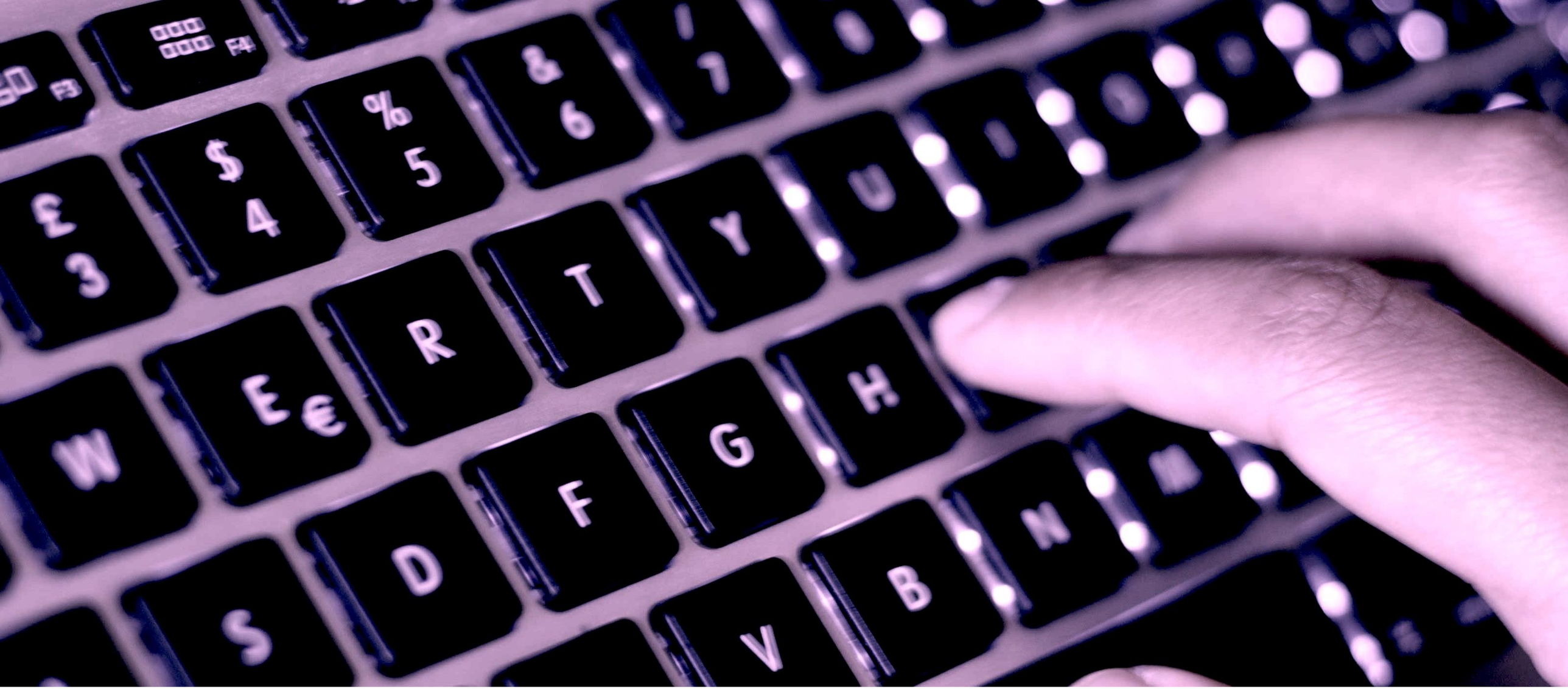


CD4002/CN4002 Computer Systems and Networks

Week 5 Computer Peripherals

University of East London

Pioneering Futures Since 1898

Agenda

- Secondary storage
  - Solid state drives
  - Magnetic disks
  - Disk arrays
- Basic display design
- Printers
- We won’t be covering optical disks, magnetic tape, network devices, keyboards or mice etc

Computer Peripherals

- Devices that are peripheral to the ‘heart’ of the computer
  - Not the CPU, memory, power supply
- Classified as input, output, or storage
- Connect via
  - Ports
  - Interface to systems bus

Storage Devices

- Primary memory
  - Conventional and cache
- Secondary storage
  - Data and programs must be copied to primary memory for CPU access
  - Permanence of data
  - Online storage
  - Offline storage – loaded when needed

Hierarchy of Storage

Increasing Storage Capacity

Device	Typical access times
CPU registers	0.25 nsec
Cache memory (SRAM)	1-10 nsec
Conventional memory (DRAM)	10-50 nsec
Flash memory	120 µsec
Magnetic disk drive	10-50 msec
Optical disk drive	100-500 msec
Magnetic tape	0.5 and up sec

Increasing access times

Solid State Drives (SSDs)

- A type of flash memory ie a non-volatile integrated circuit
- More expensive per byte than magnetic disks but
- …access times are significantly faster
- Read/write speeds similar to magnetic disks
- Data is read and written in blocks

Revision

Q. Which of the following I/O methods is used to transfer data to and from an SSD? (Choose ALL that apply.)

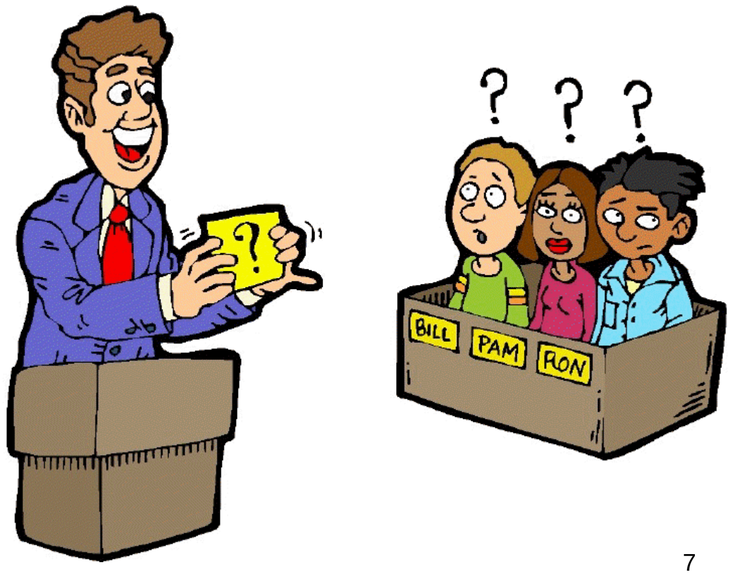
a. Programmed I/O

b. Interrupts

c. Direct memory access (DMA)

d. None of the above

e. A, B & C



Secondary Storage Devices

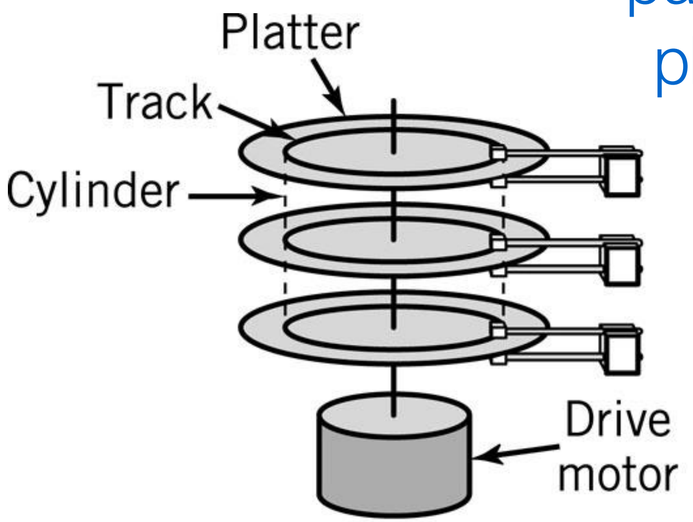
- Hard drives, floppy drives
- CD-ROM and DVD-ROM drives
- CD-R, CD-RW, DVD-RAM, DVD-RW
- Tape drives
- Network drives
- Direct access vs. Sequential access
- Rotation vs. Linear

Magnetic Disks

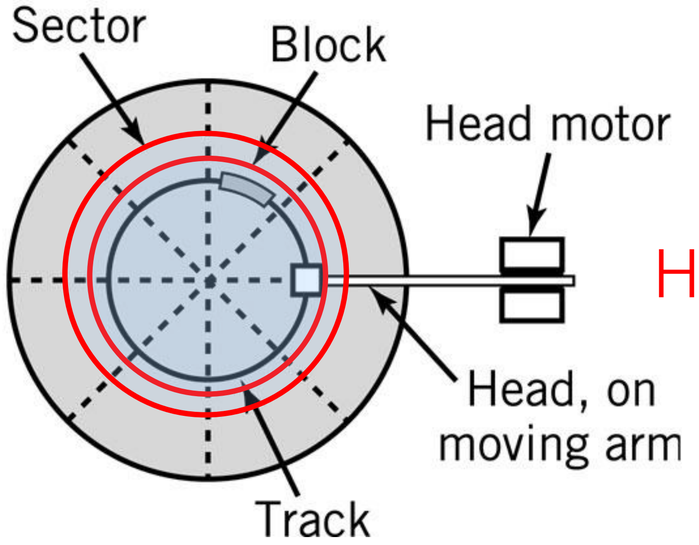
- Consists of one or more flat circular platters
  - Made of glass, metal or plastic, and coated with a magnetic substance.
- Magnetic polarisation can be used to distinguish between 1s and 0s.
- Number of bits on each track is the same
  - CAV – Constant Angular Velocity

A Hard Disk Layout

same track on all platters



pie-shaped part of a platter



small arc of a track

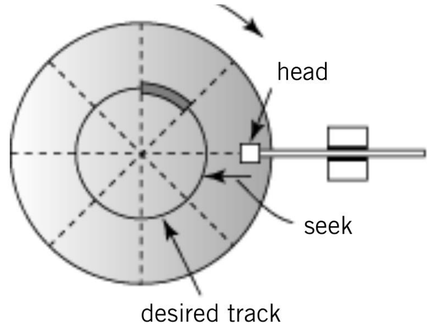
Head crash

Electromagnetic head – reads data off the disk as disk rotates at high speed (5400-15000 RPM)

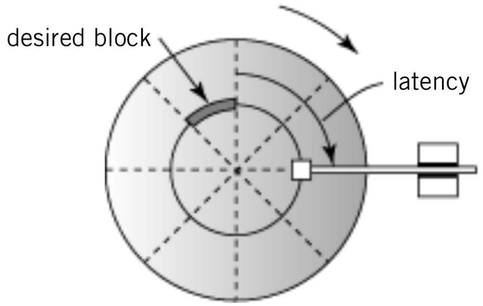
concentric circles

Locating a Block of Data

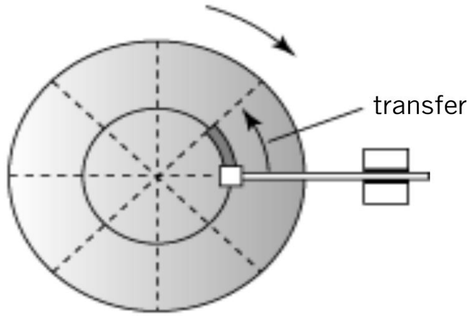
- **Average seek time:** time required to move from one track to another



- **Latency:** time required for disk to rotate to beginning of correct sector

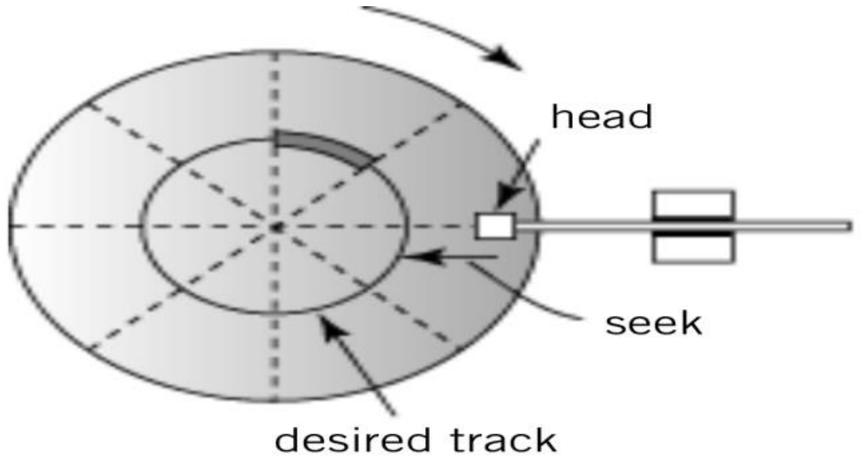


- **Transfer time:** time required to transfer a block of data to the disk controller buffer



Seek Time

- Seek time
  - Time required to move head from one track to another

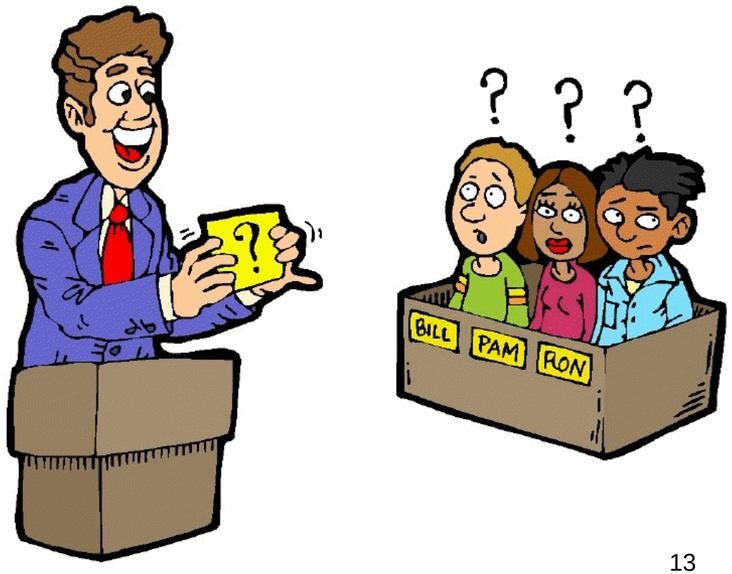


Quiz Time

Q. Under what circumstances will the seek time be at its maximum?

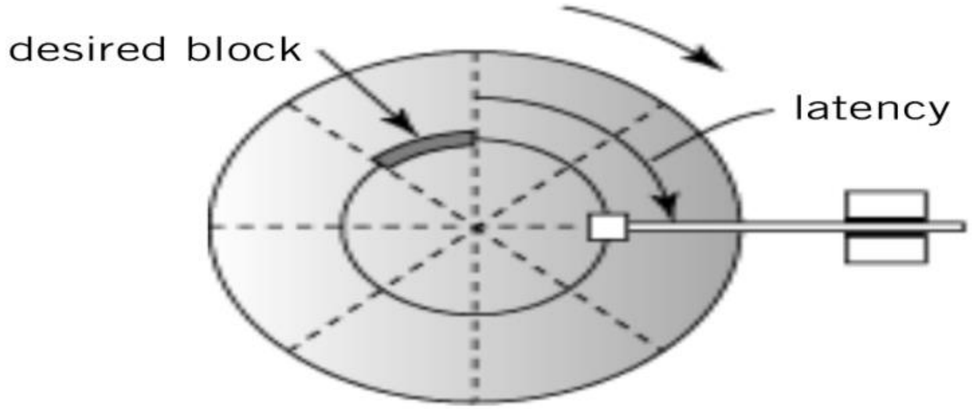
Q. Under what circumstances will the seek time be at its minimum?

Q. What is the average seek time?



Latency or Rotational Delay

- Latency
  - Time required for disk to rotate to beginning of correct sector

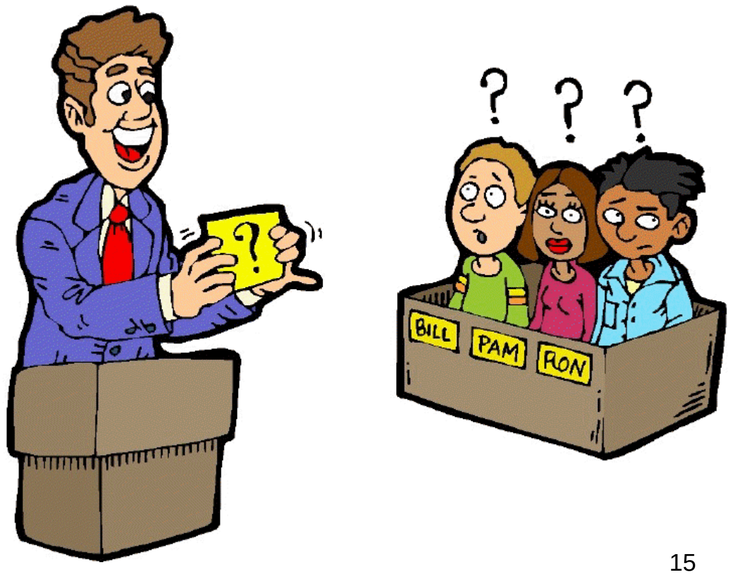


Quiz Time

Q. Under what circumstances will latency be at its maximum?

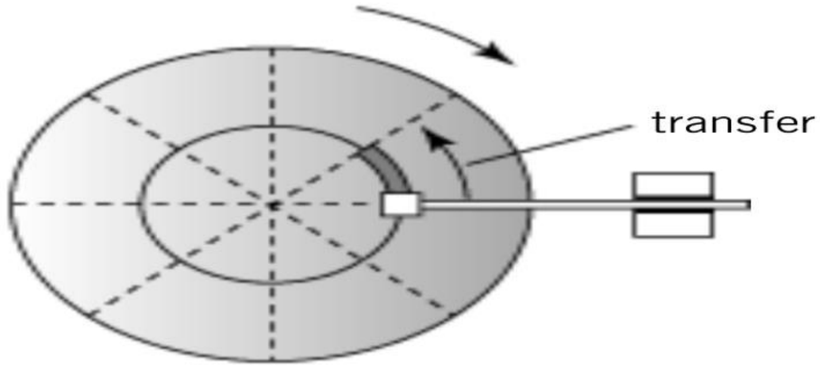
Q. Under what circumstances will latency be at its minimum?

Q. What is the average latency?



Transfer Time

- Transfer time:
  - Time required to transfer a block of data to the disk controller buffer



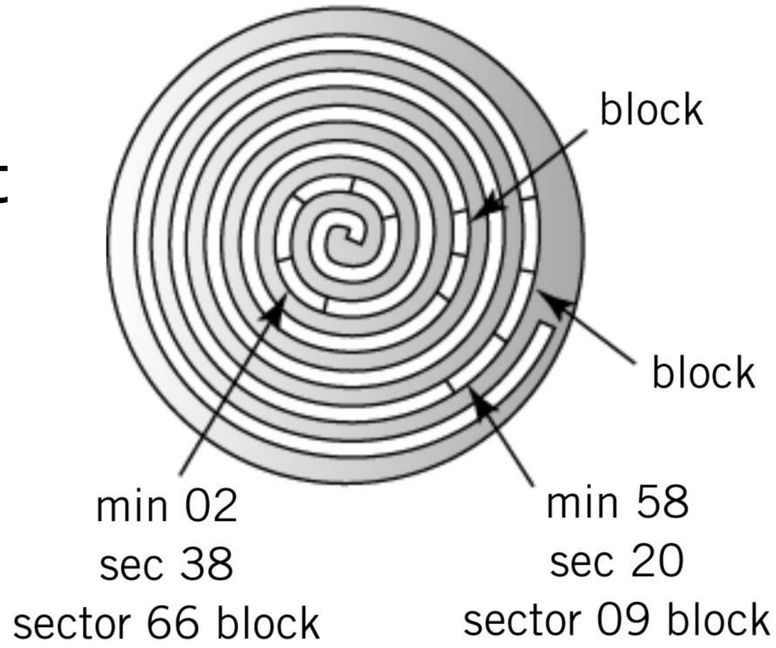
Total Access Time or Disk Access Times

- Average seek time
  - Average time to move from one track to another
- Average latency time
  - Average time to rotate to the beginning of the sector
  - Average latency time = ½ * 1/rotational speed
- Transfer time
  - 1/(# of sectors * rotational speed)
- Total time to access a disk block
  - Avg. seek time + avg. latency time + avg. transfer time

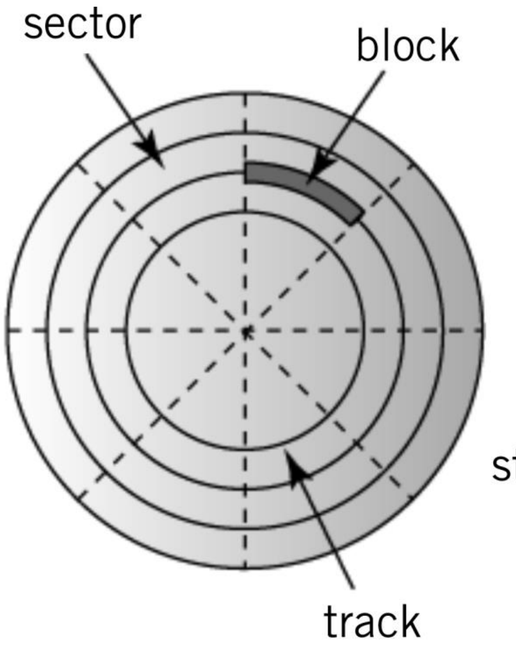
Layout: Optical Disk vs. Magnetic Disk

Optical Disk

Constant Linear Velocity



Magnetic Disk

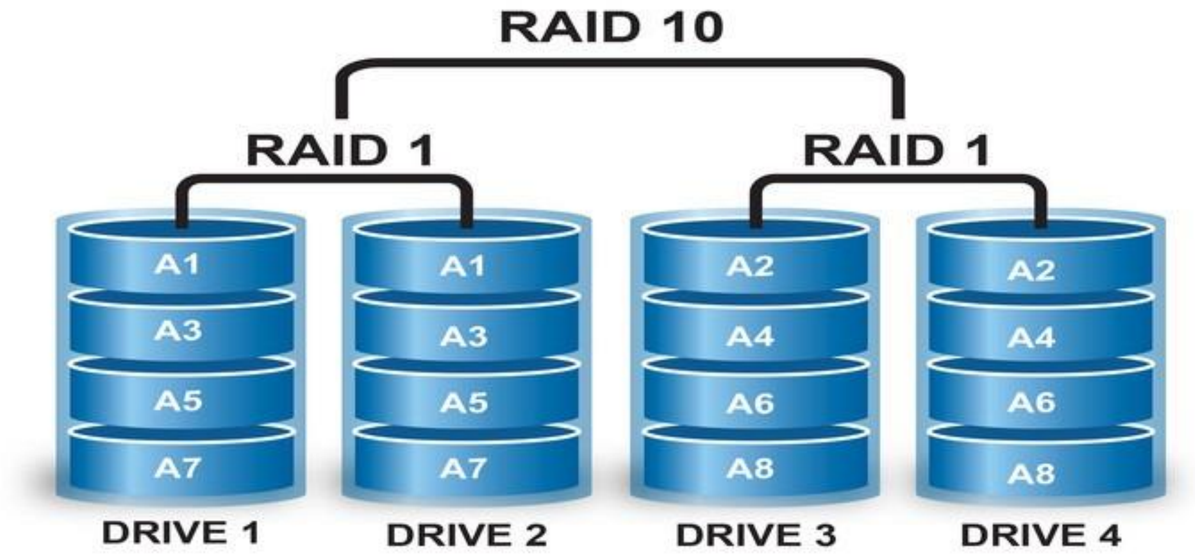


standard disk

Constant Angular Velocity

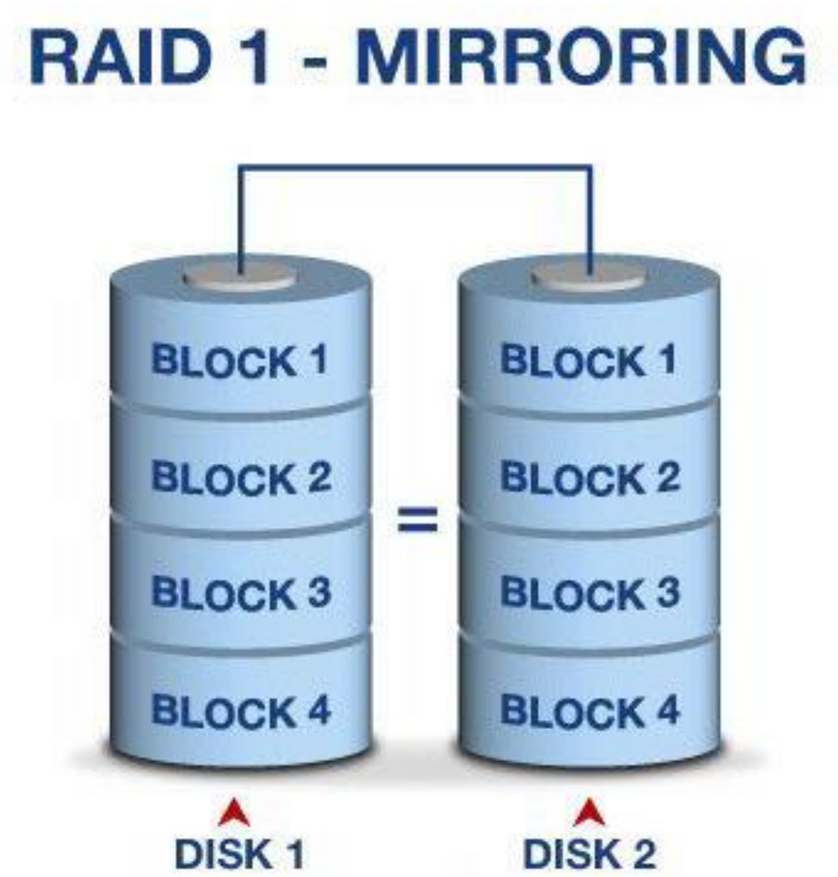
Disk Arrays

- A grouping of 2 or more disk drives used to reduce overall access time and to increase system reliability
- **Common example is RAID** - Redundant Array of Inexpensive (or Independent) Disks
- 2 standard methods of implementing arrays; mirrored and striped arrays



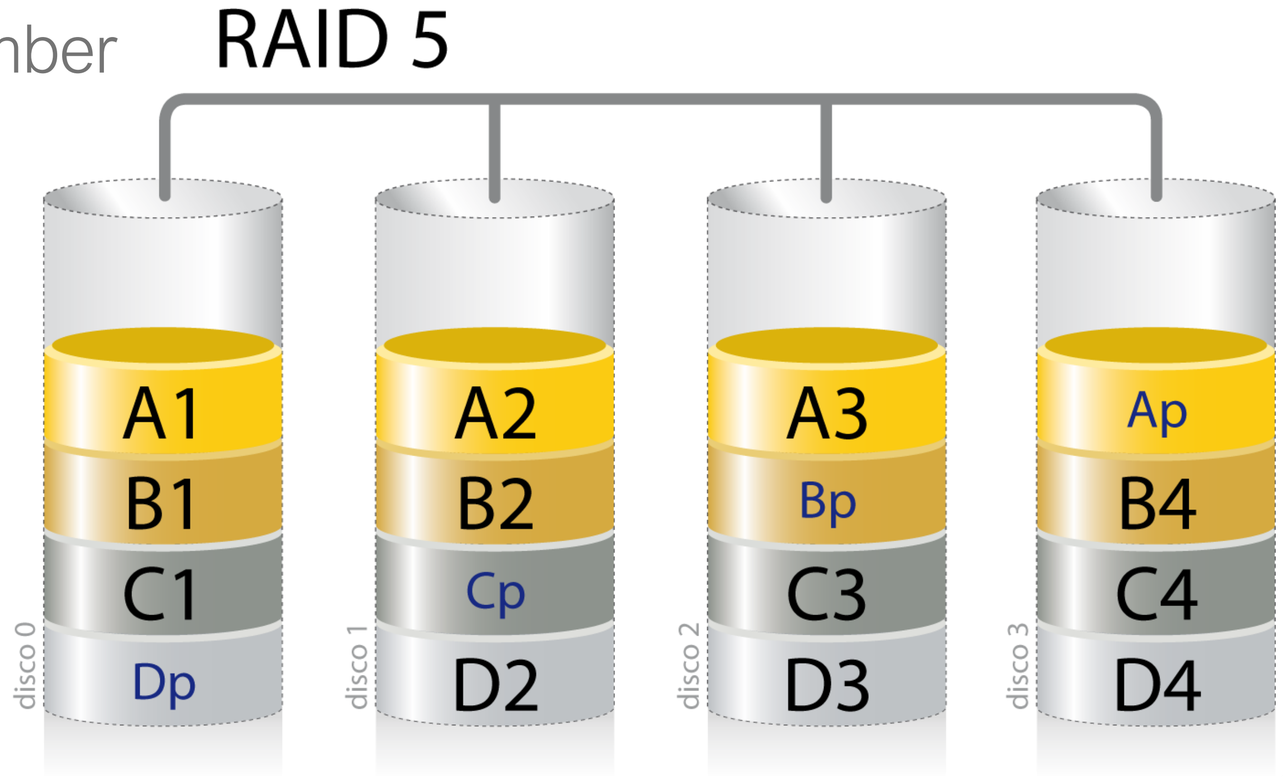
Mirrored Arrays

- Each disk stores the same data
- Alternate blocks of data are read from different drives
- Access times are reduced by factor equivalent to number of disks
- Mirrored arrays increase system reliability



Striped Arrays

- **File segments** are divided into blocks
- Different blocks are written simultaneously to different disks
- **Throughput** depends upon the number of disks
- **Requires a minimum of 3** disks to enable error checking



Quiz Time

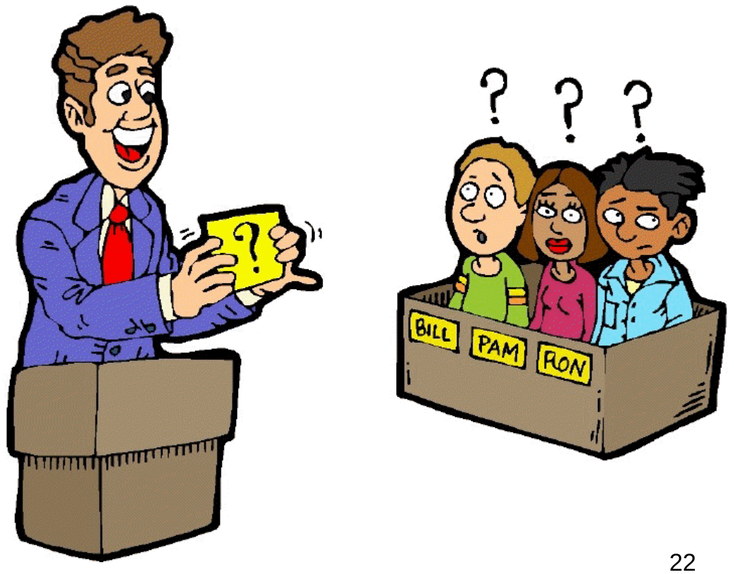
Q. Which of the following statements is TRUE? (Choose ALL that apply.)

a. Mirrored arrays improve disk read times.

b. Mirrored arrays improve disk write times.

c. Striped arrays improve disk read times.

d. Striped arrays improve disk write times.



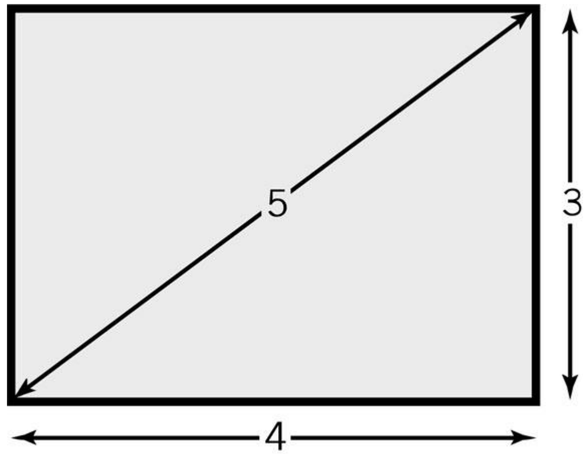
Displays

- Pixel – picture element
- Size: diagonal length of screen
- Resolution (pixels on screen)
  - VGA: 480 x 640
  - SVGA: 600 x 800
  - 768 x 1024
  - 1280 x 1024
- Picture size calculation
  - Resolution * bits required to represent number of colors in picture
  - Example: 16 color image, 100 pixels by 50 pixels

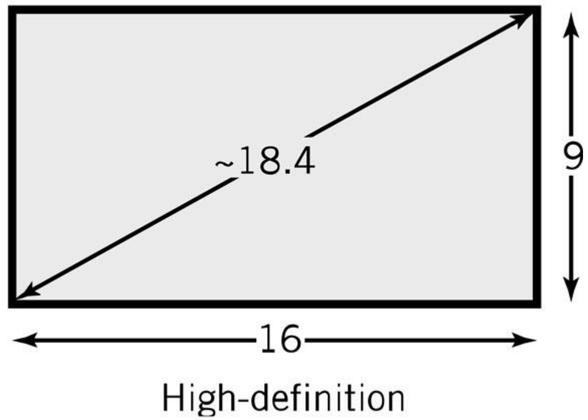
    4 bits (16 colors) * 100 * 50 = 20,000 bits

Display Screen

- Screen size: measured diagonally
- Resolution: minimum identifiable pixel size
- Aspect ratio: x pixels to y pixels
  - 4:3 on most PCs
  - 16:9 on high definition displays



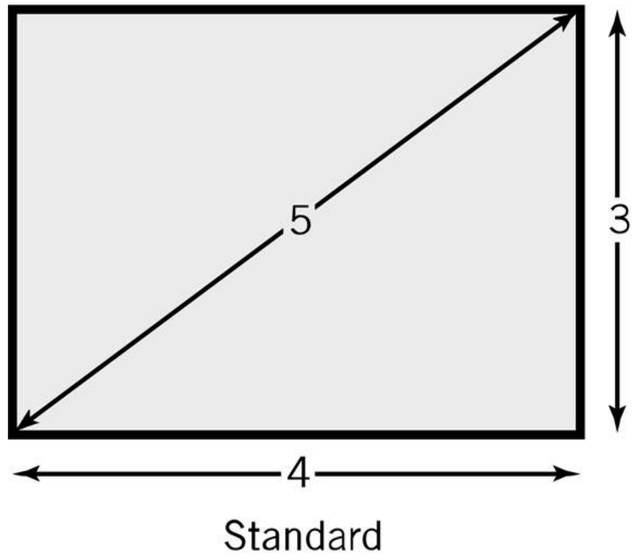
Standard



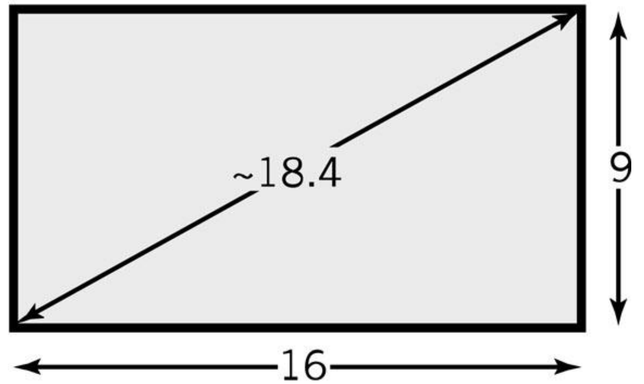
High-definition

Display Characteristics

- Made up of **picture elements (pixels)**
- **Resolution**: number of pixels in a row x number of pixels in a column eg 1280 x 1024, 1920 x 1080, 3840 x 2160 etc.
- **Aspect ratio**: x pixels to y pixels
  - 4:3 on most PCs
  - 16:9 on high definition displays
- **Pixel density**: number of pixels per inch



Standard



High-definition

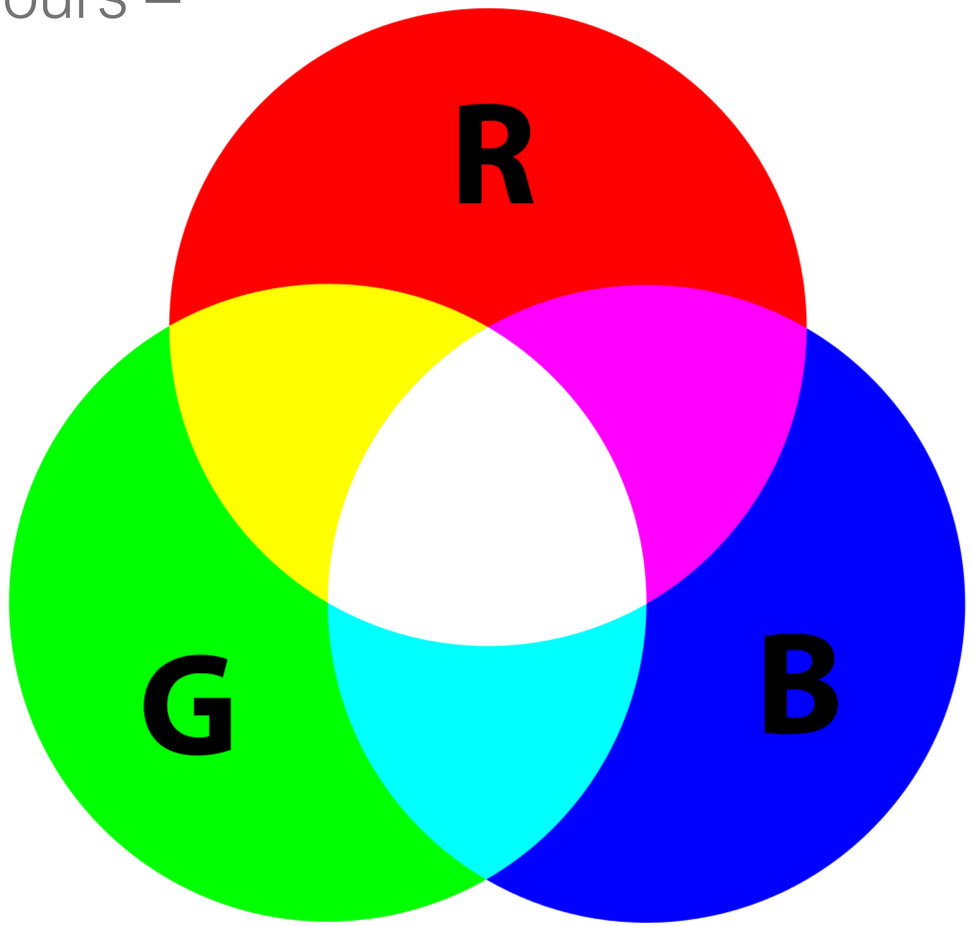
Colour and Displays

- 1-bit colour (2 colours)
- 2-bit colour (4 colours)
- 4-bit colour (16 colours)
- 8-bit colour (256 colours)
- 24 bits (16,777,216 colours) - true colour

Colour and Displays

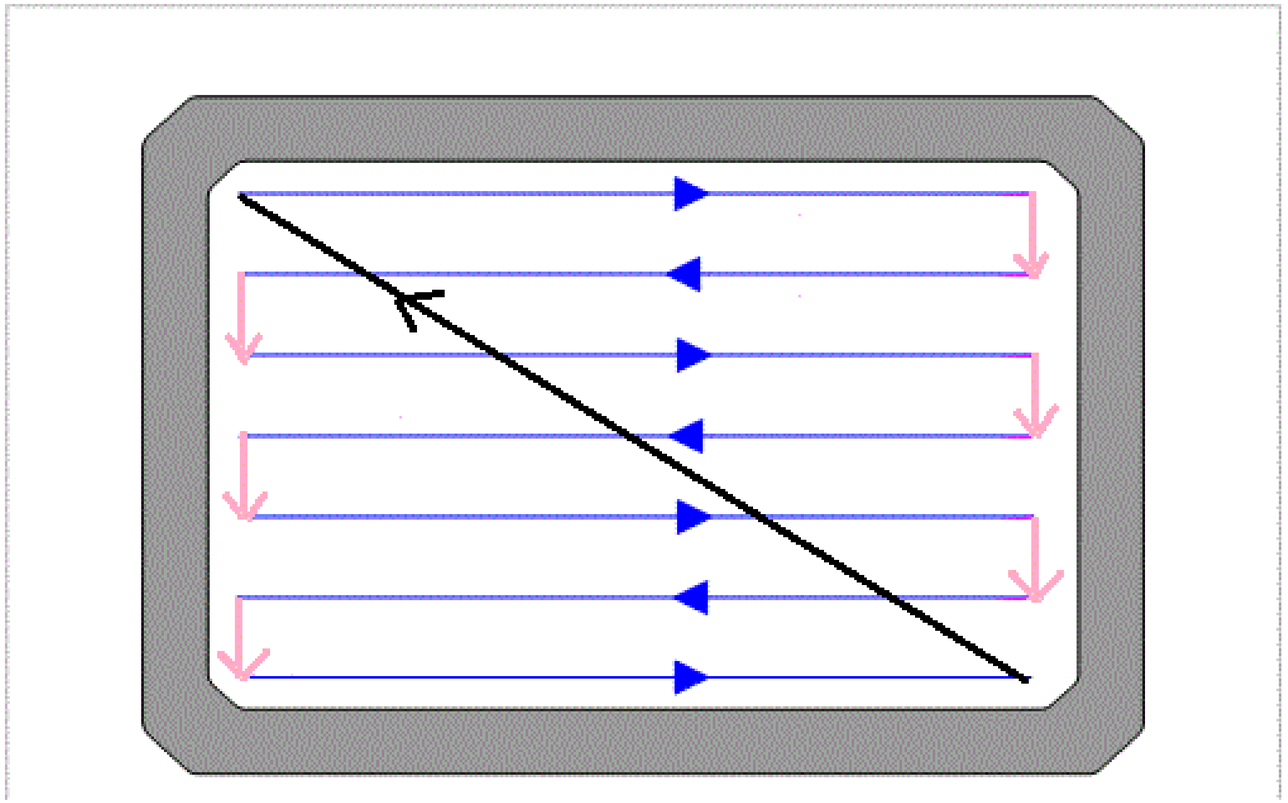
- **Pixel colour** is determined by intensity of 3 colours – red, green & blue or RGB

1. **4 bits per colour**
   - 16 * 16 * 16 = 4096 colors
2. **True Colour – 8 bits for each colour**
   - 256 levels of intensity for each colour
   - 256 * 256 * 256 = 16.7 million colors
3. **High resolution,** true colour images require significant amounts of storage and memory



Raster Scan

- Images are displayed on the screen using a technique called raster scanning



Quiz Time

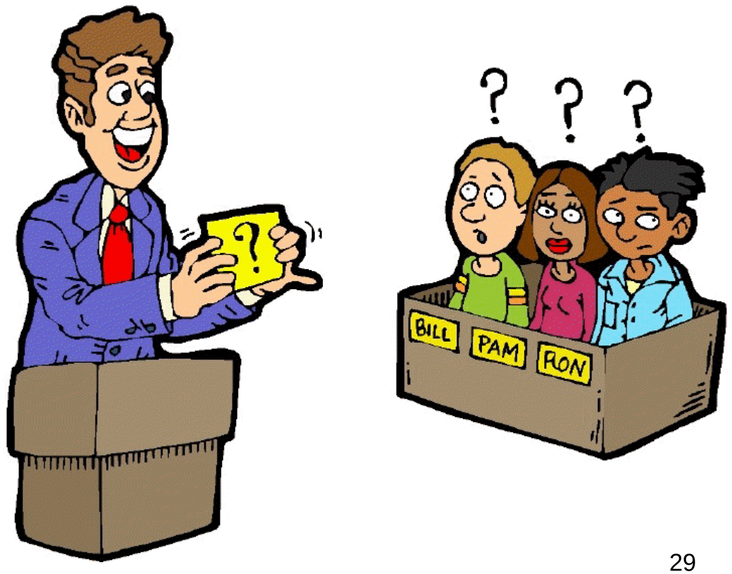
Q. How large is a true colour HD image (1,920 x 1,080 pixels)?

a. Approx 60 KB

b. Approx 600 KB

c. Approx 6 MB

d. Approx 60 MB

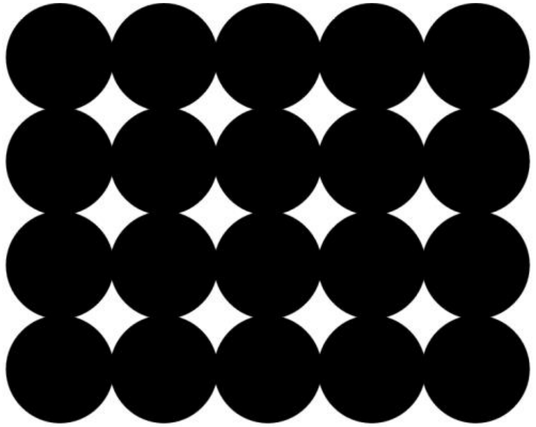


Printers

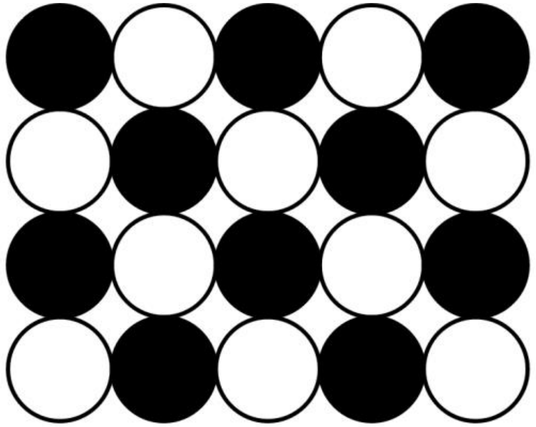
- Dots vs. pixels
  - 300-2400 dpi vs. 400+ pixels per inch
  - Dots are on or off, pixels have intensities

- Types
  - Impact printers – largely obsolete
  - Non-impact printers
    - Inkjets which spray tiny droplets of boiled ink onto paper
    - Laser printers (see slides 28 & 29 for details)

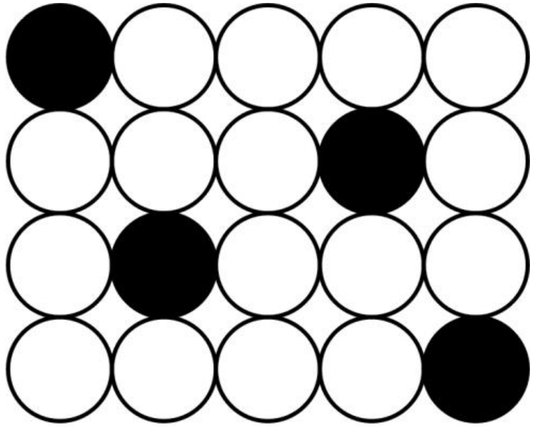
Dots vs Pixels



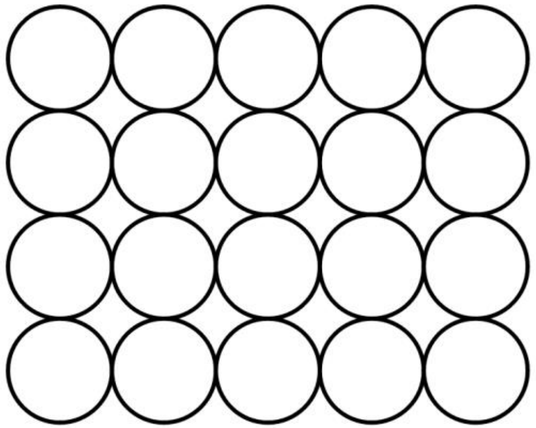
black



dark gray

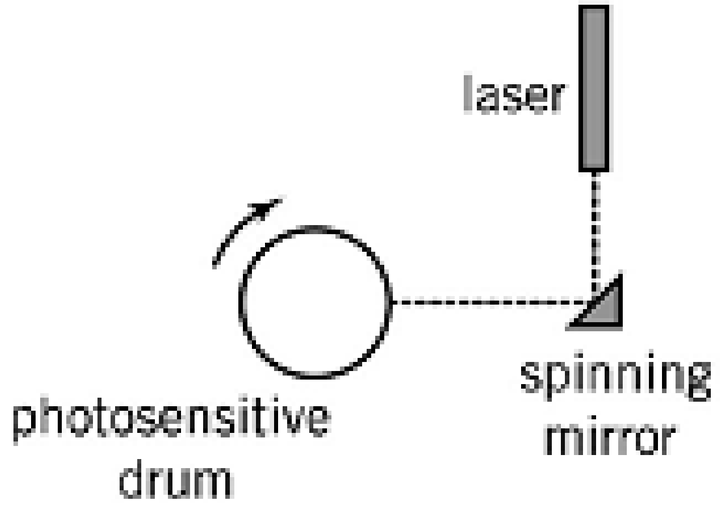


light gray



white

Laser Printing

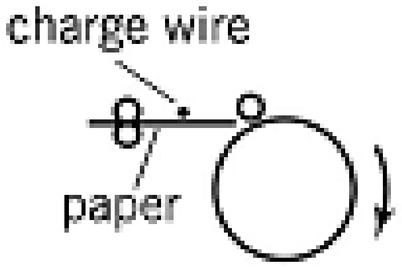


1. A laser is fired in correspondence to the dots that are to be printed. A spinning mirror causes the dots to be fanned out across the drum. The drum rotates to create the next line, usually 1/300th or 1/600th of an inch.

   The drum is photosensitive. As a result of the laser light, the drum will become electrically charged wherever a dot is to be printed.

2. As the drum continues to rotate, the charged part of the drum passes through a tank of black powder called toner. Toner sticks to the drum wherever the charge is present. Thus, it looks like the image.

Laser Printing (Contd.)



3. A sheet of paper is fed toward the drum. A charge wire coats the paper with electrical charges. When it contacts the drum, it picks up the toner from the drum.

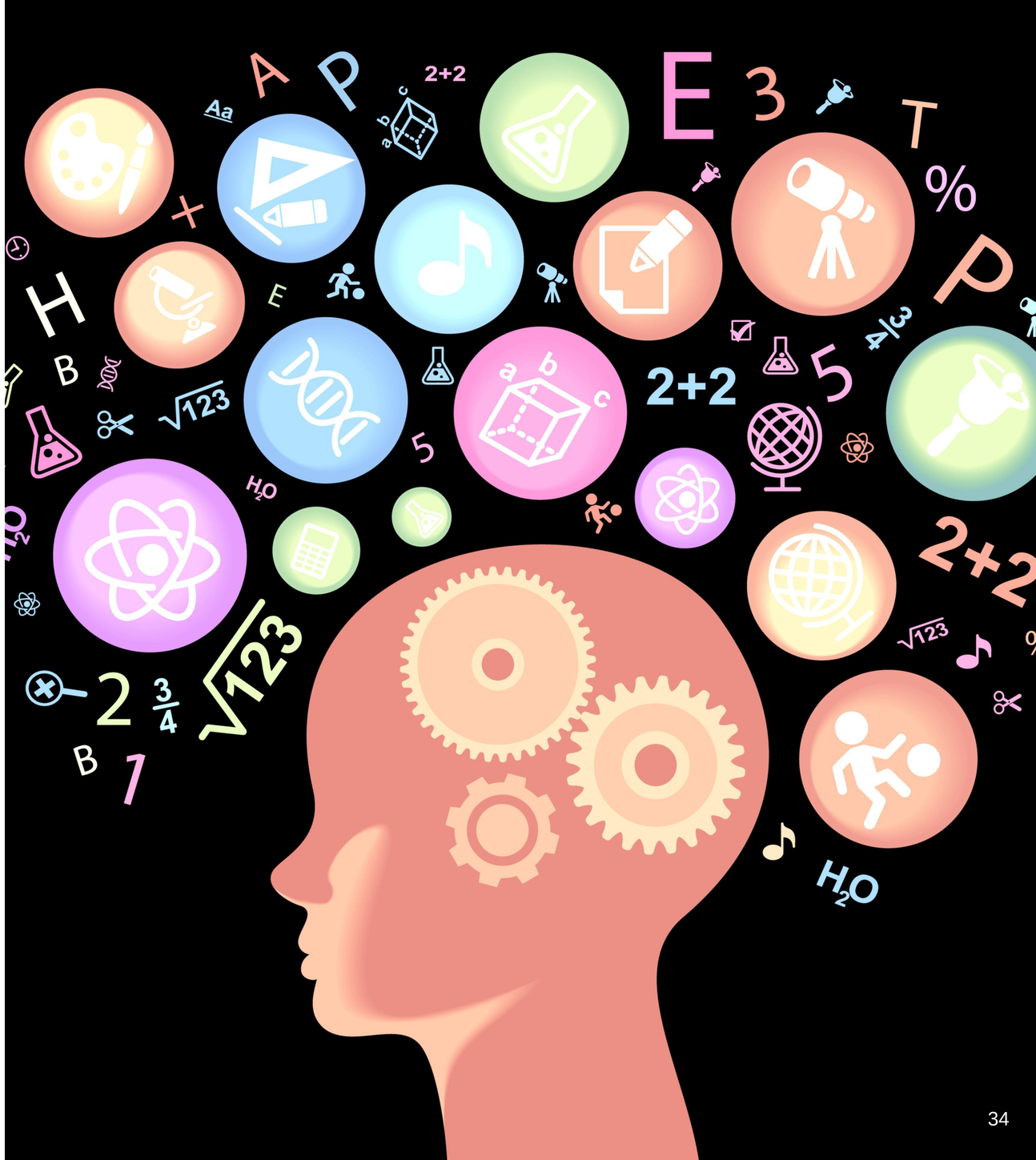
4. As the paper rolls from the drum, it passes over a heat and pressure area known as the fusing system. The fusing system melts the toner to the paper. The printed page then exits the printer.

   At the same time, the surface of the drum passes over another wire, called a corona wire. This wire resets the charge on the drum, to ready it for the next page.

Learning Objectives

On completion of this topic, you will be able to:

- Assess the relative merits of solid state drives and magnetic disks
- Explain the terms *seek time*, *latency* and *transfer time* in the context of disks
- Distinguish between mirrored and striped disk arrays
- Identify the essential characteristics of displays
- Explain the key differences between inkjet and laser printers



Directed Reading

- Englander, Chap. 10
- Stallings, Chap. 6