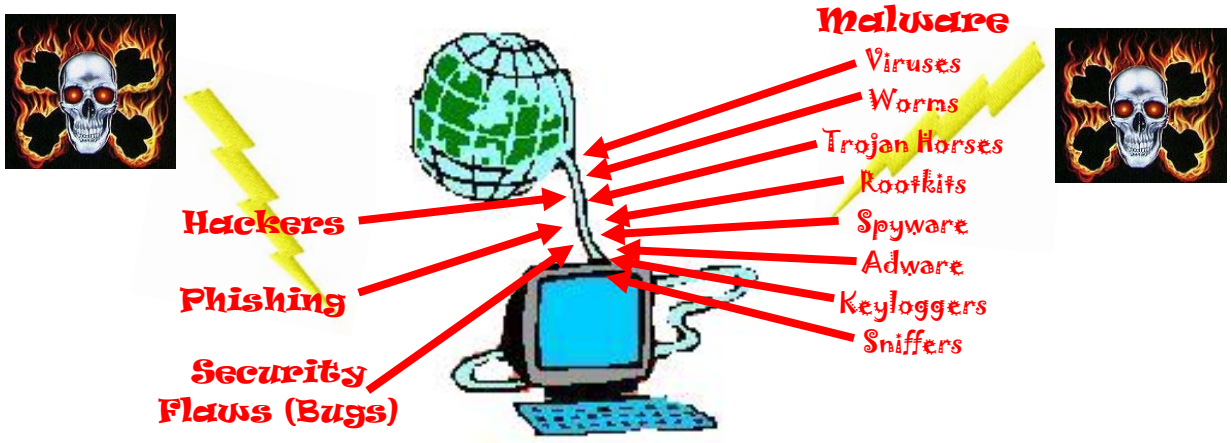
Table of Contents – Organizing, Protecting and Understanding your Computer

Protecting yourself, your Computer and your Data

Online Threats

If your Computer is connected to the Internet, it is NOT Safe!

Many people have a false sense of security when it comes to their computers. ***They incorrectly believe that they and their computers are invisible to and protected from the outside world***. Unfortunately, nothing could be further from the truth! Whenever a computer is connected to the Internet or any other network, it can become fully exposed to a variety of threats. The following diagram shows the most common dangers ***to you and your computer***.



Complete the Table

Some research is required for this question.

Threat	*Explanation*	*What is Threatened?*	*How can you Protect Yourself?*
Malware			
Viruses			
Worms			
Trojan Horses			
Rootkits			
Spyware			
Adware			
Security Flaws			
Phishing			
Hackers			
Keyloggers			
Sniffers			

How to keep your Computer Running as Smoothly and Flawlessly as Possible

Measure	*Explanation*
Use safe computing practices.	• ***Choose your passwords intelligently!*** Good passwords are easy to remember but difficult for others to guess. Strong passwords should contain letters, digits, punctuation marks and other characters. Weak passwords contain characters of only one type, personal information that is easy to find out or common words. *For more information, use Google to search for "bad passwords," "good passwords," "common passwords" and "password cracking."* • ***Only install software created by highly reputable companies or individuals***. In addition, before agreeing to the terms set out in the installation program, ***read the end-user licence agreement*** (EULA). If you click on "I Agree" without doing having read the EULA, you may actually be giving your consent to having spyware installed on your computer (usually called "Third Party Applications" in the EULAs). • Be aware of the fact that the Internet is largely unregulated. Anyone with Internet access can post documents of any kind. Therefore, you should expect that a certain percentage of the information that you find is false. Do not trust information unless it comes from an authoritative source. Also, it is wise to consult ***several sources!*** • Do not divulge personal information unless you are certain that you are dealing with a highly reputable organization. ***Never***, ***ever*** reveal your passwords or PINs! • Do not open email attachments unless you have verified that they are safe and that the source of the attachment is trustworthy. • Do not accept files during instant messaging chatting (**e.g.** MSN Messenger) unless you have verified that they are safe and that the source of the attachment is trustworthy. • ***Never***, ***ever*** agree to meet in person with any stranger who contacts you via the Internet or otherwise.
Install security software. • Firewall • Anti-virus • Anti-spyware	• A ***network firewall*** monitors and controls incoming and outgoing network traffic. Using a good firewall is the best way to stop hackers from gaining access to your computer. ***Operating system firewalls*** help to prevent malicious programs from performing dangerous actions. (e.g. ZoneAlarm free edition contains only a network firewall while ZoneAlarm Pro contains both a network and an OS firewall.) • ***Anti-virus*** software helps to prevent viruses, worms and Trojans from infecting your computer; it also helps to remove such programs from an infected computer. • ***Anti-spyware*** software helps to prevent the installation of spyware and adware; it also helps to remove such programs if they are already installed.
Obtain and install the latest updates for all your software.	• There is no such thing as perfect software! Almost all software has bugs! • Obtaining updates helps to prevent software crashes and other problems. • Updates often fix security vulnerabilities that could allow hackers to gain unauthorized access to your computer.
Uninstall software that you do not use.	• Use the "Add/Remove Programs" utility in "Control Panel" to uninstall unnecessary programs. Having too much software installed can have an impact on the performance of your computer. So if you don't really need it, get rid of it!
Delete unnecessary files.	• As you use your computer, a number of temporary files are used for system and application purposes. Often, these temporary files are not deleted automatically. You can use the Windows "Disk Cleanup" utility to remove these unneeded files. In addition, you should delete personal files that you no longer need.
Defragment your hard drive.	• A hard drive is a very slow device compared to RAM and the CPU. Therefore, it is critical that you keep the hard drive organized in such a way that it can function at maximum efficiency. A good way to do this is to ***defragment*** your drive. This process ensures that as much as possible, all "pieces" of a given file are stored "together" rather than being scattered all over your hard drive. All versions of Windows come with a defragmentation utility. In addition, there are many third party programs that keep all the "pieces" of your files organized.

Continuation of Table from Previous Page

Measure	***Explanation***
Upgrade your hardware	• Increase the amount of RAM installed. • Replace old, slow devices. • Buy a new computer!
Advanced Methods (Specifically for Windows Operating Systems)	• Use a registry cleaning utility.* • Use a registry defragmentation utility.* • Use a performance tweaking utility.* • Prevent unnecessary processes from running.* • Disable unnecessary services ("daemons").* • Use the windows "chkdsk" system utility to check your hard drive for errors and to repair the errors.*

*Only very experienced users should perform these actions. If you do not understand the nature of these actions, it is best ***not to attempt them!***

Questions

1. Find the names of at least three different anti-virus programs. Is it possible to get any free anti-virus programs?

2. Find the names of at least three different firewall programs. Is it possible to get any free firewall programs?

3. Find the names of at least three different anti-spyware programs. Is it possible to get any free anti-spyware programs?

4. State whether each of the given passwords is strong or weak. Justify each answer.

(a) green day

(b) qwertyuiop[]\

(c) 416-967-1111

(d) joe smith

(e) password

(f) computer

(g) brampton

(h) mom

(i) rex

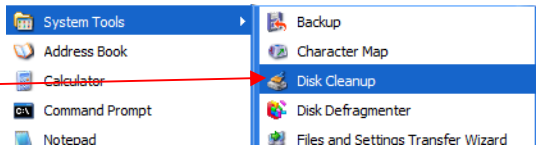
(j) greys anatomy

(k) ;kap 1 loo 2 ee;!

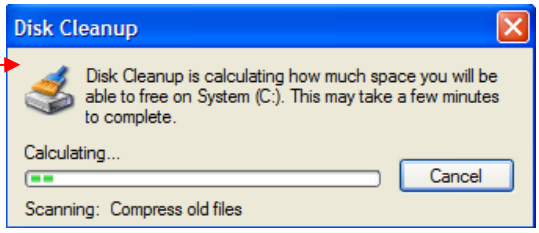
Examples of how some of the above Actions can be Performed in Windows XP

1. *Remove Unnecessary Temporary Files*

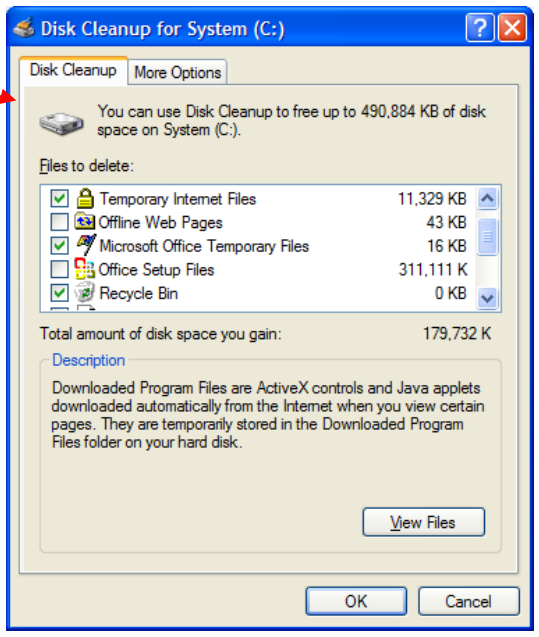
Choose "**System Tools**" from the "**Accessories**" menu and then click on "**Disk Cleanup**"



The "**Disk Cleanup**" window will appear and stay on the screen for a several seconds while Windows calculates the amount of disk space that can be saved.

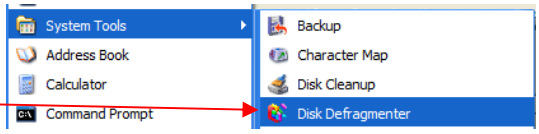


Finally, a dialogue box appears that lists several actions that can be taken to save drive space. Check the options that you like and uncheck the others. Then click "**OK**" to proceed.



2. *Defragment your Hardrive*

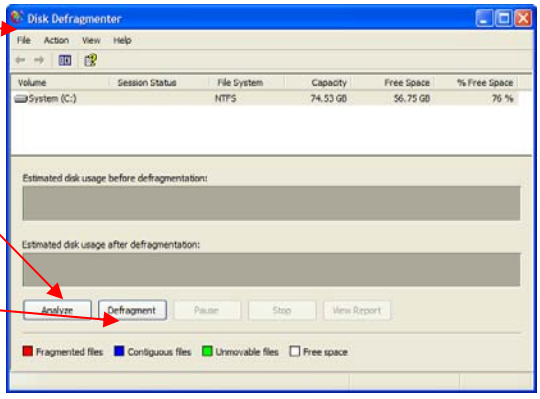
Choose "**System Tools**" from the "**Accessories**" menu and then click on "**Disk Defragmenter**"



The "**Disk Defragmenter**" management console will appear.

Click on "**Analyze**" to find out whether defragmentation is needed.

If defragmentation is necessary, click on "**Defragment**" to proceed.

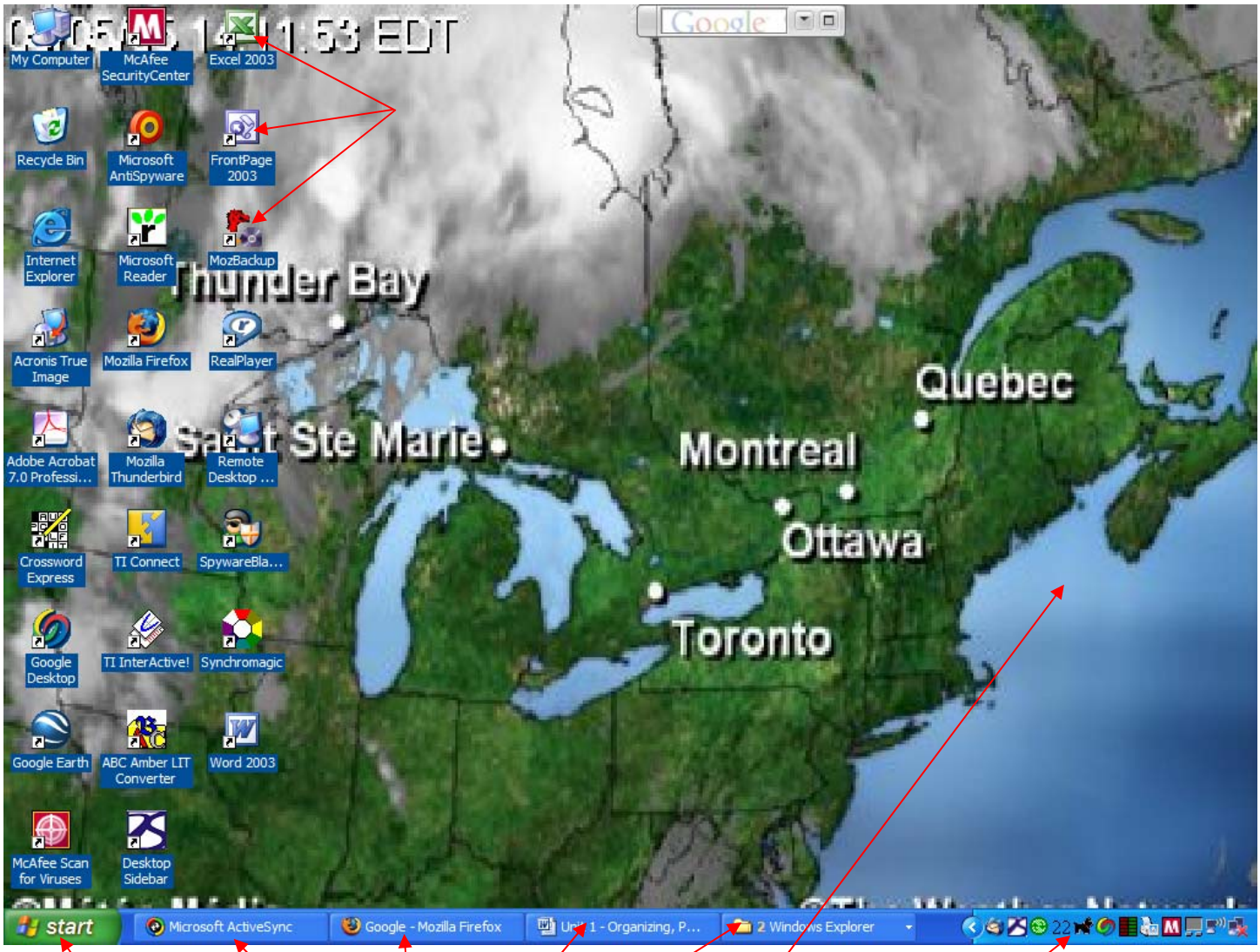


Organizing your Data

Understanding the Windows GUI (Graphical User Interface)

Question 1

Label each part of the Windows ***graphical user interface*** (GUI) to which an arrow is pointing. Besides listing the name of each part of the interface, also describe its purpose. (***Hint:*** You will find the answers to this question in question 2).



Question 2

Describe each of the following:

Concept	*Purpose and/or Description*	*Concept*	*Purpose and/or Description*
Icon (shortcut)		Start Menu	
Running Application		Desktop	
System Tray (System Notification Area)		(Desktop) Wallpaper	

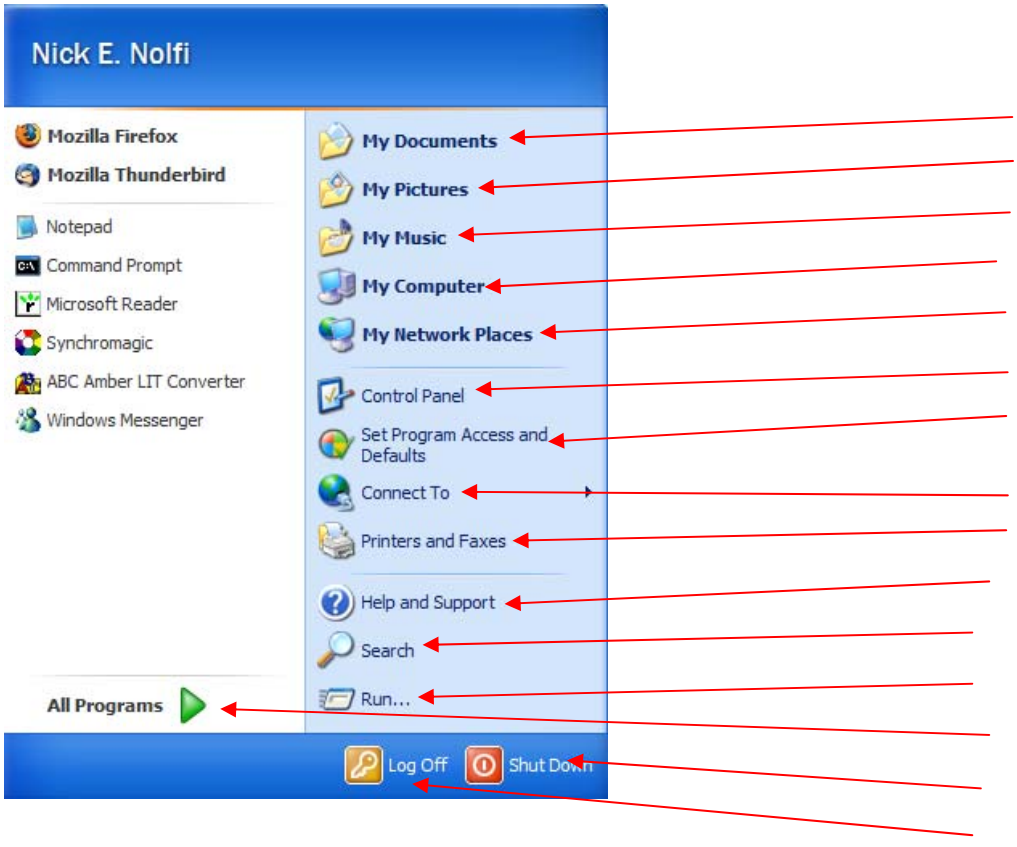
Question 3

Place a check mark in the column that best describes how you feel about each of the following terms.

Term	*I Definitely Know What this Means!*	*I Think I Know What this Means!*	*I Have no Clue!*	*Term*	*I Definitely Know What this Means!*	*I Think I Know What this Means!*	*I Have no Clue!*
hardware				resize			
software				title bar			
multi-tasking				recycle bin			
task				active window			
system task				inactive window			
process				ctrl-alt-del			
application				boot up (start up)			
task list (task manager)				reboot (restart)			
end task				program crash			
quick launch bar				system crash			
minimize				bug			
maximize				network			
restore				Internet			
close				World Wide Web			
graphical user interface (**GUI** → "gooey")				file			
interface				acronym			
file name				folder (directory)			
folder name				subfolder (subdirectory)			

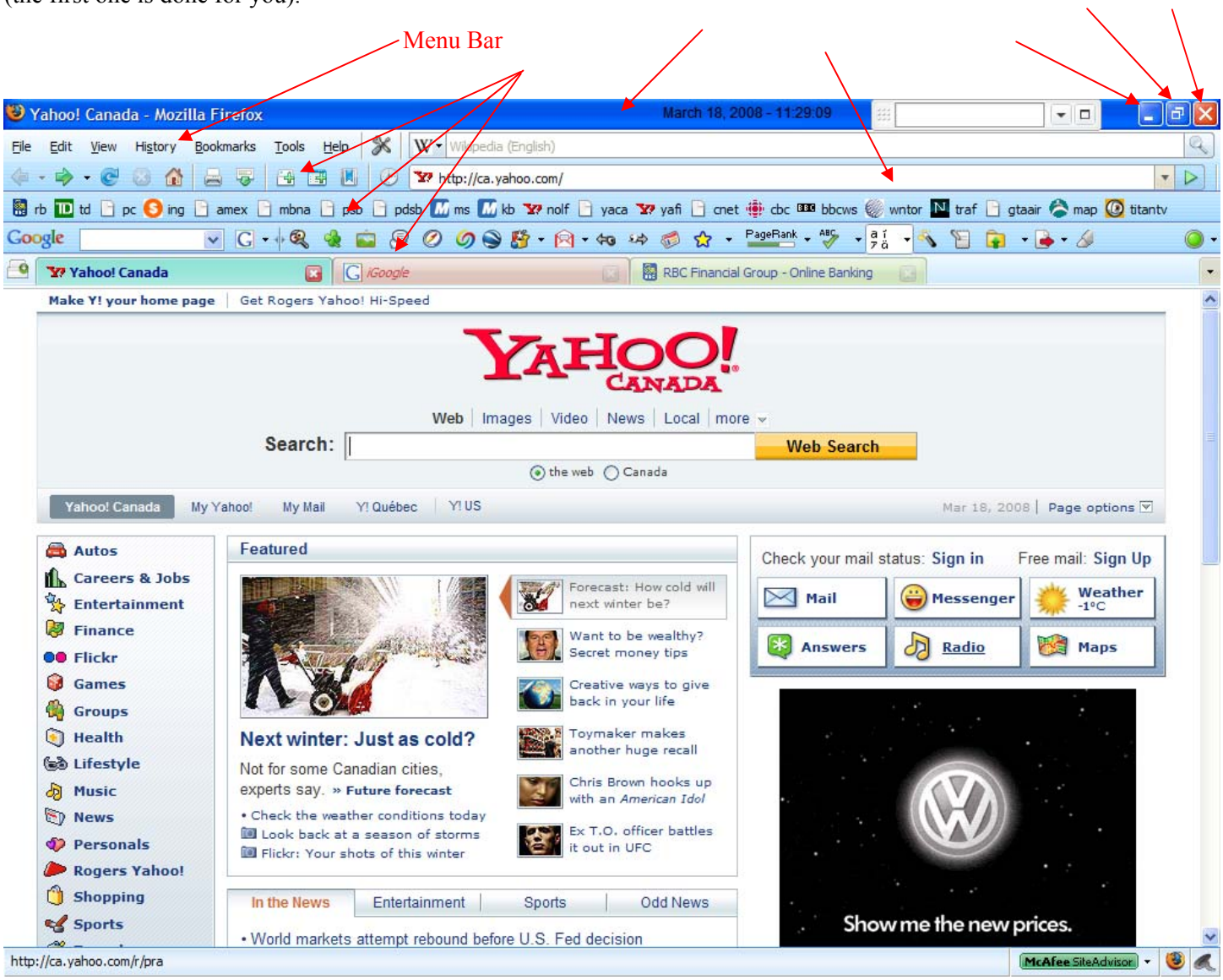
Question 4

Label each part of the start menu shown below to which an arrow is pointing. Besides listing the name of each part of the menu, also describe its purpose.



Question 5

Each arrow or group of arrows points to a general "area" or "part" of a typical window. State the ***name*** of each "part" (the first one is done for you).



Question 6

Explain the difference between ***minimizing*** an application and ***closing*** an application. When is it appropriate to close an application and when is it appropriate to minimize an application?

An Important Note on Research Skills

In the rest of this unit, you will be asked from time to time to use the Internet to find information. The following Web sites should allow you to find all the information that you need:

www.google.ca, www.webopedia.com, www.computeruser.com/resources/dictionary, foldoc.doc.ic.ac.uk/foldoc, www.techweb.com/encyclopedia, http://en.wikipedia.org

Please be aware of the fact that no single source of information can be considered authoritative! Even the sources listed above can lead you to inaccurate or misleading information. Therefore, you should consult several sources and you should exercise good judgement to ensure that you are finding reliable, trustworthy information.

Using Windows Explorer to Manage your Files

What is Windows Explorer?

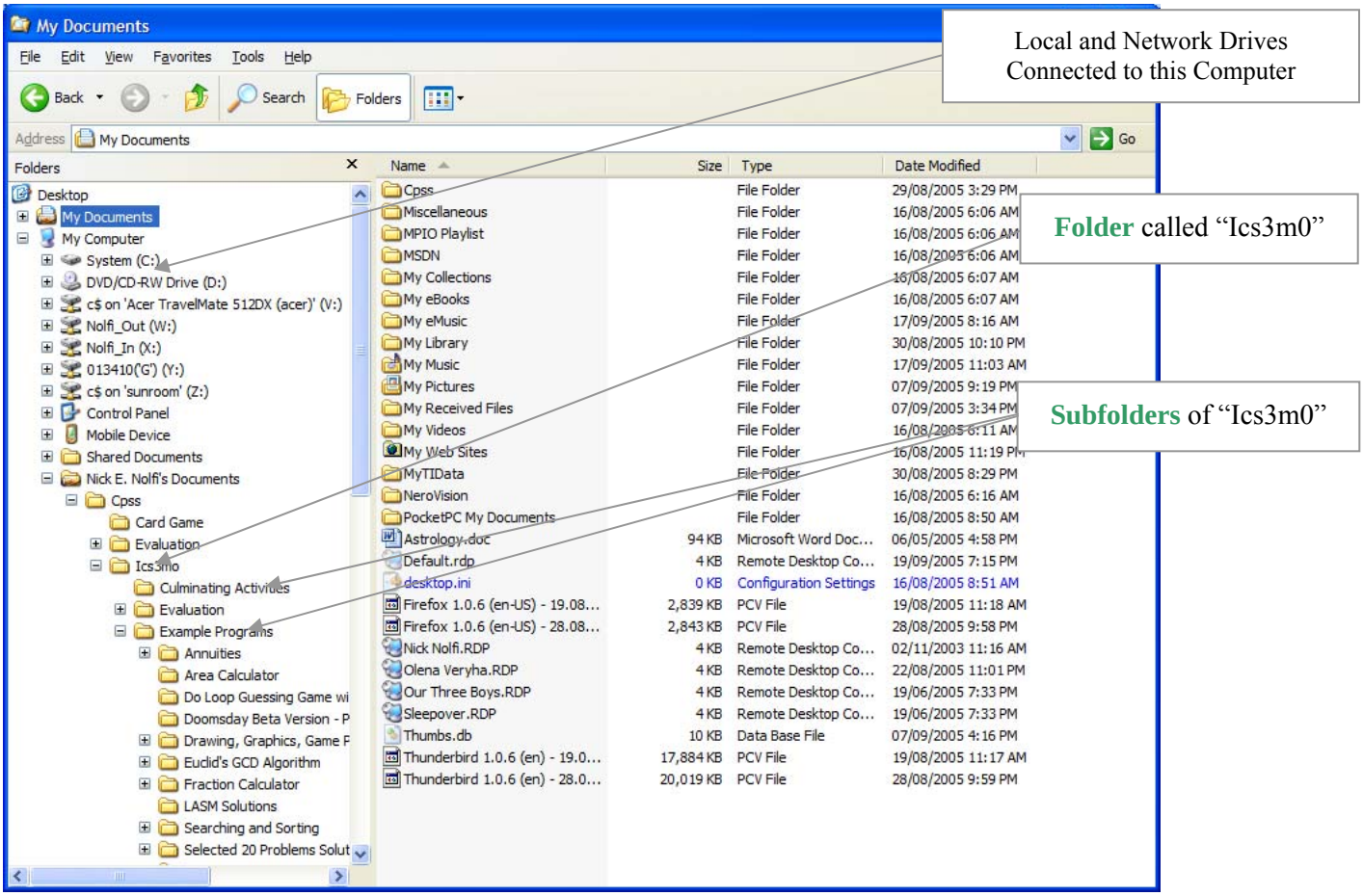
Microsoft Windows Explorer® is a program that allows Windows users to manage their files. It can be used to find, delete, move and copy ***any*** files stored on local or network drives including hard disk drives, drives with removable storage media and a host of other storage devices.

Launching Windows Explorer

There are a number of different ways of launching Windows Explorer. A few of them are listed below.

- Double-click the "My Computer" icon on the Windows desktop.
- Right-click the "Start" button and choose "Explore" from the pop-up menu.
- While holding the Windows logo ( ) key, press the "E" key.
- Double-click any program folder in the "Start" menu
- There is usually a shortcut to Windows Explorer somewhere in the "Start" menu (often in "Accessories")

Working with Windows Explorer



The following is an example of a ***folder path name:***

I:\Out\Nolfi\Ics3m0\Example Programs

Drive Letter (I:) (used to identify a ***physical*** or ***logical*** drive)	**Folder** called **"Out"** (at the ***root*** level of the "I:" drive)	**Folder** in **"Out"** called **"Nolfi"** (**"Nolfi"** is a ***subfolder*** of **"Out"**)	**"Ics3m0"** is a subfolder of **"Nolfi"**	**"Example Programs"** is a subfolder of **"Ics3m0"**

Folders are also called **Directories**

Questions

1. Define each of the following terms: **(Research Required)**

physical drive

logical drive

mapped drive

path name

root folder (or root directory)

filename extension (such as ".exe," ".txt," ".doc," ".mp3," ".wma," etc)

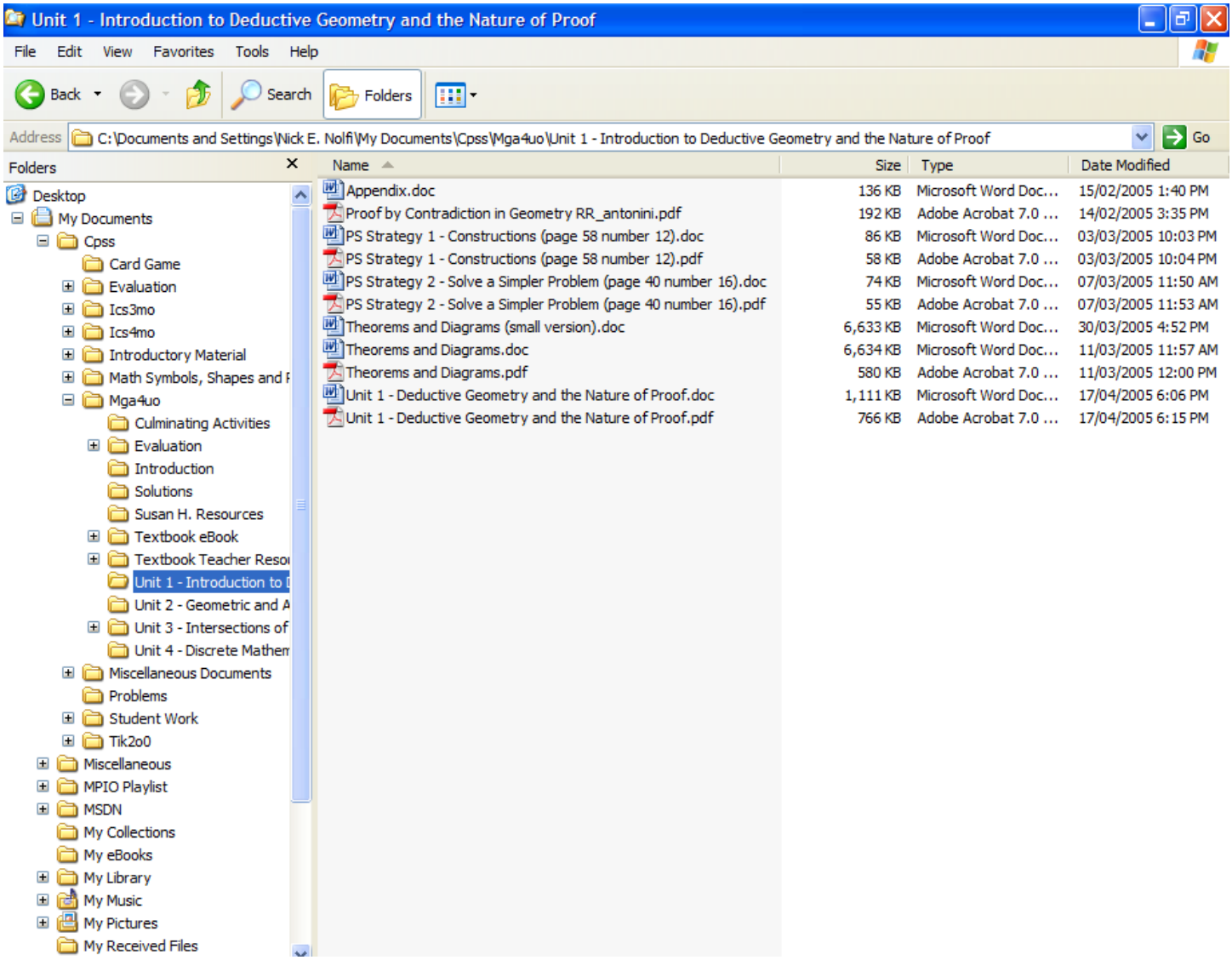
2. What are the rules for naming files and folders in Windows operating systems? **(Research Required)**

3. Organize your files in your **"g:"** drive in such a way that you have one folder for each unit in the course. Use the course outline document to determine an appropriate name for each folder. Is your **"g:"** drive a physical drive or a logical drive?

An Example of Well Organized Files and Folders

The following is an example of how I have organized my own "My Documents" folder. Notice the following:

- Each folder has a descriptive name that allows me to easily remember what is stored in the folder
- Each file has a descriptive name that allows me to easily remember the contents of the file
- The number of files in each folder isn't too large



Puzzlers 1

The names of six people are hidden in the sentence below. Can you find them? (The letters are in consecutive order.)

I wanted to go to London in September to read some prose by the river.

Can you make the following equation correct by moving only one matchstick?

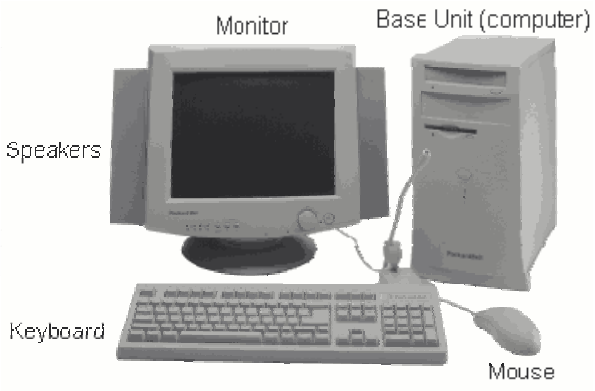
IV + II = VIII

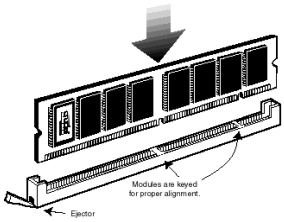
Understanding your Computer

What on Earth does all that Computer Gobbledygook Mean?

Exercise One

Name each computer component shown below (except, of course, for the ones that are already named).





Exercise Two

Define each of the following terms:

Input

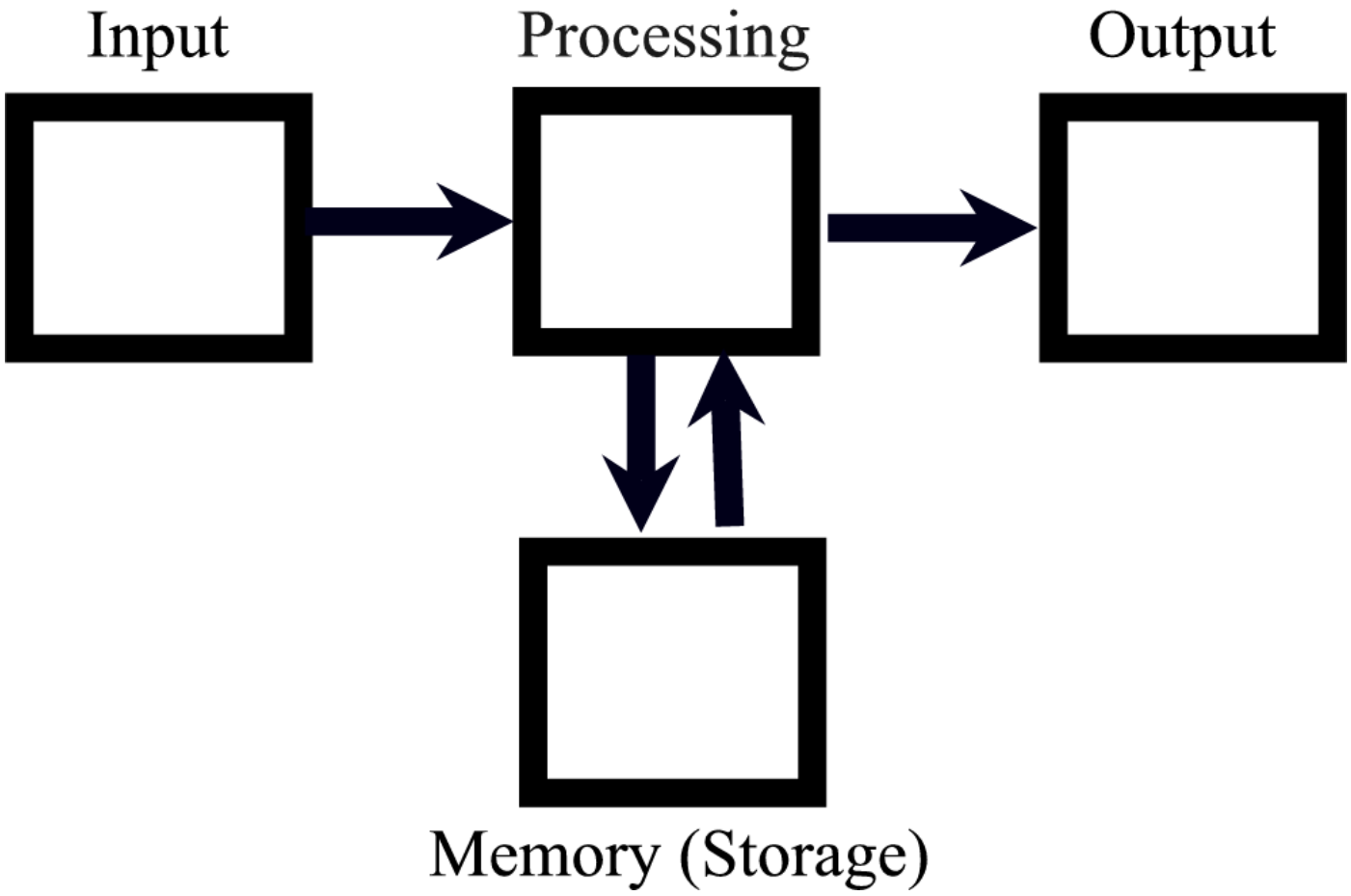
Processing

Output

Storage

Exercise Three

By placing in the appropriate box, classify each device listed in exercise one as an input device, a processing device, an output device or a storage device. (Some devices belong in more than one category.)



What on Earth does all that Computer Gobbledygook Mean? (Part 2)

Hardware versus Software

HARDWARE

Hardware – the physical components (such as electronic devices) of an apparatus (such as a computer)

Examples of computer hardware include monitors, printers, mice, keyboards, disk drives, connectors, cables, scanners, joysticks, processors, CD-ROM drives, DVD drives, and expansion cards
(**e.g.** video cards, sound cards, modem cards, etc.).



SOFTWARE

Software – computer programs (a program is a set of instructions that can be executed by a computer to complete a specific task)

Examples of computer software include Microsoft Word, Microsoft Windows 95/98/ME/NT/2000/XP/Vista, Corel WordPerfect, Norton SystemWorks, Mozilla Firefox, Microsoft Internet Explorer, Adobe Acrobat and RealPlayer.

Microsoft Windows Server 2003

real RealNetworks

System Software versus Application Software

SYSTEM SOFTWARE

System Software – The programs that allow a computer user to interact easily with computer hardware.

An ***operating system*** (OS) is software that acts as an intermediary (a "go-between") between computer hardware and a computer user. Operating systems allow users to run programs easily and manage files without the need for a technical knowledge of the hardware. Without an operating system, it would be virtually impossible for anyone to interact with a computer. Even people with the highest degree of technical expertise would find it difficult to operate a computer without an operating system.

Sometimes an OS is described as the master control program that provides an **interface** for a user to communicate with the computer, manages hardware devices, manages and maintains (disk) file systems and supports application software.

Examples of operating systems include the various versions of Windows, Linux, FreeBSD, Unix and OS X.

Mac OS X Version 10.2.8

Windows Vista

Microsoft Windows 2000 Professional

Debian Linux Ćwiczenia

Microsoft Windows xp

UNIX

APPLICATION SOFTWARE

Application Software – Computer programs that perform tasks that are of interest to computer users. Application software allows users to create or process text documents, spreadsheets, graphics and so on.

Examples of application software include games, office applications (such as word processors), image editors, programming languages, media players (for playing audio and video files) and Web browsers.

OpenOffice.org

Microsoft Office 2007

real RealNetworks

Adobe Photoshop CS3

Adobe Acrobat 7.0 Professional

Firefox Rediscover the web

Mozilla Thunderbird

Questions

1. Explain the differences between computer hardware and computer software.

2. Explain the differences between system software and application software.

3. Give ***five examples*** of application software that you have used. List both the name of the software and the type of application.

Name of Software	*Type of Application*
1.	
2.	
3.	
4.	
5.	

4. What is an operating system? Why does your computer need to have an operating system?

5. Microsoft Windows is a very popular operating system. List at least four others.

(i)

(ii)

(iii)

(iv)

Storage Capacities of Various Computer Media

						
Compact Storage Cards (Flash Memory)	**USB Flash Drive**	**CD-ROM**	**CD-R**	**CD-RW**	**DVD**	**Hard Disk Drive**
Capacities up to 16 GB or more (various types including CompactFlash, MMC, SD, XD, Memory Stick, Smart Media)	Capacities up to 16 GB or more	650 MB	700 MB	650 MB	From 2.4 GB up to 15.9 GB depending on format	Capacities up to about 1 TB – 2 TB

Storage Capacity Terms

- Commonly used storage units include bit, byte, kilobyte (KB), megabyte (MB), gigabyte (GB) and terabyte (TB)
- There are even larger units (see the Appendix) but are not yet in common usage.
- All these terms are used to express ***how much information can be stored***

Unit	*Explanation*
1 bit	The bit (***bi***nary digi***t***) is the ***smallest*** and ***most basic*** unit of storage capacity. The value of a bit can be either ***0*** or ***1***, representing the electronic states ***off*** and ***on*** respectively or the logical states ***false*** and ***true*** respectively.
1 byte = 8 bits	One bit cannot be used to represent very much information. When bits are grouped together, however, they do represent significant pieces of information. The most basic grouping of bits is the ***byte***. One byte is enough to store ***one character***. For example, using a character encoding scheme called ***ANSI***, the character "A" is represented using the byte "01000001." In more recent encoding schemes such as ***Unicode***, 2 bytes of storage are required for each character. Although this uses more storage space, it allows for the representation of far more characters. (**ANSI** → 256 characters, **Unicode** → 65536 characters)
1 KB = 1024 bytes	A group of 1024 bytes is called a ***kilobyte***. One kilobyte is a small amount of information, enough to store 1024 ANSI characters or 512 Unicode characters.
1 MB = 1024 KB	A group of 1024 kilobytes is called a ***megabyte***. One megabyte is equivalent to 1024×1024 bytes = 1048576 bytes = 1048576 ANSI characters = 524288 Unicode characters.
1 GB = 1024 MB	A group of 1024 megabytes is called a ***gigabyte***. One gigabyte is equivalent to 1024×1024 ×1024 bytes = 1073741824 bytes = 1073741824 ANSI characters = 536870912 Unicode characters.
1 TB = 1024 GB	A group of 1024 gigabytes is called a ***terabyte***. One terabyte is equivalent to 1024×1024 ×1024 ×1024 bytes = 1099511627776 bytes = 1099511627776 ANSI characters = 549755813888 Unicode characters.

- It is important to note that in the area of computer storage, the term "kilo" originally was intended to mean 1024, not 1000. This is due to the fact that computer circuits process ***binary information***, which is based on ***two*** not ***ten***! The number 1024, which is equal to 2^{10}, is the power of two that is closest to 1000.
- The above point notwithstanding, storage device and storage medium manufacturers usually exaggerate storage capacities by using kilo = 1000 instead of kilo = 1024. In this case, a lowercase "k" is sometimes used to distinguish between the binary and decimal meanings of kilo. (**e.g.** 1 kB = 1000 bytes, 1 KB = 1024 bytes). For instance, the storage capacity of a DVD-ROM is usually stated as 4.7 GB. The actual storage capacity is about 4.38 GB ($4.7\times1000^3\div1024^3$).

Confusion over the Meaning of Kilo

Decimal (Base 10) Meaning	*Binary (Base 2) Meaning*
kilo = 1000 = 10^3 • used in the metric (SI) system of units (**e.g.** 1 kilometre = 1000 metres) • used almost exclusively nowadays to express computer storage capacities and data transfer rates (**e.g.** 1 kilobyte = 1000 bytes)	kilo = 1024 = 2^{10} (power of 2 closest to 1000) • traditionally used in expressing computer storage capacities (**e.g.** 1 kilobyte = 1024 bytes) • no longer used in computer advertising but operating systems such as Windows use this meaning (**e.g.** 100 MB = 1024 KB = 1024×1024 bytes = 1048576 bytes)

Questions

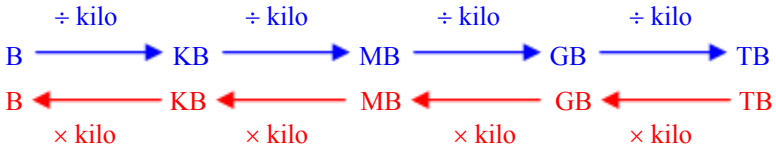
1. Explain why the prefix "kilo" means originally1024 in the world of computer storage instead of 1000. Do computer hardware manufacturers use this definition in their advertising? Explain.

2. Due to a lack of sufficient storage space on your computer, you purchase a new hard drive. According to the manufacturer, your new hard drive has a storage capacity of 1.5 TB. Once you connect it to your computer, however, your OS reports that the storage capacity of the drive is only 1397.0 GB.

(a) By writing ***one*** or ***two complete sentences***, explain the discrepancy.

(b) Show how the figure of 1397.0 GB was calculated.

3. A floppy diskette has a storage capacity of only 1.44 MB (***binary*** meaning of kilo). Use the information in the conversion chart at the right to determine how many floppy diskettes it would take to store the same amount of information as



(a) one 700 MB CD-R (assume ***binary*** meaning of kilo)

(b) one 4.38 GB DVD-ROM (assume ***binary*** meaning of kilo)

(c) one 1 TB hard drive (assume ***decimal*** meaning of kilo)

4. The average English novel contains approximately 100000 words.

(a) How many such novels would you be able to store on a hard drive with a storage capacity of 1 TB if each character is stored using the Unicode system (2 bytes per character)? You need to make reasonable assumptions about the average length of one word (including spaces and punctuation marks) and whether the decimal or binary meaning of kilo should be used.

(b) Assuming that each novel takes up 1 cm of space on a bookshelf (a very conservative estimate indeed), how much bookshelf space would be needed to store the number of novels that you calculated in (a)? Express your answer in ***kilometres***.

Storage Media

Read Only Media	*Read-Write Media*
• CD-ROM • DVD-ROM • BD-ROM (Blu-ray) • HD DVD-ROM	• Floppy diskette (1.44 MB storage capacity) ***OBSOLETE*** • Hard disk drive • CD-R, DVD-R, DVD+R, HD DVD-R, BD-R These disks are originally "blank." Once information is recorded on them (i.e. written to them), they ***cannot be erased***. • CD-RW, DVD-RW, DVD+RW, HD DVD-RW, BD-RE These disks are originally "blank." Once information is recorded on them (i.e. written to them), they ***can be erased and rewritten***.

Various Optical Disc Formats

Optical disks all operate on the same basic principles (see page 20 for details). Essentially, a ***laser beam*** is used to "read" information from a disk, hence the name ***optical*** (meaning "of or relating to or involving ***light***").

Compact Disc (CD) Formats

Pre-Pressed CDs (not burned) Used chiefly for mass produced music and software		***Burned CDs*** Used by computer users for a variety of purposes			
CD-ROM (CD Read Only Memory)		**CD-R**		**CD-RW**	
Digital Audio Use	General Data Use	Digital Audio Use	General Data Use	Digital Audio Use	General Data Use
746.9 MB	650.3 MB	807.4 MB	703.1 MB	807.4 MB	703.1 MB

Digital Versatile Disc (DVD) Formats

SS = single-sided, DS = double-sided, SL = single layer, DL = dual layer

Pre-Pressed DVDs (not burned) Used chiefly for mass produced movies				***Burned DVDs*** Used by computer users for a variety of purposes							
DVD-5 SS/SL	**DVD-9** SS/DL	**DVD-10** DS/SL	**DVD-18** DS/DL	**DVD-R** SS/SL	**DVD-R** SS/DL	**DVD+R** SS/SL	**DVD+R** SS/DL	**DVD-RW** SS/SL	**DVD-RW** SS/DL	**DVD+RW** SS/SL	**DVD+RW** SS/DL
4.38 GB	7.96 GB	7.96 GB	15.93 GB	4.38 GB	7.96 GB	4.38 GB	7.96 GB	4.38 GB	7.96 GB	4.38 GB	7.96 GB

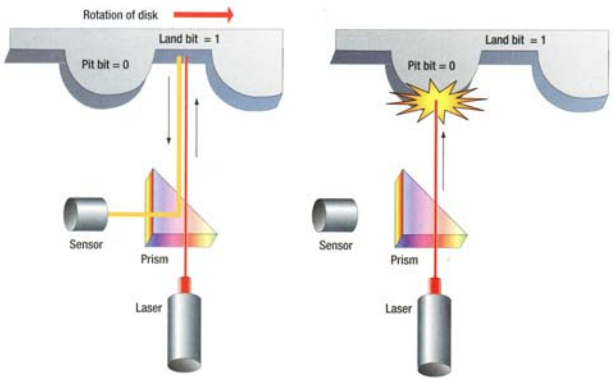
High Density or "High Definition" (HD) Disc Formats

These discs are called "high definition" only because they have enough storage space to store video in high definition (HDTV) format. They can, of course, be used to store any kind of digital data.

Pre-Pressed (not burned) Used chiefly for mass produced high definition movies				***Burned*** Used by computer users for a variety of purposes			
Blu-Ray		**HD DVD (obsolete*)**		**Blu -Ray**		**HD DVD (obsolete*)**	
BD-ROM SS/SL	**BD-ROM** SS/DL	**HD DVD-ROM** SS/SL	**HD DVD-ROM** SS/DL	BD-R	BD-RE	HD DVD-R	HD DVD-RW
23.28 GB	46.57 GB	13.97 GB	27.94 GB	807.4 MB	703.1 MB	807.4 MB	703.1 MB

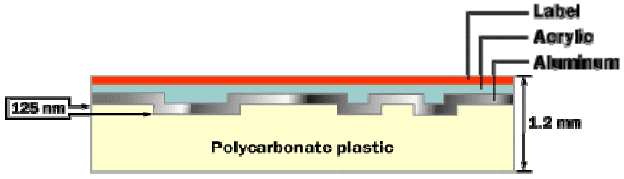
* On February 19, 2008, Toshiba announced that the company would no longer develop, manufacture or market HD DVD players and recorders. This officially ended the high definition optical disc format war, with Blu-Ray emerging as the undisputed winner.

What makes Optical storage Devices "Tick"



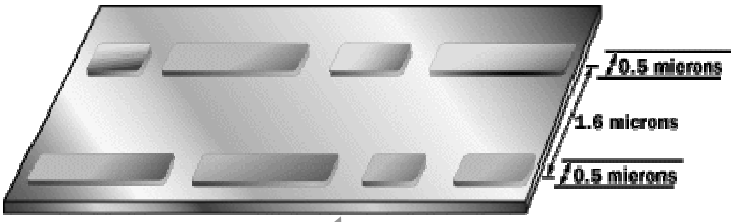
To Reflect or Scatter?

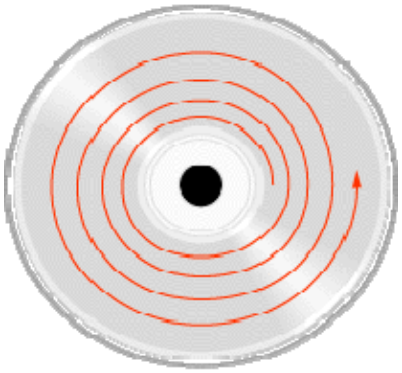
When laser light meets a land, it is reflected straight back through a prism. The prism bends the light to direct it toward a sensor. The sensor interprets the reflected light as an "on" pulse, that is, a "1." On the other hand, when laser light meets a pit, it is scattered, which either prevents it from being detected by the sensor or which causes the sensor to detect a very weak signal. The absence of a signal or a very weak signal is interpreted as an "off" pulse, that is, a "0."



Cross-Section of a CD

A CD consists of a very thin layer (125 nm = 125 nanometres = 125 billionths of one metre) of aluminium sandwiched between a relatively thick layer of polycarbonate plastic and a very thin acrylic layer. The thin acrylic layer is sprayed on to protect the aluminium layer. When viewed from the top (label) side, the layer of aluminium consists of flat areas and "pits." When viewed from below (the laser side), the "pits" appear as bumps. Since the flat areas (the "lands") and the bumpy areas ("the pits") reflect light differently, a CD reader is able to convert a sequence of pits and lands into a stream of bits (0s and 1s).

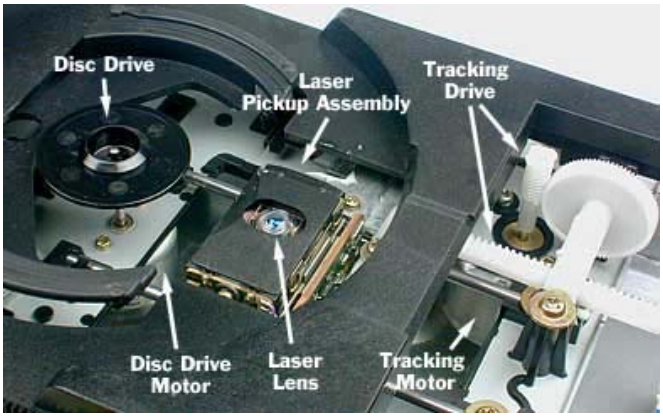




The Continuous Spiral of Data

A CD has a single spiral track of data, circling from the inside of the disc to the outside. The fact that the spiral track starts at the centre means that the CD can be smaller than 12 cm if desired.

What the picture on the left does not even begin to impress upon you is how incredibly small the data track is; it is approximately 0.5 microns (µm) wide, with 1.6 µm separating one track from the next. (A ***micron*** or ***micrometre*** (µm) is one millionth of a metre.) The elongated bumps that make up the track are each 0.5 µm wide, a minimum of 0.83 µm long and 125 nm high. (A nanometre (nm) is one billionth of a metre.)



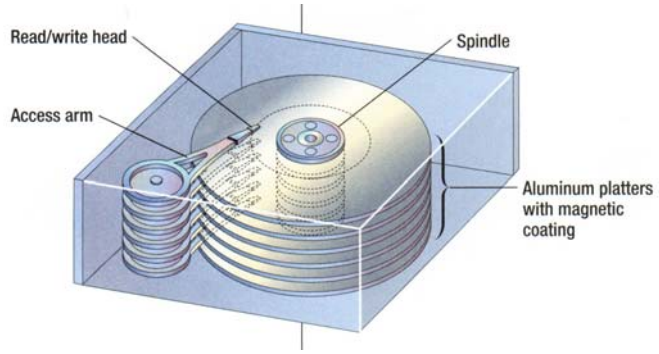
The Inner Workings of a CD Drive

The photograph at the left shows some of the internal devices found within any CD drive. The ***laser pickup assembly*** can slide back and forth to access any part of the spinning disk. The ***disk drive*** is simply a spindle attached to the ***disk drive motor***, which is used to spin the disk.

For a couple of great Flash animations that show how the workings of a CD drive in action, click on the following link:

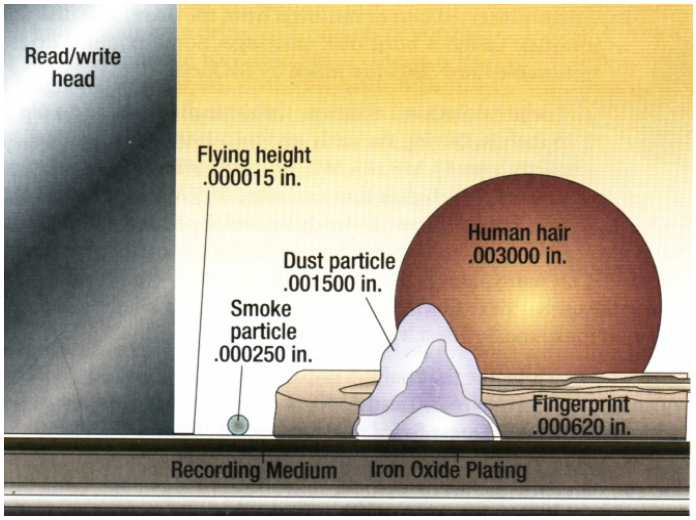
http://entertainment.howstuffworks.com/cd5.htm

What Makes Hard Drives (and other Magnetic Storage Devices) "Tick"



The Inner Workings of a Hard Drive

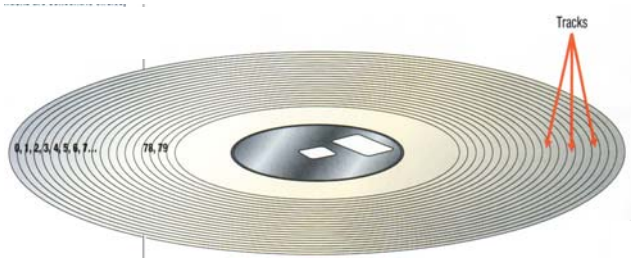
- The ***read/write head*** uses magnetism to read information from the disk surface or store information on the disk surface.
- Each read/write head is located at the end of an ***access arm***, which can move back and forth to access any area of the platter.
- Each ***platter*** is an aluminium disk coated with iron oxide. Usually, information is stored on both the top and bottom surface of each platter.

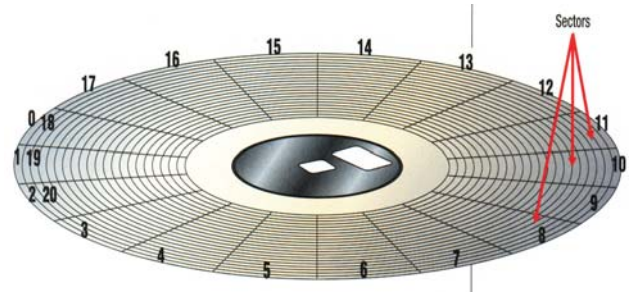


The "Flying" Read/Write Head

As mentioned above, the read/write head is used either to read the magnetic patterns stored on a hard disk or to write new magnetic patterns to the disk. In order to work properly, the read/write head must "float" a miniscule distance (0.000015 inches = 0.000038 cm) above the surface of the disk while the disk is spinning. This distance is called the ***flying height of the read/write head***. If the read/write head should come into contact with the disk surface while the disk is spinning, a ***head crash*** occurs, causing the disk to become irreparably gouged. A head crash is a very severe problem that often leads to unrecoverable data loss.

In the diagram at the left, you can clearly see that even the diameter of a particle of smoke is ***seventeen times greater than the flying height of the read/write head!*** For this reason, hard drives must be manufactured and assembled in an extremely clean environment. An airtight seal must be created to prevent the entry of any particles that could become lodged between the disk surface and the read/write head and cause a ***head crash***.





Tracks and Sectors

All magnetic disks (both floppy and hard) need to be ***formatted*** before they can be used. This means that ***tracks*** are laid down on the disk surface. Each track is then further divided into a number of ***sectors***.

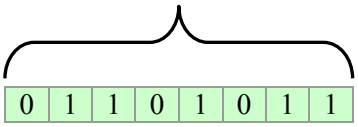
To locate any data stored on a disk, the read/write head must first be moved to the correct track. The disk must then spin in such a way that the read/write head is located above the sector containing the desired information.

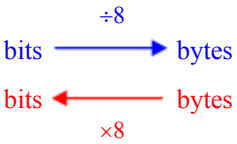
Although the diagrams at the left suggest that the tracks are somehow "carved" into the disk surface, this is not at all the case! Each track in fact consists of tiny ***magnetized areas*** that either have a "North-South" polarity or a "South-North" polarity. The read/write head is able to detect ***reversals*** in polarity (i.e. from "N-S" to "S-N" or from "S-N" to "N-S"). This information, in addition to synchronization (timing) information stored on the disk, allows the hard drive's controller circuitry to interpret the changes in polarity as zeros and ones.

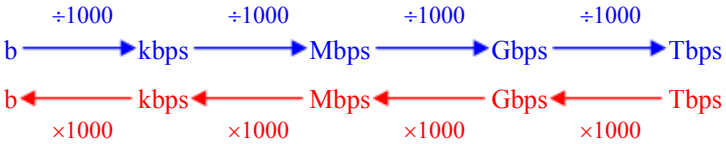
Data Transfer Rate Terminology

- For data transfer rates, "kilo" ***usually*** means 1000 instead of 1024 (lowercase "k" is used instead of uppercase "K")
- ***"b"*** stands for ***bits***, ***"B"*** stands for ***bytes***
- kilobits per second (***kbps***), Megabits per second (***Mbps***), Gigabits per second (***Gbps***), Terabits per second (***Tbps***)
  (k=1000, M=1000×1000=1000000, G=1000×1000×1000=1000000000, T=1000×1000×1000×1000=1000000000000)

One ***byte*** is a group of ***8 bits***.







Important Research Activity

1. Use the Internet to find information on each of the following methods of connecting to the Internet. You should look for very basic information on how each method works and how much each type of connection costs.
   Dial-up, ADSL, Fibre Optic (spelled "Fiber Optic" by Americans), Portable (Wireless) Internet, Cable, T-Carrier

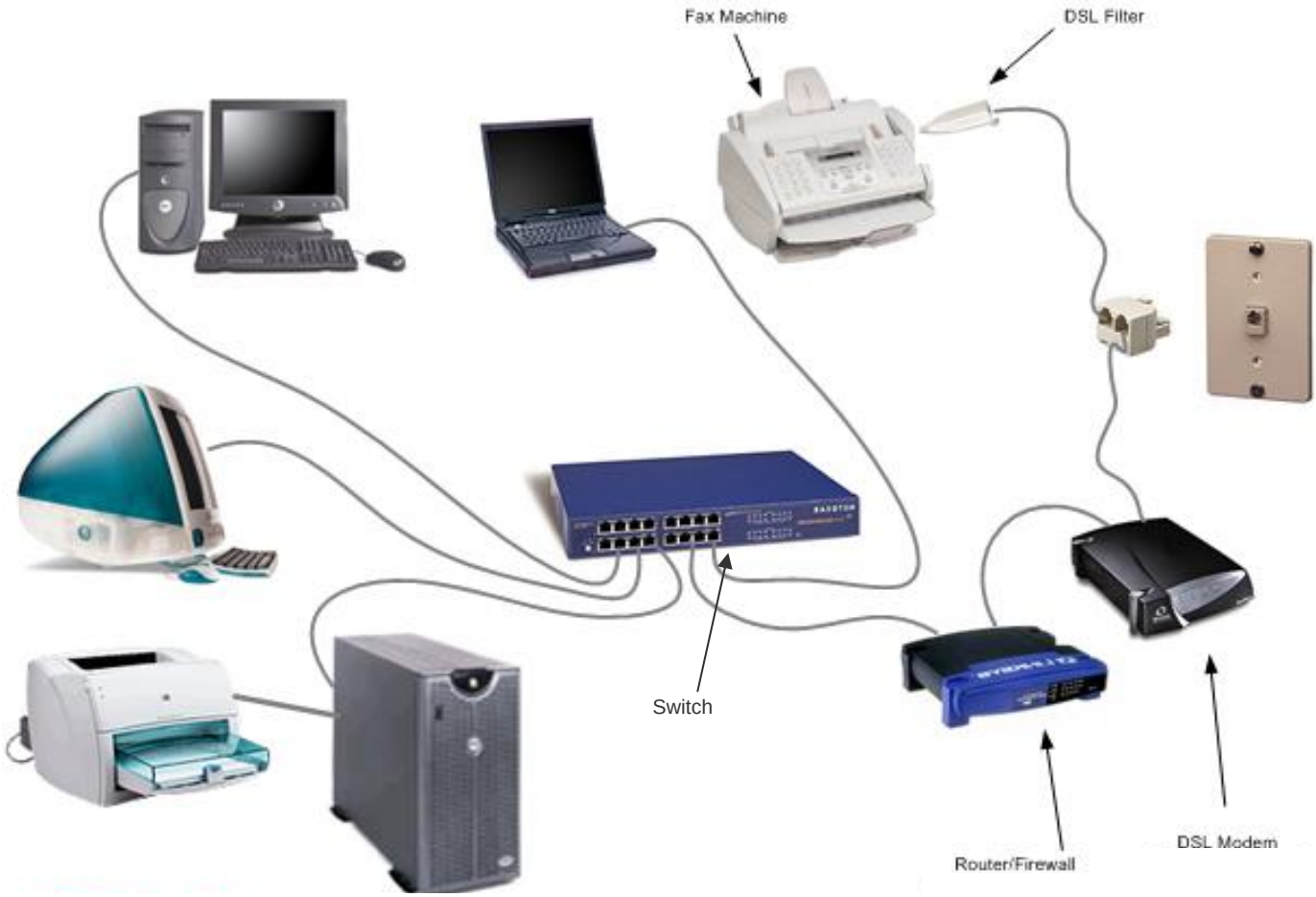
   Note: Save your research information in a word processing document. Later you will be handing in the results of your research. (Google is probably the best way to find information.)

2. Complete the following table. Use the decimal meaning of kilo for this question.

Speeds of Various Methods of Connecting to the Internet

Type of Internet Connection		*Maximum Downstream Data Transfer Rate*	*Maximum Upstream Data Transfer Rate*	*Minimum Time Required to Download one 5 GB file*	*Minimum Time Required to Upload one 1 GB file*
Dial-up	Dial-up Connection offered by any Company in North America	56.6 kbps	56.6 kbps		
Fibre Optic	Sympatico Fibre Optic Connection ("Total Internet Max")	16 Mbps	1 Mbps		
ADSL	Sympatico ADSL (fastest) ("Total Internet Performance")	7 Mbps	1 Mbps		
	Sympatico ADSL (slowest) ("Total Internet Essential")	500 kbps	500 kbps		
Portable Internet	"Bell WiMax Unplugged"	3 Mbps	384 kbps		
	"Bell WiMax Unplugged"	512 kbps	128 kbps		
	"Rogers Portable Internet"	1.5 Mbps	256 kbps		
	"Rogers Portable Internet Basic"	256 kbps	64 kbps		
Cable	Rogers Cable (fastest) ("High-Speed Internet Extreme")	8 Mbps	800 kbps		
	Rogers Cable (slower) ("High-Speed Internet Express")	7 Mbps	512 kbps		
	Rogers Cable (slowest) ("High-Speed Internet Lite")	1 Mbps	128 kbps		
T-Carrier	DS1 (T1)	1.544 Mbps	1.544 Mbps		
	DS3 (T3)	44.736 Mbps	44.736Mbps		
	DS4	274.176 Mbps	274.176 Mbps		
	DS5	400.352 Mbps	400.352 Mbps		

How to Share your Internet Connection using a Local Area Network (LAN)



Switches and Hubs

A ***switch*** (or switching hub) is a device that has multiple ports and forms a common connection point for devices in a network. It is used to filter and forward ***packets*** (small bundles of data transmitted over networks) between segments of a local area network (LAN). Switches read the destination address of each packet and ***forward packets only to the correct ports***. This helps to make the most efficient use of the available ***bandwidth*** (the maximum amount of data that can be transmitted along a channel in a fixed amount of time).

A ***hub*** (or non-switching hub) is an older technology that performs the same function as a switch but does so less efficiently. When a packet arrives at one port, it is ***copied to all the other ports*** so that all segments of the LAN can see all packets. This is usually a huge waste of the available bandwidth.

Routers

A ***router*** is a device that is used to ***connect*** a local area network (LAN) to a wide area network (WAN). Routers that are meant for home use also have a ***switch*** and a ***firewall*** built in. The firewall helps to prevent unauthorized access while the switch allows several computers to be connected to your home LAN.

Modems

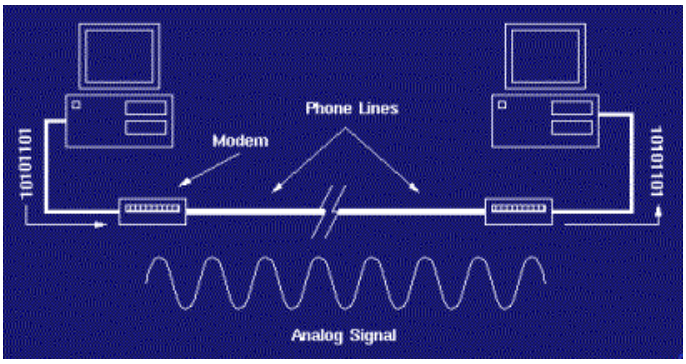
A modem is a device or a program that allows computers, which transmit, receive and store information in ***digital*** form, to transmit and receive information across ***analogue*** systems such as telephone and cable TV networks.

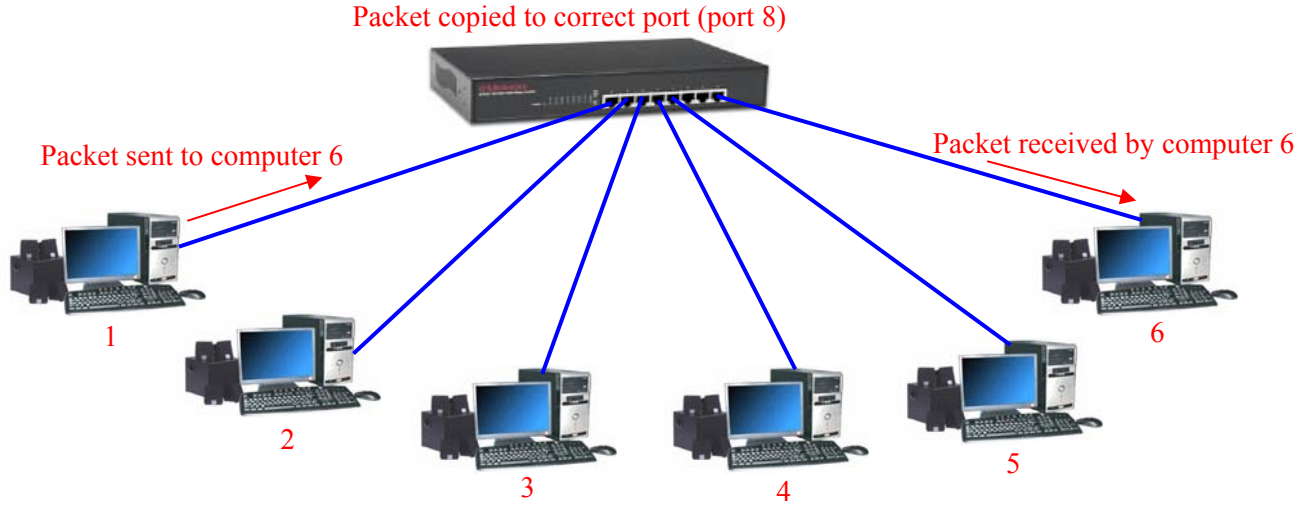
The word "modem" is an abbreviation of ***mod***ulator-***dem***odulator, a term that describes a modem's job of converting information between digital and analogue forms.

Note: Digital information is entirely encoded as a series of "on-off" pulses, often described mathematically as ***zeros*** ("off pulses") and ***ones*** ("on pulses"). Modems are necessary because telephone and cable TV lines cannot carry digital information. Instead, cable and telephone lines carry information using analogue waves. ("Analogue" is also spelled "analog," especially in the U.S.)

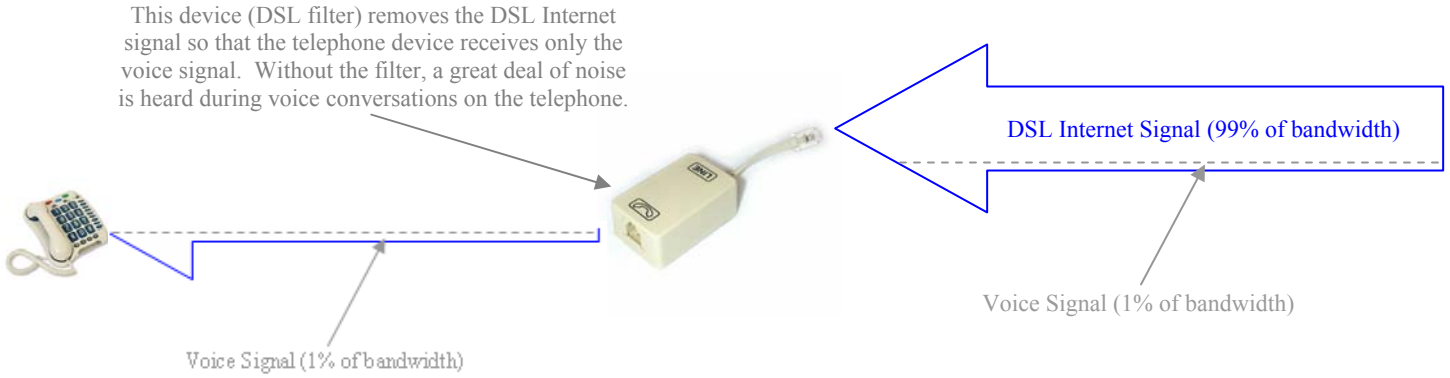
DSL Filter

DSL (digital subscriber line) is a type of high-speed Internet connection that takes advantage of the largely unused bandwidth of plain old telephone wires. Only 1% of the available bandwidth is used for voice communication over telephone lines, leaving 99% of the bandwidth available for Internet traffic. Therefore, the same wire is used to carry two different services that do not interfere with each other. However, a DSL filter must be installed for each phone to sift out all but the voice frequencies. Otherwise, a great deal of noise will be heard on the phones.





Note: The network connection device shown in the diagram must be a switch because it is able to copy packets only to the ports that require them. A hub would need to copy the packets to all ports because hubs do not read the destination addresses of packets.



Networks and Network Topologies

Network

A network is a group of two or more computer systems linked together. There are many types of computer networks including:

- **local-area networks (LANs):** The computers are geographically close together (that is, in the same building).
- **wide-area networks (WANs):** The computers are farther apart and are connected by telephone lines or radio waves.

In addition to these types, the following characteristics are also used to categorize different types of networks:

- **topology:** The geometric arrangement of a computer system. Common topologies include a bus, star and ring.
- **protocol:** A protocol defines a common set of rules and signals that computers on a network use to communicate. One of the most popular protocols for LANs is called Ethernet. Another popular LAN protocol for PCs is the IBM token-ring network.
- **architecture:** Networks can be broadly classified as using either a peer-to-peer or client/server architecture.

Computers on a network are sometimes called ***nodes***. Computers and devices that allocate resources for a network are called ***servers***.

Since computer networks allow for the easy and fast sharing of information and resources, they are vital to the success of businesses and other organizations.

Peer-to-Peer Network Architecture

A peer-to-peer network is a type of network in which each workstation has equivalent capabilities and responsibilities. This differs from client/server architectures, in which some computers are dedicated to serving the others. Peer-to-peer networks are generally simpler, but they usually do not offer the same performance under heavy loads.

Client/Server Network Architecture

A ***client/server network*** is a type in which each computer or process on a network is either a ***client*** or a ***server***. ***Servers*** are powerful computers or processes dedicated to managing disk drives (file servers), printers (print servers) or network traffic (network servers). ***Clients*** are PCs or workstations on which users run applications. Clients rely on servers for resources, such as files, devices and even processing power.

Client-server architectures are sometimes called ***two-tier architectures***.

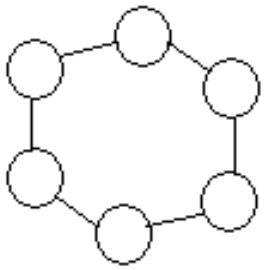
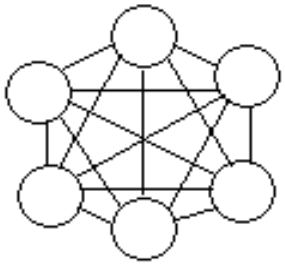
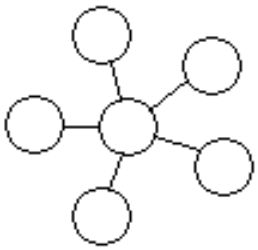
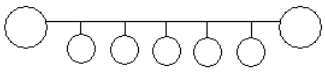
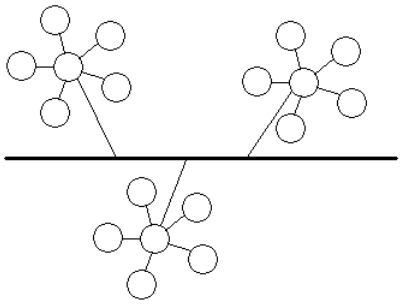
Questions

1. Why are computer networks so important to businesses and other organizations? In particular, explain how computer networks can save money and time.

2. Compare and contrast LANs and WANs.

3. Compare and contrast client/server and peer-to-peer network architectures.

Topology refers to the shape of a network, or the network's layout. How different nodes in a network are connected to each other and how they communicate are both determined by the network's topology. Below are diagrams of the five most common network topologies.

Description of Topology	*Diagram*	*Advantages*	*Disadvantages*
Ring Topology All devices are connected to one another in the shape of a closed loop, so that each device is connected directly to two other devices, one on either side of it.			
Mesh Topology Devices are connected with many redundant interconnections among network nodes. In a true mesh topology, every node has a connection to every other node in the network.			
Star Topology All devices are connected to a central hub. Nodes communicate across the network by passing data through the hub.			
Bus Topology All devices are connected to a central cable, called the bus or backbone.			
Tree Topology This is a hybrid topology. Groups of star-configured networks are connected to a linear bus backbone.			

The Internet

The ***Internet*** is a global ***network*** connecting literally billions of computers. To access the Internet, it is necessary to have an ***Internet Service Provider (ISP)***.

Unlike online services, which are centrally controlled, the Internet is decentralized by design. Each Internet computer, called a ***host***, is independent. Its operators can choose which Internet services to use and which local services to make available to the global Internet community. Remarkably, this anarchy by design works exceedingly well.

Fibre Optics

Fibre Optics is a technology that uses glass (or plastic) threads (fibres) to transmit data. A fibre optic cable consists of a bundle of glass threads, each of which is capable of transmitting messages using light waves.

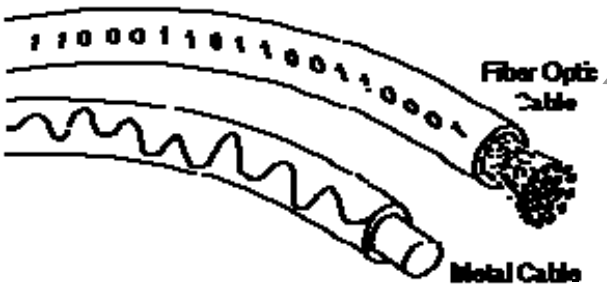
Fibre optic communication lines have several advantages over traditional metal lines:

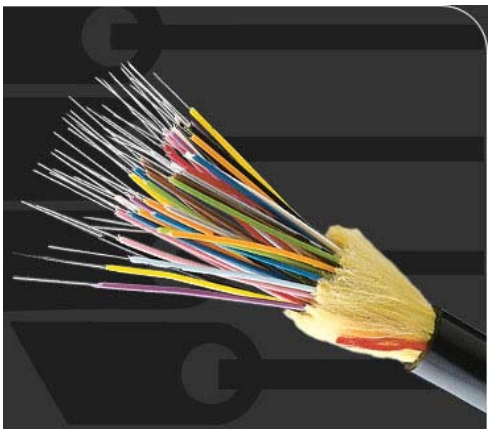
- Fibre optic cables have a much greater ***bandwidth*** than metal cables. This means that they can carry more data.
- Fibre optic cables are much less susceptible than metal cables to interference.
- Light signals travel about ten times faster than electrical signals.
- Light signals do not degrade as quickly as electrical signals.
- Fibre optic cables are much thinner and lighter than metal wires.
- Data can be transmitted ***digitally*** (the natural form for computer data) rather than ***analogically***.

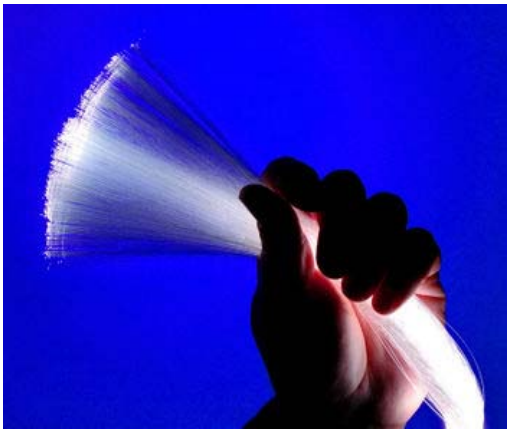
The main disadvantage of fibre optics is that the cables are expensive to install. In addition, they are more fragile than wire and are difficult to split.

Telephone companies are steadily replacing traditional telephone lines with fibre optic cables. In the future, almost all communications will employ fibre optics.

"Fiber" is the American spelling of "Fibre."







ISP

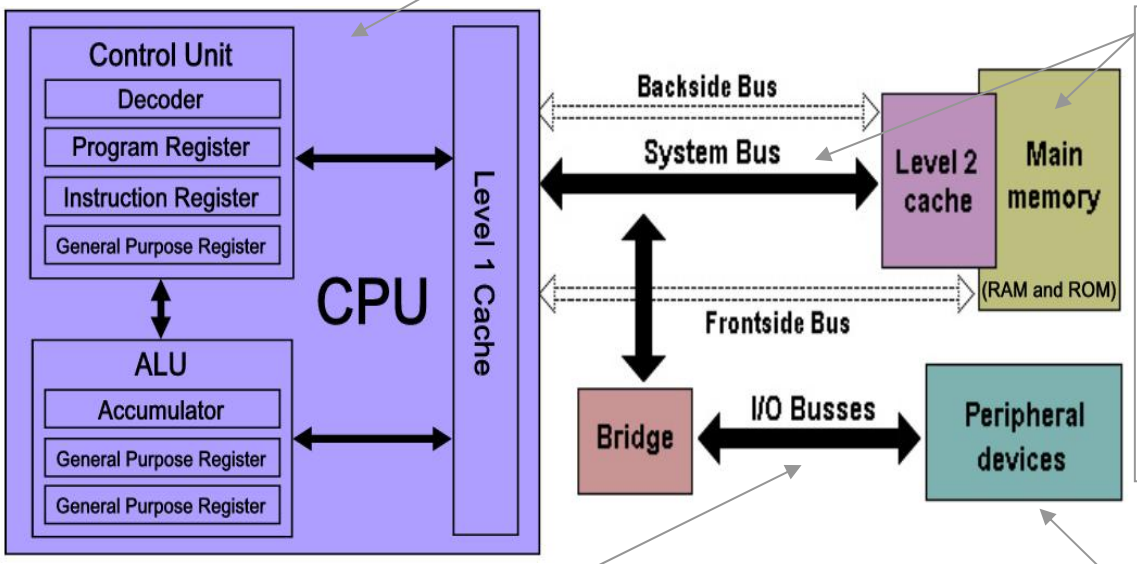
Short for ***Internet Service Provider,*** an ISP is a company that provides access to the ***Internet*****.** For a monthly fee, the service provider gives you a software package, user name, password and possibly an access phone number. A phone number is only required for a ***dial-up*** Internet connection. Other types of Internet connections do not require the dialling of a phone number.

In addition to serving individuals, ISPs also serve large companies, providing a direct connection from the companies' networks to the Internet. ISPs themselves are connected to one another through ***Network Access Points (NAPs).***

ISPs are also called ***IAPs*** (Internet Access Providers).

An Overview of a Computer System

The CPU (Central Processing Unit) is the fastest part of a computer system. Its speed is determined by the ***clock speed***, the ***number of instructions it can execute per clock cycle*** and the ***efficiency*** of its ***instruction set***.



The ***system bus*** and the ***main memory*** are generally much slower than the CPU. Special techniques have to be used to ensure that the CPU doesn't spend too much time waiting for instructions and data to arrive.

Examples of Input/Output Busses

- **IDE bus** → for hard drives, CD-ROM/RW drives, DVD-ROM/RW drives (**parallel**)
- **PCI bus** → for all expansion cards ***except*** for video cards (**parallel**)
- **AGP bus** → high speed bus similar to PCI but used exclusively for video cards (**parallel**)
- **PCI Express bus** → a new and much faster version of PCI (also used for video cards and as such, intended as a replacement of AGP)
- **USB bus** → supports up to 127 Universal Serial Bus external devices (**serial**)
- **IEEE 1394** ("FireWire") → supports up to 63 IEEE 1394 external devices (**serial**)
- **LPT bus** → old, slow parallel bus used mainly for printers (**parallel**)

Examples of Peripheral Devices

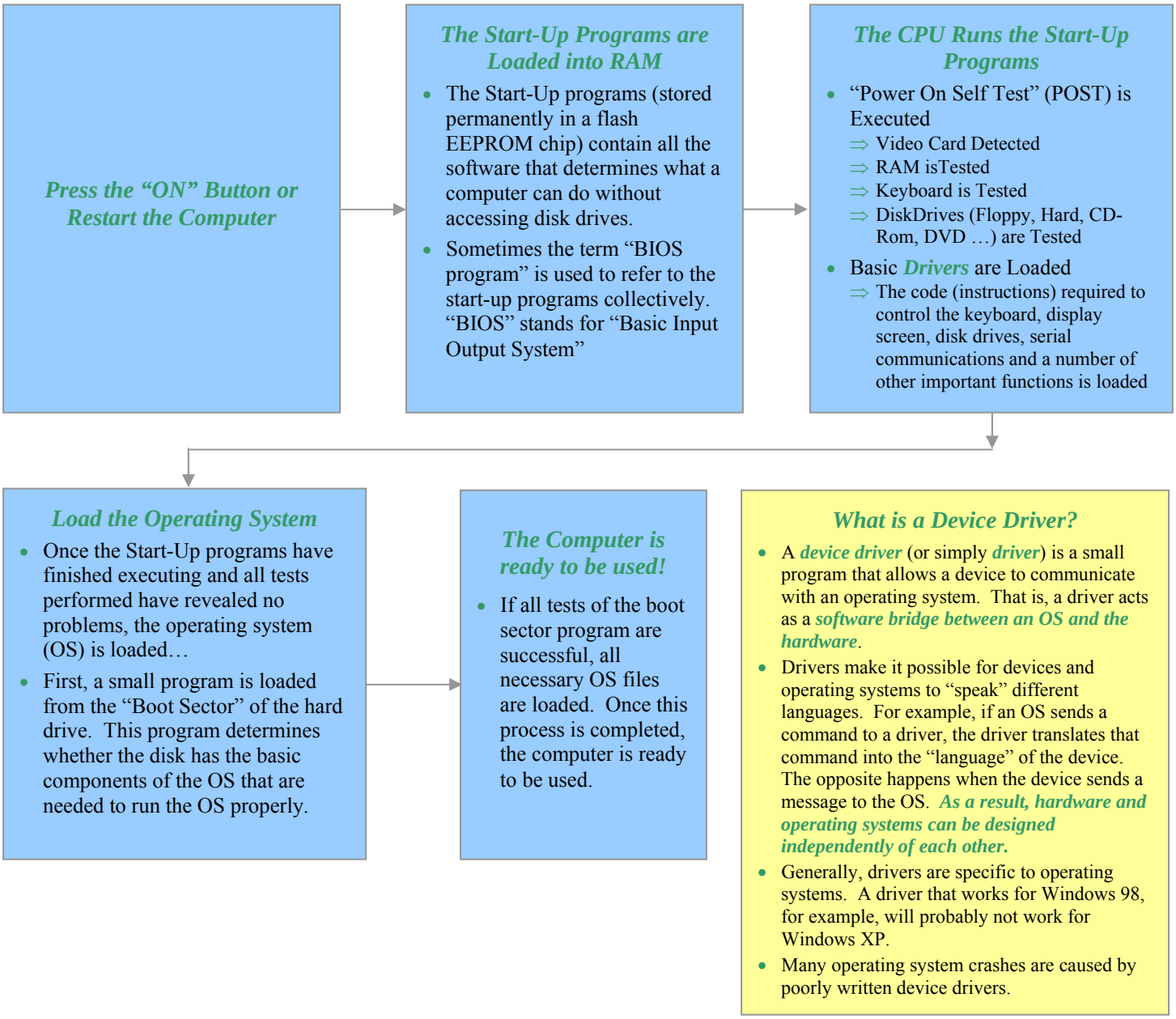
Hard drive, floppy drive, CD and DVD drives, video card, modem, printer, scanner, mouse, sound card, monitor, speakers, TV, network interface, etc

Questions

1. Explain the main differences between ***parallel*** and ***serial*** busses. What do busses have in common with highways?

2. Use Google images or a similar service to find pictures of the connectors and/or cables used for each of the above busses. Use a word processor to make a collage of all the pictures. Label each picture to ensure that you will remember the name and purpose of each connector and cable.

What happens after you Press a Computer's "ON" Button?



Questions

1. BIOS programs sometimes need to be updated. If your computer functions abnormally or your motherboard won't support certain devices, perhaps a BIOS update might help. What would you do if you discovered that your computer required an updated BIOS program? Outline the steps that you would take to find a new BIOS program and install it.

2. Suppose that your computer's video card driver contains bugs that are causing your operating system to crash. What could you do to correct this problem?

Why it takes a lot Longer to Start up a Computer than a TV

Read all the following information and then answer the questions at the end.

POST

Short for "power-on self test," POST is a series of diagnostic tests that run automatically when you turn on your computer. The actual tests can differ depending on how the BIOS is configured, but usually the POST tests the RAM, the keyboard, and the disk drives. If the tests are successful, the computer ***boots itself***. If the tests are unsuccessful, the computer reports the error by emitting a series of beeps and possibly displaying an error message and code on the display screen. The number of beeps indicates the error, but differs from one BIOS to another.

BIOS

Pronounced "bye-ose," BIOS is an acronym for "basic input/output system." The BIOS is built-in software that determines what a computer can do without accessing programs from a disk. On PCs, the BIOS contains all the code required to control the keyboard, display screen, disk drives, serial communications and a number of miscellaneous functions.

The BIOS is typically placed in a ROM chip that comes with the computer (it is often called a ROM BIOS). This ensures that the BIOS will always be available and will not be damaged by disk failures. It also makes it possible for a computer to ***boot itself***. Because RAM is faster than ROM, though, many computer manufacturers design systems so that the BIOS is copied from ROM to RAM each time the computer is booted. This is known as shadowing. Modern PCs have a "flash BIOS," which means that the BIOS has been recorded on a flash memory chip, which can be updated if necessary.

The PC BIOS is fairly standardized, so all PCs are similar at this level (although there are different BIOS versions). Additional operating system functions are usually added through software modules. This means you can upgrade to a newer version of an operating system without changing the BIOS.

PC BIOSes that can handle "Plug-and-Play" (PnP) devices are known as "PnP BIOSes," or "PnP-aware BIOSes." These BIOSes are always implemented with flash memory rather than ROM.

Memory

The term "memory" refers to internal storage areas in the computer. The term memory identifies data storage that comes in the form of chips, and the word storage is used for memory that exists on tapes or disks. Moreover, the term memory is usually used as shorthand for physical memory, which refers to the actual chips capable of holding data. Some computers also use virtual memory, which expands physical memory onto a hard disk.

Every computer comes with a certain amount of physical memory, usually referred to as main memory or RAM. You can think of main memory as an array of boxes, each of which can hold a single byte of information. A computer that has 1 megabyte of memory, therefore, can hold over 1 million bytes (actually $1024^2 = 2^{20} = 1048576$) or characters of information.

There are several different types of memory:

- **RAM** (random-access memory): This is the same as main memory. When used by itself, the term RAM refers to read and write memory; that is, you can both write data into RAM and read data from RAM. This is in contrast to ROM, which permits you only to read data. Most RAM is ***volatile***, which means that it ***requires a steady flow of electricity to maintain its contents***. As soon as the power is turned off, whatever data were in RAM are lost. (See details on the next page.)
- **ROM** (read-only memory): Computers usually contain a small amount of read-only memory that holds instructions for starting up the computer. Unlike RAM, ROM cannot be written to. In addition, ROM is ***non-volatile***, that is, ROM ***does not require a steady flow of electricity*** to maintain its contents. (See details on the next page.)
- **PROM** (programmable read-only memory): A PROM is a memory chip on which you can store a program. But once the PROM has been used, you cannot wipe it clean and use it to store something else. Like ROMs, PROMs are non-volatile. ***This technology is now obsolete.*** (See details on the next page.)
- **EPROM** (erasable programmable read-only memory): An EPROM is a special type of PROM that can be erased by exposing it to ultraviolet light. ***This technology is now obsolete.*** (See details on the next page.)
- **EEPROM** (electrically erasable programmable read-only memory): An EEPROM is a special type of PROM that can be erased by exposing it to an electrical charge. (See details on the next page.)

Boot

(verb) To "boot" is to load the first piece of software that starts a computer. Because the operating system is essential for running all other programs, it is usually the first piece of software loaded during the boot process (once the basic drivers are loaded by the start-up programs). Boot is short for bootstrap, which in olden days was a strap attached to the top of your boot that you could pull to help get your boot on. Hence, the expression "pull oneself up by the bootstrap" came to be. Similarly, bootstrap utilities help the computer get started.

(noun) "Boot" is short for bootstrap, the starting-up of a computer, which involves loading the operating system and other basic software. A cold boot occurs when you turn the computer on from an off position. A warm boot occurs when you reset a computer that is already on.

Shadowing

"Shadowing" is a technique used to increase a computer's speed by using high-speed RAM memory in place of slower ROM memory. On PCs, for example, all code to control hardware devices, such as keyboards, is normally executed in a special ROM chip called the BIOS ROM. However, this chip is slower than the general-purpose RAM that comprises main memory. Many PC manufacturers, therefore, configure their PCs to copy the BIOS code into RAM when the computer boots. The RAM used to hold the BIOS code is called shadow RAM.

ROM

Pronounced "rahm," ROM is an acronym for "read-only memory," computer memory on which data have been pre-recorded. Once data have been written onto a ROM chip, they cannot be removed and can only be read.

Unlike main memory (RAM), ROM retains its contents even when the computer is turned off. ROM is referred to as being ***non-volatile***, whereas RAM is ***volatile***.

Most personal computers contain a small amount of ROM that stores critical programs such as the program that boots the computer. In addition, ROMs are used extensively in calculators and peripheral devices such as laser printers, whose fonts are often stored in ROMs.

A variation of a ROM is a PROM (programmable read-only memory). PROMs are manufactured as blank chips on which data can be written with a special device called a PROM programmer.

RAM

Pronounced "ramm," acronym for "random access memory," a type of computer memory that can be accessed randomly; that is, any byte of memory can be accessed without accessing the preceding bytes. RAM is the most common type of memory found in computers and other devices, such as printers.

There are two basic types of RAM:

- **Dynamic RAM** (DRAM)
- **Static RAM** (SRAM)

The two types differ in the technology they use to hold data, dynamic RAM being the more common type. Dynamic RAM needs to be refreshed thousands of times per second. Static RAM does not need to be refreshed, which makes it faster; but it is also more expensive than dynamic RAM. Both types of RAM are volatile, meaning that they lose their contents when the power is turned off.

In common usage, the term RAM is synonymous with main memory, the memory available to programs. For example, a computer with 8 MB RAM has approximately 8 million bytes of memory that programs can use. In contrast, ROM (read-only memory) refers to special memory used to store programs that boot the computer and perform diagnostics. Most personal computers have a small amount of ROM (a few thousand bytes). In fact, both types of memory (ROM and RAM) allow random access. To be precise, therefore, RAM should be referred to as read/write RAM and ROM as read-only RAM.

PROM

Pronounced "prom," PROM is an acronym for "programmable read-only memory." A PROM is a memory chip on which data can be written only once. Once a program has been written onto a PROM, it remains there forever. Unlike RAM, PROMs retain their contents when the computer is turned off.

The difference between a PROM and a ROM (read-only memory) is that a PROM is manufactured as blank memory, whereas a ROM is programmed during the manufacturing process. To write data onto a PROM chip, you need a special device called a PROM programmer or PROM burner. The process of programming a PROM is sometimes called burning the PROM.

An EPROM (erasable programmable read-only memory) is a special type of PROM that can be erased by exposing it to ultraviolet light. Once it is erased, it can be reprogrammed. An EEPROM is similar to a PROM, but requires only electricity to be erased. ***This technology is now obsolete.***

EPROM

EPROM is an acronym for "erasable programmable read-only memory," and is pronounced "ee-prom." EPROM is a special type of memory that retains its contents until it is exposed to ultraviolet light. The ultraviolet light clears its contents, making it possible to reprogram the memory. To write to and erase an EPROM, you need a special device called a PROM programmer or PROM burner.

An EPROM differs from a PROM in that a PROM can be written to only once and cannot be erased. EPROMs are used widely in personal computers because they enable the manufacturer to change the contents of the PROM before the computer is actually shipped. This means that bugs can be removed and new versions installed shortly before delivery.

EPROM chips can only be found in relatively old PCs. ***This technology is now obsolete.***

EEPROM

EEPROM is an acronym for "electrically erasable programmable read-only memory." Pronounced "double-ee-prom or e-e-prom," an EEPROM is a special type of PROM that can be erased by exposing it to an electrical charge. Like other types of PROM, EEPROM retains its contents even when the power is turned off. Also like other types of ROM, EEPROM is not as fast as RAM.

EEPROM is similar to flash memory (sometimes called flash EEPROM). The principal difference is that EEPROM requires data to be written or erased one byte at a time whereas flash memory allows data to be written or erased in blocks. This makes flash memory faster. ***This technology is now obsolete.***

Flash Memory (Flash EEPROM)

"Flash memory" is a special type of EEPROM that can be erased and reprogrammed in blocks instead of one byte at a time. Many modern PCs have their BIOS stored on a flash memory chip so that it can easily be updated if necessary. Such a BIOS is sometimes called a "flash BIOS." Flash memory is also popular in modems and many other devices because it enables the manufacturers to support new protocols and standards as they become popular.

Questions

1. Describe what happens just after a computer is turned on.

2. What is the difference between main memory (also called "primary storage" or "main storage") and secondary storage (also called "secondary storage").

3. What is physical memory?

4. What does it mean to "boot" a computer?

5. What is shadowing?

6. How does a computer "know" what to do just after it is reset or just after the power is turned on?

7. What is BIOS? What is its purpose?

8. Describe the various types of ROM chips that are available. What type is used in the most recent computers?

9. Why would it be more precise to call RAM "read/write RAM" and ROM "read-only RAM?"

10. What is the difference between static RAM and dynamic RAM? Which is faster? Which is cheaper? Why?

A Brief Overview of Computer Architecture

Components in the Base Unit

The Motherboard

CPU, RAM, External Cache (L2 or L3 Cache), ROM chips with BIOS and Start-Up Programs, Chip Sets (Controllers), Ports, Buses, Expansion Slots

Disk Drives

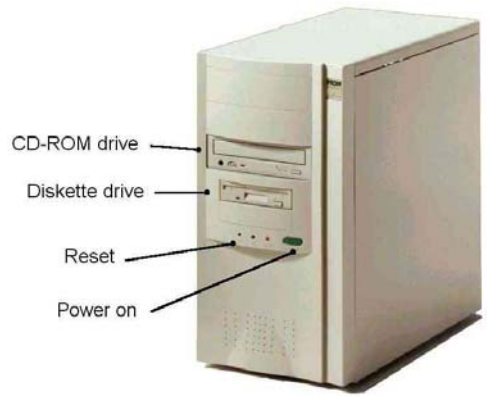
Hard Disk Drive(s), Floppy Disk Drive(s), CD-ROM Drive(s), CD-RW drive(s), DVD-ROM Drive(s), DVD-RAM Drive(s)

Expansion Cards

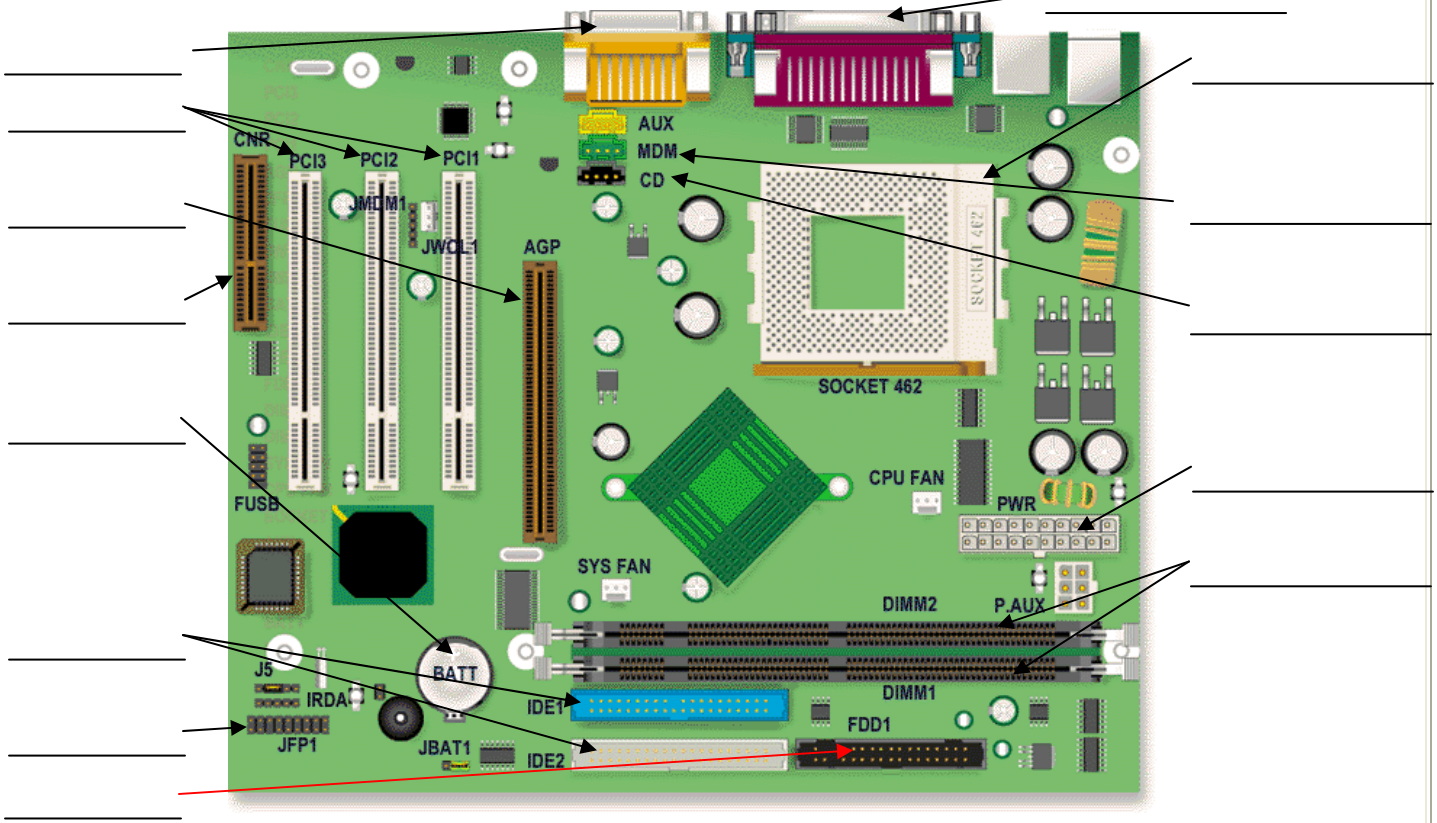
Graphics Card (Video Adapter), Network Controller, SCSI Controller, Sound Card, Video and TV Card, Internal Modem.

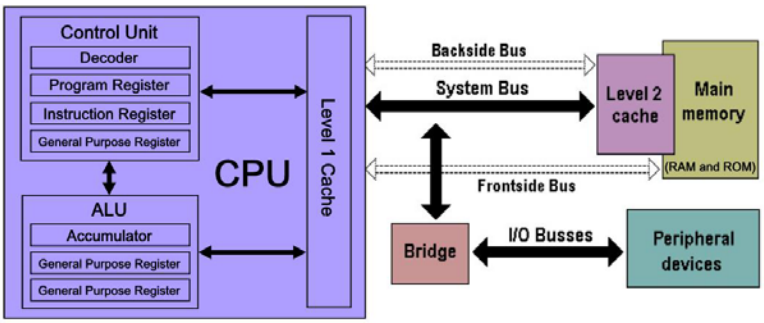
External Devices

Keyboard, Mouse, Joystick, Monitor, Printer, Scanner, Loudspeakers, External Drives, External Modem



Label each of the motherboard parts to which an arrow is pointing.





Caches

(adapted from http://www.webopedia.com)

One of the greatest challenges of designing a fast computer system is to prevent the CPU, which is by far the speediest component, from spending too much time ***idling***. This occurs whenever information is not delivered to the CPU as quickly as the CPU can process it. As the CPU waits for data to arrive, it cannot continue executing instructions, which results in a great deal of wasted processor time.

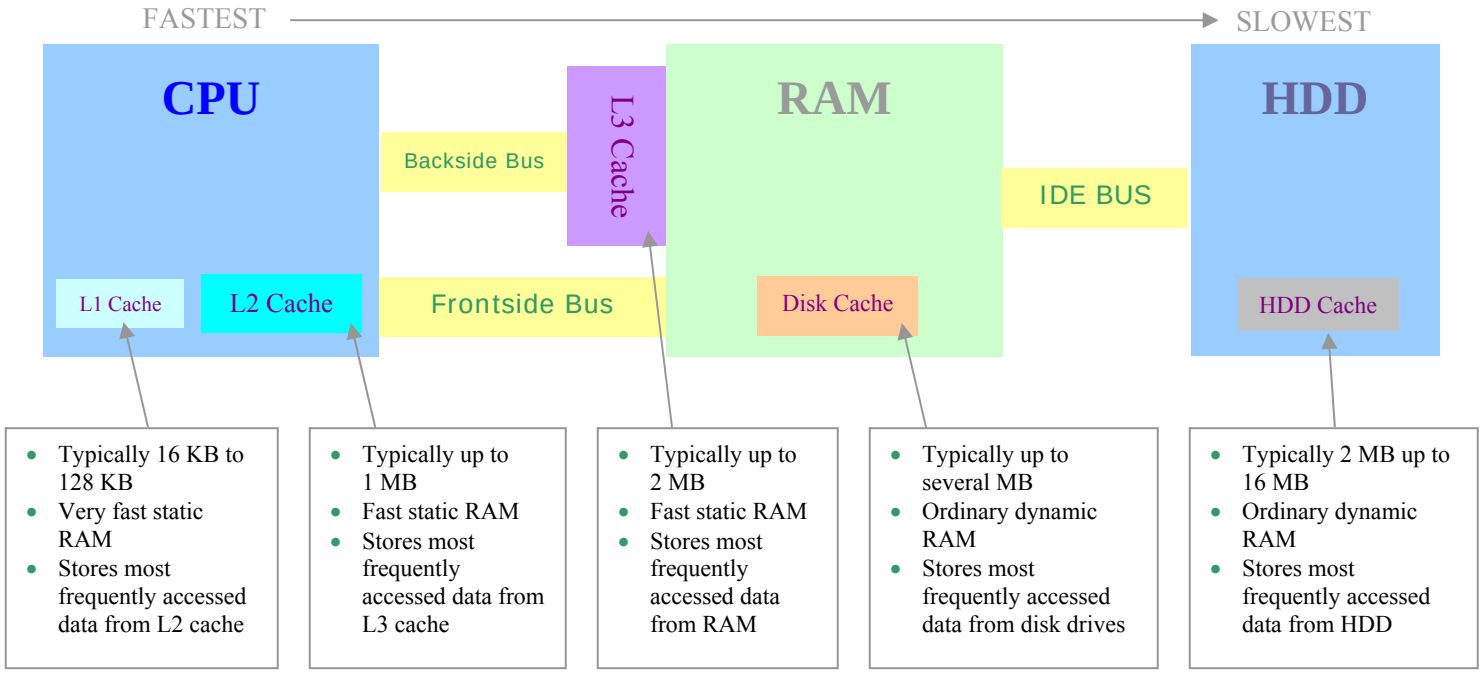
To address the ***bottlenecks*** created by computer devices of widely varying speeds, ***cache memory*** can be employed. Pronounced "cash," a ***cache*** is a special ***high-speed storage mechanism*** that is used to store ***frequently accessed data***. By storing frequently accessed data in a high-speed storage area, average data access times are reduced, thereby reducing wasted CPU time.

Two types of caching are commonly used in personal computers, ***memory caching*** and ***disk caching***. A ***memory cache***, sometimes called a ***cache store*** or ***RAM cache***, is a portion of memory made of ***high-speed static RAM*** (SRAM) instead of the slower and cheaper **dynamic RAM** (DRAM) used for main memory. Memory caching is effective because most programs access the same data or instructions repeatedly. By keeping as much of this ***frequently accessed information*** as possible in SRAM, the computer avoids accessing the slower DRAM.

Nowadays, memory caches are built into the architecture of ***microprocessors*** (i.e. CPUs). Such ***internal caches*** are often called ***Level 1 (L1) caches.*** Most modern PCs also come with external cache memory, called ***Level 2 (L2) caches***. These caches sit between the CPU and the DRAM. Like L1 caches, L2 caches are composed of SRAM but they are much larger. As more and more processors begin to include L2 cache into their architectures, L3 cache is now the name for the extra cache built into motherboards between the microprocessor and the main memory. Quite simply, what was once L2 cache on motherboards now is called L3 cache when used with microprocessors containing built-in L2 caches.

Disk caching works under the same principle as memory caching, but instead of using high-speed SRAM, a disk cache uses conventional dynamic RAM. The most frequently accessed data from the disk are stored in a memory buffer. When a program needs to access data from the disk, it first checks the disk cache to see if the data are there. Disk caching can dramatically improve the performance of applications, because accessing a **byte** of data in RAM is thousands of times faster than accessing a byte on a ***hard disk drive (HDD)***.

When data required by the CPU are found in the cache, it is called a ***cache hit***. The effectiveness of a cache is judged by its ***hit rate***. Many cache systems use a technique known as ***smart caching***, in which the system can recognize certain types of frequently used data. The strategies for determining which information should be kept in the cache constitute some of the most interesting problems in computer science.



The Start-Up Programs

The ROM chips contain instructions that are specific to a particular motherboard. The instructions usually remain stored in the PC throughout its life; ordinarily, they are not altered. All these instructions are stored on a ROM chip (usually a ***flash EEPROM***) and they are activated one-by-one during start-up.

Primarily, the ROM code holds ***start-up instructions***. In fact, several different programs make up the start-up instructions. For most purposes, however, they are considered one program. The start-up programs include the following:

- The ***Initializing Routine*** sets up the BIOS functions. A table containing all the BIOS programs is constructed. This is often called the set of ***interrupt vectors***.
- **POST** (Power On Self Test)
- The ***Setup*** instructions, which connect with the **CMOS** instructions
- **BIOS** instructions, which connect with the various hardware peripherals
- The ***boot instructions*** (the disk bootstrap loader), which call the operating system (**e.g.** Windows, Unix, Linux, Mac OS, FreeBSD, MS-DOS, OS/2, etc)

The POST

The ***Power On Self Test*** is the first program executed during start-up. If you watch your monitor screen carefully, you will see information displayed by the POST program in the following order:

1) Information about the ***graphics adaptor*** (i.e. the video card)
2) Information about the **BIOS** program (name, version)
3) Information about the **RAM**

As users, we have a limited ability to manipulate the POST instructions. Certain system boards, however, enable the user to order a quick system check. Some allow the user to disable the RAM test, thereby shortening the duration of the POST. The duration of the POST can vary considerably in different PCs. On most computers, the POST can be bypassed by pressing the **Esc** key. If the POST detects errors in the system, it will display error messages on the screen. If the monitor is not ready, or if there are error is in the video card, it will also sound a pattern of beeps (for example, 3 short and one long) to alert the error to the user.

The Bootstrap Loader

The last part of the BIOS execution at start-up is the ***bootstrap loader***. It is a tiny program that only has one task – to find the boot sector on a disk (hard disk, floppy or another boot-drive). When the disk holds no bootstrap routine, you get an error message like **"Non-system disk, replace with system disk and press any key."** The bootstrap loader is the last step in BIOS execution during start-up. It hands over the control to the bootstrap routine found on the boot disk.

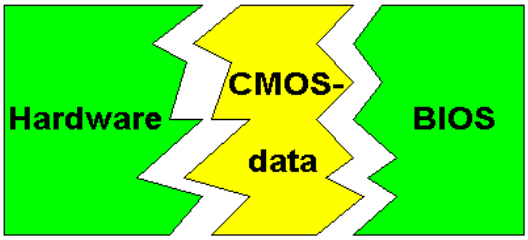
CMOS RAM

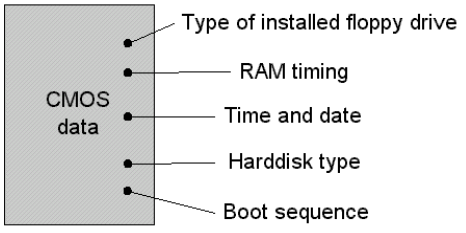
CMOS stands for ***Complimentary Metal Oxide Semiconductor***. In PCs, there is a small amount of memory in a special CMOS RAM chip. The data stored in the chip are maintained with electric power from a ***small battery*** (just a watch battery on modern motherboards). The CMOS RAM chip holds important system data, values to be used during the start-up process. These data take up perhaps 100 or 200 bytes of storage. The CMOS makes the information instantly available to the POST and BIOS programs (loaded from ROM) during the start-up.

The values stored in CMOS include the number and type of floppy and hard disk drives, the keyboard, the CPU, cache, chip set values, RAM type, date, time and much more. These data have to be set up correctly or the system can be rendered inoperable.

Conclusion

Most BIOS programs can be accessed by pressing the **Delete** key, the **F1** key or the **F2** key immediately after powering up the PC. **Generally, you should not change the BIOS settings unless you know precisely what you are doing!**





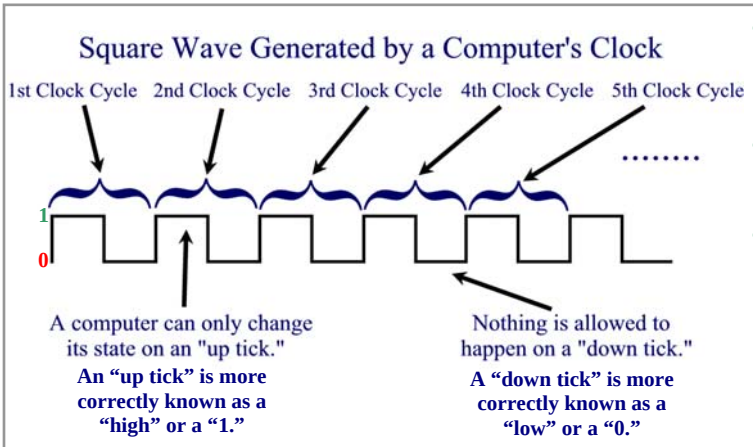
Understanding Clock Speed and the Machine Cycle (not related to the spin cycle)

Clock Cycles and Clock Speed

Operations within a processor are controlled by an ***external clock***. A clock is a circuit that generates a ***square wave of fixed period***; the ***quantum*** unit of time of a clock is known as a ***clock cycle***. The main purpose of a computer's clock is to serve as a ***timing device***. In many ways, it is just like the drummer in a band or the conductor of an orchestra. Without a drummer or a conductor to keep the beat, it is nearly impossible for a group of musicians all to play at exactly the same speed. This results in rather bad sounding music!

Similarly, without a clock to "keep the beat," the various devices of a computer system cannot operate "in sync." Eventually, the fast devices will race ahead of the slower ones, causing many instructions to be executed incorrectly. For example, this can occur if a processor proceeds immediately to execute an instruction despite the fact that the instruction requires a value that has not yet been computed by a slower device. If this is allowed to occur, computations are performed incorrectly, leading to rather disastrous results!

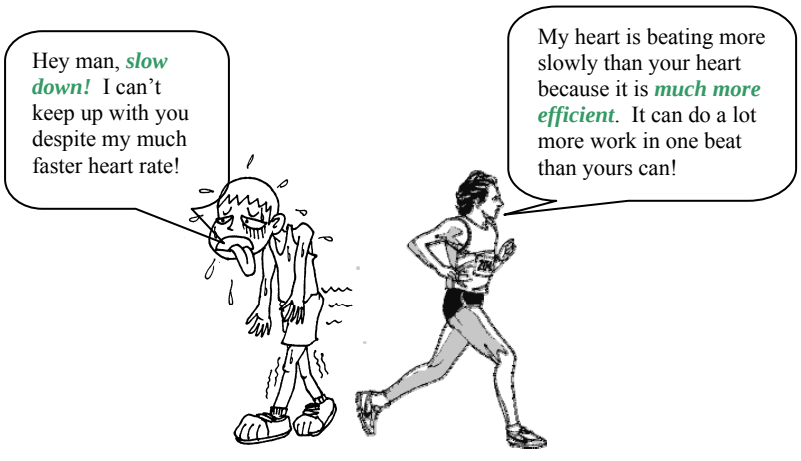
To solve the problems of synchronizing the activities of all the devices connected to a computer system, the clock circuit acts like a ***railway signalman***. It ***dictates*** the times at which the devices are allowed to proceed and the times at which they must pause and wait. The state of the CPU (or any other device) is ***only allowed to change*** on a **"high"** of a clock cycle (like a signalman giving a "green light" for a train to proceed). On a **"low"** of a clock cycle, no tasks are allowed to be carried out (like a signalman giving a "red light" for a train to stop). In this way, all devices stay in sync with one another.



- A computer's system clock continually generates a square wave as shown at the left. Each ***wave crest*** represents a "high" of the clock (mathematically modelled as a "1") while each ***wave trough*** represents a "low" of the clock (mathematically modelled as a "0").
- To ensure that all events within a computer system are ***synchronized***, nothing is allowed to happen on a "low." This keeps all devices "marching to the beat of the same drummer."
- It's easier to understand the meaning of a single clock cycle if it is compared to a single heart beat. A "high" is like a contraction of your heart muscle and a "low" is like a relaxing of your heart muscle. When your heart contracts, it actively pumps blood through your circulatory system. When your heart relaxes, however, blood is not actively pushed through your circulatory system. (Nonetheless, your blood continues to flow until the next contraction because of the momentum imparted to it by the previous contraction of the heart muscle.)

The Speed of a Processor depends on MUCH MORE than the Clock Speed!!!!!!!

The ***clock frequency*** (also called ***clock rate*** or ***clock speed***) is ***not a very good indicator of how fast a processor is***. Knowing the clock rate only allows us to determine the number of clock cycles generated per second. To determine the number of instructions executed per second, we need to know the average number of instructions that can be executed per clock cycle. Since this varies considerably from one processor to another, ***it is impossible to compare the speeds of two different processors by comparing clock speeds alone***. Moreover, since the CPU is generally the fastest component of a computer system, the overall performance of a computer depends on far more than the clock speed!



As shown in the diagram to the right, the speed of a runner is not entirely determined by his/her pulse (heart rate). In fact, well-conditioned runners usually have a much lower resting heart rate than the average person does. This is due to the much greater efficiency of their hearts. That is, their hearts are able to perform more work in a single beat than the hearts of average people. Consequently, they are able to run faster while still maintaining a relatively low heart rate.

Similarly, a well-designed, efficient processor operating at a low clock speed can outperform a poorly designed, inefficient processor operating at a higher clock rate. Boosting the clock rate of any given CPU will surely also increase its speed. However, the higher clock rate will also cause an increase in the amount of heat generated, which might lead to unstable performance or even cause the CPU to "burn out" altogether.

Fetch-Decode-Execute Cycle

The essential task of computer processor is to perform a "Fetch-Decode-Execute" cycle or "Machine Cycle.

1. In the ***fetch cycle***, the processor gets an instruction from memory; the address of the instruction is contained in an internal register called the **Program Counter** or **PC** (also known as the **Program Register**).

   While the instruction is being fetched from memory, the **PC** is incremented by one. Thus, in the next "Fetch-Decode-Execute" cycle, the instruction will be fetched from the next sequential location in memory (unless the **PC** is changed by some other instruction in the interim).

2. In the ***decode phase*** of the cycle, the processor stores the information fetched from memory in an internal register called the **Instruction Register** or **IR**. The CPU matches the instruction code to one in its internal "dictionary" and hence, recognizes which instruction has been loaded.

3. In the execution phase of the cycle, the processor carries out the instruction stored in the IR.

A Brief Summary of Caches and the Machine Cycle

1. ***Fetch*** (Retrieve the instruction from memory)

   Whether the instruction comes from the ***main memory*** (RAM) or the processor ***cache*** is irrelevant. The instruction is not loaded "into" the processor until it is specifically requested. The cache simply serves to speed things up. By loading chunks of system memory into the cache, the processor can satisfy many more of its instruction fetches by pulling instructions from the cache.

   This is necessary because processors are very fast but system memory and other components are not. There is no way the rest of the system can keep up with the processor. Indeed, the rest of the system is likely to be operating at a ***quarter of the speed of the processor*** or lower. For instance, the latest Pentium 4 processors can operate at a clock frequency of over 3.5 GHz (3.5 billion clock cycles per second) or higher while the latest RAM can operate at frequencies of up to 800 MHz (but 133 MHz or lower for systems older than the Pentium 4).

   To see the effect the cache has on your processor, use your BIOS setup program to disable both the L1 and L2 caches. You will notice a significant decrease in execution speed.

2. ***Decode***
   Figure out what the instruction is, and what it is supposed to do.

3. ***Execute***
   Perform the requested operation.

Using Pipelines to Improve the Performance of a Computer System

Using the simple "fetch-decode-execute" cycle described above, it seems that ***three clock cycles*** would be needed to execute a single instruction. This is obviously a colossal waste of processor time.

There is a clever solution to this problem called ***pipelining***. Since the three stages (fetch, decode, execute) are ***independent***, it makes much more sense to process instructions in the manner described below. (In the example given below, assume that instruction # 1 and instruction # 2 have already been fetched and that instruction #1 has already been decoded.)

```
fetch   instruction #3
decode  instruction #2
execute instruction #1
...then, on the next clock tick...
fetch   instruction #4
decode  instruction #3
execute instruction #2
...tick...
fetch   instruction #5
decode  instruction #4
execute instruction #3
... continue in this manner
```

This is exactly what a pipeline is. By using this clever method, a processor can work three times faster!

A pipeline isn't a perfect solution, however. Under certain circumstances, the instructions stored in a pipeline need to be dumped. This happens whenever instructions are not executed in sequential order. For instance, suppose that instructions 4, 5 and 6 are stored in a pipeline. When instruction 4 is executed, however, it causes a "branch" to instruction 10. This means that instruction 10 must follow instruction 4 instead of the expected instructions 5 and 6. Consequently, instructions 5 and 6 must be dumped from the pipeline as they are no longer needed.

Classification of Processor Instructions

Instructions for the processor may be classified into three major types:

1. **Arithmetic/Logic** instructions apply basic functions to one or two values (known as ***arguments***); an example is the addition of two numbers.
2. **Data Transfer** instructions move data from one location to another, for example, from an internal processor register to a location in the main memory.
3. **Control instructions** modify the order in which instructions are executed, for example, in loops or logical decisions.

Questions

1. Explain why it is impossible to compare the speeds of ***two different processors using clock speeds alone***.

2. The basic unit used to measure frequency is known as the ***Hertz***. The frequency **1 Hz** ("Hz" is the abbreviation used for "Hertz") is equal to ***one cycle per second***. How many cycles per second are generated by a clock circuit running at each of the following frequencies:
   - **(a)** 2000 Hz
   - **(b)** 3500 kHz
   - **(c)** 750 MHz
   - **(d)** 3.5 GHz
   - **(e)** 4.035 THz

3. Suppose that you are comparing two Pentium 4 processors that are identical in every respect except that one of them runs at a clock rate of 3.0 GHz while the other runs at a clock frequency of 3.5 GHz. Is this enough information to conclude which processor is faster? Can you determine the number of instructions each processor can execute per second?

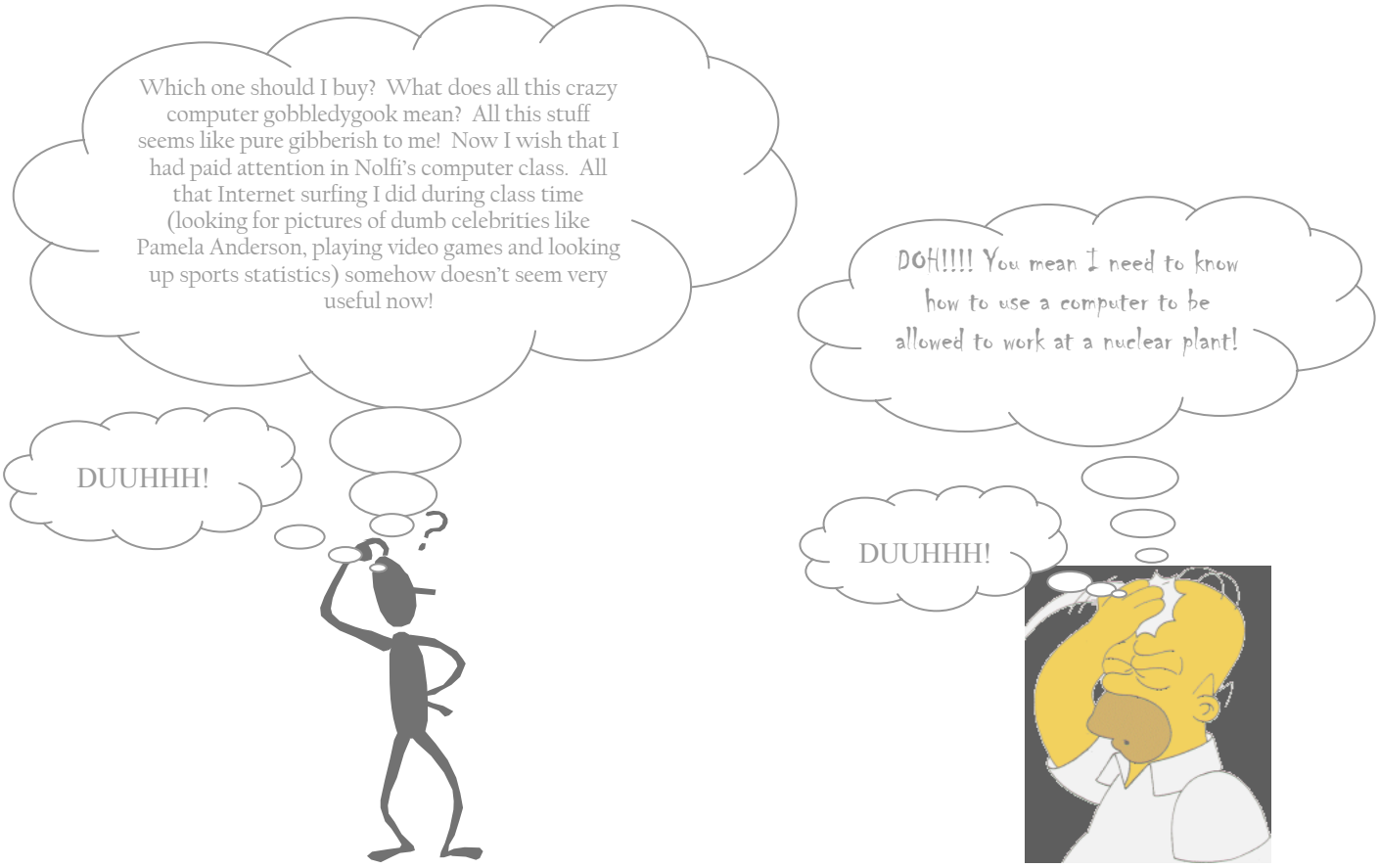
4. Explain why caches and pipelines are needed to help speed up computer systems.

5. Explain exactly how caches and pipelines work.

6. Explain some limitations of caches and pipelines.

So you want to buy a Computer, Eh? (Culminating Activity)

	System 1	System 2
OS	Microsoft Windows XP Home Edition	Microsoft Windows XP Professional Edition
CPU	**Intel Pentium 4** • 2.8 GHz clock speed • 90 nm process • 112 mm^2 die size • 32-bit internal bus • 16KB (data) + 12KB (instructions) L1 Cache • 1 MB L2 Cache	**AMD Athlon 64** • 2.2 GHz clock speed • 90 nm process • 193 mm^2 die size • 64-bit internal bus • 64KB (data) + 64KB (instructions) L1 Cache • 1 MB L2 Cache
System Bus	800 MHz, Half Duplex	2.0 GHz, Full Duplex
RAM	1 GB PC6400 RAM DDR2 (800 MHz) (exp. to 3.0 GB)	2 GB PC6400 RAM DDR2 (800 MHz) (exp. to 4.0 GB)
Expansion Slots	4 PCI, 1 AGP	2 PCI, 2 PCI Express 1×, 1 PCI Express 16×
Cache on Motherboard	2 MB L3 Cache	2 MB L3 Cache
Graphics Card	NVidia GeForce FX5500, AGP 8×, 256 MB DDR	eVGA GeForce 6800GT, PCI Express 16×,512 MB DDR2
Hard Disk Drive	Hitachi 160 GB, 7200 RPM, SATA-150, 8MB Cache	Western Digital 74 GB, 10000 RPM, SATA-150, 16MB Cache
Optical Drives	52×24×52× CD-RW, 16× DVD+/-RW dual layer	52×24×52× CD-RW, 16× DVD+/-RW dual layer
Floppy Drive	3.5" 1.44MB Floppy Drive	3.5" 1.44MB Floppy Drive
Expansion Bays	2 × 3.5", 3 × 5.25"	2 × 3.5", 4 × 5.25"
I/O Ports	6 USB 2.0, 2 IEEE1394(FireWire), 1 Parallel, 2 Serial	4 USB 2.0, 2 IEEE1394(FireWire),2 Serial, 1 Parallel
Fax/Modem	56K V.92 Modem (Dial-Up)	56K V.92 Modem (Dial-Up)
Monitor	19-inch LCD, Widescreen Max Res 1440×900	19-inch CRT, 0.21 mm dot pitch, Max Res 1600×1200
Network Card	10/100/1000 Gigabit Ethernet, 54g Wireless	10/100/1000 Gigabit Ethernet, 54g Wireless
Warranty	3 Years Parts & Labour	3 Year Parts & Labour



Culminating Activity Questions - What's in a Number? (See Evaluation Guide on page 44)

STOP! Before you begin, read this sample answer to 1(a)! STOP!

Sample Answer to 1(a)

Supercomputers are extremely fast and highly specialized computers that are used primarily for scientific purposes such as climate modelling and geologic modelling. Unlike the computers that we use in our homes and workplaces, supercomputers have thousands of processors that work together in a co-operative manner. In fact, supercomputers are roughly 100000 times faster than the computers to which we are accustomed. The fastest supercomputers nowadays can execute hundreds of trillions of floating point operations per second, a blazing speed that seems to defy comprehension. A floating point operation is a calculation that involves numbers with both a whole and fractional part. For instance, 45354.4345377+564454.7607678 is considered a floating point operation.

Elements of a good Answer

- A person with a ***limited knowledge of computers*** should understand it.
- ***Uncommon words*** and ***phrases*** (or those that the reader is likely not to understand) should be explained. (**e.g.** floating point operation)
- A ***general introductory sentence*** should be used, followed by a few sentences that provide more details.
- ***Linking words and phrases*** should be used to improve the flow of the paragraph. (**e.g.** "Unlike…", "In addition,…")
- ***Compare new ideas or facts*** with ones with which the reader is familiar. (**e.g.** ordinary desktop computer)

1. Visit the Web site www.top500.org. This site lists the 500 fastest supercomputers on the planet. Find technical information on the fastest computer on Earth and then answer the following questions.

(a) What is a supercomputer?

(b) How many floating-point instructions can the world's fastest supercomputer execute in a single second?

Note: A ***floating-point operation*** is an arithmetic calculation performed on ***floating-point numbers***. A floating-point number is a number that can have both a ***whole part*** and a ***fractional part***. Examples include –3.45673282 and 6.78543E12. Note that the symbol "E" is used to denote ***scientific notation***. Therefore, $6.78543E12 = 6.78543\times10^{12} = 6785430000000$.

(c) What kind of processor does it use? What is its clock rate? Are you surprised? Explain.

(d) How many processors does it have? Does this surprise you? Explain.

2. To answer some of the following questions, you need to refer to the table on the previous page.

(a) What is a ***vacuum tube***? Why would it be extremely difficult to design computers and many other modern electronic devices using vacuum tube technology?

(b) What is a ***transistor***? Explain how transistors revolutionized the electronics industry.

(c) What is an ***integrated circuit***? (An integrated circuit is also called an "IC" or "chip.") Explain how integrated circuits make it possible for us to have home computers, portable computers, cell phones, mp3 players and a vast array of other modern electronic devices.

(d) What is meant by the "process size" of a chip (also called "fabrication process size")? What is meant by the "die size" of a chip? Is either of these specifications related to a chip's speed?

(e) Whenever you read information about CD drives, you will see a specification such as "52×." Explain ***precisely*** what this means. (Do not write something such as, "It means 52 times faster." My response to such a statement would be "Fifty-two times faster than what?") In addition, what does a specification such as "52×32×52×" mean?

(f) When a specification such as "16×" is given for a DVD drive, does the "×" mean the same thing as it does for CD drives? Explain.

(g) What is a dual layer DVD?

(h) Which of the two systems listed on the previous page has a more powerful video card (graphics adaptor)? How can you tell?

(i) Which of the two systems is better suited to gaming and multimedia applications? Why?

(j) Which of the two systems described on the previous page would you expect to boot up faster? Explain.

(k) Which of the two computer systems has more room for expansion?

(l) The description of each hard drive includes the specification "SATA-150." What does this mean?

(m) What is "Gigabit Ethernet?" What is "54g Wireless?" Is "54g Wireless" the same as "Wi-Fi?" What is "Bluetooth?"

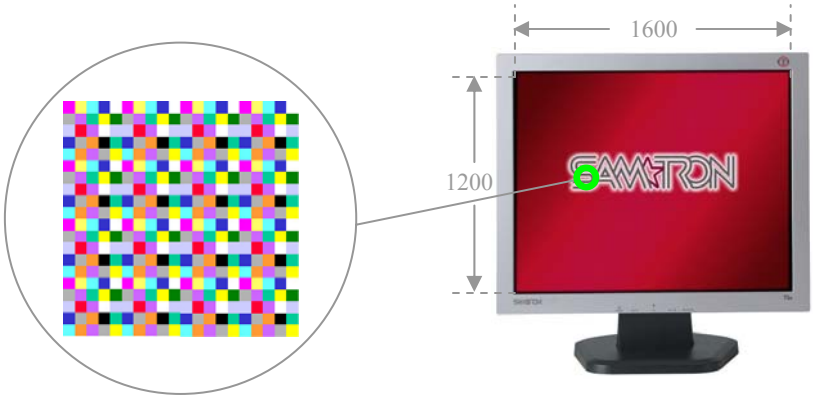
(n) Explain why system 2 has a system bus that is far superior to that of system 1.

3. Which of the following processors is faster? Is it wise to use clock speed alone to make this decision?

Specification	*Intel Pentium 4 processor 520*	*AMD Athlon 64 3700+*
Clock Speed	2.8 GHz	2.2 GHz
Architecture		
• Process Size	90 nm	90 nm
• Number of Transistors	1.25×10^8 (125,000,000)	1.059×10^8 (105,900,000)
• Die Size	112 mm^2	193 mm^2
• CPU Internal Bus Width	32 bit	64 bit
L1 Cache		
Data Cache	16 KB	64 KB
+Instruction Cache	+12 KB	+64 KB
Total L1 Cache	28 KB	128 KB
L2 Cache	1 MB	1 MB
System Bus	800 MHz	2 GHz
Number of Floating-Point Operations that can be executed per Second	? Gflops	? Gflops

4. The ***screen resolution*** of a monitor is measured by counting the number of ***pixels***. For example, if a video card supports resolutions of up to 1600 pixels × 1200 pixels, this means that there are 1200 rows with 1600 pixels in each row (see the diagram below).

This is a ***magnified*** section of an image on a computer monitor screen. Each small square is called a ***pixel*** ("picture element"), which is the smallest ***addressable*** segment of the picture. The colour of each pixel is determined by a binary code. (In CRT monitors, each pixel consists of groups of red, green and blue phosphorescent dots. The number of dots per pixel depends on the ***screen resolution***. For more information see 4(d).)



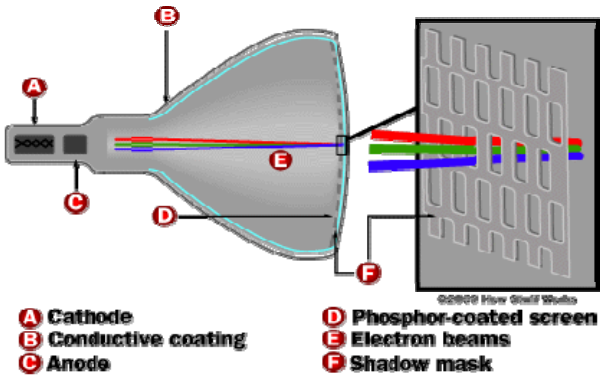
(a) How many pixels would you find on a screen with a resolution of 1600 × 1200?

(b) Video cards are able to support a variety of screen resolutions. Resolutions can be as low as 640 × 480 and as high as 2560 × 2048 (as of 2005). Suppose that you had a monitor capable of displaying such a wide variety of resolutions (it would be extremely expensive). What would you notice as you changed your display from low-resolution modes to higher resolution modes? What effect would this have on the size and number of pixels?

(c) Explain how you would change your screen resolution using Windows.

(d) Suppose that your screen resolution is set 1600 × 1200, 64-bit colour mode.
(The "64-bit colour" part means that the colour of each pixel is represented as a sequence of 64 bits such as 1101100100100100010110010010010001011001001001000100100100100101.) How much memory is needed to store a 1600 × 1200 picture if 64-bit colour is used?

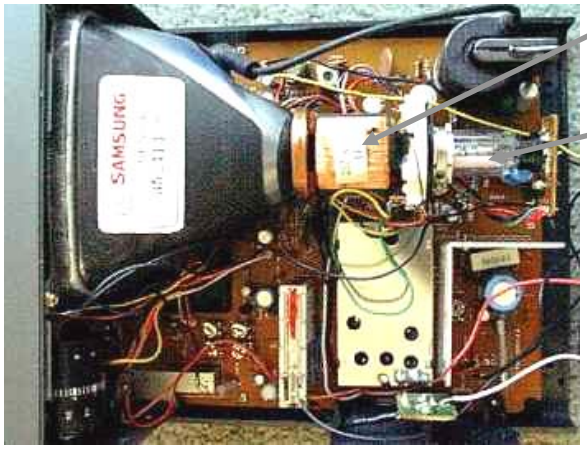
(e) The following pictures and accompanying text will help you to understand how ***cathode-ray monitors*** (CRT monitors) work.



The terms ***anode*** and ***cathode*** are used in electronics as synonyms for positive and negative terminals. For example, you could refer to the positive terminal of a battery as the anode and the negative terminal as the cathode.

In a cathode ray tube, the "cathode" is a heated filament (not unlike the filament in a normal light bulb). The heated filament is in a vacuum created inside a glass "tube." The "ray" is a stream of electrons that naturally pour off a heated cathode into the vacuum.

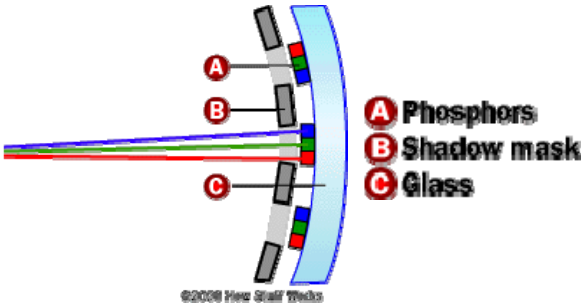
Electrons are negative. The anode is positive, so it attracts the electrons pouring off the cathode. In a TV's cathode ray tube, the stream of electrons is focused by a focusing anode into a tight beam and then accelerated by an accelerating anode. This tight, high-speed beam of electrons flies through the vacuum in the tube and hits the screen at the other end of the tube. This screen is coated with phosphor, which glows when struck by the beam.

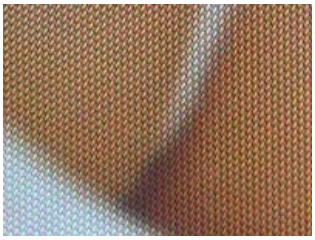


Steering Coils

Electron Gun

The ***steering coils*** are simply copper windings. These coils are able to create ***magnetic fields*** inside the tube, and the electron beam responds to the fields. One set of coils creates a magnetic field that moves the electron beam vertically, while another set moves the beam horizontally. ***By controlling the voltages in the coils, you can position the electron beam at any point on the screen***.





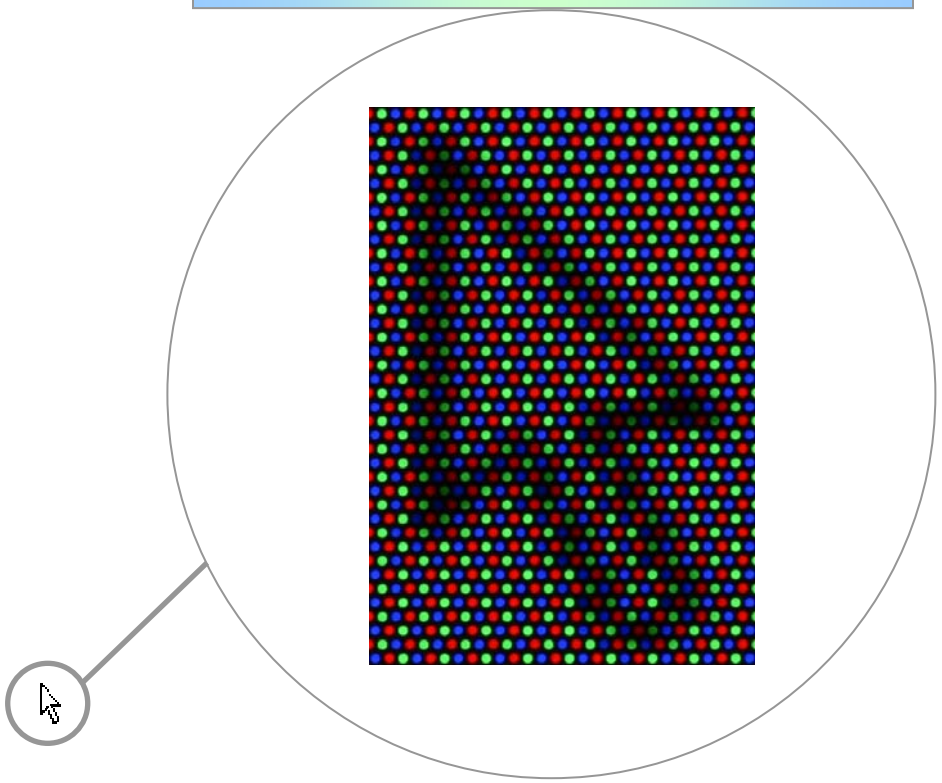
Close-up of Shadow Mask

The ***shadow mask*** is one of two major technologies used to manufacture cathode ray tube (CRT) televisions and computer displays that produce colour images (the other is aperture grille). Tiny holes in a metal plate separate the coloured phosphors in the layer behind the front glass of the screen. The holes are placed in a manner ensuring that electrons from each of the tube's three cathode guns reach only the appropriately coloured phosphors on the display. All three beams pass through the same holes in the mask, but the angle of approach is different for each gun. The spacing of the holes, the spacing of the phosphors, and the placement of the guns is arranged so that for example, the blue gun only has an unobstructed path to blue phosphors. The red, green and blue phosphors for each pixel are generally arranged in a triangular shape (sometimes called a ***triad***). All early colour television sets and the majority of computer monitors, past and present, use shadow mask technology.

This is a close-up view of the Windows mouse pointer (as displayed on a CRT monitor). Notice that the white areas show up as very bright ***triads*** of red, green and blue dots while the pointer outline is much dimmer.

The colours that we perceive are actually the result of the blending of various intensities ("shades") of ***red***, ***green*** and ***blue***, the ***primary colours*** of monitors. The colour ***white*** results from the mixing of the brightest shades of red, green and blue. We perceive the colour ***black*** when the red, green and blue phosphorescent dots don't glow at all.

By varying the intensity of the electron beam, the intensity of the primary colours is varied. In this way, a huge variety of colours can be displayed.



Now do some research to find out how ***LCD monitors*** work (including ***active-matrix LCD monitors***, which are also known as ***TFT monitors***). Then do the following:

(i) Create a series of pictures with accompanying text (as done for CRT monitors above) that help to explain the essential details of how LCD monitors work.

(ii) Compare LCD monitors and TFT monitors. In what ways are they similar? In what ways are they the different?

(iii) Does "dot pitch" apply to LCD monitors? Explain.

(iv) Now that you understand the differences between CRT and LCD monitors, are you in a better position to decide whether system 1 or system 2 has a monitor with a sharper picture? Explain.

(v) What other flat-panel technologies are used for monitors? How do they compare to LCD monitors?

Evaluation Guide for Unit 1 Culminating Activity

Victim: _____

	Level Four Masterful **80% – 100% (A)**	Level Three Skilful **70% – 79% (B)**	Level Two Mediocre **60% – 69% (C)**	Level One Marginal **50% – 59% (D)**	Level Zero Abysmal **0% – 49% (F)**
Knowledge and Understanding (KU) **Level: _____** ___ 15	➢ The ***explanations*** display a ***deep understanding*** of the ***underlying concepts***.	➢ The ***explanations*** display a ***solid understanding*** of the ***underlying concepts***.	➢ The ***explanations*** display a ***satisfactory understanding*** of the ***underlying concepts***.	➢ The ***explanations*** display a ***minimal understanding*** of the ***underlying concepts***.	➢ The ***explanations*** display a ***little or no understanding*** of the ***underlying concepts***.
Application (APP) **Level: _____** ___ 10	➢ ***Strong word processing skills*** are evident. ➢ The information is presented in an ***extremely organized*** and ***extremely aesthetically pleasing manner***.	➢ ***Good word processing skills*** are evident. ➢ The information is presented in an ***organized*** and ***aesthetically pleasing manner***.	➢ ***Moderate word processing skills*** are evident. ➢ The information is presented in a ***somewhat organized*** and ***somewhat aesthetically pleasing manner***.	➢ ***Minimal word processing skills*** are evident. ➢ The information is presented in a ***minimally organized*** and ***minimally aesthetically pleasing manner***.	➢ ***Inadequate word processing skills*** are evident. ➢ The information is presented in a ***disorganized*** and ***aesthetically displeasing manner***.
Thinking, Inquiry and Problem Solving (TIPS) **Level: _____** ___ 10	➢ A ***wide variety*** of ***resources*** have been consulted. ➢ ***Strong research skills*** are evident.	➢ A ***variety*** of ***resources*** have been consulted. ➢ ***Good research skills*** are evident.	➢ A ***few resources*** have been consulted. ➢ ***Moderate research skills*** are evident.	➢ A ***minimal number*** of ***resources*** have been consulted. ➢ ***Minimal research skills*** are evident.	➢ An ***inadequate number*** of ***resources*** have been consulted. ➢ ***Inadequate research skills*** are evident.
Communication (COM) **Level: _____** ___ 15	➢ ***Each explanation*** is ***grammatically correct***. ➢ ***All*** or ***almost all*** words are ***spelled correctly***. ➢ ***Each explanation*** can be understood ***easily*** by people who have a ***limited*** knowledge of computers. ➢ ***Diagrams*** are used ***extensively*** to illustrate written explanations.	➢ ***Most explanations*** are ***grammatically correct***. ➢ ***Most*** words are ***spelled correctly***. ➢ ***Most explanations*** can be understood by people who have a ***limited*** knowledge of computers. ➢ ***Diagrams*** are used to illustrate ***many*** written explanations.	➢ A ***moderate number*** of ***explanations*** are ***grammatically correct***. ➢ A ***moderate number*** of words are ***spelled correctly***. ➢ A ***moderate number*** of ***explanations*** can be understood by people who have a ***limited*** knowledge of computers. ➢ ***Diagrams*** are used to illustrate ***some*** written explanations.	➢ A ***minimal number*** of ***explanations*** are ***grammatically correct***. ➢ A ***minimal number*** of words are ***spelled correctly***. ➢ A ***minimal number*** of ***explanations*** can be understood by people who have a ***limited*** knowledge of computers. ➢ ***Diagrams*** are used to illustrate ***a few*** written explanations.	➢ ***Few*** if ***any explanations*** are ***grammatically correct***. ➢ ***Few*** if ***any*** words are ***spelled correctly***. ➢ ***Few*** if ***any*** explanations can be understood by people who have a ***limited*** knowledge of computers. ➢ ***Diagrams*** are ***not used*** to illustrate written explanations.

Overall Result: ___ 50

Appendix

Complete Reference for Storage and Transfer Rate Units, SI System of Units

Factor	*Storage Space Units*	*Data Transfer Rate Units*	
	Units Based on Bytes (binary)	Units Based on Bytes/s (binary)	Units Based on bps (decimal)
	8 b = 1 B	8 bps =1 B/s	1 bps
2^{10}	1 KB = 1024 B = 2^{10} B	1 KB/s = 1024 B/s = 2^{10} B/s	1 kbps = 1000 bps = 10^3 bps
2^{20}	1 MB = 1024 KB = 2^{20} B	1 MB/s = 1024 KB/s = 2^{20} B/s	1 Mbps = 1000000 bps= 10^6 bps
2^{30}	1 GB = 1024 MB = 2^{30} B	1 GB/s = 1024 MB/s = 2^{30} B/s	1 Gbps = 1000000000 bps= 10^9 bps
2^{40}	1 TB = 1024 GB = 2^{40} B	1 TB/s = 1024 GB/s = 2^{40} B/s	1 Tbps = 1000000000000 bps= 10^{12} bps
2^{50}	1 PB = 1024 TB = 2^{50} B	1 PB/s = 1024 TB/s = 2^{50} B/s	1 Pbps = 10^{15} bps
2^{60}	1 EB = 1024 PB = 2^{60} B	1 EB/s = 1024 PB/s = 2^{60} B/s	1 Ebps = 10^{18} bps
2^{70}	1 ZB = 1024 EB = 2^{70} B	1 ZB/s = 1024 EB/s = 2^{70} B/s	1 Zbps = 10^{21} bps
2^{80}	1 YB = 1024 ZB = 2^{80} B	1 YB/s = 1024 ZB/s = 2^{80} B/s	1 Ybps = 10^{24} bps

Note

1. For Storage Space Units "Kilo" means 1024 = 2^{10}

The prefix "kilo" usually means 1000 = 10^3, but since computers are based on "twos" (binary), a power of 2 is much more convenient than a power of 10. The value 1024 was chosen because it is the power of 2 closest to 1000.

2. Ambiguous use of "Kilo" for Storage Capacity and Data Transfer Rate Units

Despite the point made in "1," hardware manufacturers very often use the decimal (SI) meaning of "kilo," especially for data transfer rates. In addition, in the SI system of units, the prefix lowercase "k" is used for "kilo." When dealing with storage capacity and data transfer rate units, however, both uppercase "K" and lowercase "k" can be used. By convention, uppercase "K" means 1024 while lowercase "k" means 1000. Thus 1 KB = 1024 B while 1 kB = 1000 B. (Unfortunately, even this convention is not used consistently.)

The following table summarizes the prefixes for the ***SI system of units*** (decimal, not binary).

As you can see, the greatest factor to the "yotta" the force has given.

You may have a greater factor "yotta" but I, the "peta," am still far tastier than you!

Prefixes for SI System of Units					
Factor	*Name*	*Symbol*	*Factor*	*Name*	*Symbol*
10^{24}	yotta	Y	10^{-1}	deci	d
10^{21}	zetta	Z	10^{-2}	centi	c
10^{18}	exa	E	10^{-3}	milli	m
10^{15}	peta	P	10^{-6}	micro	μ
10^{12}	tera	T	10^{-9}	nano	n
10^{9}	giga	G	10^{-12}	pico	p
10^{6}	mega	M	10^{-15}	femto	f
10^{3}	kilo	k	10^{-18}	atto	a
10^{2}	hecto	h	10^{-21}	zepto	z
10^{1}	deka	da	10^{-24}	yocto	y

To Multiply or to Divide? That is the Question

Smaller unit → Larger unit: ÷

Smaller unit ← Larger unit: ×

Bits to Bytes

b → B: ÷8

b ← B: ×8

Conversion Table (for Kilo=1024)

B ⟷ KB ⟷ MB ⟷ GB ⟷ TB ⟷ PB ⟷ EB ⟷ ZB ⟷ YB

÷1024 (left to right) / ×1024 (right to left)

A Proposal to Avoid the Confusion caused by two Possible Meanings of "Kilo"

Introduction

Knowing whether "kilo" refers to 1000 or 1024 can cause a great deal of confusion. To prevent this confusion, a new set of prefixes has been introduced. Information about these prefixes from ***three different Web sites*** is given below. Read all the information and then answer the questions at the bottom of the page.

A Description of "Kibibyte" from Wikipedia

Kibibyte

From Wikipedia, the free encyclopedia

A **kibibyte** (a contraction of **ki**lo **bi**nary **byte**) is a unit of information or computer storage, abbreviated **KiB** (never "kiB").

1 kibibyte = 2^{10} bytes = 1,024 bytes

The kibibyte is closely related to the kilobyte, which can be used either as a synonym for kibibyte or to refer to 10^3 bytes = 1,000 bytes (see binary prefix).

Usage of these terms is intended to help prevent the confusion common among storage media, due to the ambiguous meaning of "kilobyte". Thus the term **kibibyte** has evolved to refer exclusively to 1,024 bytes.

This problem of confusion of the term *kilobyte* simultaneously being used to refer to both 1,000 and 1,024 became more prevalent when computer hard drives grew to the gigabyte and larger size, because if one expects power of two values to refer to capacity, and manufacturers were using power of ten values, the difference could be substantial, e.g. 1 megabyte, if expressed as power of two, is 1024^2 or 1024×1024, or 1,048,576, while 1000×1000 is 1,000,000. In the case of a "gigabyte", if one uses 1024^3, the size of a drive would be expected to be 1,073,741,824 bytes per gigabyte versus 1000^3, or a mere 1,000,000,000. On a 100 gigabyte drive, the difference is more than 7 billion characters additional storage, depending on whether 100 gigabytes refers to 100×1000^3 or 100×1024^3.

Quantities of bytes

SI prefixes			Binary prefixes (IEC 60027-2)	
Name (Symbol)	Popular Usage	Standard SI	Name (Symbol)	Value
kilobyte (kB)	2^{10}	10^3	**kibibyte** (KiB)	2^{10}
megabyte (MB)	2^{20}	10^6	mebibyte (MiB)	2^{20}
gigabyte (GB)	2^{30}	10^9	gibibyte (GiB)	2^{30}
terabyte (TB)	2^{40}	10^{12}	tebibyte (TiB)	2^{40}
petabyte (PB)	2^{50}	10^{15}	pebibyte (PiB)	2^{50}
exabyte (EB)	2^{60}	10^{18}	exbibyte (EiB)	2^{60}
zettabyte (ZB)	2^{70}	10^{21}	zebibyte (ZiB)	2^{70}
yottabyte (YB)	2^{80}	10^{24}	yobibyte (YiB)	2^{80}

A Description of "Kibibyte" from FOLDOC

The official ISO[?] name for 1024 bytes, to distinguish it from 1000 bytes which they call a kilobyte. "Mebibyte," "Gibibyte," etc, are prefixes for other powers of 1024. Although this new naming standard has been widely reported in 2003, it seems unlikely to catch on.

A Description of "Kibibyte" from http://www.robinlionheart.com/stds/html4/glossary

kibibyte (KiB)
A ***kibibyte*** is a unit of storage equal to exactly 1,024 bytes. Because kilobyte is used to mean either 1000 bytes or 1024 bytes, in 1999 the International Electrotechnical Commission defined a "kibi-" prefix unambiguously signifying 1024. Rarely used except by pedantic nerds, like me.

Questions

1. Explain why "kilo=1000" is called the ***decimal*** meaning and "kilo=1024" is called the ***binary*** meaning.
2. Define the words ***pedantic***, ***nerd***, ***ambiguous***, ***standard*** and ***convention***.
3. Since 1000 is very close to 1024, why should anyone bother distinguishing between the two meanings of "kilo?"
4. When using the Internet to do research, do you think that it would be wise to consult only one Web site? Explain.
5. Are there any inconsistencies in the three sources of information?