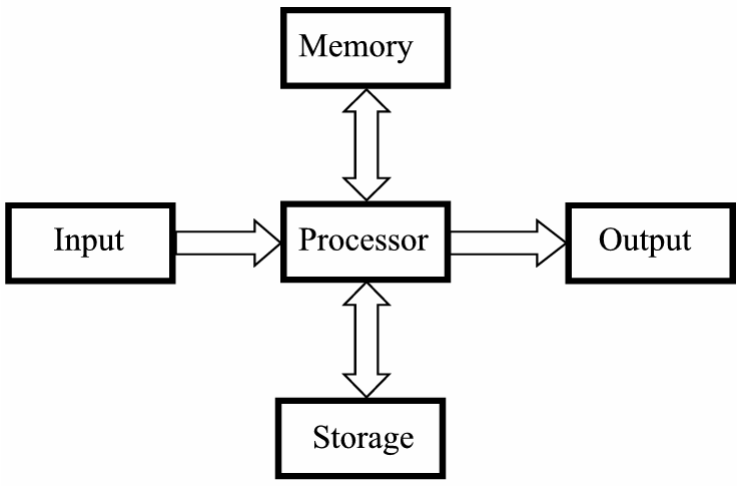
# Introduction To Computers: Hardware

**In this section of notes you will learn about the basic parts of a computer and how they work.**

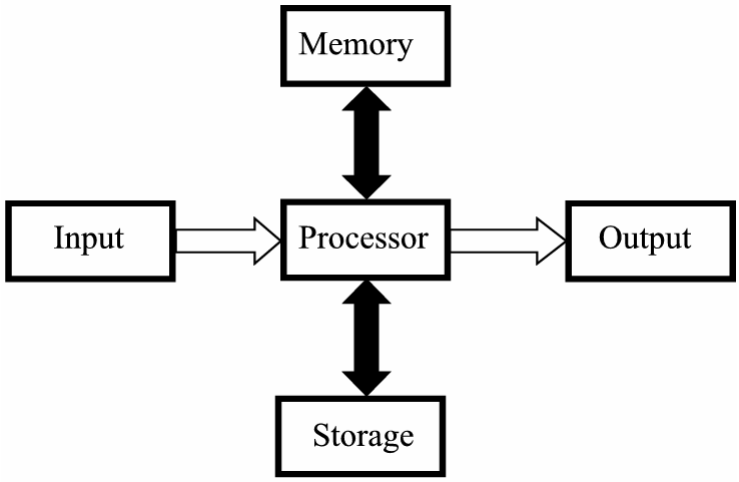


## High Level View Of A Computer



# Buses

•Connect the different parts of the computer together




James Tam

# Buses (2)

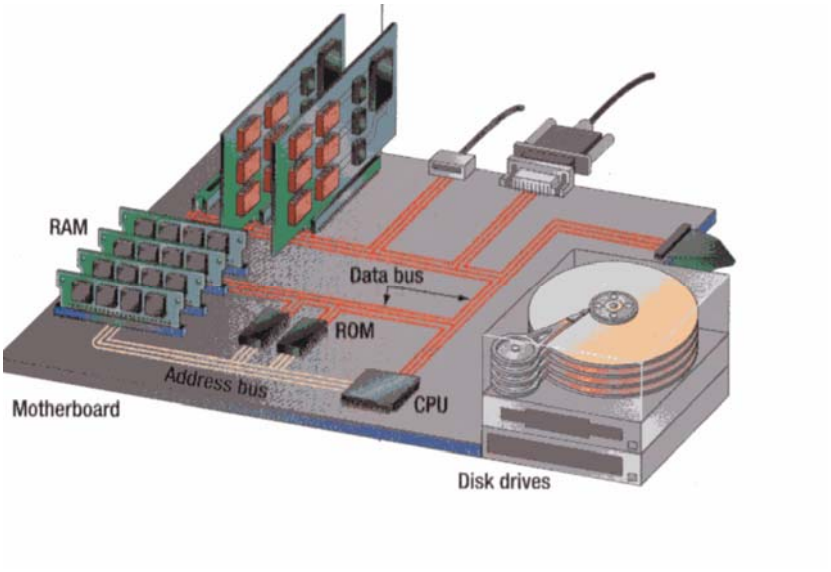



Image from Peter Norton's Computing Fundamentals (3rd Edition) by Norton P.

James Tam

# Basic Units Of Measurement

Bit  on OR  off

- *Bi*nary digi*t*
- Smallest unit of measurement
- Two possible values

Byte 

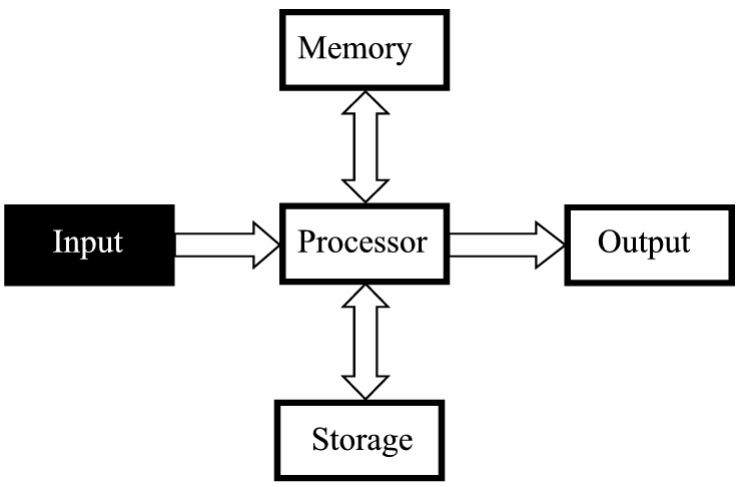
- 8 bits

Word

- The number of adjacent bits that can be stored and manipulated as a unit
- 32, 64 for home computers, 128 for faster machines or specialized systems

James Tam

# Input




James Tam

## Input Devices

•Used by a person to communicate to a computer.

**Person to computer**



## Example Input Devices

•Keyboard 

•Mouse 

•Etc.

# How Keyboard Input Works

**Keyboard**: A key is pressed

The electrical impulse is sent via a wired or wireless connection

**Keyboard controller**: based on the electrical impulses it determines which key or combination of keys was pressed

| A | p | p | l | e | ... |
|---|---|---|---|---|---|

**Keyboard buffer**: stores the keystrokes

The keyboard controller transmits an interrupt request

**Operating system**



# How Keyboard Input Works

**Operating system:**

Q: Is the key combination a (an operating) system level command e.g., <alt>-<ctrl>-<del>?

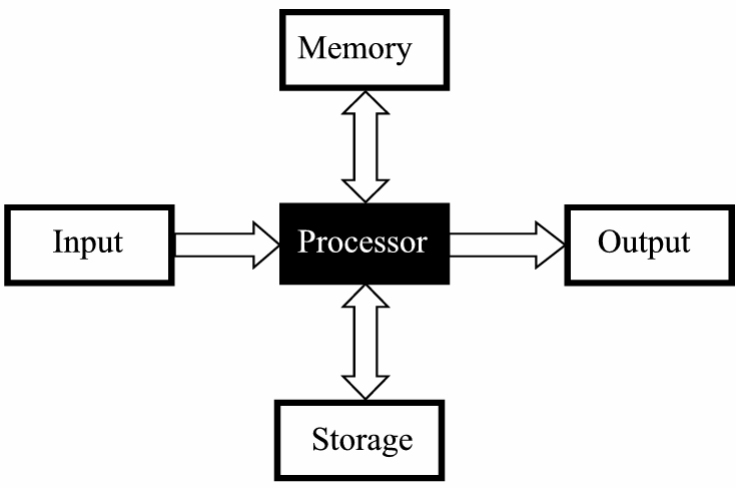
Yes

Execute operating system instruction

No


Pass the key combination onto current application

# Processor






# Processor

•The brains of a computer

Image from:
www.howstuffworks.com

•A common desktop processor

## Small Units Of Measurement (Processor And Memory Speed)

- Millisecond (ms) – a thousandth of a second ($1/1{,}000 = 10^{-3}$)
- Microsecond (μs) - a millionth of a second ($1/1{,}000{,}000 = 10^{-6}$)
- Nanosecond (ns) – a billionth of a second ($1/1{,}000{,}000{,}000 = 10^{-9}$)



## Processor Speed

- Determined by:
  - Type of processor e.g., Intel: Celeron, Pentium, AMD: Athlon, Opteron
  - Clock speed
    - 1 Hz = 1 pulse is sent out each second (1 second passes between each pulse)
    - 10 Hz = 10 pulses are sent out each second (0.1 seconds passes between each pulse)
    - :
    - 25 MHz = 25 million pulses sent out each second (0.000 000 04 seconds between each pulse or 40 ns between pulses)
    - 3.8 Ghz = 3.8 billion pulses sent out each second (0.26 ns between pulses)

# The Processor And The Computer

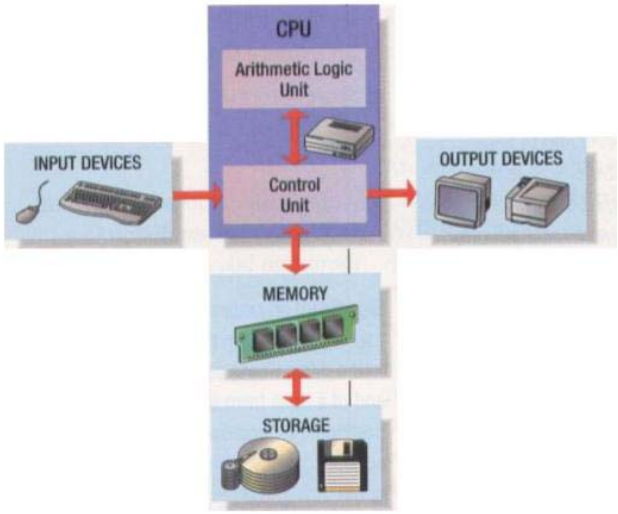
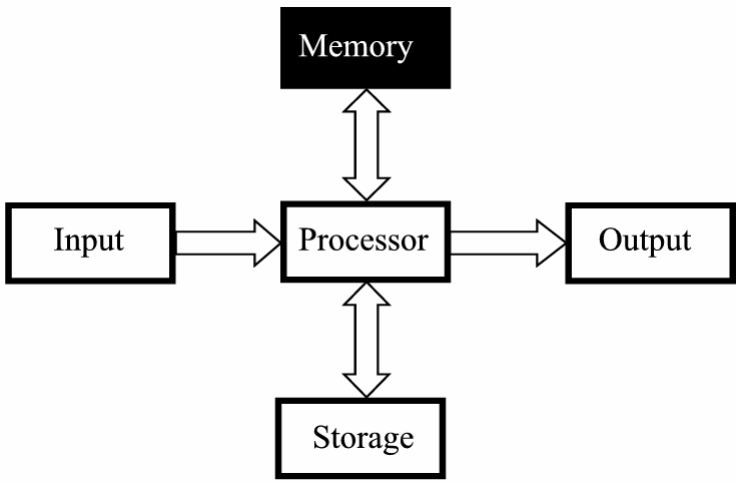



Image from Peter Norton's Computing Fundamentals (3rd Edition) by Norton P.



# Memory



## Large Units Of Measurement (Memory, Storage)

- Note: powers of two are used because computer memory and storage are based on the basic unit (bit).
- Kilobyte (KB) – a thousand bytes ($1,024 = 2^{10}$)
- Megabyte (MB) - a million ($1,048,576 = 2^{20}$)
- Gigabyte (GB) – a billion ($1,073,741,824 = 2^{30}$)
  - ~ A complete set of encyclopedias requires about 700 MB of storage
  - ~ 30 minutes of video (1/4 of the information stored on a typical DVD)
- Terabyte (TB) – a trillion ($1,099,511,627,776 = 2^{40}$)
  - ~ 20 million four-drawer filing cabinets full of text
  - ~ 200 DVD's of information

James Tam

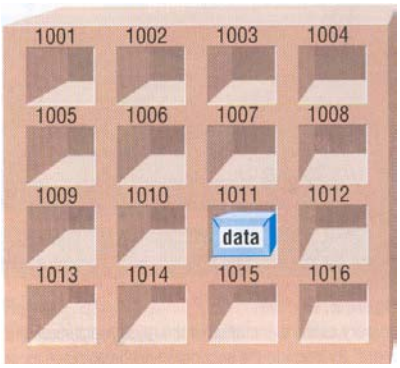
## RAM

- *R*andom *A*ccess *M*emory
- Volatile
  - Used for temporary storage
- Typical ranges 256 MB - 4 GB

James Tam

# RAM (2)

- Random access means direct access to any part of memory
- A common form of RAM is DRAM (Dynamic RAM)




Picture from Computers in your future by Pfaffenberger B



# How Does DRAM Work?

- Acts like a leaky bucket

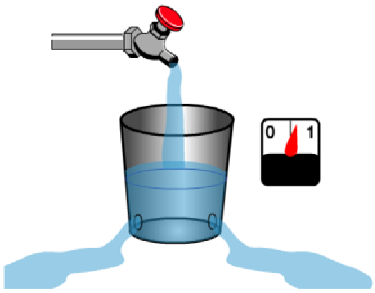



Image from www.howstuffworks.com

# How Does DRAM Work?

•Acts like a leaky bucket

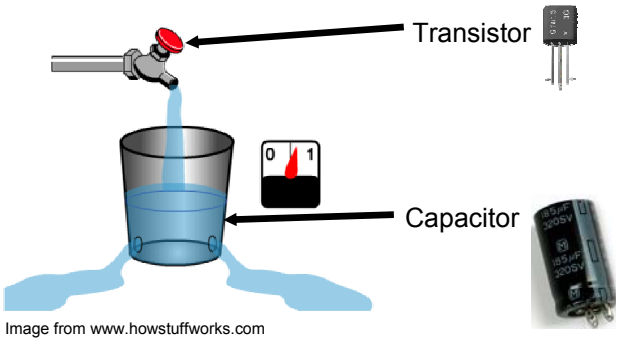
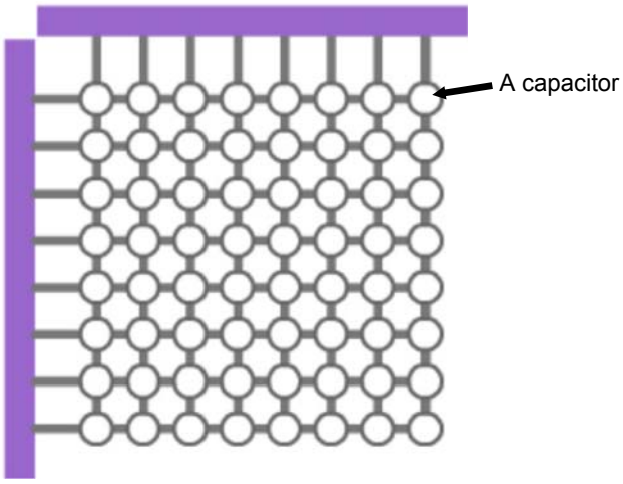



Image from www.howstuffworks.com



# DRAM: A Collection Of Capacitors




Conceptual view of DRAM

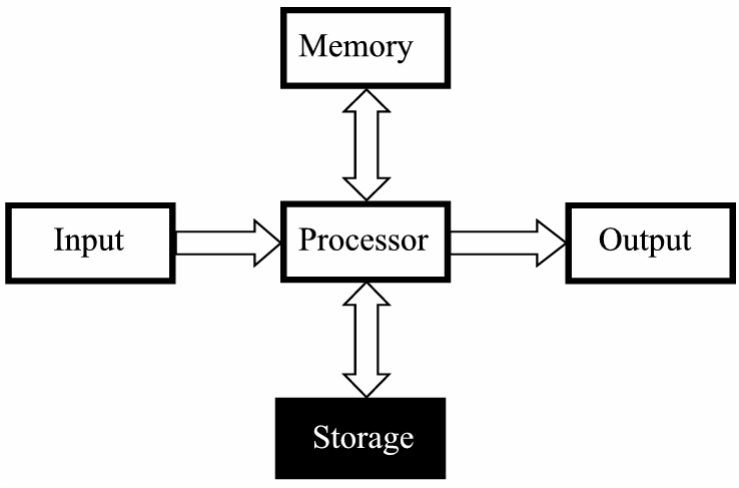
Actual DRAM

## The Word Size Of The Computer Determines The Maximum Amount of RAM

- Recall
  - $2^{30} \sim 1$ billion
  - $2^{31} \sim 2$ billion
  - $2^{32} \sim 4$ billion
  - This means that with a 32 bit computer the maximum amount of memory allowable is 4 billion (4 GB).

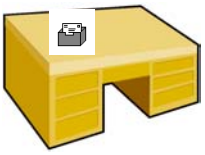


## Storage



## Storage Vs. Memory

Memory (e.g., RAM)
- Keep the information for a shorter period of time (usually volatile)
- Faster
- More expensive



Storage (e.g., Hard disk)
- The information is retained longer (non-volatile)
- Slower
- Cheaper

James Tam

## Categories Of Storage

1. Magnetic
   - Floppy disks
   - Zip disks
   - Hard drives
2. Optical
   - CD-ROM
   - DVD
3. Solid state storage devices
   - USB Key (a very common form of solid state storage)

James Tam

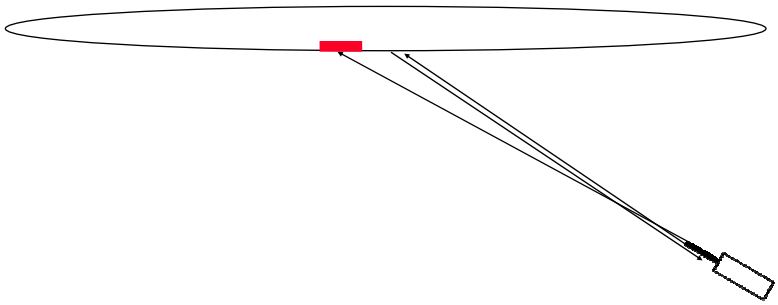
# 1. Magnetic Drives




# 1. Magnetic Drives: Storage Capacities

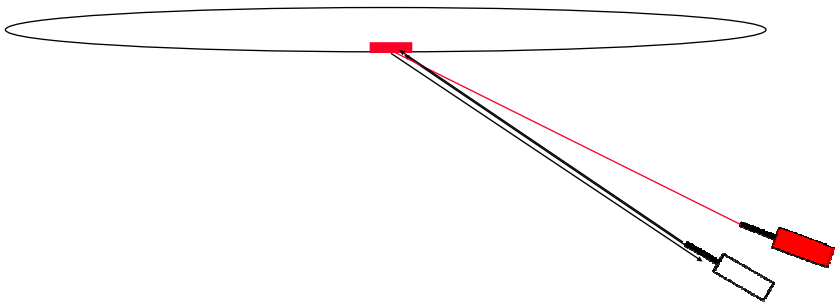
- Floppy disks
  - ~ 1 MB
- Zip disks
  - 100, 250, 750 MB
- Hard drives
  - ~80 – 500 GB (TB is possible but very rare)

## 2. Optical Drives: Reading Information



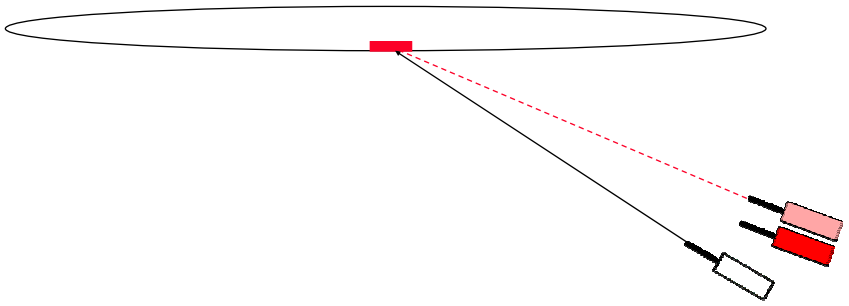
James Tam

## 2. Optical Drives: Recording and Reading Information



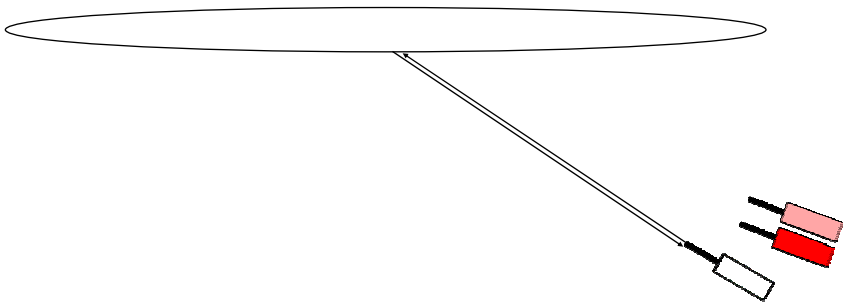
James Tam

## 2. Optical Drives: Re-Writing



James Tam

## 2. Optical Drives: Re-Writing



James Tam

## 2. Optical Drives

•CD's
- ~ 700 MB storage
- CD-ROM (read only)
- CD-R: (**r**ecord) to a CD
- CD-RW: can write and erase CD to reuse it (**r**e-**w**ritable)

•DVD-ROM
- Over 4 GB storage (varies with format)
- DVD- ROM (read only)
- Many recordable formats (e.g., DVD-R, DVD-RW; DVD+R, DVD+RW..)



## 3. Solid State Storage Devices

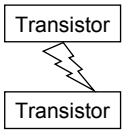
•Portable but can store a large amount of information (64 MB – 4 GB)

# 3. Solid State Storage Devices

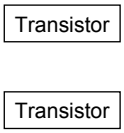
- Require no moving parts but instead uses transistors

- Use a pair of transistors to store each bit of information

**Connected: stores '1'**



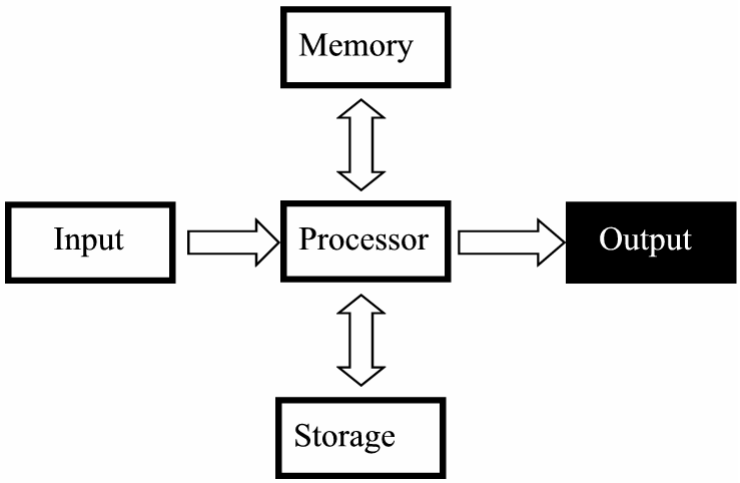

**Disconnected: stores '0'**




- An electrical current can be used to connect and disconnect the transistors
- The pair transistors will remain in their current state (connected or disconnected) until an electrical charge is applied.

James Tam

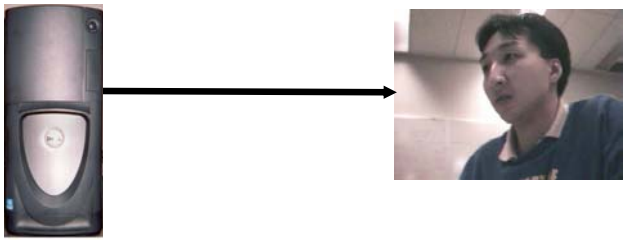
# Output




James Tam

## Output Devices

•Displays information from the computer to a person.





## The Most Common Output Device: The Monitor

- Common monitor technologies:
  1. CRT (Cathode Ray Tube)

  2. LCD (Liquid Crystal Display)

  3. Plasma displays

## How Images Are Drawn On Monitors

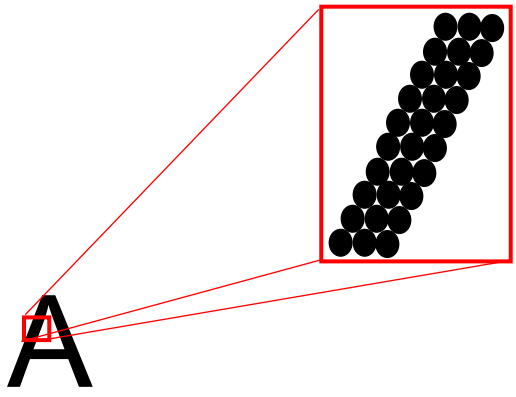
- Images and text are drawn with tiny dots (Pixels: *Pi*cture *el*ement*s)*

A



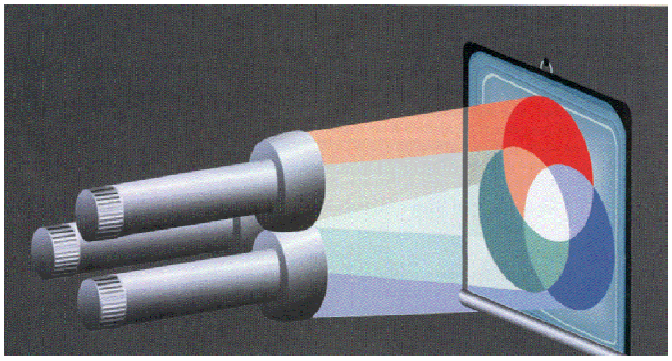
## How Images Are Drawn On Monitors

- Images and text are drawn with tiny dots (Pixels: *Pi*cture *el*ement*s)*



# 1. CRT Monitors

•The pixels are drawn with light ‘guns’



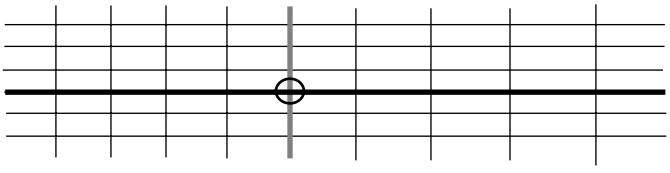
Picture from Computer Confluence by Beekman G.



# 2. LCD Monitors

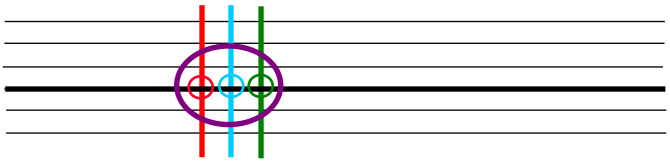
•Employ a conductive grid for each row and column

•The meeting of a row and column allows light to be emitted (a pixel can be seen)



## 2. Colour LCD Monitors

•Use three sub pixels:
- One wire for each row
- One wire for each sub-pixel
- One colour filter for each colour (red, blue, green)

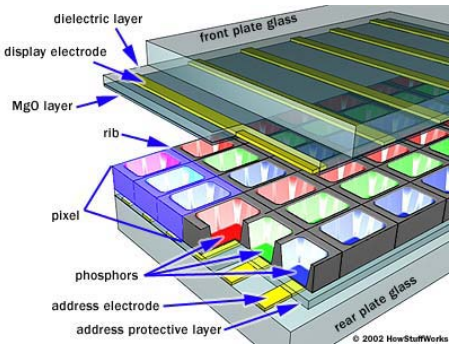


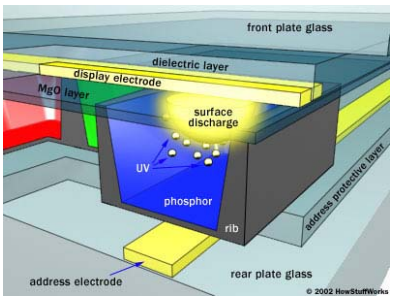


## 3. Plasma Monitors

•Sub-pixels are "drawn" by passing an electrical current through a gas.

•Again each pixel is formed by three sub-pixels




Images from www.howstuffworks.com

# All The Basic Parts Together

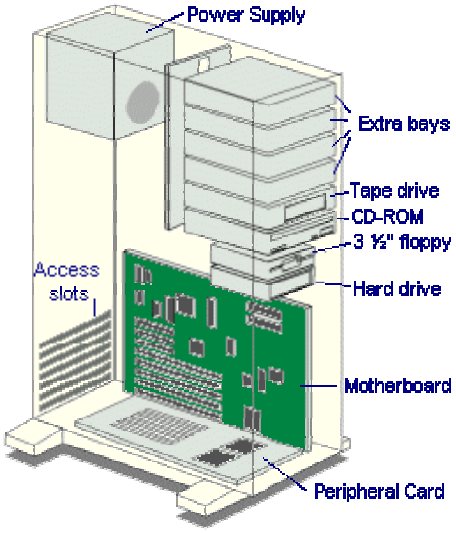



Diagram from http://www.jegsworks.com

James Tam

# The Motherboard

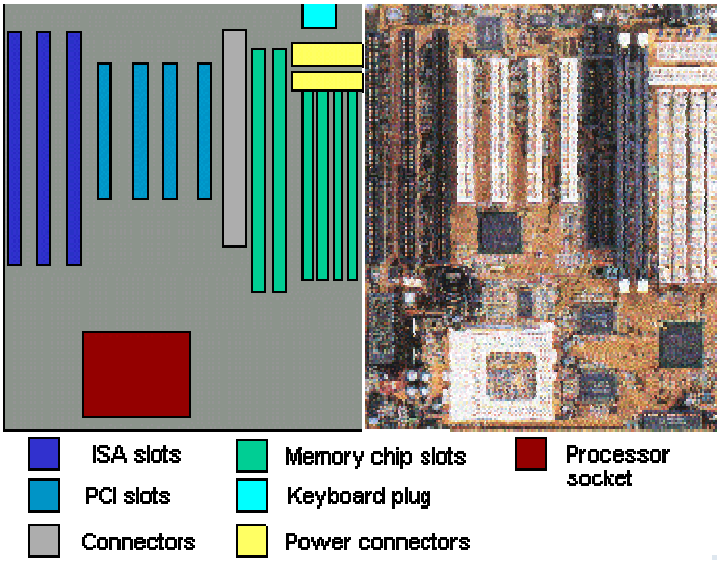
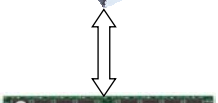



Diagram from http://www.jegsworks.com

James Tam

# Relating The Speed Of The Computer To Its Components

Storage:
Hard drive



Memory:
RAM

Processor

James Tam

# You Should Now Know

- What are common units of measurement
- What are the basic parts of the high level view of a computer
- Example input devices
- The role of the processor in a computer
- What determines processor speed
- What are the characteristics of RAM
- How does DRAM work
- The difference between storage and memory
- What are the different categories of storage devices as well as common examples of each
- How do different storage devices work
- The approximate storage capacity of memory and different storage devices
- How do computer monitors work
- How the different hardware components affects the speed of the system

James Tam