, cheaper, and more reliable computers. Fast forward to 2014, though, and the humble CMOS field-effect transistor (FET) is starting to show its age. We've pretty much hit the limit on shrinking silicon transistors any further, and they can't operate at speeds much faster than a few gigahertz. Which is why NASA's Ames Research Center is going back to the future with its new *vacuum transistor* — a nanometer-scale vacuum tube that, in early testing, has reached speeds of up to **460GHz**.

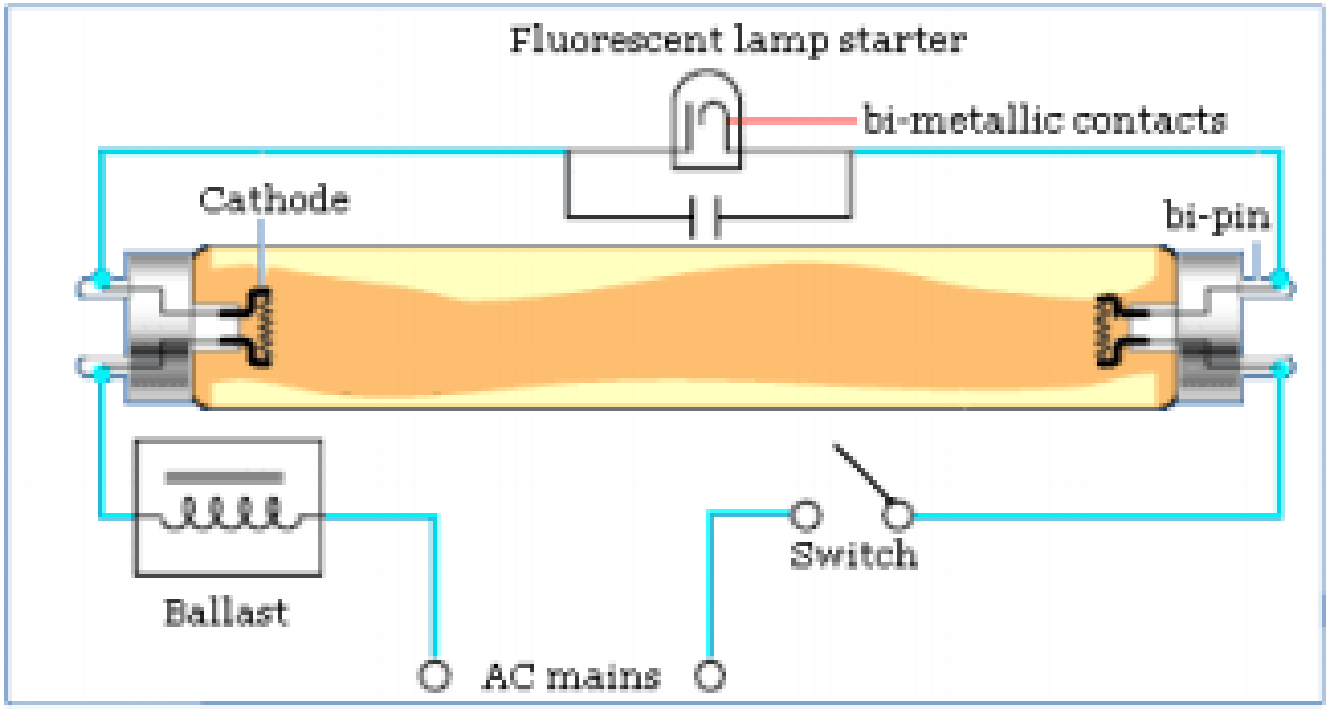


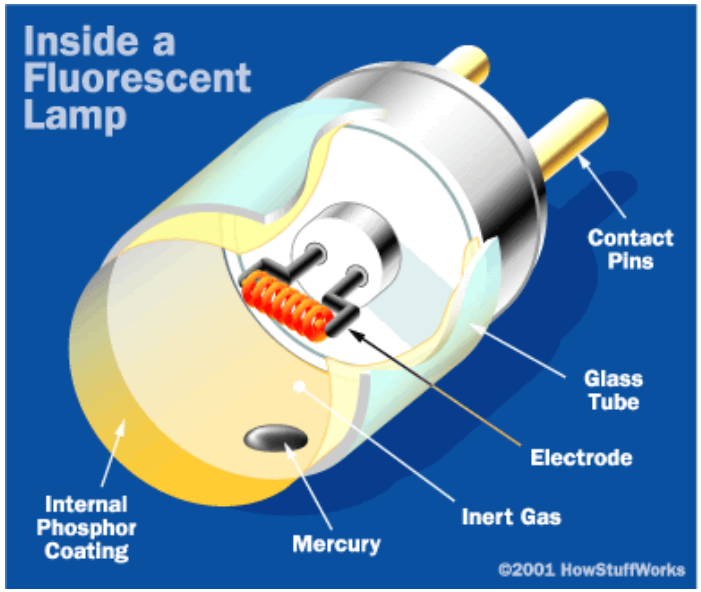
Standard MOSFET vs. vacuum-channel transistor [Image credit: IEEE Spectrum]

NASA's Ames Research Center has been working on-and-off for many years on the vacuum-channel transistor, which is essentially a vacuum tube that can be fabricated using conventional CMOS techniques. Instead of a gate sitting between the source and drain, there is... nothing. A vacuum. By a method known as *field emission*, electrons are drawn across the vacuum from the source to the drain when a current is applied to the gate (see diagram). By using field emission rather than the thermionic (hot) electron emission, these vacuum-channel transistors don't require a heat source. Importantly, they also don't require a vacuum — instead they use helium (it's sparse enough that the electrons have almost no chance of bumping into helium atoms while they traverse the few-nanometer gap between source and drain). The electrons also traverse the air gap a *lot* faster than if they had to pass through the gate electrode.

Activity1.2

- The fluorescence lamp has two small tungsten coils. Do you know why does the fluorescence lamp generates light? (Discussion)




Inside a Fluorescent Lamp
Contact Pins
Glass Tube
Electrode
Inert Gas
Mercury
Internal Phosphor Coating
©2001 HowStuffWorks

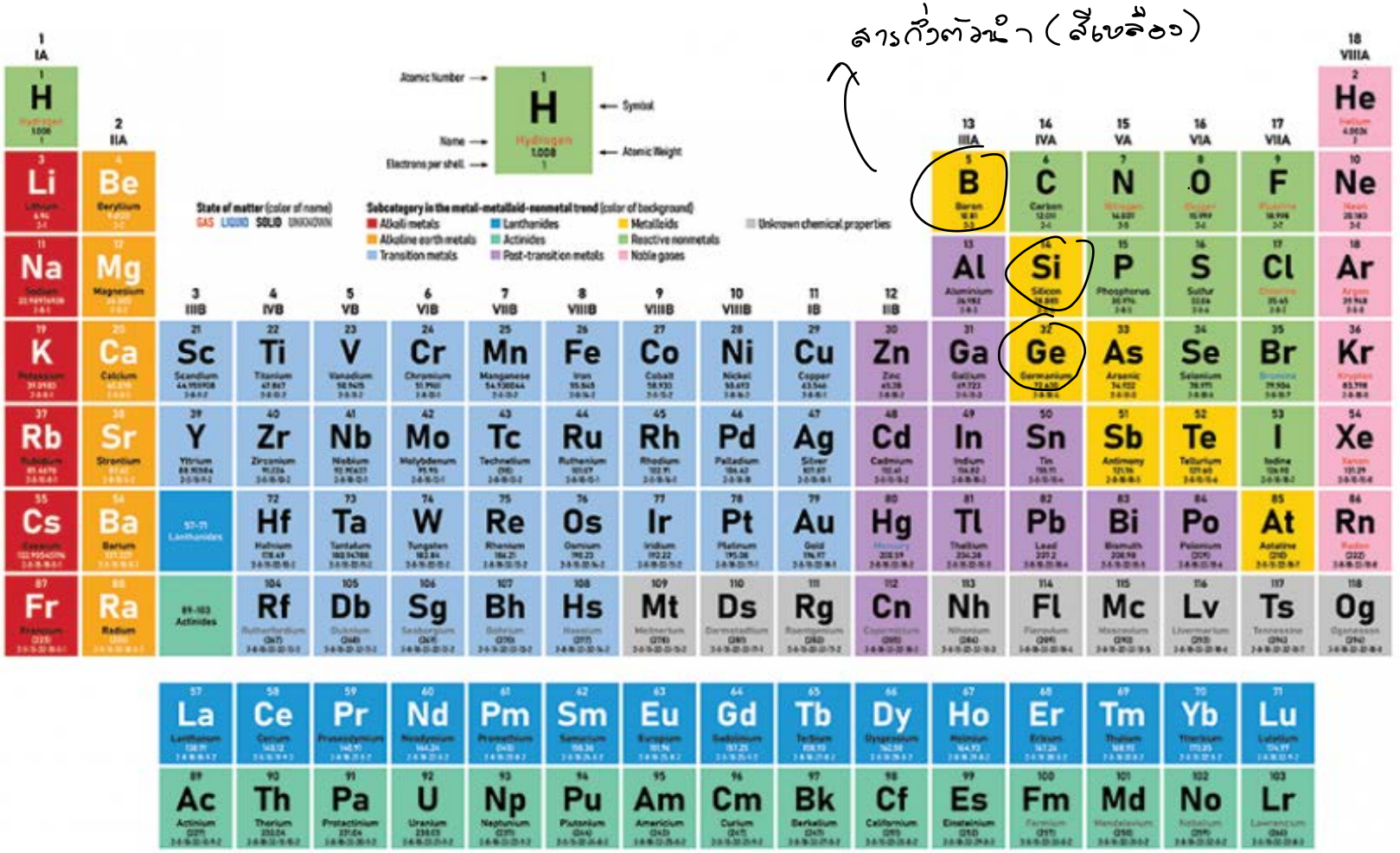

หยักละ
10k V

e.g. Silicon Chip

ELECTRON AND SILICON

1.1.3 Silicon Transistor

- Where are Silicon, Germanium, Boron, and Antimony on the periodic table?



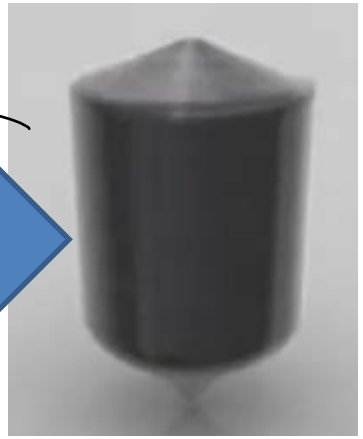
1.1.3 Silicon chip-making process

- Silicon
  - Make from the ordinary sand, quartz, rock crystal, amethyst, agate, flint, jasper, and opal.

1.1.3 Silicon chip-making process

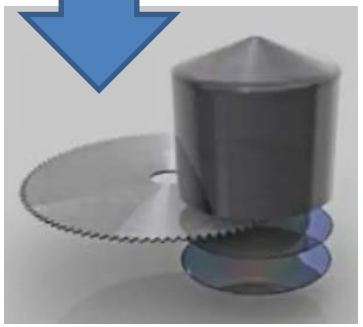
Burn

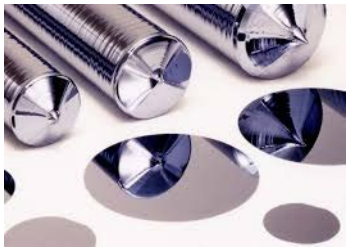
set



Pure silicon

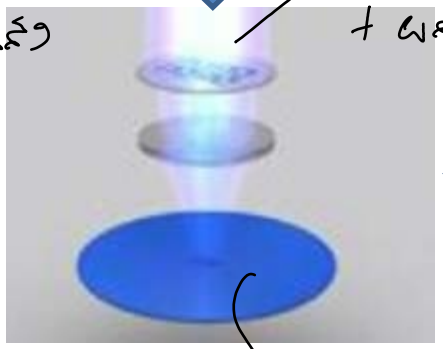
Cut





Wafer

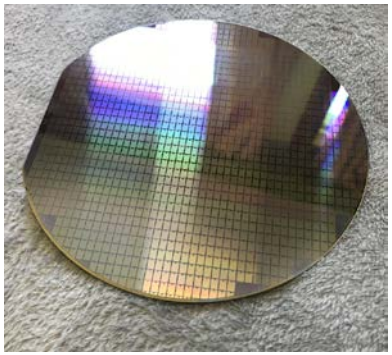
Exposure



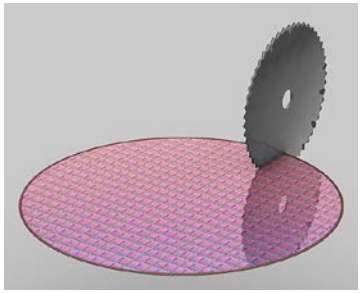
Engineer design circuit

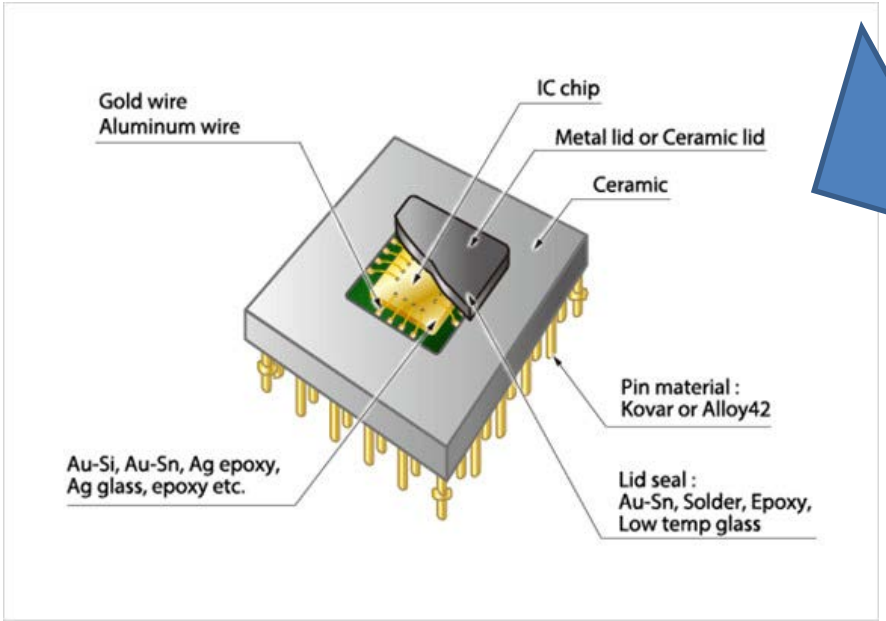
1.1.3 Silicon chip-making process

Expose
build each layer



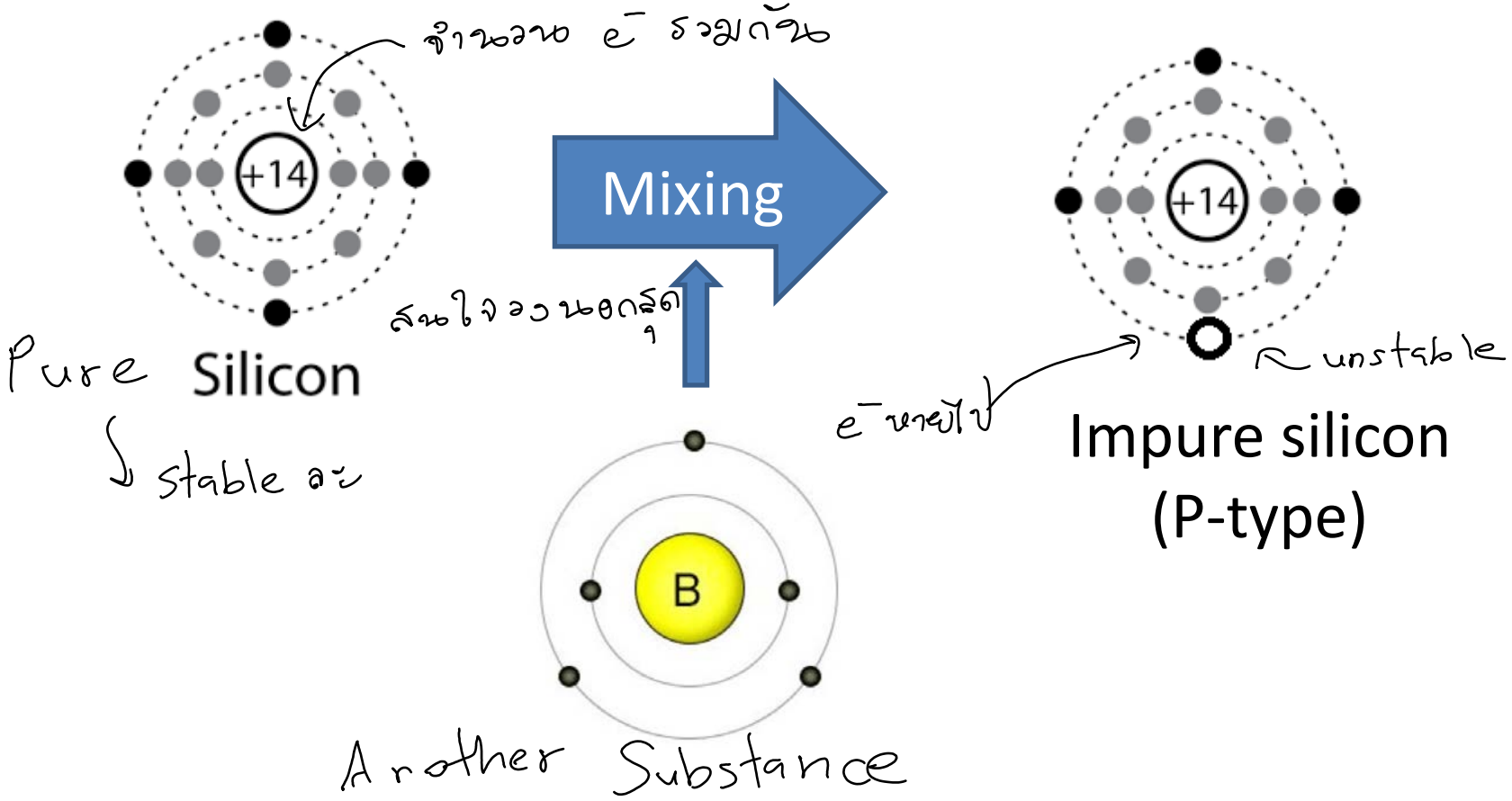
Cut and place
to package





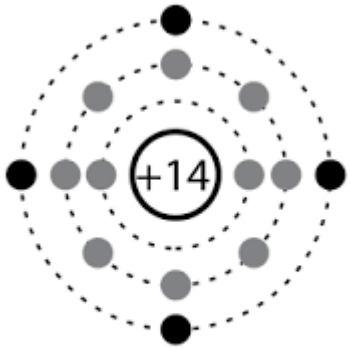
The main point of silicon chip

- Change from pure silicon to impure silicon by mixing boron to be P-type



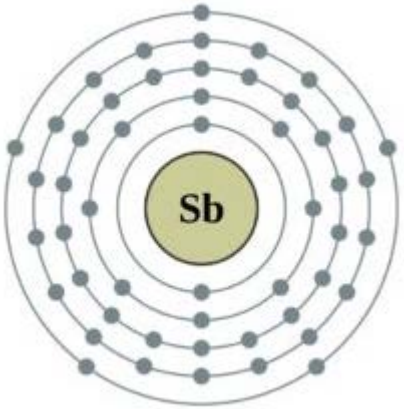
The main point of silicon chip

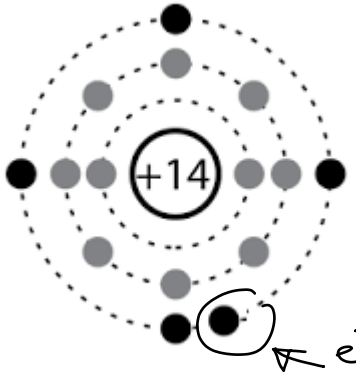
- Change from pure silicon to impure silicon by mixing antimonyแร่พวง to be N-type



Silicon

Mixing

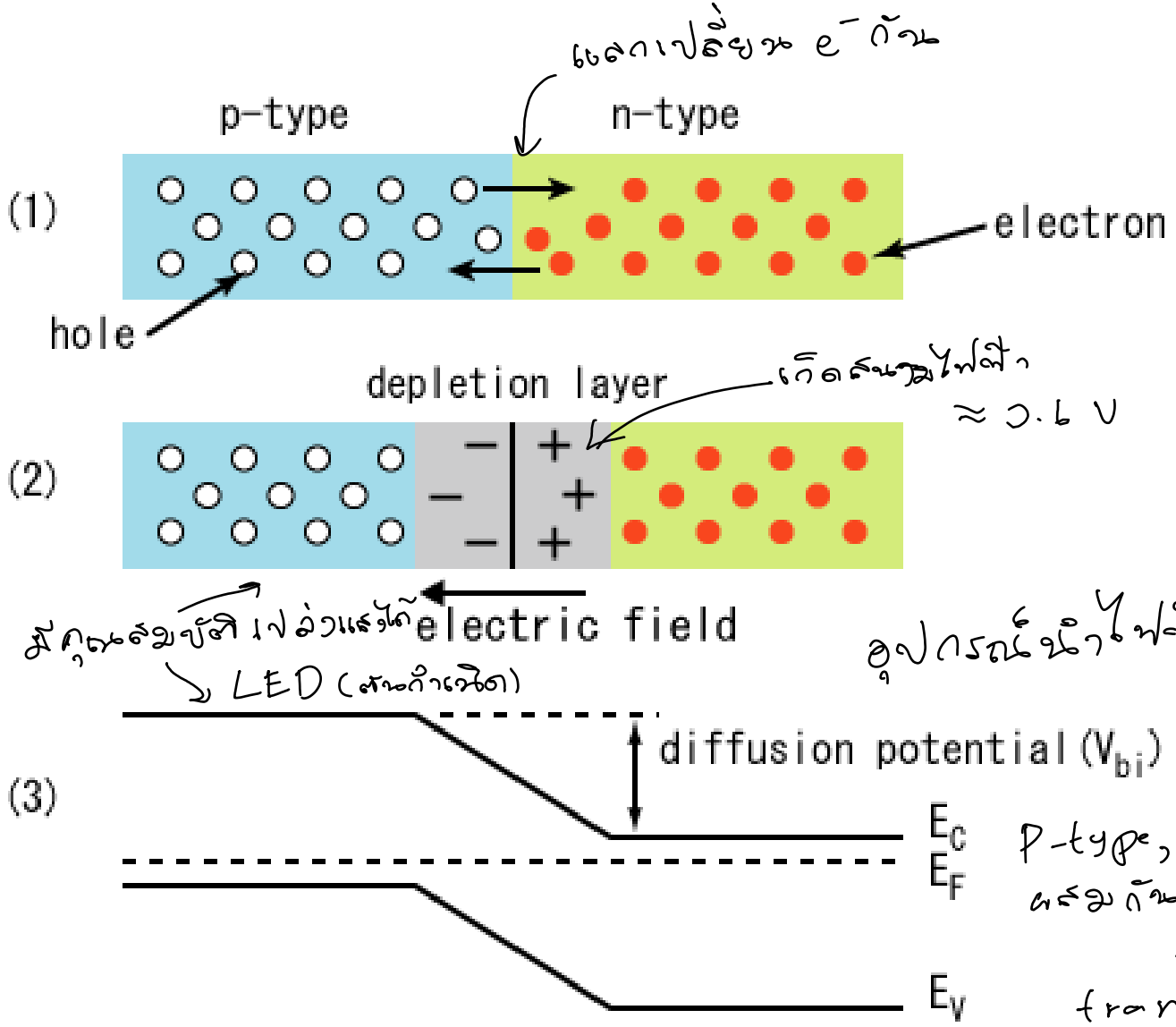




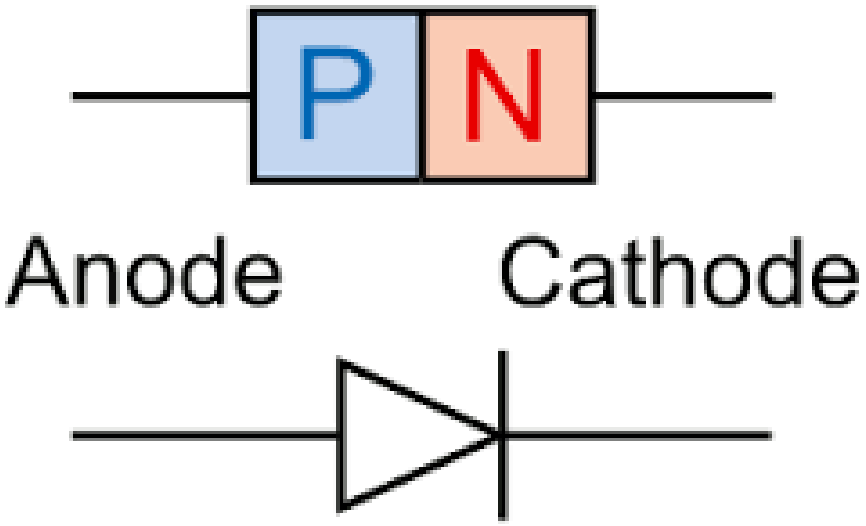
Impure silicon

(N-type)

N-type and P-type

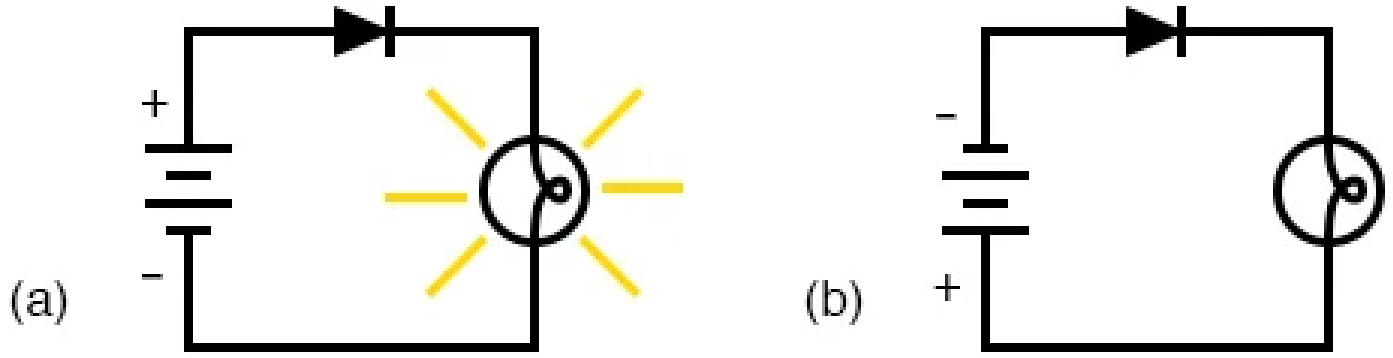


Diode

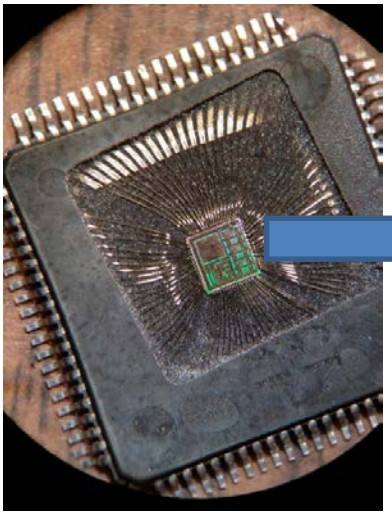


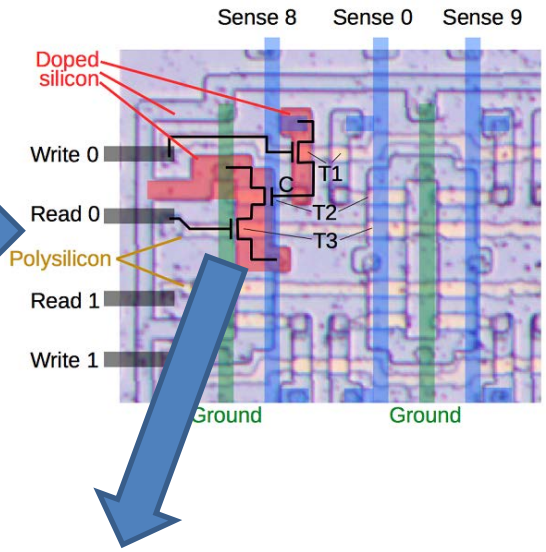
Activity 1.3

- Let’s test a diode on Thinkercad.

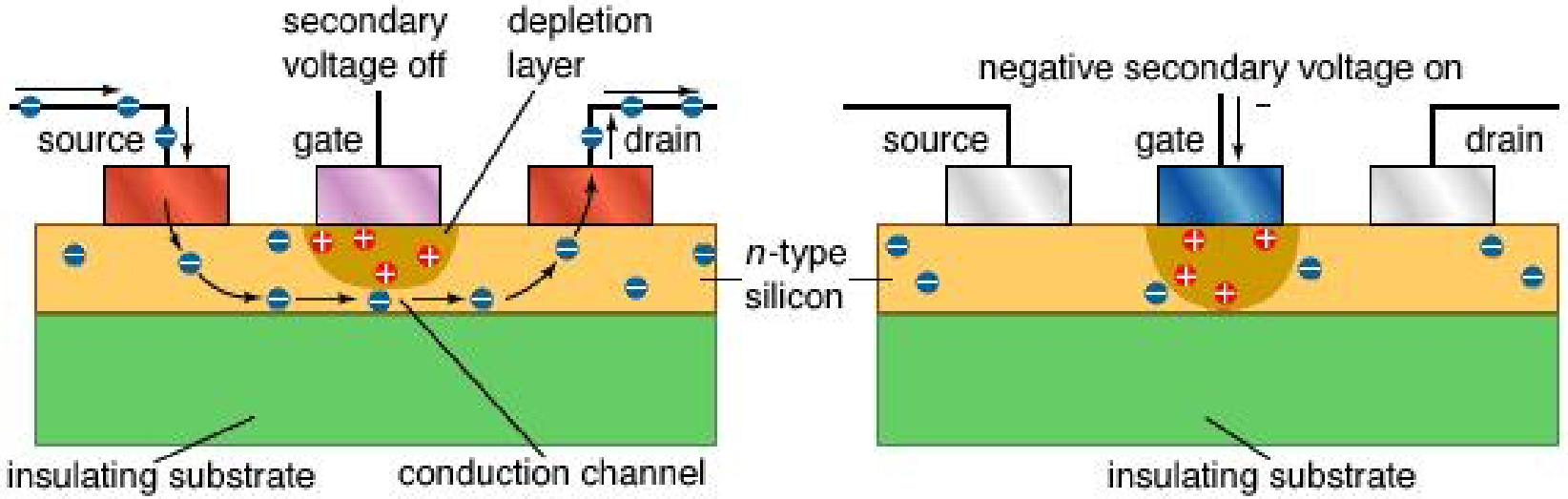


1.1.3 Silicon Transistor

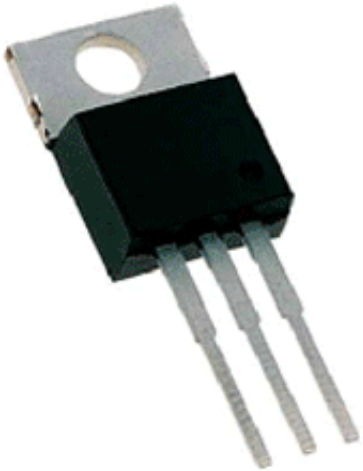


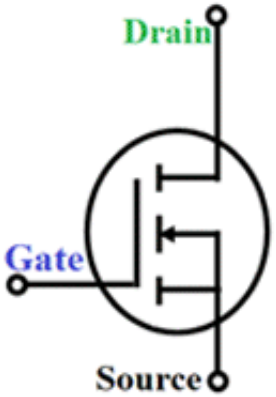


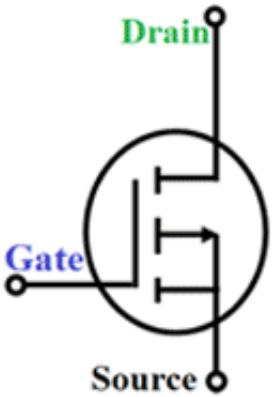
- The gate pin controls number of the electron move from the source pin to the drain.

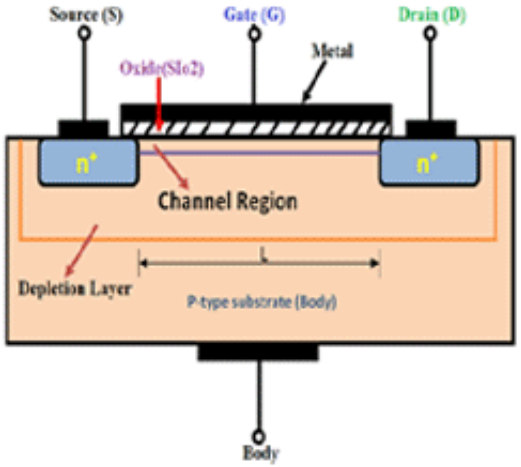


FET and Mosfet has Drain Gate Source



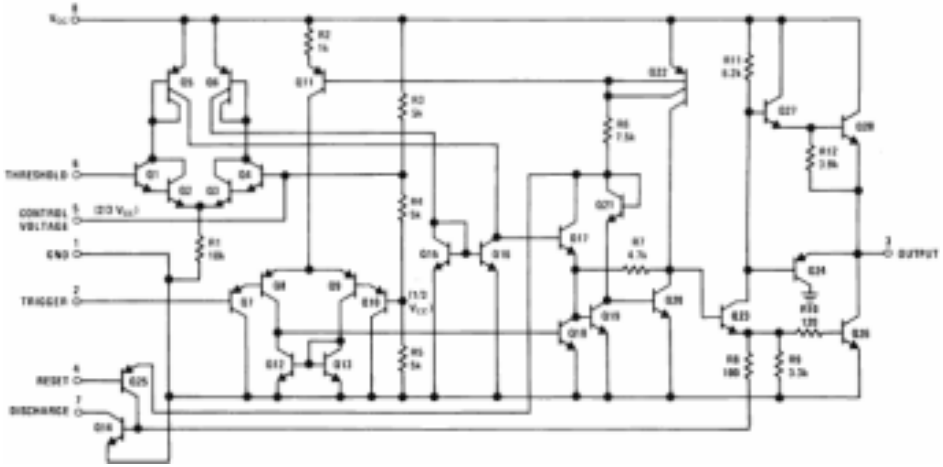


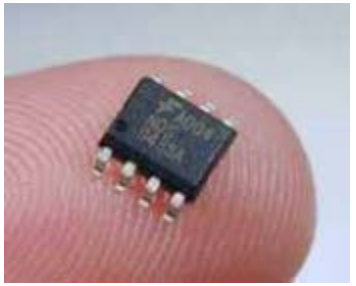




1.1.4 Integrated Circuit

- Discrete Circuit
- Integrated Circuit





1.1.4 Integrated Circuit: Chip Scale

Name	Number of Transistors
Small Scale IC (SSI)	10
Medium SI (MSI)	10 – 1000
Large SI (LSI)	1K – 100K
Very LSI (VLSI)	100K – 1M
Ultra LSI (ULS)	> 1M
(Nvidia GA100)	>54Bilion Transistor

Year	Size of the transistor in chip
1971 - 1985	10 µm – 1 µm
1989 - 1999	800nm – 180nm
2001 - 2010	130nm – 32nm
2012 - 2017	22nm – 10nm
2018	7nm
2020	5nm
Appr. 2022	3nm

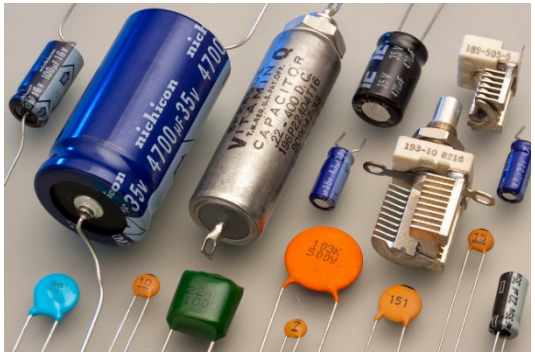
Number of transistor relate to the circuit complexity

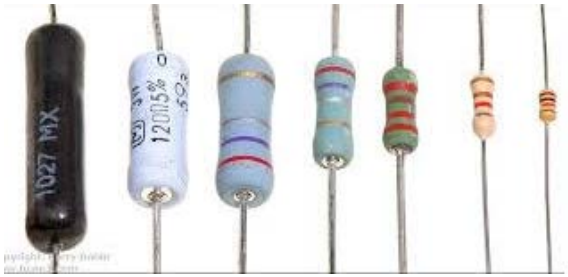
Transistor size relate to power consumption and switching speed

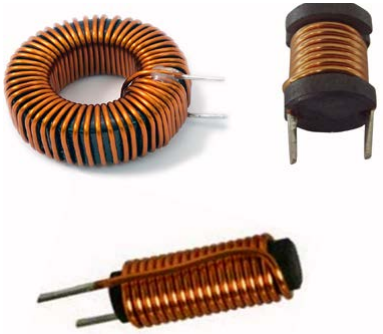
OVERVIEW ELECTRONIC DEVICES

Electronic devices

- Passive device
  - Capacitor
  - Resistor
  - Inductor
  - Transformer

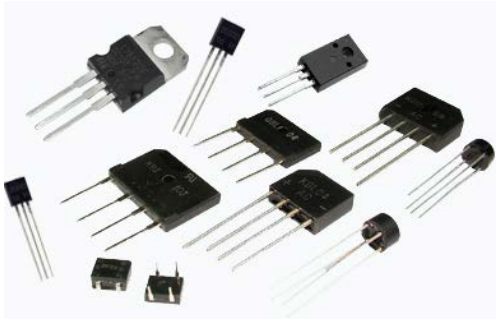


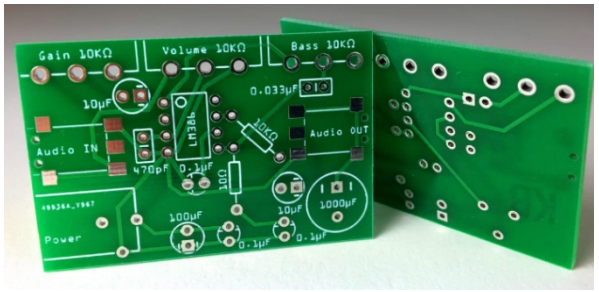




Electronic devices

- Active device
  - Diode
  - Transistor
  - Light Emitting Diode (LED)
  - IC, Chip
- Component
  - Print Circuit Board (PCB)





Activity 1.4

- Measure resistant and capacitance of R and C with an analog multimeter.

- Measure voltage from various battery size with an analog multimeter

PROCESSORS

1.2 The inside of Computer

- Processor
- Main memory
- System bus
- I/O Module

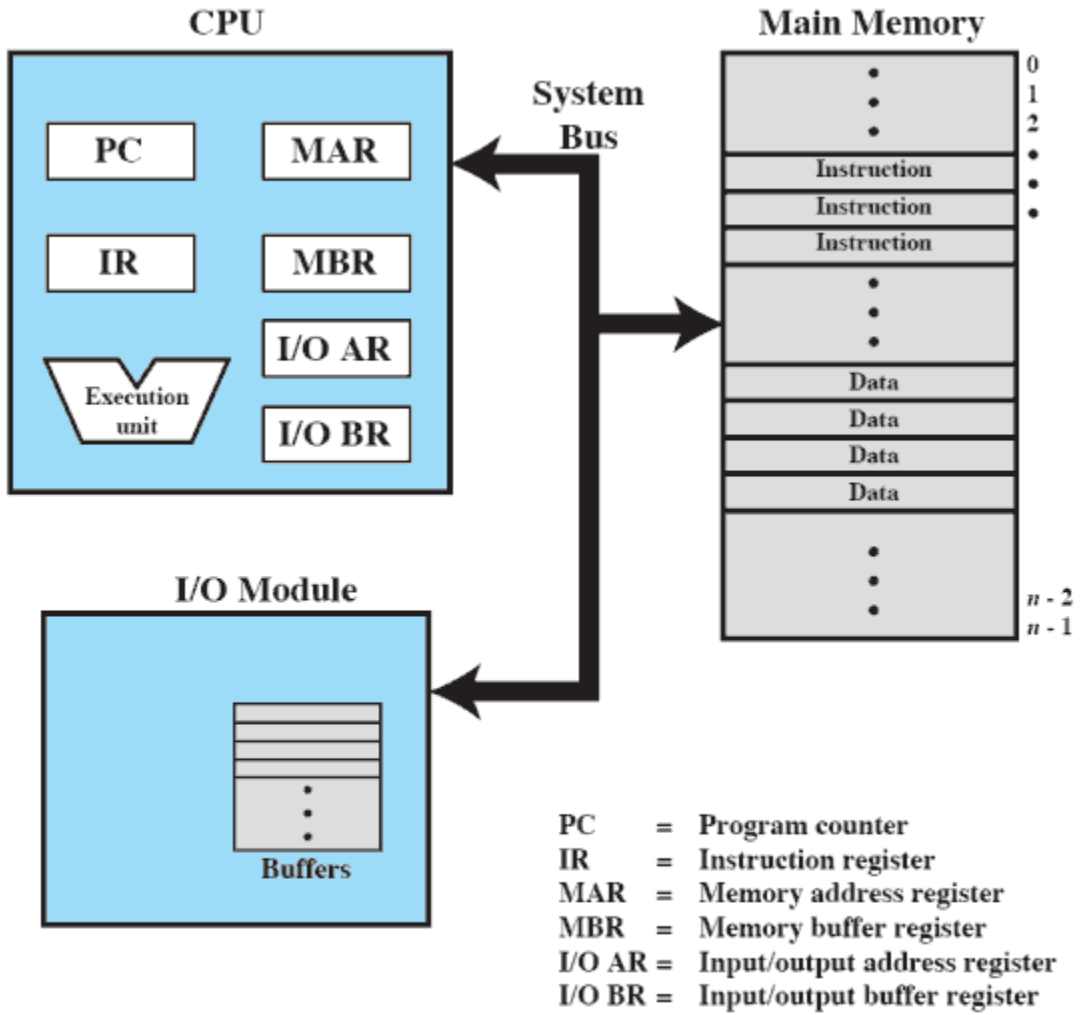
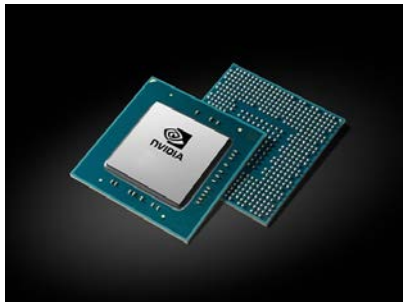
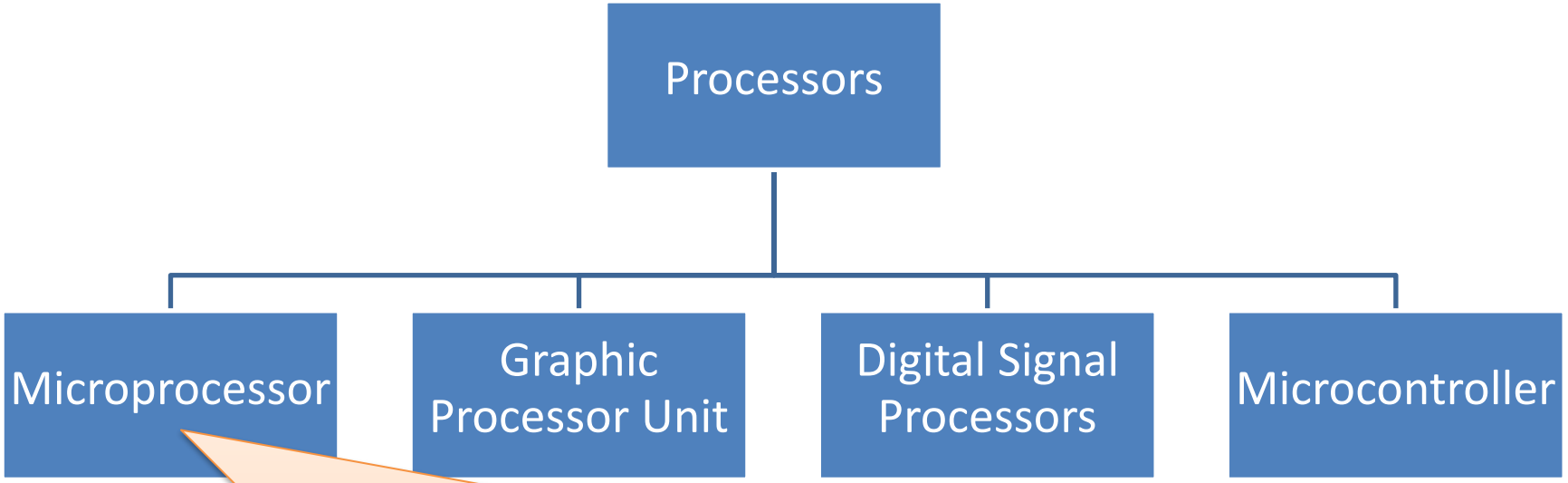


Figure 1.1 Computer Components: Top-Level View

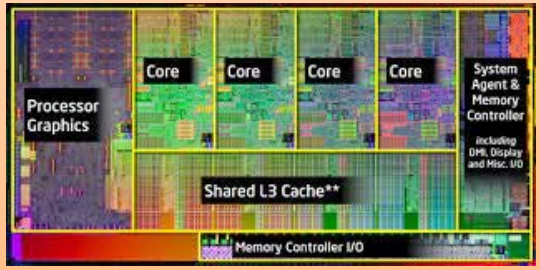
Processors

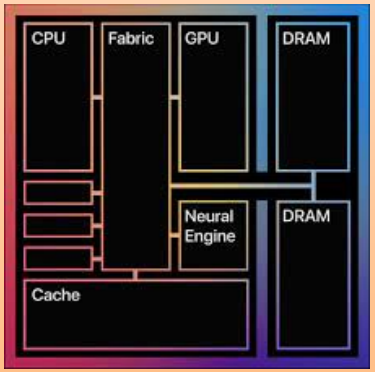
- Microprocessor
- Graphic Processor Unit
- Digital Signal Processors
- Microcontroller



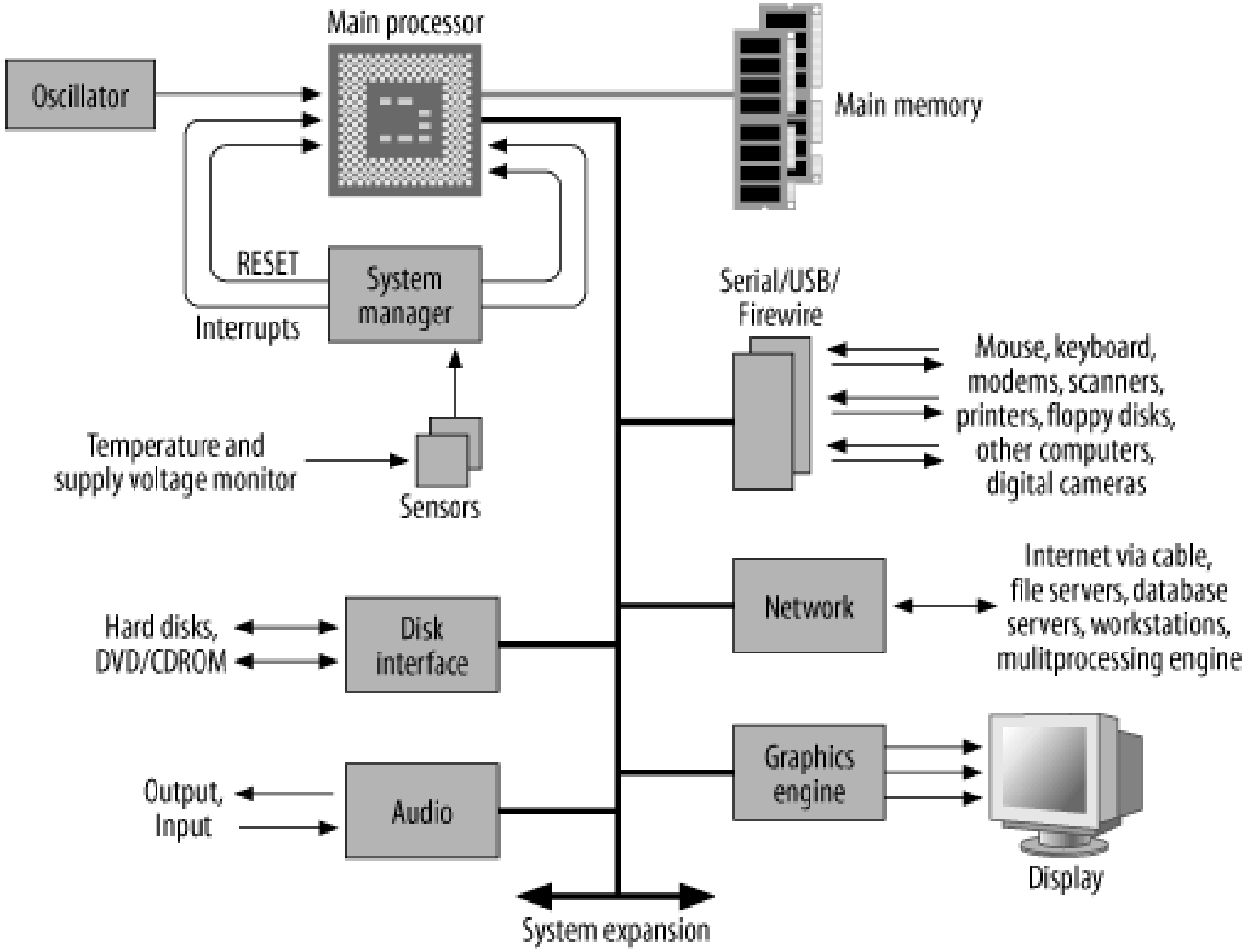


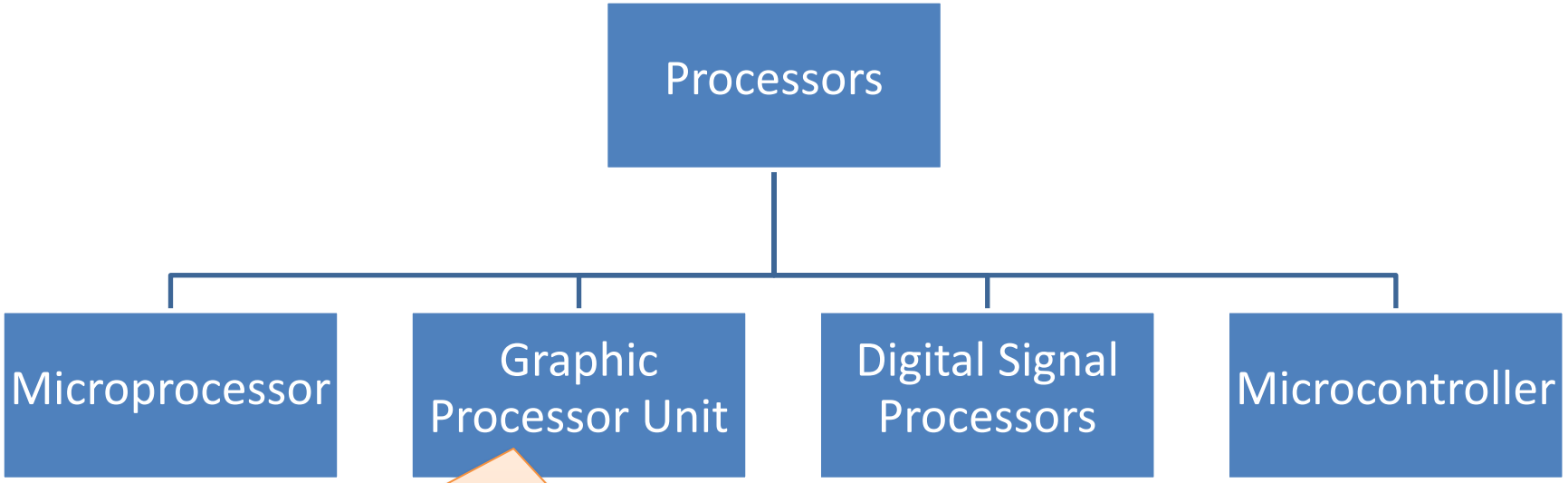
- Design instruction set for the general work
- Parallel processing
- No Input output ports (I/O)
- Some microprocessors are integrated GPU.
- Advance microprocessors are integrated GPU, I/O, and Memory by called System-on-chip (SOC)
- Example
  - Intel, Core-i7
  - AMD, Ryzen
  -



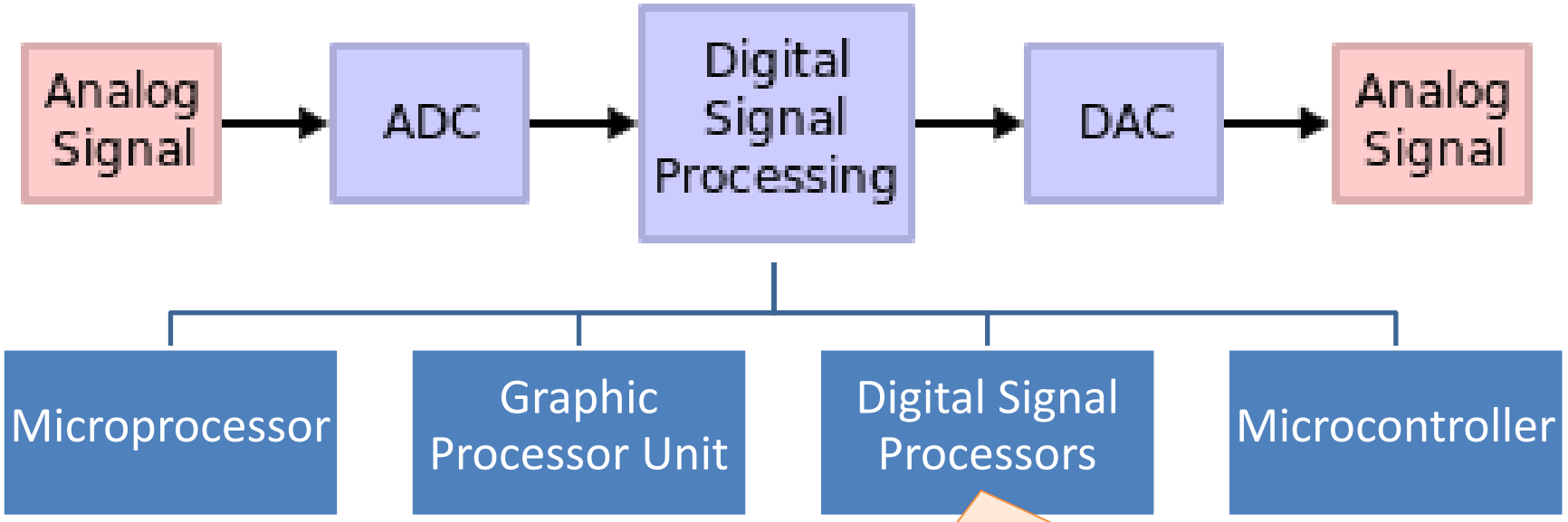


Computer systems

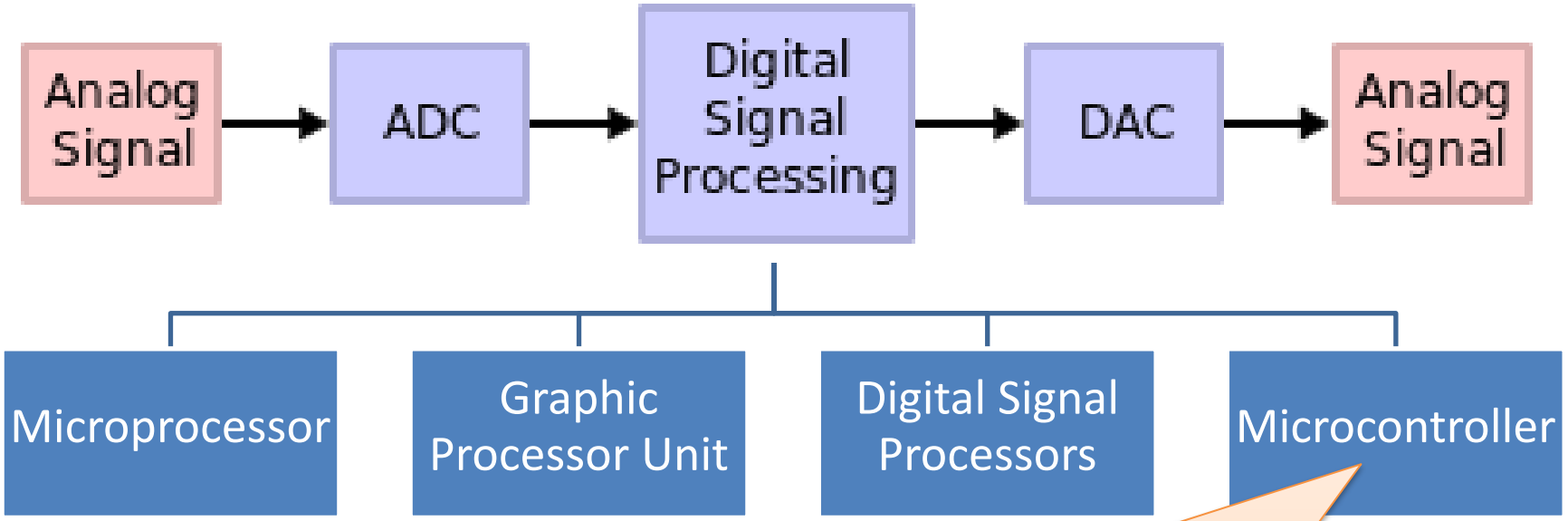




- Specific instruction set for vector and graphic computing and video rendering
- Dual ports memory interface
- Multicores
- Example family chips
  - GeForce, Radeon
  - Quadro, FirePro

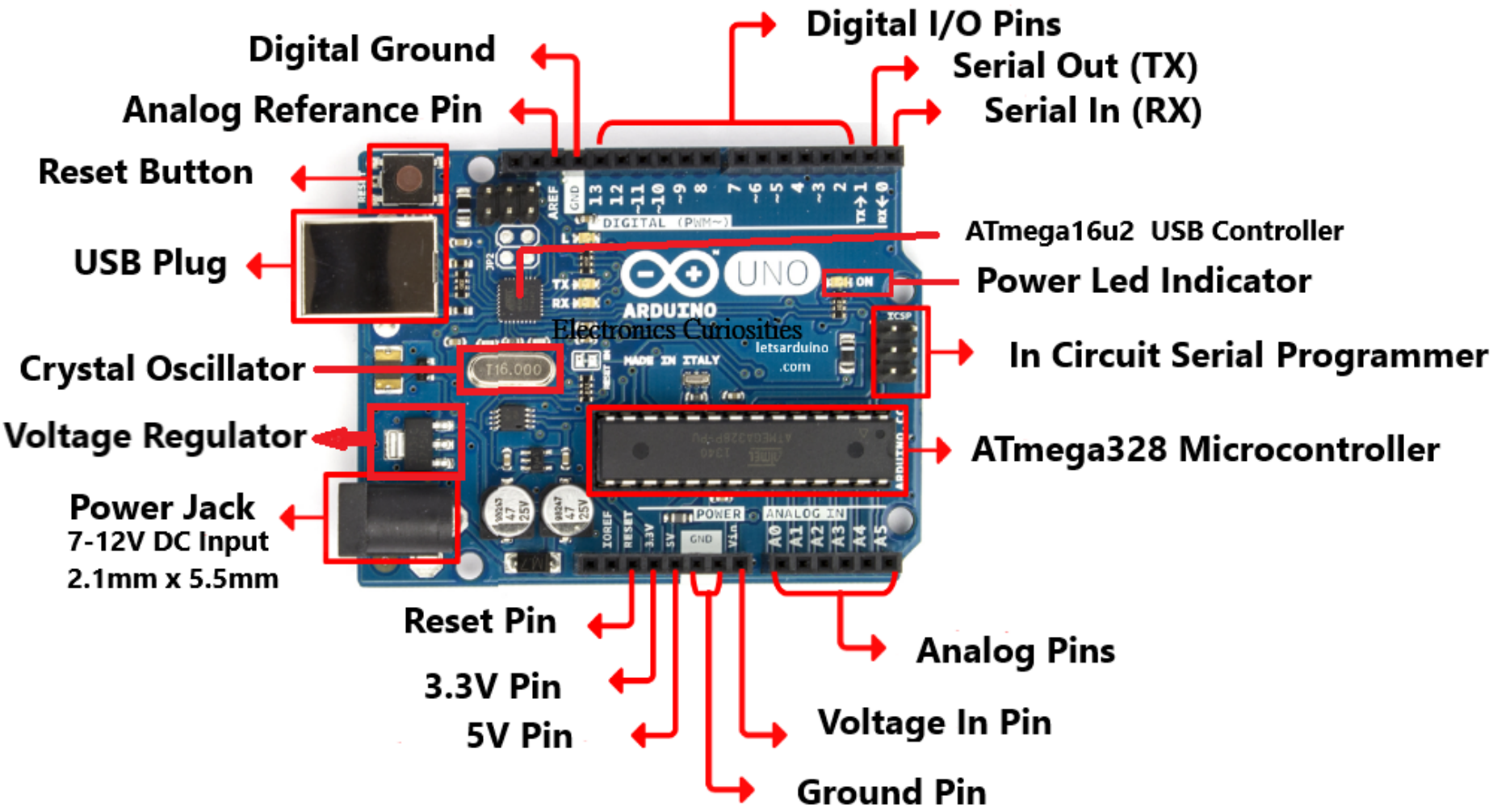


- Specific instruction set for streaming signal
  - Encoding audio/video
  - Decoding audio/video
- Example family chips
  - C6000 (Texas Instrument)
  - SHARC (Analog Devices)
  - EMU10K (Creative)



- Specific instruction set for input/output (I/O) controlling
- Design to control appliance machines such as washing machines, microwaves, toys, etc.
- Integrated I/O ports, timers, memory, Wifi, analog to digital and digital to analog.
- Example family chips
  - PIC
  - MCS-51
  - ARM

Arduino board



Activity1.5

- Identify the type of chip on the list below. You can search from Internet.
  - Z80
  - 8051
  - 68HC11
  - PIC 16Fxx
  - Atmega 328p
  - 8086
  - Geforce 1060
  - TMS32010
  - MAS3507