CAREER PATHS

Virginia Evans
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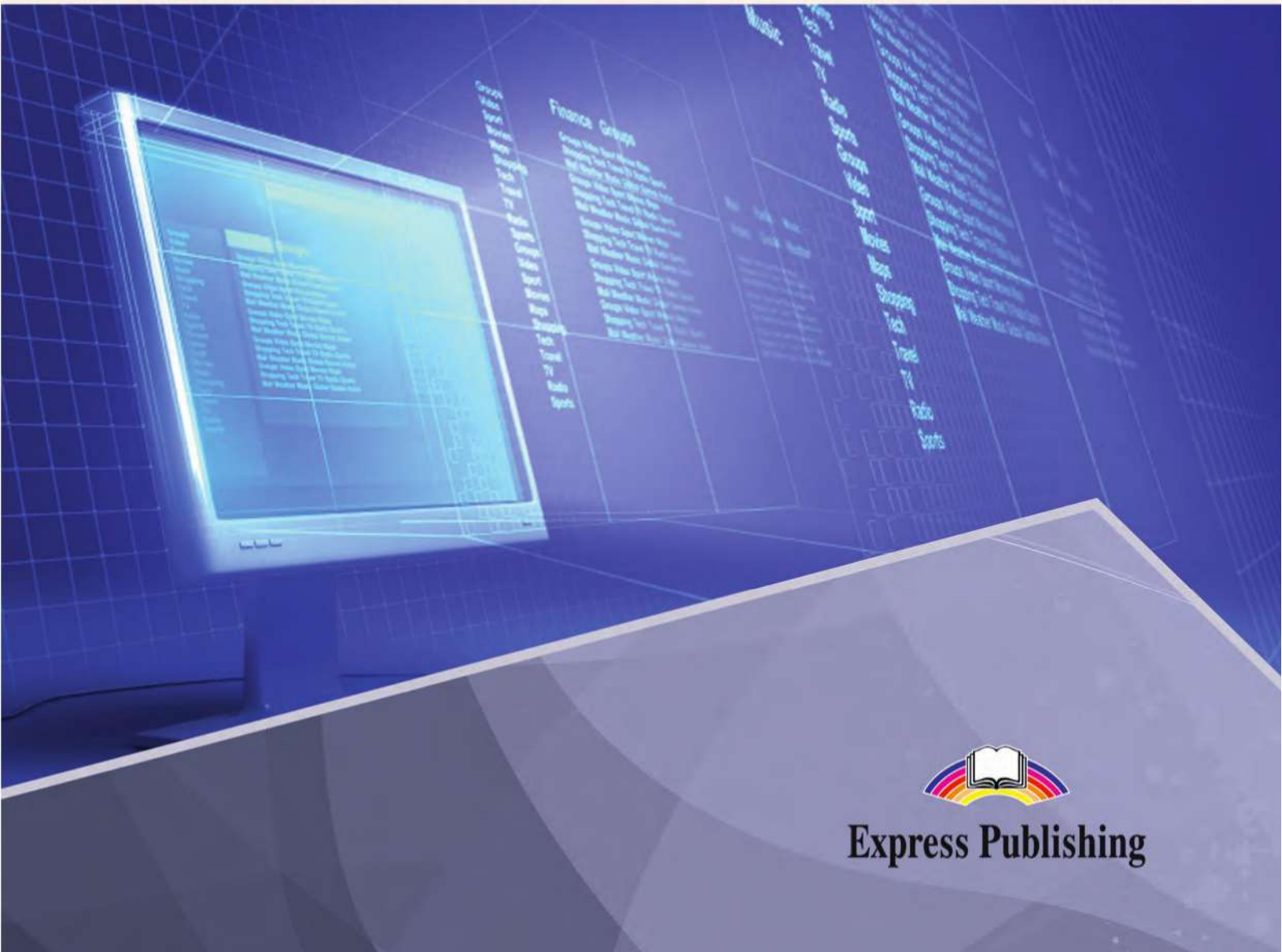
COMPUTER ENGINEERING



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COMPUTER ENGINEERING

Book 1

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Vishal Nawathe

Express Publishing

Scope and Sequence

Unit	Topic	Reading context	Vocabulary	Function
1	The Computer Engineer	Webpage	computer engineer, computer science, design, develop, evaluate, hardware, investigate, mathematical analysis, software, test	Describing goals
2	Types of Computers	Webpage	computer, computer cluster, desktop, embedded computer, laptop, notebook, PC, server, tablet, workstation	Expressing a preference
3	I/O Devices 1	Textbook chapter	active matrix, bitmap, component, CRT, display, flat-panel, frame buffer, HD, LCD, monitor, pixel, screen	Expressing satisfaction
4	I/O Devices 2	Product description	button, click, electromechanical mouse, GUI, keyboard, LED, optical mouse, peripheral, pointer, QWERTY, scroll, scroll wheel	Making a prediction
5	Storage Devices	Article	capacity, CD, DVD, flash drive, flash memory, floppy disk, hard drive, magnetic tape, storage, Zip drive	Listing features
6	Inside the Computer	Troubleshooting guide	bay, case, CD/DVD drive, cover, fan, heat sink, motherboard, processor, port, power supply	Giving instructions
7	Networks	Webpage	antenna, broadband, CAT-5 cable, Internet, LAN, modem, network, router, signal, wireless, WLAN	Making a recommendation
8	Operating Systems	Advice column	Apple®, customize, Linux®, Microsoft®, open source, operating system, OS X®, software compatibility, Windows®	Politely disagreeing
9	Basic Math	Chart	add, divide by, equals, hundred, less, minus, multiply by, over, plus, subtract, times	Making a realization
10	Analyzing Quantities	Textbook chapter	convert, decimal numbers, denominator, fraction, numerator, -out-of, percent, percentage, point, reduce	Giving a reminder
11	Measurements	Conversion chart	Celsius, centimeter, convert, degree, Fahrenheit, gram, Imperial, inch, kilogram, Metric, ounce, pound	Expressing confusion
12	Energy	Textbook chapter	chemical energy, conservation of energy, energy, friction, heat energy, kinetic energy, potential energy, release, transfer, work	Realizing an error
13	Electricity 1	Course description	alternating current, charge, conduct, direct current, electricity, electrons, negative, polarity, positive	Confirming information
14	Electricity 2	Guide	ampere, conductor, current, electrical energy, electrical power, ohm, resistance, volt, voltage, watt	Describing a problem
15	Education	Webpage	bachelor's degree, calculus, computer architecture, electrical engineering, foundation, hardware design, mathematics, physics, programming, signal processing	Describing progress

Table of Contents

1 The Computer Engineer

Get ready!

1 Before you read the passage, talk about these questions.

1 What basic subjects do computer engineers study?

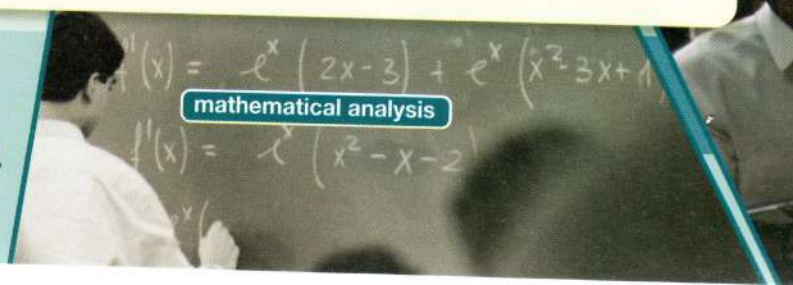
2 What kind of work are computer engineers trained for?

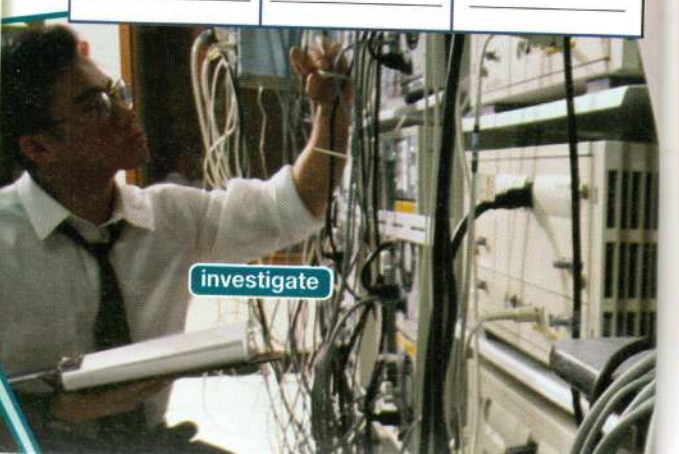
Kempko Technical Institute >
Department of Computer Engineering >
Program Overview

What will I learn in the Computer Engineering Program?

Start your career as a **computer engineer** at Kempko! Our program teaches everything you need to know about computer engineering. This growing field has many career opportunities.

- Begin with fundamental courses in engineering and **computer science**. Gain a strong understanding of **mathematical analysis** and theory.
- Learn to **develop** computer **software**. **Design** your own computer programs. Then other students will **test** them for functionality and usability.
- Also learn to **investigate** problems with **hardware**, **evaluate** causes and implement appropriate solutions. These skills will make you invaluable to potential employers.





Reading

2 Read the webpage. Then, mark the following statements as true (T) or false (F).

1 ___ Students must study computer science before they apply to the program.

2 ___ Computer engineering students test each other's software.

3 ___ According to the webpage, the school places students with potential employers.

Vocabulary

3 Match the words (1-5) with the definitions (A-E).

1 ___ test
2 ___ design
3 ___ develop
4 ___ evaluate
5 ___ investigate

A to plan the way that something will be created
B to get more information about something
C to carefully study and assess the qualities of something
D to bring something from conception to action
E to operate something to see if it works properly

4 Place the words or phrases from the word bank under the correct headings.

word BANK

mathematical analysis software
computer engineer
hardware computer science

Parts of a computer	Computer Studies	People who work with computers

5 🎧 **Listen and read the webpage again. What parts of a computer do computer engineers work with?**

Listening

6 🎧 **Listen to a conversation between an academic advisor and a student. Choose the correct answers.**

1 What is the purpose of the conversation?

- **A** to review the requirements for computer engineering students
- **B** to list different foci within the computer engineering major
- **C** to discuss the woman's experience with the computer engineering program
- **D** to determine if the man is interested in computer engineering

2 What has the man already completed?

- **A** an application to major in computer science
- **B** a few mathematical analysis courses
- **C** an overview course on hardware and software
- **D** an entrance exam for the computer engineering program

7 🎧 **Listen again and complete the conversation.**

Advisor: Okay, let's look at your next semester. Did you decide on a major?

Student: I'm not sure. My **1** _____ _____ _____ to go for something with good career potential.

Advisor: I see you already took some **2** _____ _____ courses.

Student: I want to do a course **3** _____ _____ solving problems.

Advisor: How about the computer engineering program? You will probably do well on the **4** _____ _____.

Student: I don't know much about that. Do computer engineers focus on **5** _____ _____ _____?

Advisor: Both, actually. The program teaches **6** _____ _____ and electrical engineering.

Student: Hmm. That sounds interesting. I'll look into it.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

My goal is to ...
I see you already took ...
I want to do ...

Student A: You are an academic advisor. Talk to Student B about:

- his or her interest in computer engineering
- which courses he or she has already taken
- subjects that the program covers

Student B: You are a student. Talk to Student A about your interest in computer engineering.

Writing

9 **Use the conversation from Task 8 to fill out the email from an advisor to a student.**

Dear Tim,

I think you would be a great fit for the computer engineering program. You have already taken _____.

That means you already know about _____ _____.

In the program, you will take _____ _____,

where you will learn about _____.

You will also learn about _____.

Let me know if I can answer any further questions.

Sincerely,

Gina Farrell
Academic Advisor
Kempko Technical Institute

2 Types of Computers

Get ready!

1 Before you read the passage, talk about these questions.

1 What are the benefits of different types of personal computers?

2 What types of computers do businesses use?

Seacrest **Computers** manufactures a variety of products. We mostly create custom **PCs** for individuals. Our **desktops** are great for your home or office. We also create **laptops** and **notebooks** for mobile customers. Don't miss Seacrest's first **tablet**! It is scheduled for release later this year.

Seacrest also has a great product lineup for businesses. Our **servers** are secure and reliable. Your job will become easier with our custom **workstations**. Does your company process a lot of data? Allow us to design your new **computer cluster**. We also install **embedded computers** in company vehicles.

For more information, click here to contact us!

Reading

2 Read the webpage. Then, mark the following statements as true (T) or false (F).

1 ___ The company advertises laptops for mobile customers.

2 ___ The company's tablet is one of its most popular products.

3 ___ The webpage recommends installing workstations in company vehicles.

Vocabulary

3 Match the words or phrases (1-6) with the definitions (A-F).

1 ___ PC
2 ___ tablet
3 ___ laptop
4 ___ desktop
5 ___ computer cluster
6 ___ embedded computer

A a computer designed for individual use
B a computer intended to be used in a single place
C a portable, folding computer
D a computer that is part of a larger product
E a portable computer with a flat touch screen
F a computer that can process large amounts of data

4 Read the sentence pairs. Choose which word best fits each blank.

1 **computer / server**

A These days, many families have more than one _____ at home.

B All of the company's data is transmitted through a single _____.

2 **notebook / workstation**

A The company uses a _____ for advanced graphics design.

B The student used a _____ to write an essay on an airplane.

5 Listen and read the webpage again. What types of computers does the company create for businesses?

Listening

6 Listen to a conversation between two computer engineers. Choose the correct answers.

1 What is the conversation mostly about?

A the types of computers that the engineers prefer

B how to design particular types of computers

C problems that the engineers encountered with a computer

D which computers are best for different projects

2 Which is the man's favorite computer?

A computer cluster **C** desktop

B workstation **D** laptop

7 Listen again and complete the conversation.

Engineer 1: Hey, Jack. What's your favorite **1** _____ _____ _____ to work on?

Engineer 2: I don't know. I'd have to think about it. What's yours, Kate?

Engineer 1: I think I **2** _____ _____ over other computers.

Engineer 2: Really? **3** _____ _____ _____ like laptops?

Engineer 1: Well, I travel a lot. Laptops are **4** _____ _____ _____ and their capabilities are similar to desktops.

Engineer 2: That makes sense. I guess I **5** _____ _____, because of their power.

Engineer 1: I bet you'd really enjoy using **6** _____ _____.

Engineer 2: Yeah, I think I probably would.

Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

USE LANGUAGE SUCH AS:

What's your ...?

I think I prefer ...

I bet you'd ...

Student A: You are an engineer. Talk to Student B about:

- the type of computer he or she prefers to use
- the type of computer you prefer to use
- the benefits of different computers

Student B: You are an engineer. Talk to Student A about your favorite computer.

Writing

9 Use the conversation from Task 8 to fill out the customer survey.

Seacrest Computers Customer Survey:

What kind of computer did you purchase today?

_____

Why did you choose this kind of computer?

_____

What kind of computer do you typically use?

_____

Why?

_____

3 I/O Devices 1

Get ready!

1 Before you read the passage, talk about these questions.

1 How have computer monitors improved over time?

2 What is the purpose of a frame buffer?

Reading

2 Read the textbook chapter. Then, mark the following statements as true (T) or false (F).

1 ___ Most flat panel monitors use CRTs to display images.

2 ___ Active matrices allow monitors to display HD images.

3 ___ Multiple bitmaps come together to create a single image.

Vocabulary

3 Fill in the blanks with the correct words from the word bank.

word BANK

CRT screen flat-panel
component HD pixel

1 People can control tablet PCs by touching the _____ .

2 The customer was impressed by the thinness of the _____ monitor.

3 On very old displays, you could see each individual _____ .

4 Old monitors were bulkier than new ones because they each used a(n) _____ .

5 For the best resolution, get a(n) _____ display.

6 Each _____ of the computer performs a different function.

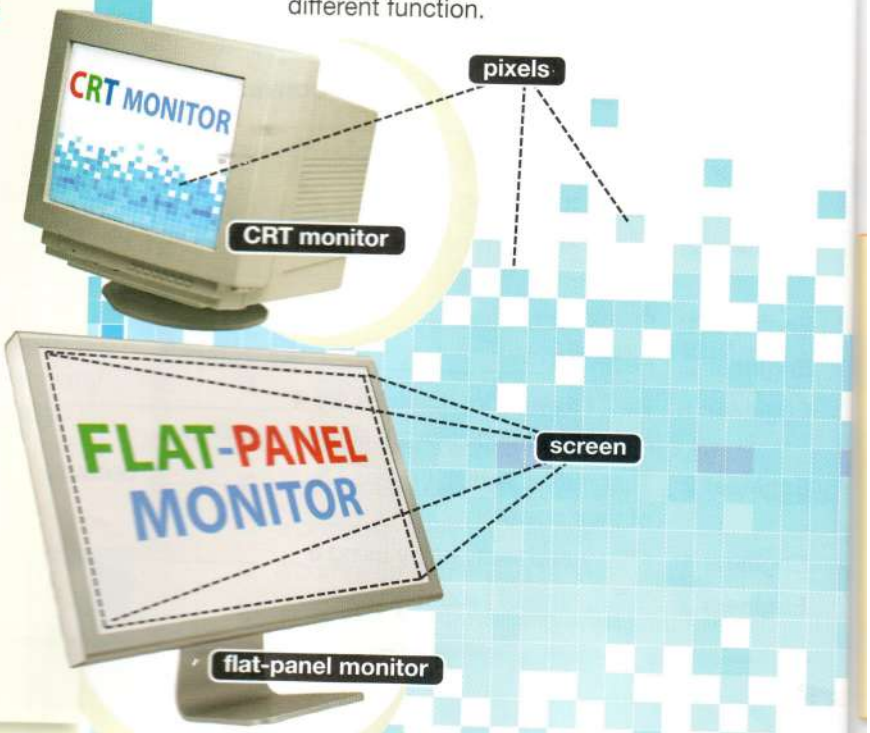
Chapter 3.2

Monitors

A **monitor** is a computer **component** that shows images. **Displays** appear on monitor **screens**.

Most of today's monitors have **flat-panel** displays. They usually produce images using **LCDs**. Older monitors used **CRTs**, which made them bulky. As monitors became thinner, image resolution also improved. Current **HD** displays have far better resolution than standard ones. **Active matrices** give monitors this capability.

Displays are made up of many tiny **pixels**. A **bitmap** organizes many pixels into a single image. To display images, computers switch between bitmaps. **Frame buffers** store bitmaps before displaying them on the monitor.



4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 **bitmap / LCD**

A The computer's _____ is capable of showing detailed, vibrant images.

B A(n) _____ tells pixels on a screen how to form into an image.

2 **active matrix / frame buffer**

A The display's _____ allows it to control each individual pixel.

B The _____ stores bitmaps before the monitor displays them.

3 **display / monitor**

A Jim's _____ is so old that it still uses a CRT.

B Consumers really like the sharp _____ on the new screens.

5 Listen and read the textbook chapter again. How do HD displays differ from standard displays?

Listening

6 Listen to a conversation between two managers. Choose the correct answers.

1 What is the conversation mostly about?

A a request for new monitors in an office

B which company makes the highest-quality monitors

C the type of monitor that a company used to use

D a disagreement about which monitors are best

2 Which monitor feature does the woman especially like?

A flat panel design C LCD technology

B HD resolution D bitmap display

7 Listen again and complete the conversation.

Manager 1: Have you seen **1** _____ _____ _____? They're pretty nice.

Manager 2: Yeah. I really like the new **2** _____ _____.

Manager 1: It's great. Then again, **3** _____ _____ _____ we have flat-panel monitors now.

Manager 2: Did the office have those bulky monitors before?

Manager 1: Yes. When I started here, we had CRT-based monitors.

Manager 2: What's **4** _____ _____?

Manager 1: A cathode ray tube. **5** _____ _____ _____ the old monitors so bulky.

Manager 2: Oh, yeah. I've seen those. Those took up way **6** _____ _____ _____.

Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

USE LANGUAGE SUCH AS:

Have you seen ...?
I really like ...
It's great.

Student A: You are a manager. Talk to Student B about:

- how monitors have improved
- benefits of the new monitors
- features of the old monitors

Student B: You are a manager. Talk to Student A about how monitors have improved.

Writing

9 Use the conversation from Task 8 to fill out an email from one manager to another manager.

To: d.g@digisyst.com
From: e.m@digisyst.com
Subject: New monitors

Hi Dave,

I think we need to get some new monitors for the office. The old ones are _____ because _____. I think we should get _____ instead. This would be better because _____ and _____.

Let me know what you think.

Erica

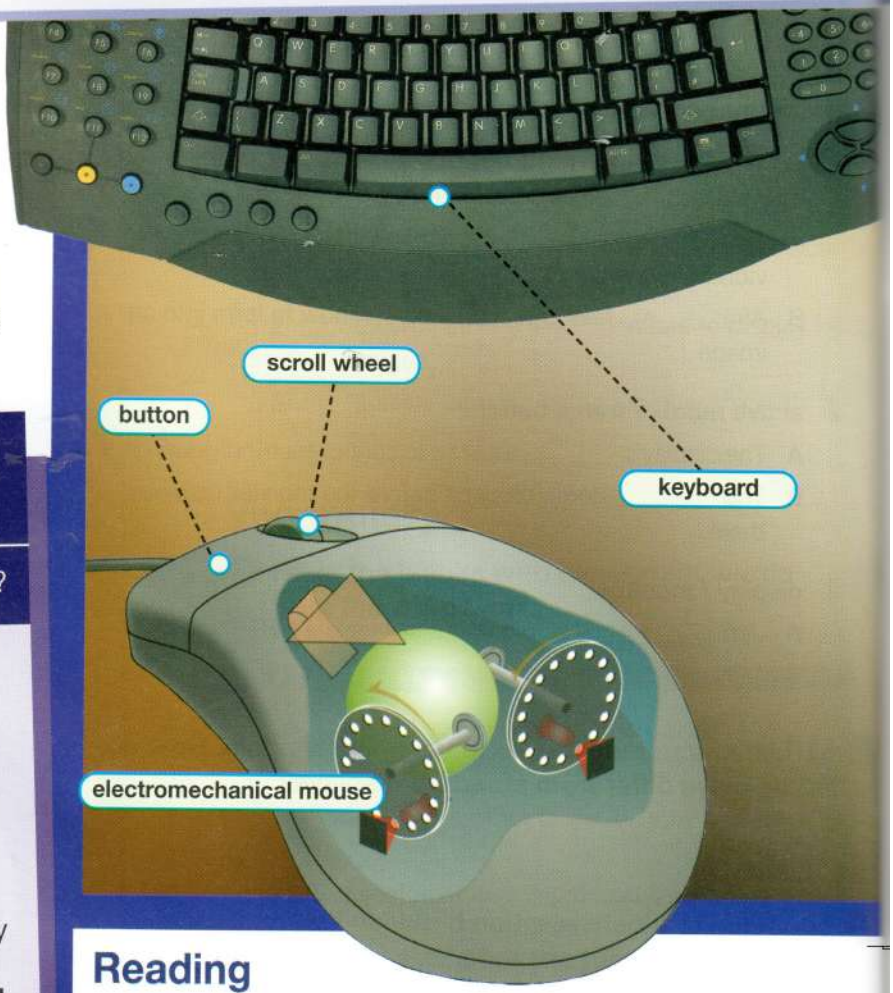
4 I/O Devices 2

Get ready!

1 Before you read the passage, talk about these questions.

1 What information do keyboards and mice input into computers?

2 What is the difference between a mechanical mouse and an optical mouse?



Vanrey 5650 Desktop Computer

What comes with my new computer?

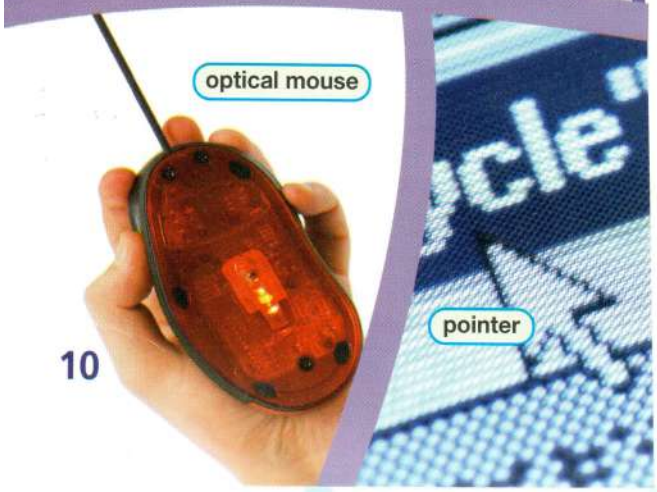
Included Peripherals

Every desktop model comes with a Vanrey **keyboard**. This **QWERTY** keyboard features new quiet-key technology. It also comes with wrist support to reduce muscle strain.

Each unit also comes with the Vanrey EM750 **electromechanical mouse**. **Scroll** smoothly with a durable **scroll wheel**. Then easily **click** your selections with the two large **buttons**. This standard mouse is perfect for light, everyday use.

Recommended Peripherals

The Vanrey Omega **optical mouse** tracks movements with **LEDs**. This mouse is recommended for architects, engineers, and other design professionals. It guides **pointers** across **GUIs** with precise, smooth movements. This accessory is sold separately.



Reading

2 Read the product description. Then, mark the following statements as true (T) or false (F).

1 ___ Users can choose which keyboard the computer comes with.

2 ___ An electromechanical mouse is included with the computer.

3 ___ The optical mouse is recommended for design professionals.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 ___ GUI
2 ___ button
3 ___ pointer
4 ___ keyboard
5 ___ scroll wheel
6 ___ optical mouse
7 ___ electromechanical mouse
8 ___ peripheral

A an icon on a computer's display controlled by a mouse
B an input device that uses a ball to track its movement
C the part of a device that a user presses to perform a function
D an input device with many keys for inputting data
E an input device that uses an LED to track its movement
F a visual display that computer users can interact with
G a device on a mouse that lets users move up and down smoothly on a screen
H any device that is connected but not built into a computer

4 **Read the sentence pairs. Choose which word or abbreviation best fits each blank.**

1 **scroll / click**

A Use the button to _____ on different selections.

B The wheel lets users _____ smoothly through documents.

2 **QWERTY / LED**

A The mouse uses a(n) _____ to track its movements.

B Keyboards for English speakers usually have _____ layouts.

5 🎧 **Listen and read the product description again. What are an electromechanical mouse's main features?**

Listening

6 🎧 **Listen to a conversation between a salesperson and a customer. Choose the correct answers.**

1 What is the conversation mostly about?

A prices for computer accessories

B the benefits of a new mouse

C a problem with the man's current equipment

D why the man prefers his old keyboard

2 Which product does the woman recommend?

A an optical mouse **C** an electromechanical mouse

B a new computer **D** a QWERTY keyboard

7 🎧 **Listen again and complete the conversation.**

Customer: Hi, I'd like to buy this keyboard.

Salesperson: Great! Can I also **1** _____ _____ in a new mouse?

Customer: No. That's okay. I'm pretty happy with **2** _____ _____ _____.

Salesperson: Are you sure? What **3** _____ _____ _____?

Customer: It's an **4** _____ _____. It came with my old computer.

Salesperson: I think **5** _____ _____ _____ an optical mouse. They're much more precise.

Customer: Yeah? That could really help me out. I'm a graphic designer.

Salesperson: Then you should definitely have the **6** _____ _____. Come take a look.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

I'd like to buy ...

I think you'll ...

That could really ...

Student A: You are a salesperson. Talk to Student B about:

- peripherals for a computer
- your recommendation
- how he or she will benefit from your recommendation

Student B: You are a customer. Talk to Student A about peripherals for your computer.

Writing

9 **Use the conversation from Task 8 to fill out the customer feedback form.**

Computers Direct

Customer Feedback Form

What did you purchase?

_____

_____

Was the salesperson helpful? **Y / N**

Why or why not?

_____

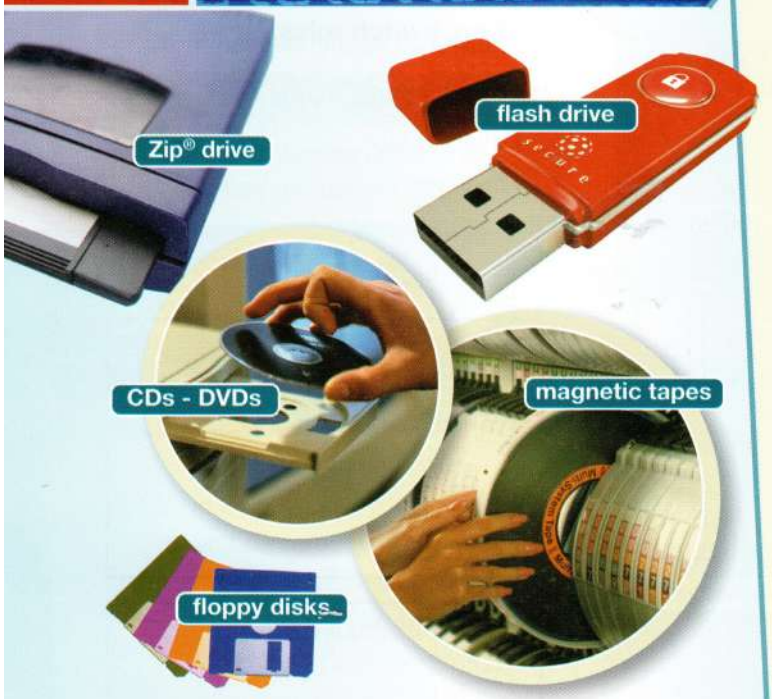
_____

_____

5 Storage Devices

COMPU-LIVING MONTHLY

Let's Talk Storage!



Computer technology grows rapidly. The **capacity** of data **storage** is no exception. **Hard drives** and storage devices improve all the time.

Early computers relied on **magnetic tape**. Developers soon replaced these with more efficient **floppy disks**. However, these still had limited space. For a while, **Zip® drives** were a larger-capacity solution.

Then **CDs** came along. These lightweight, inexpensive devices are easy to store and discard. **DVDs** have similar benefits, and hold much more data. However, erasing and reprogramming these devices is often unreliable.

Today, we have compact **flash memory**. Tiny **flash drives** hold more information than earlier devices, including DVDs. Unlike most DVDs and CDs, flash drives are easily erasable.

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some early forms of computer data storage?

2 What are the benefits of flash memory?

Reading

2 Read the article. Then, choose the correct answers.

1 What is the main idea of the article?

- **A** the rising costs of data storage devices
- **B** a history of data storage devices
- **C** materials used to make data storage devices
- **D** addressing problems with data storage devices

2 Which of the following is NOT a benefit of CDs?

- **A** They are easy to store.
- **B** They are lightweight.
- **C** They can be erased and reprogrammed.
- **D** They have a lower capacity than DVDs.

3 According to the article, what makes Zip® drives better than floppy disks?

- **A** a smaller size
- **B** more affordable cost
- **C** a higher capacity
- **D** the ability to be erased

Vocabulary

3 Write a word or phrase that is similar in meaning to the underlined part.

1 The engineer could not erase the data from the <u>flat, round data device</u>.
_ _ _

2 Most new computers cannot read <u>flat, square, low-capacity data devices</u>.
_ l o _ _ _ d _ _ k s

3 The firm needs a new method of <u>saving information</u> for its electronic files.
s _ _ r a _ _

4 New devices have more <u>space to store information</u> than old devices.
_ a _ a _ i t _

4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 **hard drive / flash drive**

A A _____ is built into a computer.

B A _____ is designed to move easily from one computer to another.

2 **flash memory / magnetic tape**

A _____ was one of the earliest methods of computer data storage.

B _____ has a larger storage capacity than earlier methods, like DVDs.

3 **CDs / Zip® drives**

A _____ were popular because they were cheap and disposable.

B _____ were popular because they were like large-capacity floppy disks.

5 Listen and read the article again. What product does the article recommend?

Listening

6 Listen to a conversation between a customer and a salesperson. Mark the following statements as true (T) or false (F).

1 __ The man needs help choosing a new hard drive.

2 __ The man requests a product that will not meet his storage needs.

3 __ According to the woman, the man needs multiple storage devices.

7 Listen again and complete the conversation.

Customer: Excuse, me. Can you help me **1** _____ _____ some CDs?

Salesperson: Of course. What do you need them for?

Customer: Data storage. I'm moving about ten gigabytes off my employer's **2** _____ _____.

Salesperson: That's going to take a lot of CDs. I'd recommend a **3** _____ _____ instead.

Customer: Why is that better?

Salesperson: I **4** _____ _____ _____ with a sixteen-gigabyte capacity.

Customer: Oh, so all the data will fit on **5** _____ _____?

Salesperson: Right. Plus, you can **6** _____ _____ later and use it for something else.

Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

USE LANGUAGE SUCH AS:

Can you help me ...?

What do you need ...?

Plus, you can ...

Student A: You are a customer. Talk to Student B about:

- your data storage needs
- a product you are looking for
- his or her recommendations

Student B: You are a salesperson. Talk to Student A about his or her data storage needs.

Writing

9 Use the conversation from Task 8 to fill out the note from the customer to his or her employer.

Hi Jenny,

I picked up a storage device at the electronics store today. I know you said that you wanted _____. However, I got _____ instead. The salesperson recommended that because _____ and _____. I hope that's okay.

Glenn

6 Inside the Computer

Get ready!

1 Before you read the passage, talk about these questions.

1 Why do computers have fans and heat sinks?

2 What is the purpose of a computer bay?

Reading

2 Read the troubleshooting guide. Then, mark the following statements as true (T) or false (F).

1 ___ According to the guide, the most likely cause of overheating is a problem with the fan.

2 ___ The first troubleshooting step is to disconnect the fan from the motherboard.

3 ___ According to the guide, malfunctioning fans produce additional heat.

Vocabulary

3 Match the words or phrases (1-6) with the definitions (A-F).

1 ___ fan
2 ___ bay
3 ___ cover
4 ___ processor
5 ___ motherboard
6 ___ CD/DVD drive

A a device that makes something cooler by moving air

B a part of a computer that interprets and runs programs

C a part of something that protects its interior components

D a location where hardware is stored inside a computer

E a part of a computer that reads disc-based media

F a computer's central circuit board

Troubleshooting Guide

Overheating

The most common cause of overheating is a malfunctioning **fan**. Most computers have a **heat sink**. This has its own fan. Other computers have a separate fan in the **case**.

To troubleshoot overheating, first remove the computer's **cover**. Then check whether the fan is functioning.

- If the fan is not functioning, check the **power supply**. Some fans attach to the **motherboard**. Others connect directly to the PSU. Reconnect it to the proper **port** if it is disconnected.
- If the fan is functioning, it may be inadequate. Additional hardware installations produce extra heat. Check **bays** for heat from added **processors** or **CD/DVD drives**. In this situation, you may need to purchase a stronger fan.

4 **Read the sentence pairs. Choose which word or phrase best fits each blank.**

1 **heat sink / power supply**

A The computer's _____ regulates the computer's temperature.

B The computer won't turn on without a _____.

2 **case / port**

A To connect the monitor, make sure the cable is in the right _____.

B The computer has a clear _____ so users can see the interior components.

5 **Listen and read the troubleshooting guide again. What is the first step when troubleshooting an overheating computer?**

Listening

6 **Listen to a conversation between a technician and a customer. Choose the correct answers.**

1 What is the purpose of the conversation?

A to determine why a computer will not turn on

B to discuss a possible solution to a temperature problem

C to explain why some hardware components are more effective than others

D to record a formal complaint about a manufacturer's product

2 What will the woman likely do next?

A replace the central processor

B move hardware to other bays

C reconnect the fan to the port

D open the computer's case

7 **Listen again and complete the conversation.**

Technician: This is tech support. How may **1** _____ _____ _____?

Customer: My computer **2** _____ _____.

Technician: Have you checked whether **3** _____ _____ _____ working?

Customer: Yes. I opened **4** _____ _____, and I can see the fan spinning.

Technician: Go ahead and try moving the hardware to different bays.

Customer: How would that help?

Technician: It helps to **5** _____ _____ _____ from other heat-producing hardware.

Customer: Okay. I'll call back if that **6** _____ _____.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Have you checked ...?

Yes. I opened the case and ...

Go ahead and do that.

Student A: You are a technician. Talk to Student B about:

- a problem with his or her computer
- what he or she has already tried
- possible solutions to the problem

Student B: You are a customer. Talk to Student A about fixing your computer.

Writing

9 **Use the conversation from Task 8 to fill out the tech support log.**

Tech Support Log

Customer ID: _____

Problem: _____

_____

Actions already taken: _____

_____

_____

Actions recommended: _____

_____

_____

7 Networks

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some different types of networks?

2 What is the difference between a router and a modem?

Reading

2 Read the webpage. Then, mark the following statements as true (T) or false (F).

1 __ The bronze package includes a wireless network.

2 __ The silver package connects computers through a router.

3 __ The gold package is the least expensive option.

Vocabulary

3 Match the words or abbreviations (1-6) with the definitions (A-F).

1 __	LAN	3 __	WLAN	5 __	wireless
2 __	signal	4 __	Internet	6 __	CAT-5 cable

A a large network that reaches all over the world

B a small network of computers that are connected by cables

C a collection of information transmitted by hardware

D not requiring or involving wires

E a type of cable used to create computer networks

F a small network of computers that are connected wirelessly

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LinkoConnect

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Linko Connect provides a wide variety of products and services. Are you in need of a **network**? Linko Connect has many different networking packages.

Get our lowest available price with the bronze package. Link multiple home or office computers together with a **LAN**. We use enhanced **CAT-5 cables** to connect your machines.

Don't like wires and cables? Don't worry! With our silver package you'll get a **WLAN**. Our **wireless** networks transmit **signals** through a central **router**. Each router's **antenna** can transmit signals from blocks away.

Finally, our gold package includes our best high speed **broadband**. You'll surf the **Internet** at 50 Mbps!

All packages come with separate or built-in **modems**.

4 **Read the sentence pairs. Choose which word best fits each blank.**

1 **modem / antenna**

A A computer uses a(n) _____ to connect to the telephone line.

B Some devices receive wireless signals through a(n) _____.

2 **router / network**

A The computers are all part of the same _____.

B A _____ directs information to the computers it is connected to.

5 **Listen and read the webpage again. What kind of network is available with the bronze package?**

Listening

6 **Listen to a conversation between a representative and a customer. Choose the correct answers.**

1 What is the conversation mostly about?

A a problem with a network connection

B the most appropriate Internet package

C the benefits of purchasing an additional product

D the costs of different connection speeds

2 Why does the woman decline a particular product?

A She thinks it is too expensive.

B She does not want wireless access.

C She wants a better connection speed.

D She already has the product.

7 **Listen again and complete the conversation.**

Representative: This is Linko Connect. How may I help you?

Customer: I'm interested in an **1** _____ _____. What are my options?

Representative: Well, our gold package comes with **2** _____ _____ _____. And its connection speed is forty megabits per second.

Customer: I don't need that. **3** _____ _____ _____ a router.

Representative: In that case, **4** _____ _____ _____ basic package. It doesn't come with a router.

Customer: But is it **5** _____ _____?

Representative: Yes, it's the same speed. You'll just **6** _____ _____ on the router.

Customer: Great. I'll take that.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

How may I help you?

I don't need ...

I recommend ...

Student A: You are a representative for an Internet service provider. Talk to Student B about:

- his or her Internet connection options
- his or her Internet needs
- your recommendation

Student B: You are a customer. Talk to Student A about Internet connection options.

Writing

9 **Use the conversation from Task 8 to fill out the order form.**

LinkoConnect

Service Order Form

Customer Name: _____

Customer ID: _____

Order: _____

This package includes: _____

_____

_____

8 Operating Systems

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some commonly used operating systems?

2 What are the benefits of an operating system that you use?

Dear Mr. Tech,

I'm considering buying a new computer. However, I don't know which **operating system** to choose. Which one do you recommend?

James in Glenwall

Dear James,

Each operating system (OS) has different benefits. **Apple®** produces a popular OS called **OS X®**. This system has fewer known viruses than other systems. **Microsoft®** makes an OS called **Windows®**. One of its benefits is **software compatibility**. Windows works with a wide variety of programs. Finally, there is also the **Linux®** OS. Linux® is **open source** and easy to **customize**. I hope this helps you make your decision!

Mr. Tech

Reading

2 Read the advice column. Then, complete the table.

Operating System	Benefit
1 _____	Has fewer known viruses.
Windows®	2 _____ _____
Linux®	3 _____ _____

Vocabulary

3 Write a word that is similar in meaning to the underlined part.

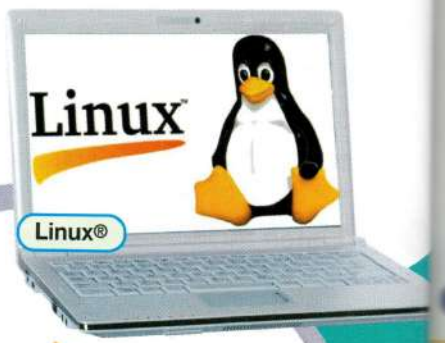
1 The new computer was made by a company that produces both operating systems and computers. _ _ p l _®

2 The engineer works for the company that makes the Windows operating system. M _ _ _ o _ o _ _®

3 Some people prefer an open source operating system. _ i n _ _

4 The operating system made by Apple® is popular for its virus security. _ _ _

5 The operating system made by Microsoft® is popular for its wide range of uses. _ _ n d _ _ s®



Microsoft®

Microsoft®

Windows®

4 **Fill in the blanks with the correct words or phrases from the word bank.**

WORD BANK

operating system open source
customize software compatibility

1 The source code for _____ software is freely available.
2 _____ determines whether a computer can run certain programs.
3 Most complex computers cannot function without a(n) _____.
4 Many people like to _____ software to fit particular needs.

5 **Listen and read the advice column again. Which company's operating system is least likely to get a virus?**

Listening

6 **Listen to a conversation between two computer engineers. Choose the correct answers.**

1 What is the conversation mostly about?
- **A** which software a particular operating system can run
- **B** which companies produce different operating systems
- **C** which operating system has the best features
- **D** which operating system is the easiest to install

2 What is true about the man?
- **A** He dislikes the Windows® operating system.
- **B** He likes a larger software selection.
- **C** He prefers the system that's less likely to get a virus.
- **D** He wants a system that is more customized.

7 **Listen again and complete the conversation.**

Engineer 1: Hey, you prefer OS X® **1** _____ _____, don't you?
Engineer 2: Not at all. Windows® is my favorite **2** _____ _____.
Engineer 1: Really? I'm surprised.
Engineer 2: What's surprising about it? Windows® has great **3** _____ _____.
Engineer 1: Perhaps, but OS X® is less **4** _____ _____ _____ viruses.
Engineer 2: I see where **5** _____ _____ _____. But I prefer a large software library.
Engineer 1: But don't you agree that OS X® is better all around?
Engineer 2: Nope. I guess we have to **6** _____ _____ _____.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

I prefer ...
But wouldn't you agree that ...?
We have to agree to disagree.

Student A: You are an engineer. Talk to Student B about:
- your favorite operating system
- his or her favorite operating system
- the advantages of each operating system

Student B: You are an engineer. Talk to Student A about your favorite operating system.

Writing

9 **Use the conversation from Task 8 to fill out an email from a computer engineer to a client.**

Dear _____,

I heard that the office is getting new computers. Did you choose an operating system yet? I recommend _____ because _____. Some people in the office would prefer _____ because _____. Let me know what you decide.

Regards,

_____
Computer Engineer

9 Basic Math

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some different ways to describe combining numbers?

2 What are some different ways to describe splitting numbers apart?

Reading

2 Read the chart. Then, mark the following statements as true (T) or false (F).

1 __ Four times seven equals seven minus four.

2 __ Two plus three equals five.

3 __ Six divided by three is the same as six over three.

Vocabulary

3 Read the sentences and choose the correc words or phrases.

1 Five **less / plus** three equals two.

2 Eight **divided by / times** two equals four.

3 **Subtract / Equal** one number from another to find the difference between them.

4 Two **multiplied by / divided by** three is six.

5 If you **add / subtract** two amounts of something, you get a larger amount.

1,400

-hundred

How do they say it?

Symbol	*Interpretation*	*Examples*
=	**equals**	¼ = 0.25 One quarter equals point two five.
+	**plus, add**	A + B = C A plus B equals C. Add A and B to get C.
–	**minus, less, subtract**	A – B = C A minus B is C. Subtract B from A to get C.
×	**multiplied by, times**	A × B = C A multiplied by B is C. A times B equals C.
÷, /	**divided by, over**	A ÷ B = C A divided by B equals C. A / B = C A over B is C.
1,900	one thousand nine hundred or nineteen **hundred**	We spent nineteen hundred dollars on office supplies.

2 + 3 = 5

plus

3 - 2 = 1

minus

2 x 3 = 6

times

6 ÷ 2 = 3

divided by

4 + 3 = 7

equals

4 **Place the correct words from the word bank under the correct headings.**

WORD BANK

equal minus times plus over

Combining amounts	Splitting amounts	Expressing results

5 **Listen and read the chart again. What is the result if someone multiplies two quantities instead of dividing them?**

Listening

6 **Listen to a conversation between two engineering students. Choose the correct answers.**

1 What is the main idea of the conversation?

- **A** why the man got the wrong answer to a test question
- **B** which student got a higher grade on a test
- **C** when the students will be tested on new math concepts
- **D** how the woman's test score was calculated

2 Which operation was required in the first part of the equation?

- **A** dividing
- **B** adding
- **C** subtracting
- **D** multiplying

7 **Listen again and complete the conversation.**

Student 1: How did you do on the **1** _____ _____?

Student 2: I missed something on the first part. I don't know what I **2** _____ _____.

Student 1: Let's see. The equation started with fourteen hundred **3** _____ _____.

Student 2: So **4** _____ _____ _____ five equals seven thousand, right?

Student 1: No, that's not it. You **5** _____ instead of dividing.

Student 2: Oh, of course. I get it now. It **6** _____ _____ fourteen hundred *over* five.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

I don't know what I did...

You ... instead of ... / I get it now.

Student A: You are an engineering student. Talk to Student B about:

- his or her performance on a math test
- a question he or she answered incorrectly
- the mathematical operation he or she should have used

Student B: You are an engineer student. Talk to Student A about your performance on a math test.

Writing

9 **Use the conversation from Task 8 to fill out the test revision sheet.**

Course: Math 100

Student:

Please write the equation you missed. Then, explain what you did wrong and write the corrected equation.

Incorrect Equation	*What did you do wrong?*	*Corrected Equation*
1. 4 - 1 = 3	I subtracted instead of adding.	4 + 1 = 5
2. 1.400 x 5 = 7,000	I multiplied instead of dividing.	_____
3. _____	I substracted instead of adding.	1.500 + 500 = 2,000

10 Analyzing Quantities

Get ready!

1 Before you read the passage, talk about these questions.

1 How are fractions expressed?

2 How are percentages expressed?

Reading

2 Read the textbook chapter. Then, mark the following statements as true (T) or false (F).

1 ___ The numerator of a fraction expresses the total units possible.

2 ___ Percentages can be expressed as whole or decimal numbers.

3 ___ A percentage as a numerator over 100 is a fraction.

Vocabulary

3 Match the words (1-6) with the definitions (A-F).

1 ___ point

2 ___ percent

3 ___ -out of

4 ___ numerator

5 ___ denominator

6 ___ decimal number

A the number above the line on a fraction

B the number below the line on a fraction

C describing the ratio between actual and potential quantities

D the quantity of something expressed in terms of 100

E a dot that separates whole and partial numbers

F a number with whole and partial numbers separated by a dot

10.1 Quantities Expressed in Engineering

Numbers appear in multiple forms. Some quantities are expressed in **fractions**.

Example: 4 **out of** every 5 people in a region have home computers. Therefore, $^4/_5$ of people have home computers.

The same number can be a **percentage**.

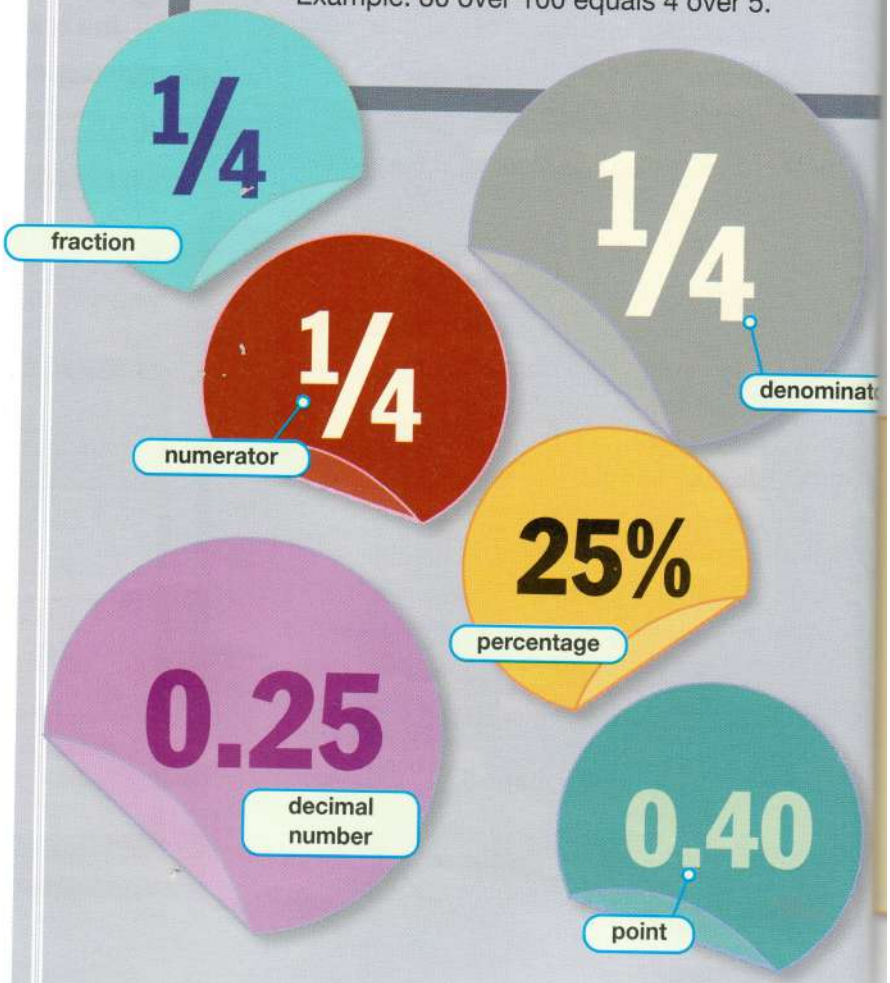
Example: 80 **percent** of people have home computers.

Percentages sometimes appear as **decimal numbers**. In this case, the percentage comes after a zero and a **point**.

Example: 0.80 of people have home computers.

It is easy to **convert** a percentage to a fraction. Simply use the percentage as a **numerator** and 100 as the **denominator**. Then, **reduce** the fraction to its lowest form.

Example: 80 over 100 equals 4 over 5.



4 **Read the sentence pairs. Choose which word best fits each blank.**

1 **fraction / percentage**

A The denominator of a _____ is the number on the bottom.

B The _____ stated the quantity as a number out of one hundred.

2 **convert / reduce**

A The student attempted to _____ the fraction to its lowest form.

B The student explained how to _____ fractions to percentages.

5 🎧 **Listen and read the textbook chapter again. How are percentages expressed as decimal numbers?**

Listening

6 🎧 **Listen to a conversation between a student and an instructor. Choose the correct answers.**

1 What is the conversation mostly about?

A a conversion error that the woman made on a test

B the benefits of expressing numbers as percentages

C how to convert a number into a fraction

D the importance of including points in decimal numbers

2 What does the man remind the woman to do?

A remove points from whole numbers

B reduce fractions to the lowest forms

C convert whole numbers into decimal numbers

D use a percentage as a denominator

7 🎧 **Listen again and complete the conversation.**

Student: Mr. Logan, could you help me with something?
Instructor: Of course. What **1** _____ _____ _____?
Student: I'm having trouble converting **2** _____ _____fractions.
Instructor: Just make a fraction with 100 as **3** _____ _____ and the percentage as the numerator.
Student: So the decimal number is 0.75. I **4** _____ _____ _____ 100?
Instructor: Not exactly. You need to convert the percentage into a **5** _____ _____.
Student: Oh, of course. So it's 75 over 100.
Instructor: Exactly. Then **6** _____ _____ _____ reduce the fraction to its lowest form.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

What do you need?
I'm having trouble ...
Don't forget to ...

Student A: You are a student. Talk to Student B about:

- your difficulty performing a conversation
- a number you are trying to convert

Student B: You are an instructor. Talk to Student A about converting numbers.

Writing

9 **Use the conversation from Task 8 to fill out the student's notes.**

Number Conversions: Notes

- To convert a percentage into a decimal number, simply put _____ _____.
- To convert a decimal number into a percentage, simply remove _____ _____.

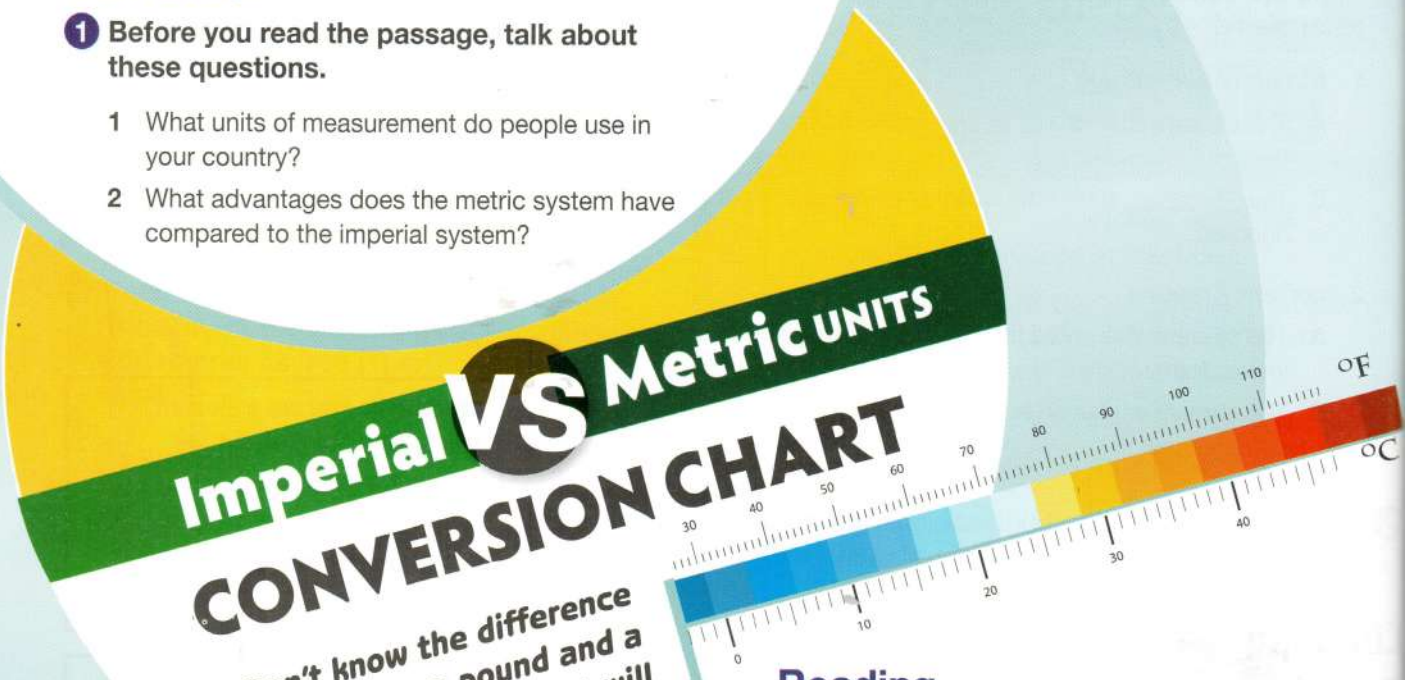
11 Measurements

Get ready!

1 Before you read the passage, talk about these questions.

1 What units of measurement do people use in your country?

2 What advantages does the metric system have compared to the imperial system?



IMPERIAL UNITS 1 pound = 0.453 kilos

pounds 0 2 4 6 8 10 20

kilograms 0 1 2 3 4 5 10

METRIC UNITS 1 kilo = 2.205 pounds

Measurements of Temperature

Use the following formula to convert **degrees** in **Fahrenheit** (°F) to **Celsius** (°C): °C = (°F – 32) × 5/9

Measurements of Weight

1 **pound** = .45 **kilograms**
1 **ounce** = 28.35 **grams**

Measurements of Length

1 **inch** = 2.54 **centimeters**

To **convert** a measurement from imperial units to the metric system, just multiply.
5 inches to centimeters: 5 x 2.54 = 12.7 centimeters.

To convert a measurement from metric units to imperial units, just divide.
12 kilograms to pounds: 12 ÷ .45 = 26.67 pounds.

Reading

2 Read the conversion chart. Then, mark the following statements as true T) or false (F).

1 __ A two-pound object is heavier than a two-kilogram object.

2 __ A gram of matter is equal to several ounces.

3 __ To calculate inches, someone can divide a number of centimeters by 2.54.

Vocabulary

3 Match the words (1-7) with the definitions (A-G).

1 __ ounce
2 __ metric
3 __ Celsius
4 __ imperial
5 __ kilogram
6 __ centimeter
7 __ Fahrenheit

A a system of measurement based on meters and grams

B a temperature system in which water boils at 212 degrees

C a temperature system in which water freezes at zero degrees

D a system of measurement based on feet and pounds

E a unit equal to one sixteenth of a pound

F a unit equal to one hundredth of a meter

G a unit equal to one thousand grams

4 **Read the sentence pairs. Choose which word best fits each blank.**

1 **inch / pound**

A The sandwich weighed almost a(n) _____ .

B The coin is about a(n) _____ inch in diameter.

2 **gram / degree**

A The paperclip weighed about one _____ .

B The temperature cooled one _____ over ten minutes.

5 **Listen and read the conversion chart again. How can someone convert grams into ounces?**

Listening

6 **Listen to a conversation between two engineers. Choose the correct answers.**

1 What is the conversation mostly about?

A why the woman prefers the metric system

B an error while making a measurement conversion

C the challenges of working with the imperial system

D the conversion rate for units of length

2 According to the woman, why should the man show measurements in both systems?

A It will make further conversions easier.

B Everyone will be able to read the measurements.

C Engineers tend to use both measurement systems.

D Other products include both types of measurements.

7 **Listen again and complete the conversation.**

Engineer 1: How should I list **1** _____ _____ _____ this hardware component?

Engineer 2: You should probably list them in both metric **2** _____ _____ units.

Engineer 1: So, to be clear that's centimeters **3** _____ _____, right?

Engineer 2: Yeah. That way, everyone will be able to read them.

Engineer 1: Good idea. Do you know the conversion rates? I always **4** _____ _____.

Engineer 2: I think an inch **5** _____ _____ _____ 2.54 centimeters.

Engineer 1: Okay. This component is eight **6** _____ _____. Eight times 2.54 equals 20.32 centimeters.

Engineer 2: Yeah, that sounds about right.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

How should I ...?

So to be clear, that's ...

I think ...

Student A: You are an engineer. Talk to Student B about:

- which system you should use to measure something
- how to convert measurements into the correct units

Student B: You are an engineer. Talk to Student A about conversion rates between measurement units.

Writing

9 **Use the conversation from Task 8 to fill out the conversion notes.**

Measurements of: Weight

There are _____ in a(n) _____ .

Two _____ equals _____ .

Measurements of: _____

There are _____ in a(n) _____ .

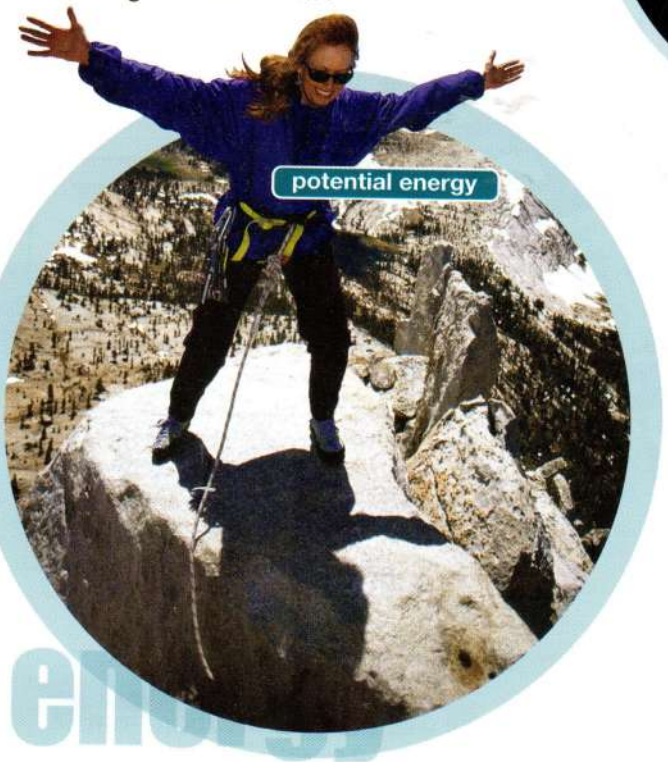
Half of a(n) _____ equals _____ .

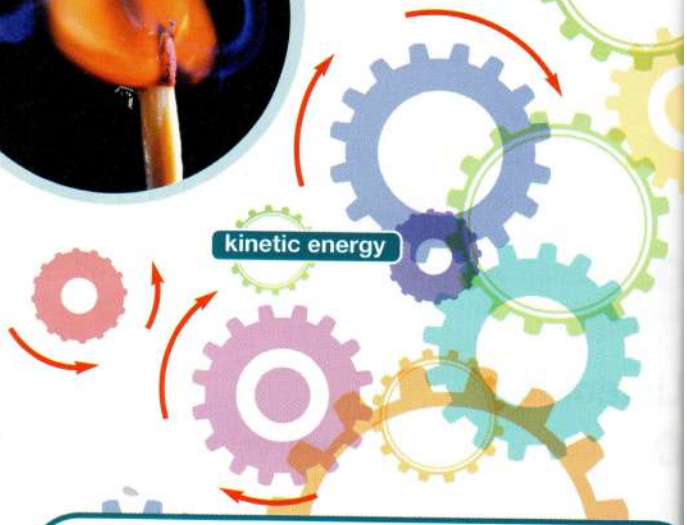
12 Energy

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some different types of energy?
2 What happens when two surfaces rub against each other?





Chapter 12.1.1

energy

All **energy** is either **kinetic energy** or **potential energy**. For instance, **chemical energy** is a form of potential energy. During a chemical reaction, a substance **releases** potential energy. When this happens, the energy becomes kinetic. The result of kinetic energy is often called **work**.

Energy cannot be destroyed. In physics, the law of **conservation of energy** states that the total amount of energy in a system remains constant over time. However, energy can change forms. Many processes **transfer** energy between objects. For example, substances rubbing together encounter **friction**. This prevents objects from sliding smoothly against each other. Friction prevents some potential energy from becoming kinetic. During friction, some of the energy is released as **heat energy**.

Reading

2 Read the textbook chapter. Then, mark the following statements as true (T) or false (F).

1 ___ The two main types of energy are potential energy and chemical energy.
2 ___ Chemical reactions convert potential energy into kinetic energy.
3 ___ The laws of physics prevent the transfer of energy between objects.

Vocabulary

3 Match the words or phrases (1-6) with the definitions (A-F).

1 ___ heat energy
2 ___ work
3 ___ conservation of energy
4 ___ kinetic energy
5 ___ potential energy
6 ___ chemical energy

A action or movement produced by kinetic energy
B energy expressed though activity or movement
C to keep constant through physical or chemical reactions
D energy that is released through a chemical reaction
E energy which is stored, ready to be released
F a form of energy that causes temperatures to rise

4 **Read the sentence pairs. Choose which word best fits each blank.**

1 **friction / energy**

A According to the laws of physics, it is impossible to destroy _____.

B Ice is slippery because it does not have much _____.

2 **transfers / releases**

A An explosion usually _____ a large amount of energy into the surrounding area.

B A stove _____ heat from the burner to the pot.

5 **Listen and read the textbook chapter again. What are the energy transfers during friction?**

Listening

6 **Listen to a conversation between an instructor and a student. Choose the correct answers.**

1 What is the main idea of the conversation?

A methods for conserving energy
B how to classify a type of energy
C ways to avoid releasing energy
D which type of energy is most useful

2 What does the woman identify incorrectly?

A friction
B chemical energy
C potential energy
D heat energy

7 **Listen again and complete the conversation.**

Instructor: Are you ready for the test tomorrow?
Student: Yeah, I think so.
Instructor: Okay, then. What are the two basic **1** _____ _____ _____?
Student: Are they **2** _____ _____ and kinetic energy?
Instructor: Correct. And which type of energy is **3** _____ _____?
Student: Hmm. Chemical energy is a form of **4** _____ _____, right?
Instructor: Nope. You've **5** _____ _____ _____. Chemical energy is actually a form of potential energy.
Student: Ah, that's right. Chemical energy becomes kinetic energy through **6** _____ _____.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

What are the ...?
You've got that backwards.
That's right.

Student A: You are an instructor. Talk to Student B about:

- the basic types of energy
- an error that he or she makes
- the characteristics of a particular type of energy

Student B: You are a student. Talk to Student A about types of energy.

Writing

9 **Use the conversation from Task 8 to fill out the student's notes.**

Notes on Energy

- The two basic types of energy are _____ and _____.
- _____ is a type of _____.
- _____ becomes _____ when _____.

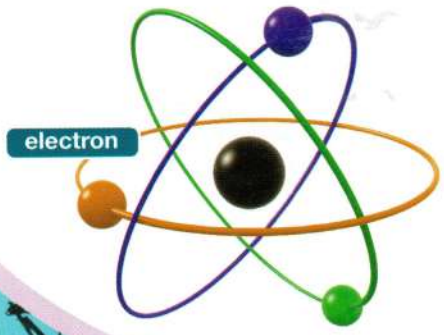
13 Electricity 1

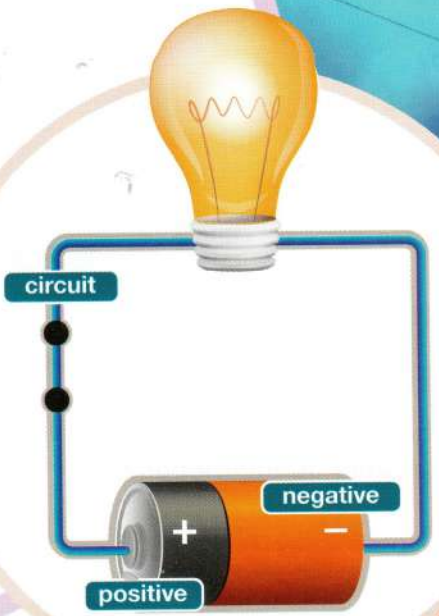
Get ready!

1 Before you read the passage, talk about these questions.

1 What determines whether an object has a positive or negative charge?

2 What is the difference between a direct current and an alternating current?





ENGR 120

INTRODUCTION TO electricity

Harnessing **electricity** is one of mankind's greatest achievements. ENGR 120 introduces the fundamentals of this fascinating natural force.

The course begins with the basics of electricity. It addresses how **electrons** and electron holes create **positive** and **negative charges**. Students will learn why some substances **conduct** electricity while others do not. They will also learn what determines a circuit's **polarity**.

Later in the semester, the course covers applications of electricity. The class will visit a power plant. There, they will learn about generating electricity. Students must also attend a workshop on everyday applications of electricity. The workshop includes practical experiments with **direct currents** and **alternating currents**.

Reading

2 Read the course description. Then, mark the following statements as true (T) or false (F).

1 __ The course begins with practical uses of currents.

2 __ Students will go to a power plant later in the semester.

3 __ Students must attend a workshop on generating electricity.

Vocabulary

3 Match the words or phrases (1-6) with the definitions (A-F).

1 __ conduct
2 __ positive
3 __ negative
4 __ electricity
5 __ direct current
6 __ alternating current

A possessing a charge the same as that of an electron

B possessing a charge opposite to that of an electron

C to allow electricity to pass through something

D a form of energy caused by charged particles

E a charge that switches the direction of its flow constantly

F a charge that flows in a single direction

4 **Read the sentence pairs. Choose which word best fits each blank.**

1 **charge / circuit**

A A negative _____ has extra electrons.

B If a _____ is broken, electricity cannot flow all the way through it.

2 **electron / polarity**

A A(n) _____ is a very small particle.

B The circuit's _____ changed from positive to negative.

5 **Listen and read the course description again. How will the class learn about generating electricity?**

Listening

6 **Listen to a conversation between two students. Choose the correct answers.**

1 What is the conversation mostly about?

A a test question that the man missed

B what information is likely to be on a test

C a concept that the woman misunderstands

D which concepts will be covered in class

2 What is the man mistaken about?

A the types of electrical charges

B where electricity comes from

C the definition of an electron

D the difference between direct and alternating currents

7 **Listen again and complete the conversation.**

Student 1: Hey, do you know what **1** _____ _____ _____ tomorrow's electricity test?

Student 2: Well, it'll probably ask what **2** _____ _____ is.

Student 1: Oh, I know that one. It's a subatomic particle with a **3** _____ _____.

Student 2: Right. The test might ask about different charges, too.

Student 1: Charges are **4** _____ _____ _____, right?

Student 2: No. You're thinking of currents. A charge can be either **5** _____ _____ _____.

Student 1: Oh, that's right. And that depends on how many electrons it has.

Student 2: You've got it. **6** _____ _____ _____ you'll do fine on the test.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Do you know ...? / Isn't that ...? / You're thinking of ...

Student A: You are a student. Talk to Student B about:

- the information that will likely be on a test
- definitions of electrical terms
- a concept that you are not sure about

Student B: You are a student. Talk to Student A about the information that will likely be on a test.

Writing

9 **Use the conversation from Task 8 to fill out the student's notes.**

CHAPTER 7: ELECTRICITY

Notes:

- _____ can be either _____.
  This is determined by _____.
- The definition of a(n) _____ is _____.

Reminder: Study for the test next week. It will cover _____.

14 Electricity 2

HANDY'S HOME GUIDES

COMPUTERS

Power Supply Units (PSU)

Before you purchase a power supply unit, you should understand its basic functions. A computer's PSU controls its supply of **electrical energy**. It works by managing the strength of electrical **currents**.

A PSU receives energy from a wall outlet. Then, it regulates the **electrical power** that travels through the circuit. The power is delivered to the computer at the appropriate **wattage**. Most computers require between 300 and 350 **watts**.

However, different computer components require different **voltages**. To find a component's voltage requirements, you need to know its **resistance**. Some components are better **conductors** than others. These components have fewer **ohms** of resistance. Many processors require 100 **amperes** of power at about two **volts**. Understand your system's specifications before you install a PSU.

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some different units that are used to measure electrical currents?
2 What is the difference between electrical energy and electrical power?

Reading

2 Read the guide. Then, choose the correct answers.

1 What is the main idea of the guide?
- **A** how to improve a computer's performance
- **B** how to choose the right part for a computer
- **C** how to install replacement components
- **D** how to know when to replace a computer

2 Which of the following is NOT determined by a PSU?
- **A** a circuit's electrical power
- **B** the voltage of a power supply
- **C** a conductor's resistance
- **D** the strength of a current

3 Why do different components require different voltages?
- **A** they have different levels of resistance
- **B** some of them do not conduct electricity
- **C** they use electrical energy differently
- **D** some have independent power sources

Vocabulary

3 Match the words (1-6) with the definitions (A-F).

1 __ ohm
2 __ watt
3 __ voltage
4 __ current
5 __ conductor
6 __ resistance

- **A** a unit that measures electrical power
- **B** a material that transmits electricity
- **C** the amount of power in an electrical current
- **D** a flow of electricity caused by the movement of charged particles
- **E** a unit that measures an object's resistance
- **F** the ability to obstruct the flow of electricity

4 **Read the sentence pairs. Choose which word or phrase best fits each blank.**

1 electrical energy / electrical power

A Some computer components manipulate a circuit's _____.

B The movement of electrons generates _____.

2 ampere / volt

A A(n) _____ measures an electrical current's flow.

B A(n) _____ measures the electrical power of a current.

5 **Listen and read the guide again. What are the power requirements of most processors?**

Listening

6 **Listen to a conversation between an engineer and a homeowner. Mark the following statements as true (T) or false (F).**

1 __ The man connected the power supply incorrectly.

2 __ The man's PSU cannot handle the resistance of the computer components.

3 __ The woman recommends replacing most of the computer components.

7 **Listen again and complete the conversation.**

Engineer: No, your wiring was fine. But it looks like you **1** _____ an older PSU.

Homeowner: That's right. I got one from a friend.

Engineer: Well, your computer requires a higher wattage. This PSU isn't **2** _____.

Homeowner: Why **3** _____ need to be higher?

Engineer: You have a number of extra cables and components. That **4** _____ on the current.

Homeowner: Oh, I see. Can **5** _____ a better PSU?

Engineer: Certainly. Give me **6** _____ to check all the specifications.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

I found the problem ...

Did I ... incorrectly?

You need to have something that ...

Student A: You are an engineer. Talk to Student B about:

- a problem with his or her computer
- the cause of the problem
- how to fix the problem

Student B: You are a homeowner. Talk to Student A about a problem with your computer.

Writing

9 **Use the conversation from Task 8 to fill out the engineer's receipt for services.**

Receipt for Services

Customer: _____

Malfunction: _____

Cause of malfunction: _____

_____

Actions taken: _____

_____

Recommendations: _____

_____

15 Education

Get ready!

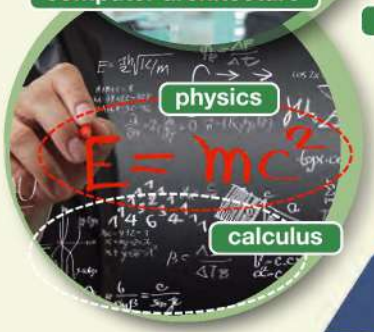
1 Before you read the passage, talk about these questions.

1 What classes do students usually take as part of a computer engineering degree?

2 What are some common prerequisites for computer engineering programs?

Central University – Bachelor's of Science in Computer Engineering

www.central-university.edu/programs/degrees/ computerengineering.html



Central University offers a **bachelor's degree** in computer engineering. The program covers circuitry and other aspects of **electrical engineering**. It also includes a comprehensive education in computer science. Students will gain an advanced understanding of computer hardware and software.

The first semester includes courses in **computer architecture**. These teach the basic physical structure of computers. Then, students move on to **programming**. This is where they will learn how to create software. Later courses include **signal processing** and **hardware design**.

Program applicants must have a strong background in **mathematics** and science. Before officially entering the program, students must take several **foundation** courses. These include introductory courses in **physics** and **calculus**.

Reading

2 Read the webpage. Then, mark the following statements as true (T) or false (F).

1 __ Students study mathematics before they are admitted to the program.

2 __ The first semester includes a course in signal processing.

3 __ Students are required to take calculus courses during the first year of the program.

Vocabulary

3 Match the words (1-6) with the definitions (A-F).

1 __ foundation
2 __ mathematics
3 __ bachelor's degree
4 __ signal processing
5 __ electrical engineering
6 __ computer architecture

A a certificate that is earned after four years of study

B a class that students take to prepare for a degree program

C the process of creating computers from hardware components

D a general field of study concerned with numbers and shapes

E a branch of engineering that focuses on the uses of electricity

F a branch of engineering that studies communication between electrical components and devices

4 **Read the sentence pairs. Choose which word or phrase best fits each blank.**

1 **calculus / physics**

A The lecture on _____ explains how gravity works.

B The student used _____ to find the slope of the curve.

2 **programming / hardware design**

A The student's skill at _____ helped her rewrite the software.

B The man created a new processor in his _____ class.

5 **Listen and read the webpage again. What courses must students take before applying to the computer engineering program?**

Listening

6 **Listen to a conversation between an academic advisor and a student. Choose the correct answers.**

1 What is the conversation mostly about?

A the woman's grades in the previous semester's courses

B the woman's application to enter the computer engineering program

C the woman's progress towards a bachelor's degree

D the woman's concerns about completing her engineering courses

2 Which of the following courses did the woman already take?

A programming **C** hardware design

B electrical engineering **D** signal processing

7 **Listen again and complete the conversation.**

Advisor: So, Lisa. You wanted to discuss **1** _____ _____ towards your degree?

Student: Yes. I'd also like to plan my next **2** _____ _____ _____.

Advisor: Let's see. You're about **3** _____ _____ the bachelor's degree program.

Student: That sounds about right. I just finished classes in programming and **4** _____ _____.

Advisor: Good. It looks like your ready for advanced **5** _____ _____.

Student: What does that include?

Advisor: Well, I'd recommend enrolling in **6** _____ _____ and hardware design.

Student: Okay. I'll sign up for both next semester.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

You're about halfway ...

I just finished ...

I thought I'd ...

Student A: You are an academic advisor. Talk to Student B about:

- his or her progress towards a degree
- the classes the student has already taken
- the classes the student still needs to take

Student B: You are a student. Talk to Student A about your progress towards a degree.

Writing

9 **Use the conversation from Task 8 to fill out the degree progress report.**

Mid-Year Progress Report

Advisor: _____

Student: _____

Before entering the program, the student completed _____

_____

After entering the program, the student completed _____

_____

Next, the student should _____

_____

_____

Glossary

active matrices [N-PLURAL-U3] **Active matrices** are display systems that control each of the pixels individually.

add [V-T-U9] To **add** a number to another number is to increase it by that amount.

alternating current [N-COUNT-U13] An **alternating current** is an electrical current that changes the direction it flows in at regular intervals.

ampere [N-COUNT-U14] An **ampere** is a unit that measures the flow of an electrical current.

antenna [N-COUNT-U7] An **antenna** is a piece of hardware that is used to send and receive radio signals.

Apple® [TRADEMARK-U8] **Apple®** is a company that designs and develops computers and computing systems.

bachelor's degree [N-COUNT-U15] A **bachelor's degree** is a certificate indicating that someone has completed an educational program, usually after four years of study, and is qualified to practice a particular profession.

bay [N-COUNT-U6] A **bay** is an area of a computer where hardware can be installed.

bitmap [N-COUNT-U3] A **bitmap** is an organization of bits or pixels that forms an image when it is displayed on a computer screen.

broadband [N-UNCOUNT-U7] **Broadband** is a system that allows large amounts of information to be sent very quickl between computers.

button [N-COUNT-U4] A **button** is a part of a device that a user presses to perform a function or make a selection.

calculus [N-UNCOUNT-U15] **Calculus** is a complex branch of mathematics that deals with rates of change and advanced measurements of physical properties.

capacity [N-UNCOUNT-U5] **Capacity** is the amount of information, such as computer data, that can be stored on a disk or USB drive.

case [N-COUNT-U6] A **case** is a protective enclosure that contains the parts of something.

CAT-5 cable [N-COUNT-U7] A **CAT-5 cable** is a wire that is commonly used to connect computers on a LAN.

CD [ABBREV-U5] A **CD** (Compact Disc) is a flat, round computer data storage device.

CD/DVD drive [N-COUNT-U6] A **CD/DVD** drive is a device that reads and writes data on CDs and DVDs.

Celsius [ADJ-U11] If a measurement is **Celsius**, is uses the temperature scale in which water boils at 100 degrees an freezes at 0 degrees.

centimeter [N-COUNT-U11] A **centimeter** is a metric unit of length. A meter is made up of 100 centimeters.

charge [N-COUNT-U13] A **charge** is the amount of electricity that something carries.

chemical energy [N-UNCOUNT-U12] **Chemical energy** is the energy in a substance that can be released through a chemical reaction.

circuit [N-COUNT-U13] A **circuit** is a complete, closed path through which an electrical current can flow.

click [V-T-U4] To **click** on something on a computer screen is to place the pointer on it and press the mouse button t select it.

component [N-COUNT-U3] A **component** is one of multiple parts of something, usually performing an important role in the overall function of the whole.

computer [N-COUNT-U2] A **computer** is an electronic instrument for storing data and performing various electronic tasks and functions.

computer architecture [N-UNCOUNT-U15] **Computer architecture** is the physical configuration of hardware components and subcomponents of a computer.

computer cluster [N-COUNT-U2] A **computer cluster** is a group of interconnected computers, designed to process large quantities of data.

computer engineer [N-COUNT-U1] A **computer engineer** is a professional who is trained in computer science and electrical engineering, and can usually design both hardware and software components for computers.

computer science [N-UNCOUNT-U1] **Computer science** is the study and application of mathematical principles in computer technology.

conduct [V-T-U13] To **conduct** electricity is to allow it to flow through something.

conductor [N-COUNT-U14] A **conductor** is a material that transmits electricity.

conservation of energy [N-UNCOUNT-U12] **Conservation of energy** is a law in physics that states that the total energy of a system remains constant over time.

convert [V-T-U10] To **convert** something is to change it into a different form or system of measurement.

cover [N-COUNT-U6] A **cover** is something that is placed over something else for protection.

CRT [ABBREV-U3] A **CRT** (Cathode Ray Tube) is a vacuum tube used in older computer monitors.

current [N-COUNT-U14] A **current** is a flow of electricity caused by the movement of charged particles.

customize [V-T-U8] To **customize** something is to change it to fit individual needs.

decimal number [N-COUNT-U10] A **decimal number** is a number that contains a decimal point.

degree [N-COUNT-U11] A **degree** is a unit in a system of measuring temperature.

denominator [N-COUNT-U10] A **denominator** is the number that is below the line in a fraction. In the fraction ½, the denominator is 2.

design [V-T-U1] To **design** something is to plan the way that something will be created.

desktop [N-COUNT-U2] A **desktop** is a personal computer intended to be used at a single location, such as a desk in a home or office.

develop [V-T-U1] To **develop** something is to bring it from the initial stages of conception to action or implementation.

direct current [N-COUNT-U13] A **direct current** is an electrical current that flows in only one direction.

display [N-COUNT-U3] A **display** is the image on a monitor screen.

divide by [V-T-U9] To **divide** a number (A) **by** another number (B) is to split number A evenly into B number of parts.

DVD [ABBREV-U5] A **DVD** (Digital Video Disc) is a flat, round computer data storage device that is similar to a CD, but is capable of storing a much larger amount of data.

electrical energy [N-UNCOUNT-U14] **Electrical energy** is energy generated by the movement of electrons.

electrical engineering [N-UNCOUNT-U15] **Electrical engineering** is a branch of engineering that studies how electricity can power machines and communication.

electrical power [N-UNCOUNT-U14] **Electrical power** is the rate at which electrical energy is transferred through a circuit.

electricity [N-UNCOUNT-U13] **Electricity** is a form of energy caused by charged particles. People use it for many purposes, including heat, light, and mechanical movement.

electromechanical mouse [N-COUNT-U4] An **electromechanical mouse** is a computer mouse that uses a rubber ball to track hand movements across a surface.

electron [N-COUNT-U13] An **electron** is a subatomic particle that carries a negative charge.

embedded computer [N-COUNT-U2] An **embedded computer** is a computer that is part of a larger product.

energy [N-UNCOUNT-U12] **Energy** is the ability to cause movement or action, or to transfer heat.

equal [V-T-U9] To **equal** something is to be precisely the same number or amount as something.

evaluate [V-T-U1] To **evaluate** something is to carefully study it and assess its qualities.

Fahrenheit [ADJ-U11] If a measurement is **Fahrenheit**, is uses the temperature scale in which water boils at 212 degrees and freezes at 32 degrees.

fan [N-COUNT-U6] A **fan** is a device that makes something cooler by moving air.

flash drive [N-COUNT-U5] A **flash drive** is a data storage device containing flash memory.

flash memory [N-UNCOUNT-U5] **Flash memory** is a type of computer data storage that can be easily erased and reprogrammed with new information.

Glossary

flat-panel [ADJ-U3] If a monitor has a **flat-panel** display, it is much lighter and thinner than a monitor that has a CRT.

floppy disk [N-COUNT-U5] A **floppy disk** is a low-capacity computer data storage device in the form of a flat square of plastic.

foundation [N-COUNT-U15] A **foundation** is a general course of study that students take to prepare for a degree program

fraction [N-COUNT-U10] A **fraction** is a part of a whole number, such as ½, or one half.

frame buffer [N-COUNT-U3] A **frame buffer** is a part of computer memory that stores the images displayed on the screen before they are displayed.

friction [N-UNCOUNT-U12] **Friction** is a force that causes resistance when surfaces rub against each other.

gram [N-COUNT-U11] A **gram** is a metric unit of weight equal to 1/1000 kilogram or about 0.035 ounces.

GUI [ABBREV-U4] A **GUI** (Graphical User Interface) is a visual way of interacting with a computer using menus, icons, and windows.

hard drive [N-COUNT-U5] A **hard drive** is the main data storage device that is built into a computer.

hardware [N-UNCOUNT-U1] **Hardware** is the physical components of a computer, such as the processor, memory, and hard drive.

hardware design [N-UNCOUNT-U15] **Hardware design** is a branch of computer and electrical engineering that focuses on creating functional hardware components.

HD [ABBREV-U3] If a computer display is **HD** (High-Definition), it has a higher resolution than a standard display.

heat energy [N-UNCOUNT-U12] **Heat energy** is a form of energy that produces high temperatures and includes the kinetic energy of atoms and ions within an object.

heat sink [N-COUNT-U6] A **heat sink** is a finned piece of metal that transfers heat to the air.

-hundred [NUMBER-U9] **-Hundred** is a way of expressing numbers in the thousands by counting how many times 10 goes into the number. For example, the number 1,400 could be expressed as "fourteen hundred."

imperial [ADJ-U11] If a measurement is **imperial**, it uses the system that is based on the pound and the foot.

inch [N-COUNT-U11] An **inch** is an imperial measurement of length equal to 1/12 of a foot.

Internet [N-UNCOUNT-U7] The **Internet** is a global network of computers that allows users all over the world to exchange information.

investigate [V-T-U1] To **investigate** something is to get more information about it.

I/O device [N-COUNT-U3] An **I/O device** is a tool to input/output data from a computer such as a mouse, keyboard, screen or printer.

keyboard [N-COUNT-U4] A **keyboard** is a panel of keys for entering data into a computer.

kilogram [N-COUNT-U11] A **kilogram** is a metric unit of weight equal to 1000 grams or about 2.2 pounds.

kinetic energy [N-UNCOUNT-U12] **Kinetic energy** is energy that is produced when an object moves.

LAN [ABBREV-U7] A **LAN** (Local Area Network) is a small network of computers.

laptop [N-COUNT-U2] A **laptop** is a small computer that can be easily carried and used in many locations, and usuall has a screen and keyboard that fold together on a hinge.

LCD [ABBREV-U3] An **LCD** (Liquid Crystal Cisplay) is a display that uses crystals to show output on a computer scree

LED [ABBREV-U4] An **LED** (Light Emitting Diode) is a semiconductor that converts electricity into light.

less [PREP-U9] If a number is **less** another number, the second number is subtracted or taken away from the first numbe

Linux® [TRADEMARK-U8] **Linux®** is an operating system that uses a free and open source software model.

magnetic tape [N-COUNT-U5] **Magnetic tape** is a material used for early computer data storage that involves recording information onto a long strip of plastic.

mathematical analysis [N-UNCOUNT-U1] **Mathematical analysis** is the theoretical study of numbers and equations

mathematics [N-UNCOUNT-U15] **Mathematics** is the study of numbers and shapes used to calculate, represent, and describe entities.

metric [ADJ-U11] If a measurement is **metric**, it is uses the system that is based on the kilogram and the liter.

Microsoft® [TRADEMARK-U8] **Microsoft®** is a company that designs and develops computing systems.

minus [PREP-U9] If a number is **minus** another number, the second number is subtracted or taken away from the first number.

modem [N-COUNT-U7] A **modem** is a device that connects two computers by a telephone line.

monitor [N-COUNT-U3] A **monitor** is an electronic device that is used to display computer signals.

motherboard [N-COUNT-U6] A **motherboard** is the central circuit board of a computer.

multiply by [V-T-U9] To **multiply** a number (A) **by** another number (B) is to add number A to itself B number of times.

negative [ADJ-U13] If something is **negative**, it carries the same electrical charge as an electron.

network [N-COUNT-U7] A **network** is a collection of computers or devices that are connected so that they can share information.

notebook [N-COUNT-U2] A **notebook** is a mobile computer that is typically smaller than a laptop, and often has fewer features or functions.

numerator [N-COUNT-U10] A **numerator** is a number that appears above the line in a fraction. In the fraction ½, the numerator is 1.

ohm [N-COUNT-U14] An **ohm** is a unit that measures electrical resistance.

open source [ADJ-U8] If software is **open source**, its source code is available to anyone.

operating system [N-COUNT-U8] An **operating system** is a type of software that controls a computer's basic functions, such as its running applications.

optical mouse [N-COUNT-U4] An **optical mouse** is a mouse that uses LEDs to track hand movements across a surface.

OS X® [TRADEMARK-U8] **OS X®** is an operating system developed by Apple® for use on their computers.

ounce [N-COUNT-U11] An **ounce** is an imperial unit of weight equal to 1/16 of a pound or about 28.35 grams.

-out of- [PREP-U10] If a quantity is *x* **out of** *y*, it has *x* parts per every *y* parts possible.

over [PREP-U9] If a number is **over** another number, it is divided by that number.

PC [ABBREV-U2] A **PC** (personal computer) is a computer that is intended for individual use. It is sometimes used specifically to refer to a personal computer with the Microsoft Windows® operating system.

percent [N-COUNT-U10] A **percent** is a part of 100 that is usually represented by the "%" symbol.

percentage [N-COUNT-U10] A **percentage** is the rate at which something occurs, measured per 100 units.

peripheral [N-COUNT-U4] A **peripheral** is a device that is connected to a computer but is not built into it.

physics [N-UNCOUNT-U15] **Physics** is a branch of science that focuses on the properties of matter and energy.

pixel [N-COUNT-U3] A **pixel** is a small unit on a display screen that is combined with many other units to produce an image.

plus [PREP-U9] If a number is **plus** another number, the two numbers are added together.

point [N-COUNT-U10] A **point** is a dot placed after a whole unit in a decimal number.

pointer [N-COUNT-U4] A **pointer** is an icon, which is usually controlled by a mouse that a user can move around on a computer's GUI and click on files, links, etc.

polarity [N-UNCOUNT-U13] **Polarity** is the positive or negative charge of an electric field.

port [N-COUNT-U6] A **port** is an outlet that allows an electronic device to communicate to other devices using a plug or cable.

positive [ADJ-U13] If something is **positive**, it carries an electrical charge that is opposite to an electron's charge.

potential energy [N-UNCOUNT-U12] **Potential energy** is energy that is stored for possible future use, e.g. water in a dam, a coild spring, etc.

pound [N-COUNT-U11] A **pound** is an imperial unit of weight equal to 16 ounces or about 0.45 kilograms.

power supply [N-COUNT-U6] A **power supply** is a device that provides energy to something.

processor [N-COUNT-U6] A **processor** is a computer part that allows programs to be interpreted and run.

programming [N-UNCOUNT-U15] **Programming** is the process of writing computer programs.

QWERTY [ABBREV-U4] If a keyboard is **QWERTY,** it uses the standard layout for English-language keyboards that starts with the letters Q, W, E, R, T, and Y in the upper left corner.

reduce [V-T-U10] To **reduce** a fraction is to change it into the form with the lowest possible whole numbers.

release [V-T-U12] To **release** something is to let it move away from something else that previously held it.

resistance [N-UNCOUNT-U14] **Resistance** is the ability of something to obstruct the flow of electricity through it.

router [N-COUNT-U7] A **router** is a piece of hardware that directs information around a network.

screen [N-COUNT-U3] A **screen** is the surface part of a monitor that displays a computer's output.

scroll [V-I-U4] To **scroll** is to move information in a certain direction across a computer screen.

scroll wheel [N-COUNT-U4] A **scroll wheel** is a device on a computer mouse that allows a user to scroll.

server [N-COUNT-U2] A **server** is a central computer that provides services or stores data for many other computers.

signal [N-COUNT-U7] A **signal** is a collection of information sent from one piece of hardware to another.

signal processing [N-UNCOUNT-U15] **Signal processing** is a branch of engineering that focuses on examining communication between electrical components and devices.

software [N-UNCOUNT-U1] **Software** is a program or set of programs that perform particular functions on a compute

software compatibility [N-UNCOUNT-U8] **Software compatibility** is a computer's ability to run a particular software application.

storage [N-UNCOUNT-U5] **Storage** is space where information can be saved.

subtract [V-T-U9] To **subtract** one number from another number is to reduce the second number by the amount of the first number.

tablet [N-COUNT-U2] A **tablet** is a portable computer with a flat touch screen that is smaller than a laptop and usually does not have a physical keyboard.

test [V-T-U1] To **test** something is to operate something to see what it does or whether it works properly.

times [PREP-U9] If a number is **times** another number, it is multiplied by that number.

transfer [V-T-U12] To **transfer** something is to change its location.

volt [N-COUNT-U14] A **volt** is a unit that measures the voltage of an electrical current.

voltage [N-UNCOUNT-U14] **Voltage** is the amount of electric potential difference.

watt [N-COUNT-U14] A **watt** is a unit used to measure electrical power.

wattage [N-UNCOUNT-U14] **Wattage** is the amount of power in an electrical current.

Windows® [TRADEMARK-U8] **Windows®** is an operating system developed by Microsoft®.

wireless [ADJ-U7] If a network is **wireless**, it does not use wires to connect computers.

WLAN [ABBREV-U7] A **WLAN** (Wireless Local Area Network) is a wireless LAN.

work [N-UNCOUNT-U12] **Work** is action or movement that is produced by kinetic energy.

workstation [N-COUNT-U2] A **workstation** is a powerful computer that can process complex tasks that typical desktops cannot handle, such as advanced graphics design.

Zip® drive [N-COUNT-U5] A **Zip® drive** is a moderate-capacity computer data storage device that reads information from a flat square of plastic.

CAREER PATHS

COMPUTER ENGINEERING

Book 2

Virginia Evans
Jenny Dooley
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Express Publishing

Scope and Sequence

Unit	Topic	Reading context	Vocabulary	Function
1	Traits of a Computer Engineer	Job listing	critical thinking, curious, dedicated, detail-oriented, efficient, focus on, innovative, logical, mastery, pay close attention, talented, thorough	Describing skills and traits
2	The Scientific Method	Webpage	conclusion, control group, evaluation, experiment, experimental group, hypothesis, independent variable, observation, problem, prototype, result, scientific method, testable	Confirming information
3	Accounting	Textbook chapter	closed system, consumption, extensive quantity, final, generation, initial, input, intensive quantity, open system, output, system, universal accounting equation	Expressing confusion
4	SI and IEC Units	Email	binary, byte, exponential, factor, IEC, kibi-, kilo-, mebi-, mega-, prefix, SI unit, tebi-, tera-	Emphasizing a point
5	Describing Change	Magazine article	correspond, decline, decrease, double, expand, fluctuate, increase, Moore's law, obsolescence, rise, stabilize, steady, trend	Expressing interest
6	Describing Performance	Guide	availability, bandwidth, bit/s, compact, compression ratio, data compression, data decompression, data transmission, rate, resource, response time, terminal	Asking for a recommendation
7	Concepts in Physics	Course description	conservation, constant, electromagnetism, equilibrium, gravity, law, magnetism, momentum, motion, thermodynamics, vibration, wave	Correcting oneself
8	Theory of Computation	Textbook chapter	abstract, automata theory, computability theory, computational complexity theory, efficiently, machine, process, solvable, space complexity, theory of computation, time complexity, Turing machine	Asking for help
9	Control Systems	Class handout	control system, derivative, error, integral, ladder logic, linear control, logic control, negative feedback, on/off control, oscillation, PID control, process variable, proportional control, set point	Offering help
10	Solid-state Electronics	Webpage	charge carrier, confined, crystalline, electromechanical, electron hole, gas-discharge tube, moving part, semiconductor, solid, solid-state, vacuum	Realizing an error
11	Design Processes	Employee manual	assemble, constraint, construct, criteria, detailed design, estimate, feasibility, identify, narrow down, preliminary design, sketch, study, verify	Clarifying information
12	Algorithms	Textbook chapter	algorithm, automated, calculation, decidable, decision problem, determine, effective method, elegance, finite, function, goodness, sequence, step-by-step	Asking for an opinion
13	Memory	Journal article	cache memory, DIMM, DRAM, memory, nonvolatile memory, primary memory, secondary memory, SIMM, SRAM, volatile memory	Agreeing with an opinion
14	Chips	Webpage	bond, chip, defect, die, discard, insulator, integrated circuit, on/off switch, pattern, silicon, transistor, ULSI, VLSI, wafer	Reporting on progress
15	Internet Security	Email	anti- virus, audit log, authenticate, deny, encrypt, firewall, log in, password, permit, security, software, SSL connection, virus	Making a recommendation

Table of contents

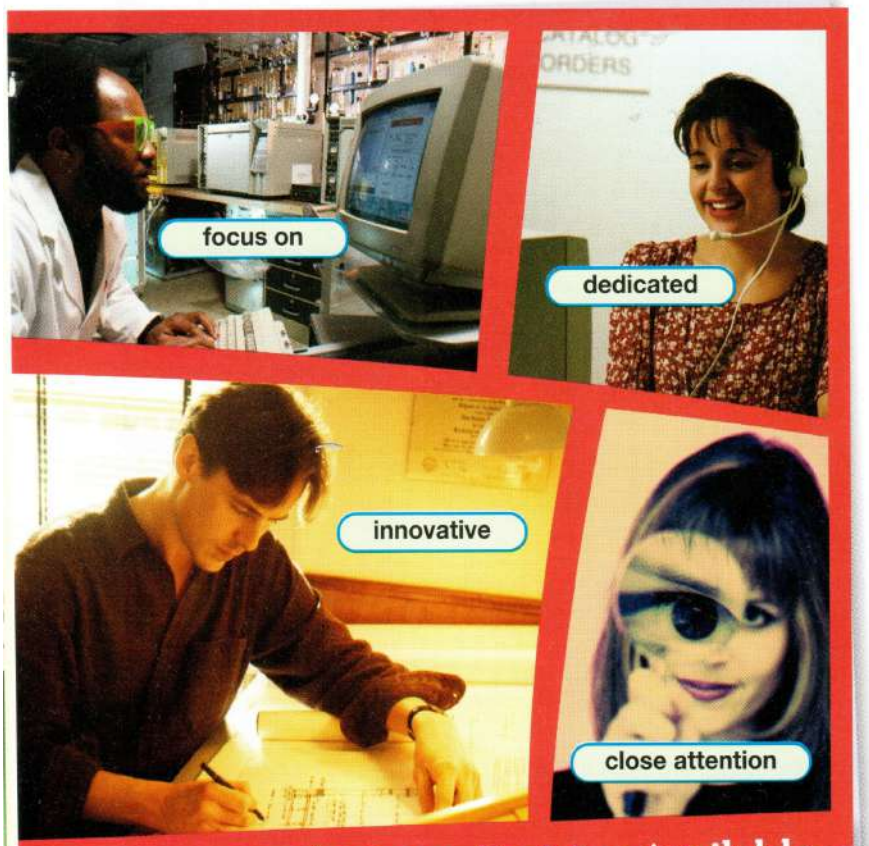
1 Traits of a Computer Engineer

Get ready!

1 Before you read the passage, talk about these questions.

1 What traits are valuable in an engineer?

2 Why is critical thinking an important skill in an engineer?



Computer Engineer Position Available

Dynxis Corp. is seeking **talented** computer engineers. Candidates must have at least five years of experience. They should have **mastery** of both hardware design and programming. We will only consider an applicant with a bachelor's degree in a relevant field. Additionally, he or she must **pay close attention** to current technology and trends.

We want someone who is **thorough** and **detail-oriented**. Candidates should be able to **focus on** multiple tasks simultaneously. Our systems are extremely complex. This means that even minor errors can be critical.

At Dynxis Corp., we value **critical thinking**. We appreciate employees who can find **logical** solutions. However, we also seek **curious** individuals with **innovative** ideas. We encourage employees to think creatively. We want people with a balance of both practical and creative skills.

We have high standards at Dynxis Corp. If you are **dedicated** and **efficient**, we encourage you to apply.

Email your résumé to hr@dynxis.com.

Reading

2 Read the job listing. Then, mark the following statements as true (T) or false (F).

1 __ The company will train inexperienced candidates.

2 __ The company is hiring someone to resolve previous critical errors.

3 __ The candidate should be equally practical and creative.

Vocabulary

3 Match the words (1-6) with the definitions (A-F).

1 __	focus on	4 __	dedicated
2 __	mastery	5 __	innovative
3 __	efficient	6 __	detail-oriented

A able to pay attention to small, specific parts of something

B new, creative, and advanced

C able to do something competently and quickly

D advanced knowledge or skills in a particular area

E to be devoted to a task or cause

F to give full attention to something

4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 **critical thinking / close attention**

A The supervisor pays _____ to his team's work.

B The junior engineer program promotes problem-solving and _____

2 **thorough / logical**

A The technician found a _____ solution to the problem.

B The employee was _____ and checked each compartment.

3 **talented / curious**

A A display of the engineer's advanced skills proved how _____ she was.

B The employee was _____ about the new software, so he researched it further.

5 🎧 **Listen and read the job listing again. Why does the company want thorough and detail-oriented candidates?**

Listening

6 🎧 **Listen to a conversation between an interviewer and an applicant. Choose the correct answers.**

1 What is the conversation mostly about?

A traits that are most important to the woman
B the man's work experience
C educational requirements for a position
D responsibilities at a new job

2 Why does the man mention that he monitored multiple projects?

A to demonstrate his programming mastery
B to indicate that he is efficient
C to prove that he is detail-oriented
D to suggest that he is curious

7 🎧 **Listen again and complete the conversation.**

Interviewer: Yes, it's very impressive. Can you **1** _____ _____ your skills?
Applicant: Well, I try to find **2** _____ _____ to problems whenever possible.
Interviewer: I like to hear that. Could you provide **3** _____ _____ ?
Applicant: Um, actually, I once had to troubleshoot a problem in my company's mainframe.
Interviewer: Wow. I'm sure that required **4** _____ _____ to detail.
Applicant: Oh, yes. **5** _____ _____ _____ I'm very detail-oriented.
Interviewer: How else do you use this trait?
Applicant: At my previous job, I had **6** _____ _____ _____ multiple projects at once.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Can you elaborate on ...?
I'd say that I'm ...
How else have you used this trait?

Student A: You are an interviewer. Talk to Student B about:

- his or her traits as an employee
- his or her responsibilities at a previous job
- traits needed for particular tasks

Student B: You are an applicant for a job. Talk to Student A about your traits as an employee.

Writing

9 **Use the conversation from Task 8 to fill out the interviewer's notes.**

Applicant: _____

Applicant's previous job responsibilities:

_____

_____

Applicant's traits:

_____

_____

Do you plan to hire the applicant? Why or why not?

_____

_____

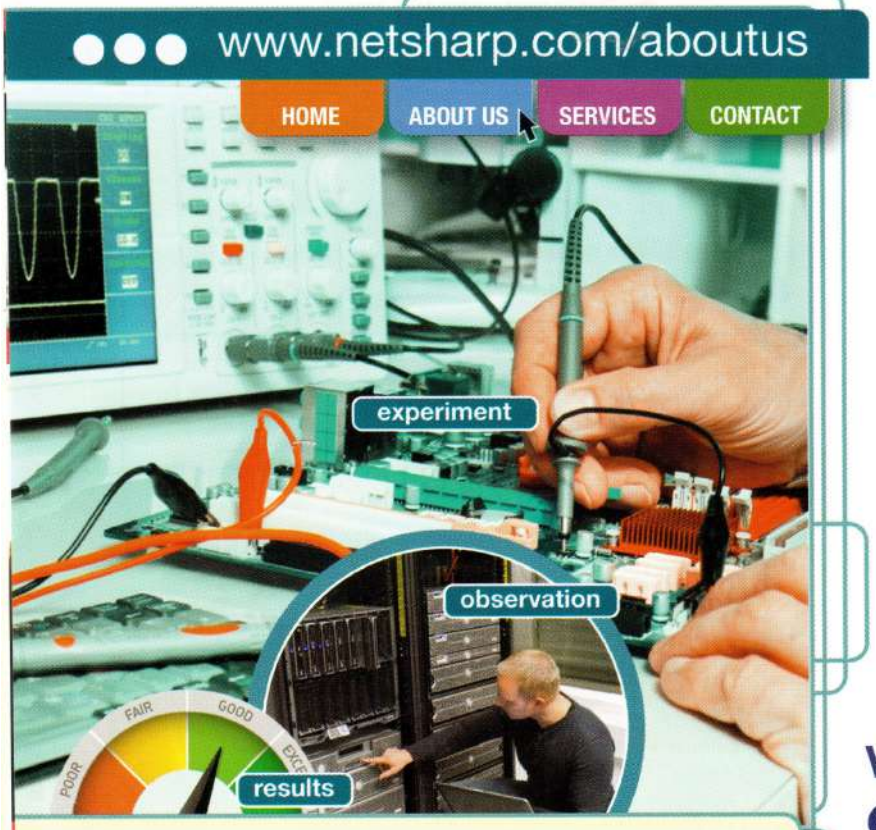
2 The Scientific Method

Get ready!

1 Before you read the passage, talk about these questions.

1 Why is the scientific method an effective way to solve problems?

2 How does the scientific method apply to engineering?



About our engineering process:

NetSharp is dedicated to solving **problems**. That's why we structure our engineering process around the **scientific method**.

First, we make an **observation** about a problem. For computer engineers, problems are usually defined by hardware or software requirements.

Next, we research the problem and form a **hypothesis**. To test it, we need a **testable prototype**. We expect a prototype to function, but we aren't certain until we perform **experiments**.

During the test, we note if a component does not work as expected. We adjust this **independent variable** and test again. The new prototype becomes the **experimental group**, while the **control group** remains unchanged. That lets us monitor whether our adjustments improved functionality.

Finally, we draw **conclusions** based on the **results**. If the new prototype functions better, we test the next independent variable. Our **evaluation** is not complete until we have a fully functional product.

Reading

2 Read the webpage. Then, choose the correct answers.

1 What is the purpose of the webpage?

- **A** to illustrate how product users can apply the scientific method
- **B** to describe a company's problem-solving process
- **C** to explain the challenges of experimenting o computer products
- **D** to show how testing prototypes slows production

2 What part of an experiment does a prototype test?

- **A** an observation
- **B** an evaluation
- **C** a conclusion
- **D** a hypothesis

3 Which of the following is NOT part of the company's engineering process?

- **A** altering a control group
- **B** making an observation
- **C** studying a problem
- **D** testing a variable

Vocabulary

3 Match the words or phrases (1-7) with the definitions (A-G).

1 __ control group
2 __ testable
3 __ conclusion
4 __ hypothesis
5 __ independent variable
6 __ scientific method
7 __ experimental group

- **A** a system that tests ideas through experimentatio
- **B** part of an experiment that tests the effect of a altered variable
- **C** a determination or decision made after an experiment
- **D** an idea that explains something that has not been tested
- **E** able to be proven or disproven through an experiment
- **F** the factor that changes between groups in an experiment
- **G** part of an experiment that does not have an altered variable

4 **Read the sentence pairs. Choose which word best fits each blank.**

1 **observation / evaluation**

A After the procedure, the professor made an _____.

B After careful study, the engineer formed his _____ of the chip's performance.

2 **problem / experiment**

A The team developed a(n) _____ to test the hypothesis.

B The hypothesis seeks to explain a(n) _____.

3 **prototype / result**

A At the end of the experiment, the engineer reported a surprising _____.

B The engineer was disappointed when the _____ failed to function.

5 **Listen and read the webpage again. What do you need in order to test a hypothesis?**

Listening

6 **Listen to a conversation between two engineers. Mark the following statements as true (T) or false (F).**

1 __ The processor stopped functioning.

2 __ The experiment was conducted correctly.

3 __ The man plans to conduct the experiment again.

7 **Listen again and complete the conversation.**

Engineer 1: The processor speed wasn't **1** _____ _____ _____. But it's much faster in the experimental group.

Engineer 2: Hmm. Do you think something interfered **2** _____ _____ _____?

Engineer 1: I don't know. We definitely altered just one **3** _____ _____, right?

Engineer 2: That's what the test log says. Maybe we should just record it **4** _____ _____ _____.

Engineer 1: What do you mean?

Engineer 2: Well, maybe it's faster **5** _____ _____ _____ the independent variable. That could mean that the new prototype performs better.

Engineer 1: That's possible. But we'll have to **6** _____ _____ _____ to be sure.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Do you think ...?

Maybe, it's ...

That's possible.

Student A: You are an engineer. Talk to Student B about:

- the unexpected results of an experiment
- possible causes of the results
- what to do next

Student B: You are an engineer. Talk to Student A about the results of an experiment.

Writing

9 **Use the conversation from Task 8 to fill out the engineer's log entry.**

TEST LOG:

Experiment # 45009

How did the experimental group perform?

_____

Why did this happen?

_____

What are your suggestions?

_____

Accounting

Engineering projects require engineers to monitor various quantities. The process they use to monitor quantities is known as accounting.

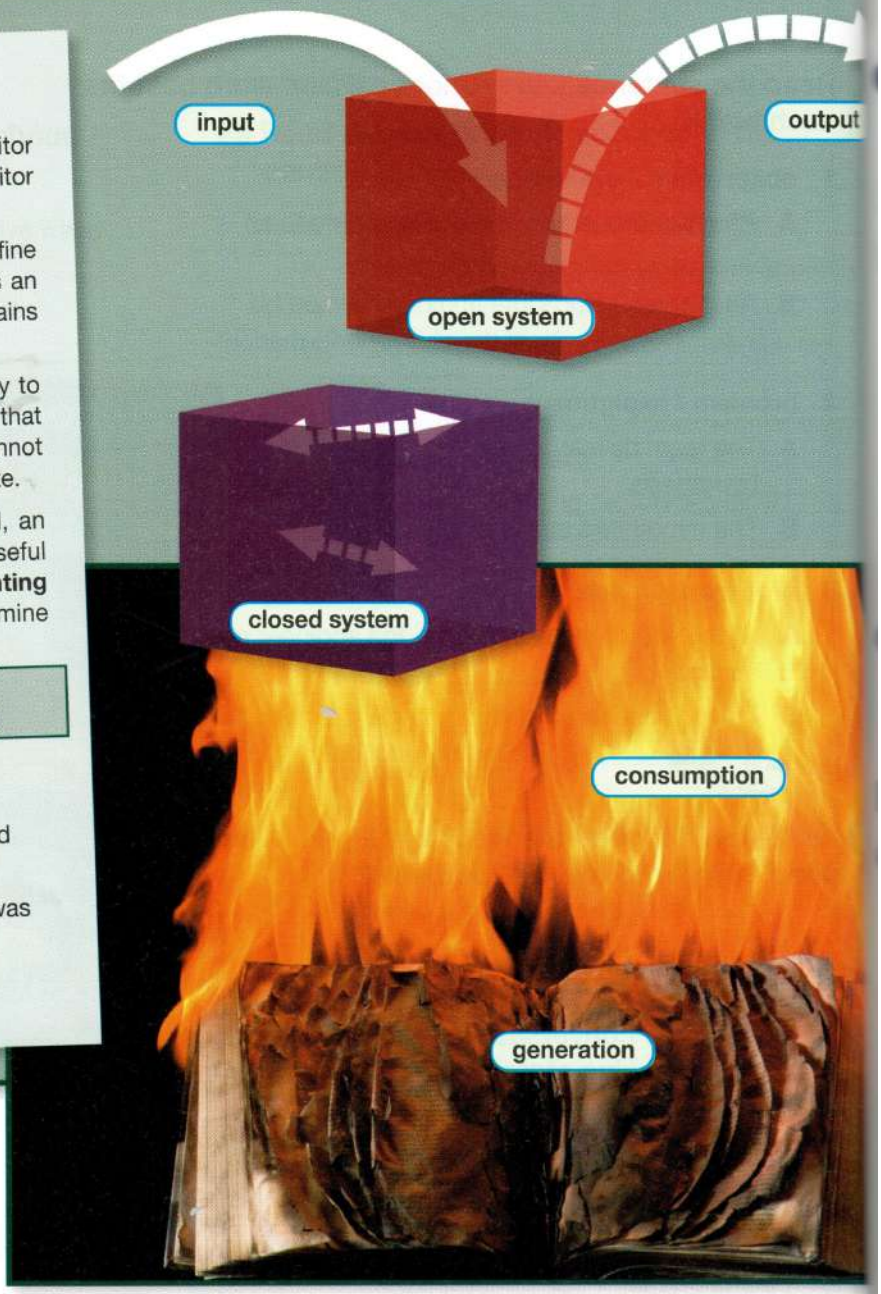
Before accounting can begin, engineers must define the monitored **system**. Mass enters and leaves an **open system**. In a **closed system**, the mass remains constant.

Engineers must also know what kind of quantity to account for. **Extensive quantities** are quantities that an engineer can count. **Intensive quantities** cannot be counted, but they still affect the system's state.

Once the system and quantity are determined, an engineer can begin accounting. The most useful accounting measure is the **universal accounting equation** (UAE). This is a simple way to determine changes in amounts:

Final amount – **initial** amount =
(input – output) + **(generation – consumption)**

- **Step 1:** Take the amount that you started with (input).
- **Step 2:** Subtract any amount that was removed (output).
- **Step 3:** Add the amount of new material that was created (generation).
- **Step 4:** Subtract any material that was lost or destroyed (consumption).



Get ready!

1 Before you read the passage, talk about these questions.

1 What is the purpose of accounting in the field of engineering?

2 What are some examples of open and closed systems?

Reading

2 Read the textbook chapter. Then, mark the following statements as true (T) or false (F).

1 __ In a closed system, mass changes constantly.

2 __ The UAE determines whether a quantity is extensive or intensive.

3 __ According to the UAE, the output should be subtracted from the input.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ final
2 __ initial
3 __ open system
4 __ consumption
5 __ closed system
6 __ intensive quantity
7 __ extensive quantity
8 __ universal accounting equation

A relating to something's status at the end of a period of time
B a type of measurable quantity that can be counted
C a system that allows mass to enter or leave it
D an amount of a quantity that is destroyed in a system
E a system that does not allow mass to enter or leave it
F a way to measure changes in countable quantities
G relating to something's status at the beginning of a period of tim
H a type of measureable quantity that cannot be counted

4 Read the sentence pairs. Choose which word best fits each blank.

1 **system / output**

A The engineer defined the colling fan as the monitored _____.

B The engineer measured the engine's _____ of exhaust.

2 **generation / input**

A The engineer measured the _____ that the system created.

B The engineer did not account for the _____ of mass from other sources.

5 Listen and read the textbook chapter again. What is the difference between an extensive quantity and an intensive quantity?

Listening

6 Listen to a conversation between two students. Choose the correct answers.

1 What is the conversation mostly about?

A the differences between accounting concepts
B how to calculate changes in quantities
C terms on an upcoming accounting test
D the importance of measuring accurate quantities

2 What term does the man use incorrectly?

A extensive quantity
B intensive quantity
C generation
D input

7 Listen again and complete the conversation.

Student 1: I'm having trouble understanding these **1** _____.

Student 2: Perhaps I can help. Which ones don't you understand?

Student 1: Extensive quantities and **2** _____, for one. How are they different?

Student 2: Well, extensive quantities change based on the **3** _____. Volume measurements are one example.

Student 1: I still don't really get it. Can you explain that further?

Student 2: Let's say a system has one liter of water. Then you add mass, and **4** _____ two liters of water.

Student 1: Okay, so the **5** _____. So what's an intensive quantity?

Student 2: Color, **6** _____. One liter of water is clear. If you add a second liter, the water is still clear.

Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

USE LANGUAGE SUCH AS:

I really don't understand ...
What's the problem?
I still don't get it.

Student A: You are a student. Talk to Student B about:

- differences between accounting concepts
- examples of different concepts
- a term that he or she uses incorrectly

Student B: You are a student. Talk to Student A about the differences between accounting terms.

Writing

9 Use the conversation from Task 8 to fill out the student's notes.

Accounting Notes

Concept: _____

An example of this concept is _____

_____

because _____.

Concept: _____

An example of this concept is _____

_____

because _____.

4 SI and IEC Units

Get ready!

1 Before you read the passage, talk about these questions.

1 What is the difference between an SI unit and a binary unit?

2 Between SI units and binary units, which do you think is more useful?

Dear Mr. Dvorak,

I am worried about the company's inconsistent use of units. Some of our products have **SI units** like **mega**bytes. Meanwhile, others use the **IEC's binary** units, such as **mebi**bytes.

Some **prefixes** sound similar, but the units are quite different. SI units increase by **factors** of ten. For instance, something with the prefix **kilo-** has 1,000 units. So a kilobyte equals 1,000 **bytes**. Binary units, on the other hand, increase by factors of two. A **kibi**byte actually contains 1,024 bytes. This may seem like a small difference. However, it increases at an **exponential** rate. The difference between a megabyte and mebibyte is 48,576 units. And a **tera**byte and **tebi**byte are separated by nearly 100 billion units!

That's why our labeling needs to be clear and consistent. I recommend listing SI units. The factors of ten are easier for customers to understand and remember.

Regards,
Rebecca Moore
Computer Engineer
Hype Drive Systems

Reading

2 Read the email. Then, mark the following statements as true (T) or false (F).

1 __ The company labels its products with both SI and binary units.

2 __ The difference between SI and binary units increases exponentially.

3 __ The email recommends switching to binary units only.

Vocabulary

3 Match the prefixes (1-6) with the definitions (A-F).

1 __ kilo-
2 __ tebi-
3 __ kibi-
4 __ mebi-
5 __ mega-
6 __ tera-

A a prefix equal to 1,000,000 units
B a prefix equal to 1,048,576 units
C a prefix equal to 1,024 units
D a prefix equal to 1,000 units
E a prefix equal to 1,000,000,000 units
F a prefix equal to 1,099,511,627,776 units

4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 **binary / exponential**

A The amount increased at a(n) _____ rate.

B The _____ system measures amounts in factors of two.

2 **prefix / factor**

A To scale the image, increase its dimensions by a _____ of two.

B The _____ of a unit indicates ho large it is.

3 **IEC / SI units**

A The device memory is listed in both binary and _____.

B The company follows guidelines that are established by the _____.

exponential

5 🎧 **Listen and read the email again. What recommendation is made in the email?**

Listening

6 🎧 **Listen to a conversation between an engineer and a manager. Choose the correct answers.**

1 What is the main idea of the conversation?

- **A** which system of units the company should use
- **B** why the company should use one set of units
- **C** how to tell the difference between types of units
- **D** why the company recently had to correct units on its labels

2 Why does the man prefer the current system?

- **A** The units are easier to remember.
- **B** The customers are more comfortable with it.
- **C** The company requires a particular system.
- **D** The product labels are already designed.

7 🎧 **Listen again and complete the conversation.**

Engineer: Why not? Customers are getting confused. They're buying products with **1** _____ _____ _____ than they need.

Manager: Perhaps. But we'd have to **2** _____ _____ _____. Besides, aren't the differences small?

Engineer: Not at all. The two sets of units convey very different numbers.

Manager: The difference between **3** _____ _____ and a kibibyte is twenty-four bytes, right?

Engineer: Indeed it is. But the differences grow exponentially as **4** _____ _____ _____.

Manager: **5** _____ _____ _____. *What do* you mean?

Engineer: Well, the difference between a terabyte **6** _____ _____ _____ is over *ninety-nine billion bytes.*

Manager: Wow. That actually seems like a lot.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Have you ...?
As I mentioned ...
I don't follow ...

Student A: You are an engineer. Talk to Student B about:

- the company's data measurement system
- why you think the company should change the system
- the consequences of keeping the current system

Student B: You are a manager. Talk to Student A about the company's data measurement system.

Writing

9 **Use the conversation from Task 8 to fill out the email about changing the company's unit labeling practices.**

Hi Janice,

I've been thinking about your suggestion. I'm not sure whether we should change the units on product labels. The idea has both pros and cons.

Pros:

- _____
- _____

Cons:

- _____
- _____

Let's schedule a meeting to talk about this further.

Lou

5 Describing Change

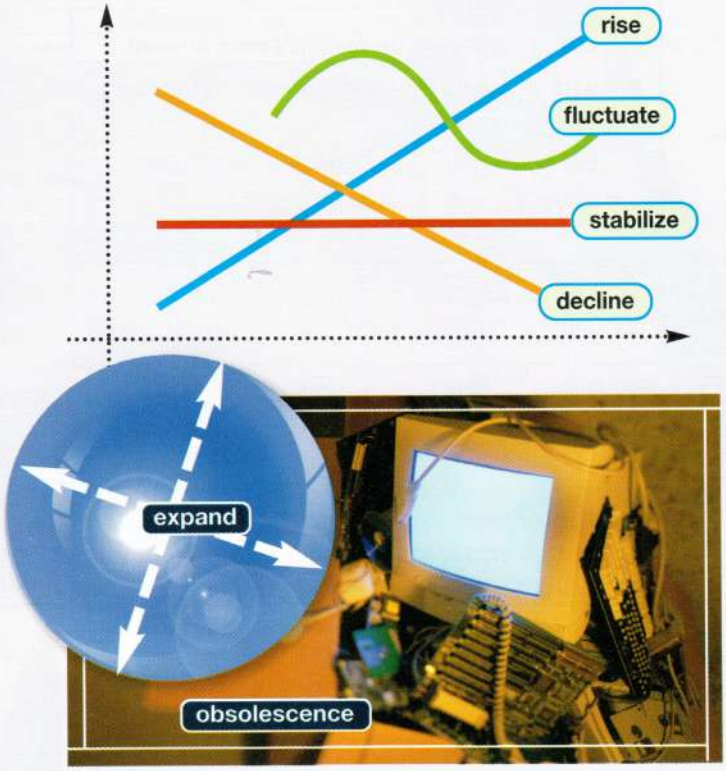
Get ready!

1 Before you read the passage, talk about these questions.

1 What is Moore's law?

2 How does Moore's law affect consumers who buy computers?

Moore's Law



In 1965, engineer Gordon Moore made a remarkable prediction. He said that computer processing power should **double** every two years. While the rate **fluctuates**, the overall **trend** actually follows it quite closely. This theory is known as **Moore's law**.

Moore's law is based on various factors. As manufacturing improves, the cost of transistors **decreases**. The **decline** in costs **corresponds** to a **rise** in production. Engineers can afford to place more transistors on each circuit. As a result, computing power **increases** at a **steady** rate.

However, not everyone benefits from such rapid improvements. As computing power **expands**, older models fade quickly into **obsolescence**. Even though costs have decreased, computers are still very expensive for some. Many average consumers cannot afford a new computer every two years.

Some analysts predict that the trend will not last. They suggest that growth will begin to **stabilize** in a few years. If predictions are correct, growth may double in three years instead of two.

Reading

2 Read the magazine article. Then, choose the correct answers.

1 What is the purpose of the article?

- **A** to discuss the rate at which computers improve over time
- **B** to explain how consumers influence computer technology trends
- **C** to persuade people to buy more efficient computers
- **D** to describe the need for new processing systems

2 Which of the following is NOT a component of Moore's law?

- **A** a decline in technology costs
- **B** doubled computing power
- **C** a rise in transistors per circuit
- **D** decreased obsolescence

3 What do analysts predict about the growth of processing power?

- **A** It will lead to higher costs.
- **B** It will slow down.
- **C** It will stop within a few years.
- **D** It will become more rapid.

Vocabulary

3 Match the words or phrases (1-7) with the definitions (A-G).

1 __ trend
2 __ steady
3 __ double
4 __ stabilize
5 __ correspond
6 __ Moore's law
7 __ obsolescence

- **A** a consistent change over time
- **B** the state of not being useful anymore
- **C** a rule that says computer power doubles every two years
- **D** to reach a state with infrequent change
- **E** to become twice as much
- **F** not changing or changing slowly
- **G** to have a direct relationship with something

4 **Read the sentence pairs. Choose which word best fits each blank.**

1 **rise / decline**

A The need for new computers caused a _____ in sales.

B The price of computers is in _____ as parts become cheaper.

2 **decrease / expand**

A The abilities of computers _____ as they grow more powerful.

B The rate of progress will _____ without better technology.

3 **fluctuate / increase**

A Some trends are hard to predict because they _____ wildly.

B In general, the abilities of computers _____ over time.

5 **Listen and read the magazine article again. What happens to older computer models as a result of Moore's law?**

Listening

6 **Listen to a conversation between two engineers. Mark the following statements as true (T) or false (F).**

1 __ The article predicts that the growth of computing power will increase at a faster rate.

2 __ The man is concerned that the changes will hurt the computer industry.

3 __ The woman believes that the change will lead to added waste.

7 **Listen again and complete the conversation.**

Engineer 1: Did you read the article about **1** _____ _____?
It looks like growth may begin to stabilize.

Engineer 2: So computer power will double **2** _____ _____?

Engineer 1: Yes. Basically, within a few years, computing power **3** _____ _____ _____ every three years.

Engineer 2: That's unfortunate. The steady increase in power **4** _____ _____ _____ the entire industry. This could really damage software companies.

Engineer 1: I'm **5** _____ _____ _____ about that. I think such a trend may have positive effects.

Engineer 2: Really? How could it be beneficial?

Engineer 1: Well, for one thing, it may mean that the rate of **6** _____ _____ will decrease.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

According to ...
That's interesting ...
Really? How so?

Student A: You are an engineer. Talk to Student B about:

- an article about Moore's law
- how predicted changes could have negative effects
- how predicted changes could have positive effects

Student B: You are an engineer. Talk to Student A about Moore's law.

Writing

9 **Use the conversation from Task 8 to fill out the engineer's blog.**

Computalking
with Ryan Henderson

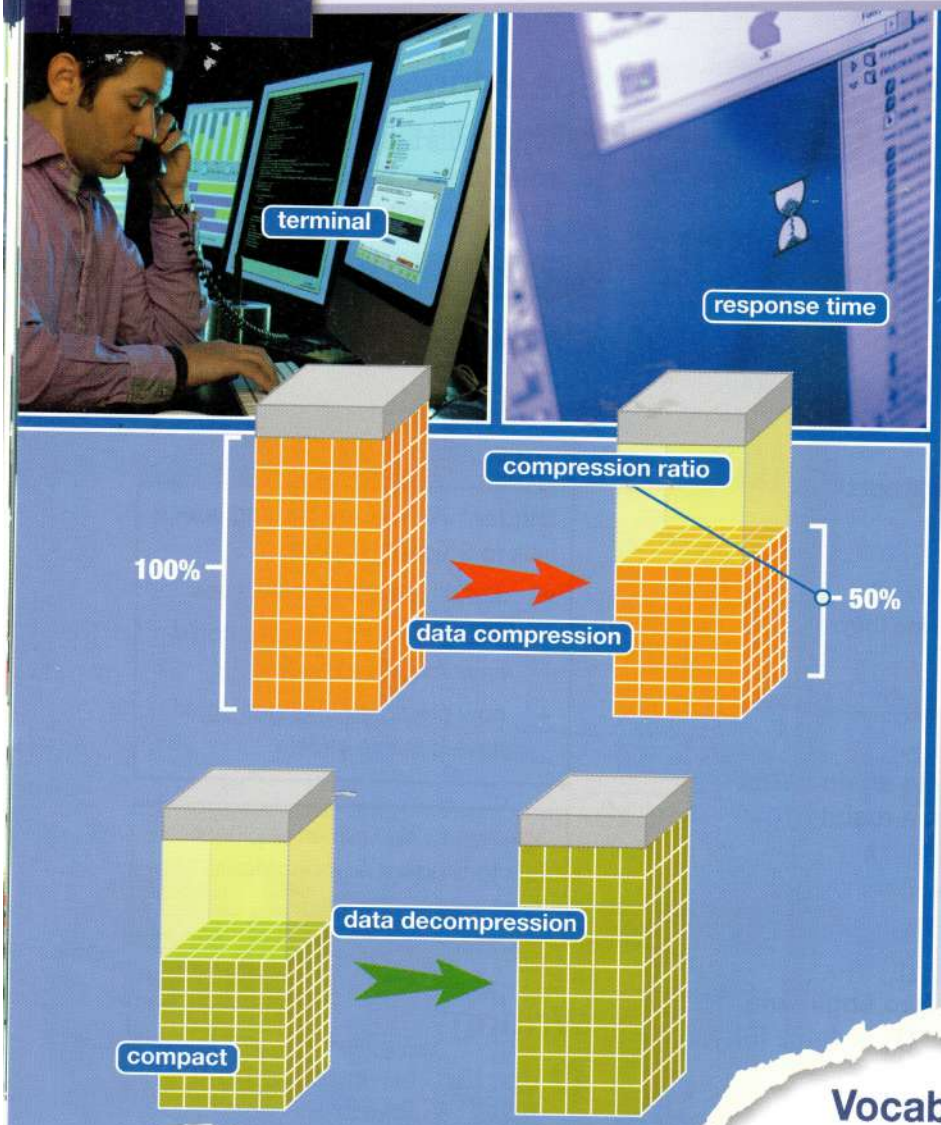
I recently read an article about Moore's law. It predicted that computer processing growth will _____ _____. This could be positive because _____.

On the other hand, it could also be negative because _____.

What do you think?

Ryan

6 Describing Performance



Computer Performance

A computer's performance is measured by how well it performs tasks. Good computers can perform work quickly with few **resources**. Users can use various criteria to evaluate computer performance.

Response time – When a user enters data at a **terminal**, the computer responds. The amount of time the process takes is the response time. Computers with slow response times are inefficient and frustrating.

Availability – A computer's availability is simply its ability to work at any given time. Most users need a computer that is available immediately, and at any time.

Data transmission – A computer's ability to send and receive data quickly is important. The transmission **rate** is measured in **bit/s** and is called **bandwidth**. Slow bandwidth leads to delays receiving information.

Software implementation – A computer's **compression ratio** is how **compact** it can make information. Its rates of **data compression** and **decompression** also affect its performance.

Get ready!

1 Before you read the passage, talk about these questions.

1 How does data compression affect computer performance?

2 How does bandwidth affect computer performance?

Reading

2 Read the guide. Then, mark the following statements as true (T) or false (F).

1 ___ According to the guide, computers with additional terminals are less efficient.

2 ___ According to the guide, most people need the same type of availability.

3 ___ Data compression ratios are measured in bit/s.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 ___ bit/s
2 ___ terminal
3 ___ compact
4 ___ bandwidth
5 ___ data compression
6 ___ data transmission
7 ___ compression ratio
8 ___ data decompression

A a measure of how quickly a computer transmits information

B the exchange of information between computers

C occupying a small amount of space

D a process that restores compressed information to its original size

E a unit that measures the rate of information transmission

F a compressed size compared to an uncompressed size

G a process that reduces the size of information

H a location where a user can access a computer system

4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 **resource / rate**

A The software ensures systems can access each _____ quickly.

B The new cables should improve the _____ of data transmission.

2 **availability / response time**

A Installing faster processors will improve the computer's _____.

B The frequent power outages decrease the system's _____.

5 Listen and read the guide again. What are the consequences of poor computer response times?

Listening

6 Listen to a conversation between an IT manager and a salesperson. Choose the correct answers.

1 What is the conversation mostly about?

A choosing a system which can transmit information quickly

B how to improve response times

C pricing options

D how to calculate data compression ratios

2 What performance aspect is the man most concerned about?

A the data compression speeds

B the system's availability

C the data transmission rate

D the system's response time

7 Listen again and complete the conversation.

Salesperson: We offer a range of high quality computer systems. What **1** _____ _____ do you require?

IT Manager: Well, I'd like a quick **2** _____ _____. But of course, bandwidth is really important as well.

Salesperson: Okay. We have two systems that excel in both those areas, the 2260 model and the 2950 model.

IT Manager: Which of the systems **3** _____ _____ _____?

Salesperson: That depends on whether you're more concerned about response time or transmission.

IT Manager: I'm definitely more concerned with the system's **4** _____ _____ capabilities.

Salesperson: In that case, I recommend the 2950 model. It runs at more **5** _____ _____ _____.

IT Manager: That **6** _____ _____.

Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

USE LANGUAGE SUCH AS:

We offer a ...

Which ... would you recommend?

That depends on ...

Student A: You are an IT manager. Talk to Student B about:

- purchasing a new system for your company
- a system that he or she recommends
- what aspects contribute to the system's performance

Student B: You are a salesperson. Talk to Student A about his or her computer performance needs.

Writing

9 Use the conversation from Task 8 to fill out the salesperson's email.

Hi Mr. Gregson,

Thank you for your interest in our computer systems. I'm confident that we have something to meet your needs. Since you need something that _____, I recommend _____. It has _____ _____.

If you would prefer something with _____, then I might recommend _____ instead.

Let me know if you have further questions.

Sincerely,

Gina Bolino

CMM Computer Supply and Consulting

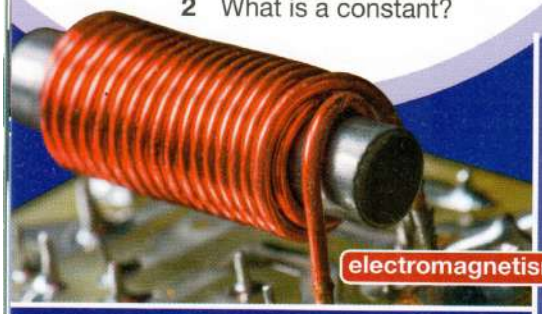
7 Concepts in Physics

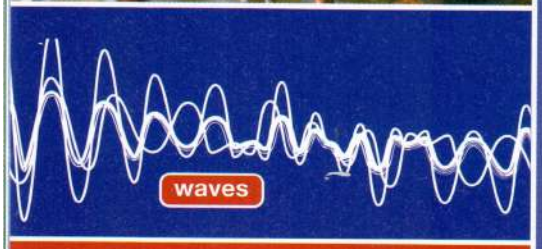
Get ready!

1 Before you read the passage, talk about these questions.

1 What is a scientific law?

2 What is a constant?





Intro to Physics 101

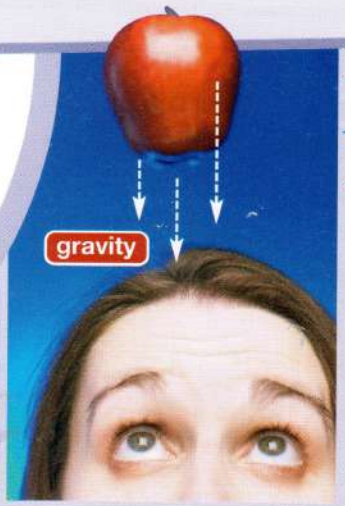
This course provides students with a basic understanding of physics. It consists of three sections: mechanics, **electromagnetism**, and **thermodynamics**.

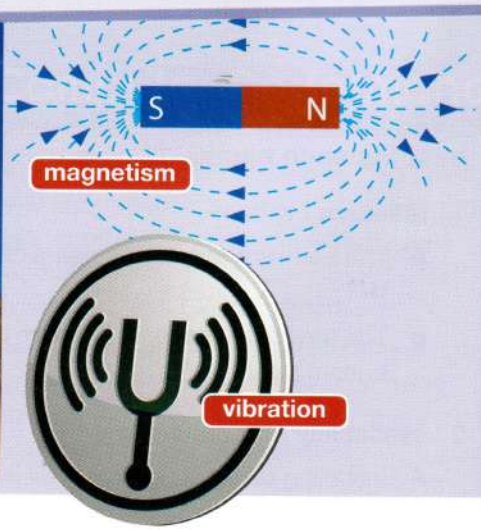
In the mechanics section, students will learn about **motion**. This section will primarily focus on Newton's **laws** of motion. Students will use Newton's laws to calculate quantities like **momentum**. Students will also use the gravitational **constant** to calculate **gravity** between objects.

In thermodynamics, the course will address the **conservation** of energy. Students will discuss energy's relationship with heat. They will also explore how mechanical **waves** and **vibrations** transfer energy. Thermodynamic **equilibriums** in systems will also be covered.

Finally, the electromagnetism portion of the course will discuss electricity and **magnetism**. Students will learn how these properties interact with each other. The class will conclude by exploring how each section's concepts act together.

Prerequisites include Calculus and Intro to Physical Science.





Reading

2 Read the course description. Then, mark the following statements as true (T) or false (F).

1 ___ The conservation of energy and thermodynamic equilibriums are covered in the same section.

2 ___ In the last section, students will study Calculus.

3 ___ Students must study electromagnetism before enrolling in the course.

Vocabulary

3 Match the words (1-8) with the definitions (A-H).

1 ___ law
2 ___ wave
3 ___ motion
4 ___ constant
5 ___ vibration
6 ___ equilibrium
7 ___ thermodynamics
8 ___ electromagnetism

A a disturbance that moves through a substance

B a repeated movement in a substance or field of energy

C the action or process of moving

D an explanation for a natural process that is always true

E a number that does not change

F the interactions that occur between electricity and magnetism

G a stable condition in which forces cancel one another

H a branch of physics that deals with the relations between heat and other forms of energy

4 Read the sentence pairs. Choose which word best fits each blank.

1 **magnetism / gravity**

A _____ causes objects to fall to the ground.

B Many people use _____ to hold metal objects together.

2 **conservation / momentum**

A The swinging pendulum shows the principal of _____ of energy in action.

B The tire generated _____ as it rolled down the hill.

5 🎧 **Listen and read the course description again. What is covered in the thermodynamics section of the course?**

Listening

6 🎧 **Listen to a conversation between two students. Choose the correct answers.**

1 What's the conversation mostly about?

- **A** why a range of ideas is important
- **B** the meanings of different terms
- **C** practical applications of physics concepts
- **D** which topics appeared on a recent test

2 What does the man confuse with equilibrium?

- **A** conservation
- **B** constants
- **C** magnetism
- **D** gravity

7 🎧 **Listen again and complete the conversation.**

Student 2: Okay. What is a constant?

Student 1: Oh, that's easy. **1** _____ _____ _____ a number that doesn't change, like the gravitational constant.

Student 2: You are correct. Now give me a term.

Student 1: All right. **2** _____ _____.

Student 2: Magnetism is the interaction between magnetic and electrical fields. **3** _____ _____, that's electromagnetism.

Student 1: Right. Magnetism is the force between two objects caused by a magnetic field. How about **4** _____?

Student 2: Let's see. Is that **5** _____ _____ _____ two opposing forces?

Student 1: No. **6** _____ _____. Conservation is a principle that prevents a total quantity from changing.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Would you like me to ...?
Now give me a ...
No, wait ...

Student A: You are a student. Talk to Student B about:

- studying for an exam
- what terms will be in the exam
- the definitions of different terms

Student B: You are a student. Talk to Student A about what terms will be in an exam

Writing

9 **Use the conversation from Task 8 to fill out the student's exam correction sheet.**

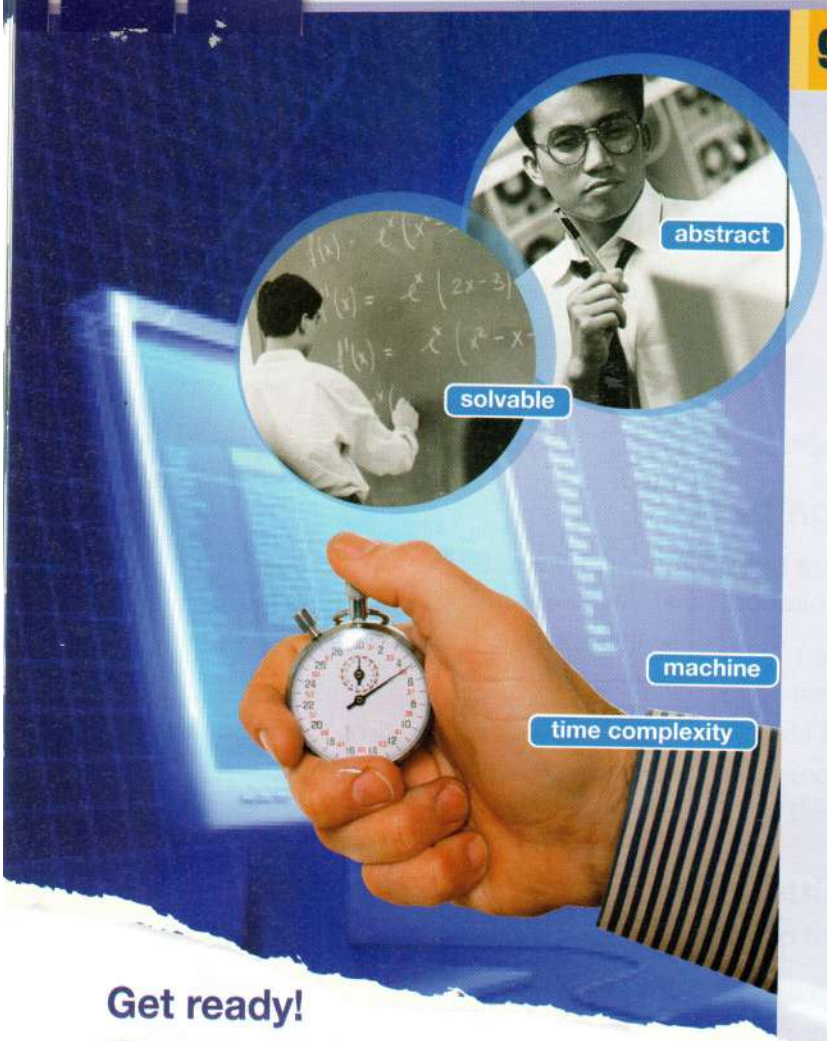
Intro to Physics Exam #3

Exam Corrections

Name: _____

Concept	What was your error?	Correction
1 Magnetism	Identified as the interaction between magnetic and electrical fields.	This is actually the definition for electromagnetism
2 _____	_____ _____	_____ _____
3 _____	_____ _____	_____ _____

8 Theory of Computation



9.2 Theory of Computation

The **theory of computation** is mainly concerned with efficient computation and computer modeling. This branch of computer science is further divided into smaller fields. **Automata theory**, **computability theory**, and **computational complexity theory** are all aspects of general computing theory.

Automata theory deals primarily with **abstract machines**, or imaginary computers. Unlike real computers, abstract machines are mathematical models. Automata theory seeks to discover what problems they could potentially solve.

Computability theory studies to what extent problems are **solvable**. It does this with current computer models. The **Turing machine** is one of computability theory's main tools. Turing machines are abstract machines that have unlimited memory. If a Turing machine can **process** a problem, it is considered solvable.

Finally, computational complexity theory is based on computer resources. It attempts to organize problems in order of difficulty. A problem's difficulty reflects how **efficiently** a computer can solve it. This efficiency is measured in terms of **time complexity** and **space complexity**.

Get ready!

1 Before you read the passage, talk about these questions.

1 What is the purpose of abstract machines?

2 What is the difference between computability theory and computational complexity theory?

Reading

2 Read the textbook chapter. Then, mark the following statements as true (T) or false (F).

1 __ Real computers are not typically used in Automata theory.

2 __ Computability theory studies ways to improve Turing machine memory.

3 __ Efficiency is a major subject of computational complexity theory.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ process
2 __ efficiently
3 __ time complexity
4 __ Turing machine
5 __ automata theory
6 __ theory of computation
7 __ computability theory
8 __ computational complexity theory

A the study of abstract machines and the computational problems they can solve

B to organize data or change it from one form to another

C the amount of time a computer needs to process a problem

D a field that studies the resources computers need to solve problems

E operating while using minimal resources

F an abstract computer with infinite storage capacity

G a general branch of computer science that deals with modeling and efficiency

H a field that examines whether certain problems are solvable

4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 **solvable / abstract**

A _____ computers test hypothetical problems.

B If a Turing machine can't process it, it is not _____.

2 **machine / space complexity**

A The _____ of a problem contributes to its overall difficulty.

B A computer is a _____ that most people use.

5 Listen and read the textbook chapter again. What does a Turing machine do?

Listening

6 Listen to a conversation between a teaching assistant and a student. Choose the correct answers.

1 What is the conversation mostly about?

A a comparison of computing theories

B practical applications for different computing theories

C why studying computing theories is important

2 What error does the man make?

A He mixes up automata theory and computability theory.

B He incorrectly defines computational complexity theory.

C He thinks an unsolvable problem is solvable.

7 Listen again and complete the conversation.

Student: I'm having trouble understanding some of the concepts from class. **1** _____ _____ _____ clarifying a few things?

Teaching Assistant: Sure, no problem. What are you having trouble with?

Student: The three theories that make up the **2** _____ _____ _____. They all seem to study whether an abstract computer can solve a problem.

Teaching Assistant: Well, they do sound pretty similar at first. However, they concentrate on different aspects.

Student: So what's the focus of **3** _____ _____?

Teaching Assistant: Automata theory checks if abstract machines can **4** _____ _____.

Student: So it's about **5** _____ _____ _____, then.

Teaching Assistant: That's right. And **6** _____ _____ _____ studies resources.

Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

USE LANGUAGE SUCH AS:

Would you mind ...?

Isn't that the same ...?

So it's primarily ...

Student A: You are a student. Talk to Student B about:

- the theory of computation
- how to distinguish between different theories
- the focus of each theory

Student B: You are a teaching assistant. Talk to Student A about the theory of computation.

Writing

9 Use the conversation from Task 8 to fill out the student's notes.

Theory of Computation

Automata Theory focuses on _____

_____.

It deals with machines that are _____

_____.

_____

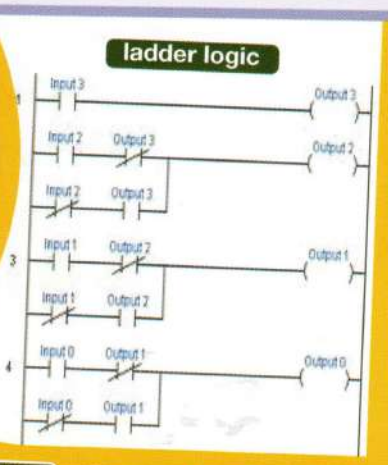
focuses on _____

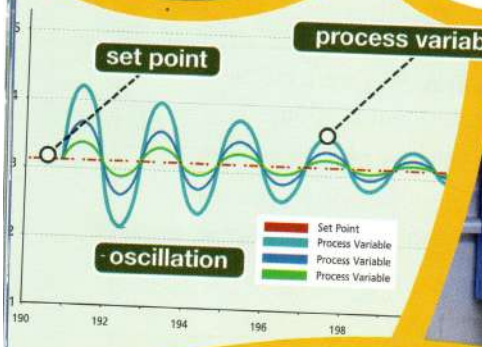
_____.

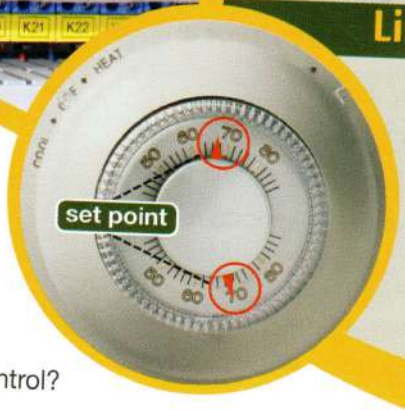
It deals with machines that are _____

_____.

9 Control systems







Unit 12.4 Nov. 17 & 19

Review of Control Systems

There are a number of different **control systems**. Some are very simple, while others are much more elaborate.

Logic control:

In Unit 12.3, we designed control systems using **ladder logic**. These were simple **logic control** systems. Historically, logic control systems consisted of multiple small mechanical relays. Today, most logic control systems use microcontrollers instead.

Feedback control:

Simple **on/off controls** are a type of feedback control. A standard electric oven is a good example. The oven thermostat uses **negative feedback** to control the heating elements. The thermostat monitors the temperature, or **process variable** (PV). The elements turn off when the PV passes the **set point** (SP). The difference between the PV and SP is the **error**.

Linear control:

Linear control produces a constant control signal. Simple **proportional control** changes the control signal relative to the error. However, these may produce undesirable **oscillations** in PV. More advanced **PID control** uses **derivative** and **integral** functions to increase efficiency.

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some different types of control systems?

2 What are the characteristics of PID control?

Reading

2 Read the class handout. Then, choose the correct answers.

1 What is the handout mostly about?

A benefits of combining control systems
B troubleshooting steps for control systems
C characteristics of different control systems
D historical uses of control systems

2 Which control system can create oscillations in the value of PV?

A proportional control
B logic control
C PID control
D on/off control

3 What is NOT true about the set point of an oven?

A It is needed to calculate the error.
B It is used to determine the PV.
C It is connected to the thermostat.
D It can prompt a component to turn off.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 ___ error
2 ___ ladder logic
3 ___ set point
4 ___ linear control
5 ___ process variable
6 ___ on/off control
7 ___ control system
8 ___ proportional control

A a system that responds to input with equivalent reverse action
B a system that activates and deactivates a device
C a device or set of devices that regulate the actions of other devices
D the desired value of the PV
E a system that produces a constant output signal
F a condition that is being monitored by the control system
G the difference between the PV and SP
H a way to express relay logic in a diagram

4 **Read the sentence pairs. Choose which word or phrase best fits each blank.**

1 **integral / derivative**

A A(n) _____ action keeps increasing its effort until the error is zero.

B A(n) _____ action measures the change in error over time.

2 **oscillation / PID control**

A _____ uses mathematical functions to increase efficiency.

B A(n) _____ is a repeated variation in signal.

3 **logic control / negative feedback**

A _____ uses binary inputs and outputs.

B Common thermostats operate on the principle of _____.

5 🎧 **Listen and read the class handout again. When does the oven thermostat turn the heating elements off?**

Listening

6 🎧 **Listen to a conversation between two students. Mark the following statements as true (T) or false (F).**

1 __ The man is confused about integral functions in PID control.

2 __ The woman explains the difference between logic and linear control.

3 __ According to the woman, logic control parts are sometimes used in linear control systems.

7 🎧 **Listen again and complete the conversation.**

Student 1: Well, I'm going over my notes. And I don't quite understand the difference between **1** _____ _____ _____ and PID control.

Student 2: Okay. Well, they both respond in proportion to the **2** _____.

Student 1: Right, I knew that. But what do the derivative and integral functions do in **3** _____ _____?

Student 2: Straight proportional control creates **4** _____ in PV. Derivative and integral functions reduce the oscillations.

Student 1: I see. So they make the control signal more precise?

Student 2: Yeah, exactly.

Student 1: And they're both **5** _____ _____, right?

Student 2: Yes. But **6** _____ _____ _____, in the real world there's some overlap. Linear control systems might have some logic control parts.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Can you help me?

What do you need ...?

I'm confused about ...

Student A: You are a student. Talk to Student B about:

- an upcoming exam on control systems
- differences between control systems
- what you are confused about

Student B: You are a student. Talk to Student A about different types of control systems.

Writing

9 **Use the conversation from Task 8 to fill out the test on control systems.**

Unit 12.4 Control Systems

Name: _____

Date: _____

1 **Name two types of control systems.**

_____

_____

2 **What is the difference between them?**

_____

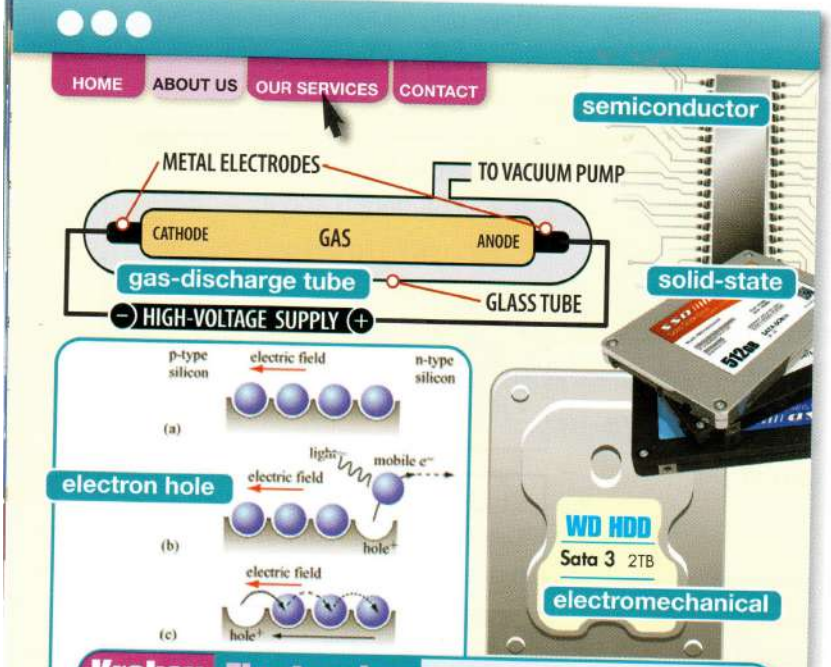
_____

10 Solid-state Electronics

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some examples of solid-state devices?
2 What types of devices existed before solid-state technology?



Krakov Electronics
A leader in solid-state technology

Krakov began as a manufacturer of **gas-discharge tubes** in 1902. In the 1930s, many early computers used Krakov **vacuum** tubes. Today, Krakov specializes in manufacturing **solid-state** drives and storage devices.

What are solid-state electronics?

Solid-state electronics consist entirely of **solid** components. Krakov Electronics builds solid-state devices out of **crystalline semiconductors**. Semiconductors are unique because they contain both electrons and **electron holes**. In solid-state devices, electrical current only flows within solid parts. Electrons and other **charge carriers** move within the **confined** space. This makes solid-state devices exceptionally fast and efficient.

What is the difference between solid-state drives and hard disk drives?

A hard disk drive (HDD) is an **electromechanical** device. An HDD stores information on a rigid, magnetic spinning disk. A solid-state drive (SSD) stores data in integrated circuits. The SSD has many advantages over devices with vulnerable **moving parts**. They are quieter, more durable, and more power-efficient. Make your next storage device a Krakov solid-state drive!

Reading

2 Read the webpage. Then, choose the correct answers.

1 What is the webpage mostly about?
- **A** the historical applications of solid-state technology
- **B** a catalog of solid-state devices available for purchase
- **C** a comparison of solid-state and older technologies
- **D** instructions for installing solid-state drives

2 According to the webpage, what is NOT an advantage of solid-state devices?
- **A** They are quieter than electromechanical devices.
- **B** They do not have vulnerable moving parts.
- **C** They require low levels of power to operate.
- **D** They store information on a magnetic disk.

3 What is true of semiconductors?
- **A** They have both electrons and electron holes.
- **B** They are usually made up of multiple pieces.
- **C** They allow charge carriers to move freely in and out.
- **D** They contain rigid, spinning disks.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ solid
2 __ vacuum
3 __ confined
4 __ electron hole
5 __ crystalline
6 __ charge carrier
7 __ electromechanical
8 __ gas-discharge tube

- **A** a space devoid of air or other matter
- **B** a device that runs on electricity and also has moving parts
- **C** restricted to a certain area
- **D** a positively charged space where a negatively charged particle could be
- **E** a subatomic particle that is electrically charged
- **F** devoid of cavities or breaks
- **G** having the structural qualities of a solid with a regular molecular pattern
- **H** a glass cylinder filled with ionized gas

4 **Read the sentences and choose the correct words or phrases.**

1 A **crystalline / solid-state** device has no mechanical parts.
2 A material with moderate conductivity is a **semiconductor / gas-discharge** tube.
3 In portable devices, the **electron holes / moving parts** are most likely to break.

5 **Listen and read the webpage again. Where does electrical current flow in solid-state devices?**

Listening

6 **Listen to a conversation between an intern and a computer engineer. Mark the following statements as true (T) or false (F).**

1 ___ The woman recently learned about gas-discharge tubes on TV.
2 ___ The woman mistakes a hard drive for a solid-state device.
3 ___ The man explains the difference between electrons and electron holes.

7 **Listen again and complete the conversation.**

Intern: Definitely. We watched a TV program about those. It said that **1** _____ _____ practically every day. Can you imagine that?
Engineer: I'm sure it was really frustrating.
Intern: **2** _____-_____ technology is so much better. Hard drives hold so much more information. And they're way more reliable.
Engineer: Well actually, a hard drive isn't solid-state. It's **3** _____.
Intern: Really? I thought they were made from **4** _____ parts.
Engineer: Technically, that's true. But devices with **5** _____ _____ aren't really solid-state.
Intern: Oh, okay. I thought solid-state just meant it didn't have vacuum tubes.
Engineer: No, solid-state electronics are made out of **6** _____.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

It's amazing ...
Actually ...
I thought ...

Student A: You are an intern. Talk to Student B about:

- recent advancements in solid-state technology
- a TV program you saw about older technology
- the distinction between different technologies

Student B: You are an engineer. Talk to Student A about solid-state technology.

Writing

9 **Use the conversation from Task 8 to fill out the intern evaluation form.**

Monthly Intern Evaluation

Intern: _____
Mentor: _____

Overall Performance:
Excellent ❑ Good ❑ Fair ❑ Poor ❑

What additional training do you recommend?

_____
_____

Why do you recommend this training?

_____
_____

11 Design Processes

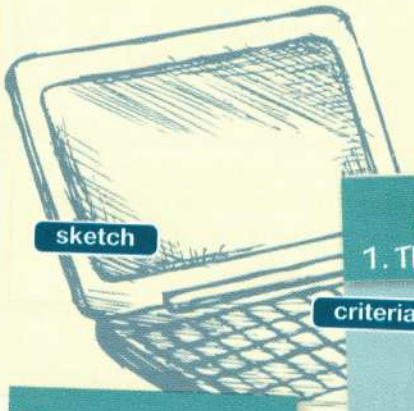
Get ready!

1 Before you read the passage, talk about these questions.

1 What are the major stages of the computer design process?

2 Why do engineers conduct feasibility studies?

Tekknic Systems: Policies & Procedures



CHECK LIST

1. The new model must be

criteria

- Quiet ☐
- Cost-effective ☐
- Energy efficient ☐

Design Methods

All new products and devices go through a standard design process:

1. **Identify** a need in the market. Research any similar products from competitors. Identify flaws in the existing products.
2. Present **preliminary designs** and **sketches** to your creative team. Explain how the product will meet market demands.
3. Conduct an in-depth **feasibility study** to determine the project's likelihood for success. **Estimate** the cost and time required to **construct** prototype models. (This applies to hardware devices only.) Identify the practical **constraints** of the project.
4. **Narrow down** designs to the most feasible options. Eliminate any designs that are obviously not cost-effective.
5. With the results of the feasibility study, produce some **detailed designs**. Identify potential problems in the designs and make changes as necessary.
6. **Assemble** and test prototypes or produce initial version of software. Adjust the design to ensure the product meets company **criteria**.
7. Decide on the final design version. **Verify** the final designs with the creative team and superiors.

Reading

2 Read the employee manual. Then, choose the correct answers.

1 According to the manual, what is the purpose of researching products from other companies?

A to identify problems with existing designs
B to estimate the possible costs of prototypes
C to eliminate designs that are not cost-effective
D to determine a project's likelihood for success

2 Which of the following is NOT part of the feasibility study?

A estimating costs of prototypes
B producing detailed designs
C identifying practical limitations
D narrowing down design options

3 According to the manual, which designs should engineers eliminate?

A designs with potential problems
B designs with many practical constraints
C designs that are too expensive
D designs that are available from competitors

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ sketch
2 __ identify
3 __ verify
4 __ construct
5 __ constraint
6 __ narrow down
7 __ detailed design
8 __ preliminary design

A to eliminate less desirable options
B to recognize or establish something
C a rough drawing that is not meant to be a finished product
D to build something
E a restricting condition
F an in-depth version of project plans
G an initial, conceptual version of project plans
H to make sure something is correct or valid

4 **Read the sentence pairs. Choose which word or phrase best fits each blank.**

1 **assemble / estimate**

A It took two hours to _____ the parts.

B We need to _____ the total cost of the project.

2 **criteria / feasibility study**

A The engineer is waiting for the results of the _____.

B The prototype did not meet the company's _____.

5 **Listen and read the employee manual again. When do engineers estimate the cost of building a prototype?**

Listening

6 **Listen to a conversation between two computer engineers. Mark the following statements as true (T) or false (F).**

1 __ The woman will bring detailed designs to the meeting.

2 __ The man plans to work with other engineers on a preliminary design.

3 __ The woman is used to a different type of design process.

7 **Listen again and complete the conversation.**

Engineer 1: Well, you'll start by bringing your **1** _____ to the meeting tomorrow.

Engineer 2: Okay. Is that when we'll discuss the **2** _____ _____ _____?

Engineer 1: Yes. The engineering team will **3** _____ the strengths and weaknesses of the design. Then we'll make some initial adjustments.

Engineer 2: Right. I realize that the design process is **4** _____ _____ _____.

Engineer 1: Yes, very much so. After tomorrow's meeting, we'll do a **5** _____ _____.

Engineer 2: And that's when we'll decide whether to proceed, right?

Engineer 1: Exactly. If it looks like the project is viable, we'll move on to the **6** _____ _____.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

You'll start by ...

Is that when we'll ...?

Exactly.

Student A: You are an engineer. Talk to Student B about:

- his or her designs for a new project
- the steps he or she will take in the design process
- the benefits of the design procedures

Student B: You are an engineer. Talk to Student A about the design process.

Writing

9 **Use the conversation from Task 8 to fill out the manual.**

Tekknic Systems:

Guidelines for new employees – Stages of the design process

Firstly, _____ _____ to the board.

A team of engineers will help you to narrow down the designs.

If your design is approved _____ _____.

12 Algorithms

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some uses of algorithms?

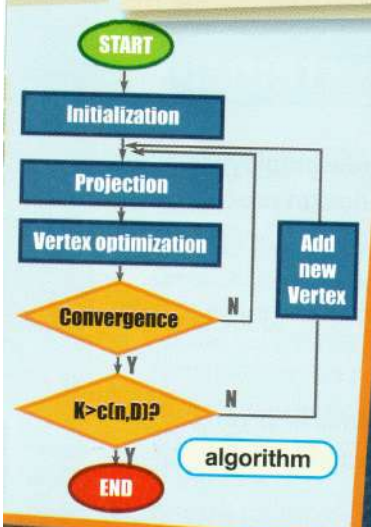
2 What are the two desirable traits of a computer algorithm?

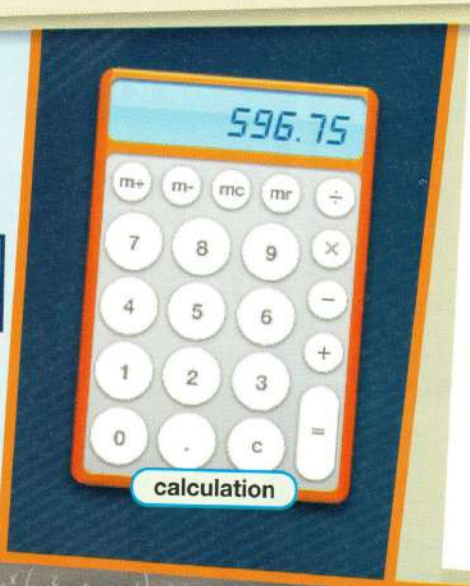
Algorithms

An **algorithm** is a **step-by-step** process for performing **calculations**. In computer engineering, algorithms have many uses. They are an **effective method** for **automated** reasoning and data processing. People first began to use algorithms to solve the famous **decision problem**.

In essence, an algorithm **determines** the procedure to calculate a **function**. In computing, algorithms take input values through a prescribed **sequence**. The output of the algorithm is the solution to the problem. By definition, an algorithm is a **finite** list of steps. Algorithms can only solve problems that are inherently **decidable**.

Computer algorithms come with a unique set of problems. The main problem is striking a balance between **goodness** and **elegance**. A computer can solve a 'good' algorithm very quickly and efficiently. By contrast, an 'elegant' algorithm has a minimal number of steps. Skilled engineers can create algorithms that are both good and elegant.





Reading

2 Read the textbook chapter. Then, choose the correct answers.

1 What is the passage mostly about?

A a comparison of different types of algorithms
B an overview of the properties of algorithms
C instructions for programming algorithms
D a history of the use of algorithms

2 Which idea is NOT in the passage?

A An algorithm is a finite sequence of steps.
B Algorithms should be both good and elegant.
C Algorithms are used for automated reasoning.
D Algorithms are used to create new functions.

3 Why were algorithms first used?

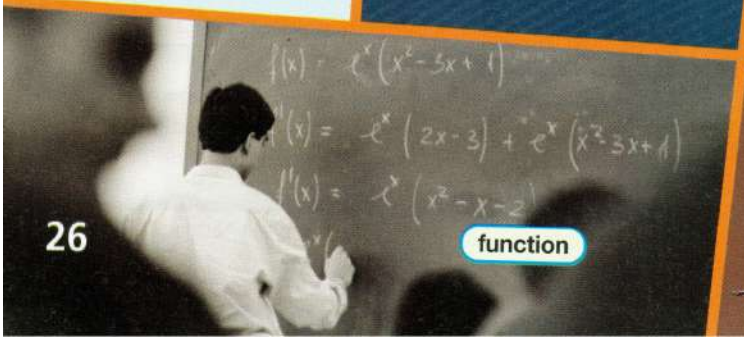
A to perform data processing tasks
B to solve the decision problem
C to aid in computer engineering
D to ensure that problems are decidable

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ finite
2 __ sequence
3 __ elegance
4 __ algorithm
5 __ determine
6 __ step-by-step
7 __ calculation
8 __ effective method

A a problem-solving process that always produces the correct answer
B following a specific sequence of actions
C the process of analyzing and solving a mathematical problem
D a set of actions or numbers arranged in order
E having definite limits on its value
F a set of precise rules for solving mathematical functions
G the compactness of a computer program
H to decide conclusively based on the available evidence



4 **Read the sentences and choose the correct words or phrases.**

1 In a(n) **finite / automated** system, machines are programmed to do the work.
2 The **goodness / sequence** of an algorithm is its speed and efficiency.
3 Algorithms calculate the value of a(n) **function / elegance**.
4 A **calculation / decision problem** is a formal question with a yes or no answer.
5 An algorithm can only solve a problem that is **step-by-step / decidable**.

5 **Listen and read the textbook chapter again. What kind of problems can algorithms solve?**

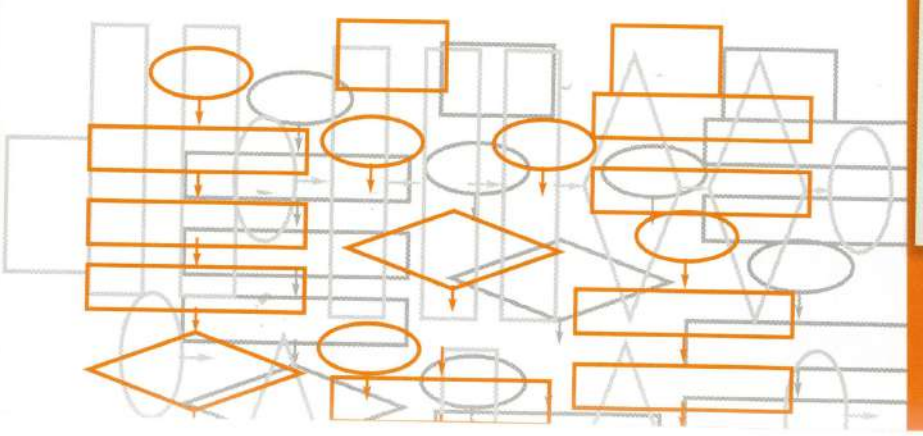
Listening

6 **Listen to a conversation between two engineers. Mark the following statements as true (T) or false (F).**

1 ___ The woman wants the man to create a new algorithm.
2 ___ The man suggests removing a calculation.
3 ___ The algorithm needs improved goodness.

7 **Listen again and complete the conversation.**

Engineer 1: Hey Matt, I'm having a hard time with this algorithm. **1** _____ your opinion on it?
Engineer 2: Sure, Maggie. Let me **2** _____ at it.
Engineer 1: It's just a simple **3** _____ for a spam filter.
Engineer 2: Yes, I'm familiar with those. So it's **4** _____ based on keywords, right?
Engineer 1: That's right. It looks for common words in spam messages. But I'm worried that it's too big.
Engineer 2: Let me see. I think you can remove one of the **5** _____. It's kind of redundant.
Engineer 1: In what way?
Engineer 2: Go through it **6** _____-_____-_____. You'll see that you're doing the same calculation twice.



Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Could I get your opinion on ...?
I think you ...
In what way?

Student A: You are an engineer. Talk to Student B about:

- an algorithm you are working on
- what you should add or remove
- how the changes will improve the algorithm

Student B: You are an engineer. Talk to Student A about an algorithm.

Writing

9 **Use the conversation from Task 8 to fill out the note from a computer engineer to a coworker.**

Hi Matt,

I made some changes to that algorithm.

Changes I made:

_____

_____

Why I made these changes:

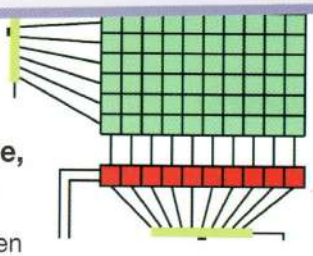
_____

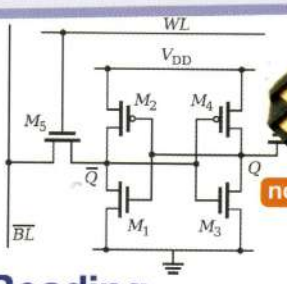
_____

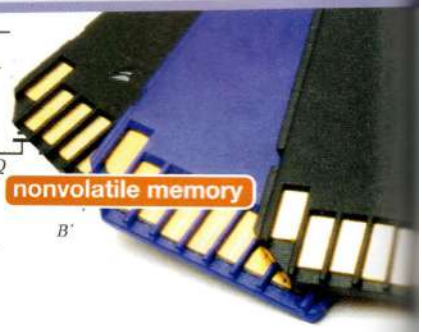
Let me know what you think now.

Maggie

13 Memory





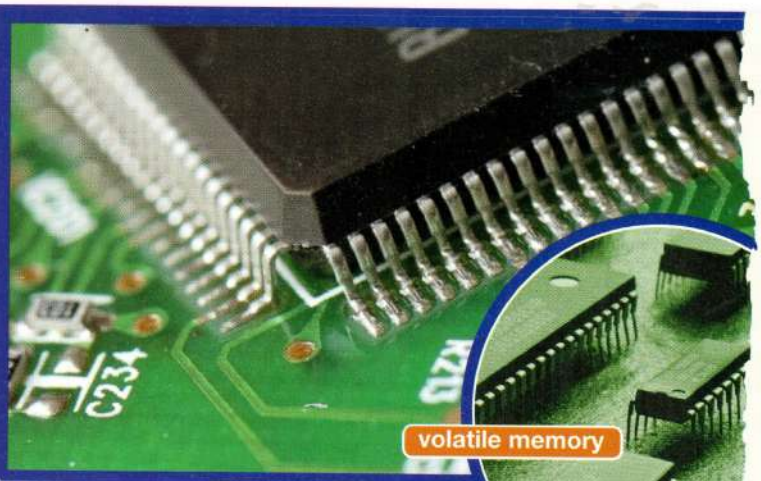


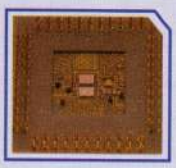
Get ready!

1 Before you read the passage, talk about these questions.

1 What is the difference between volatile and nonvolatile memory?

2 What are some different kinds of volatile memory?





Trends in Computer Memory Usage

Article from the Journal of Computer Science and Microelectronics

An examination of recent computer **memory** trends produced interesting results. Last year, experts predicted that the cost of **SRAM** would drop. In this prediction, they were correct. However, they also predicted that SRAM would begin to replace **DRAM**. To date, SRAM is still used primarily in **cache memory**. Most memory used in **DIMMs** and **SIMMs** today is still DRAM. Why isn't the industry switching to faster **volatile memory**? The production cost of DRAM is still significantly lower. But some analysts still see SRAM as the **primary memory** of the future.

This year's trends in **nonvolatile memory** followed industry predictions. Flash memory is overtaking optical discs at a steady rate. Compared to flash memory, discs are inconvenient and easily damaged. Most consumers are abandoning CD-ROMs for portable flash drives. For **secondary memory**, solid-state drives are gaining popularity. Experts predict they will replace magnetic discs within five years.

Reading

2 Read the journal article. Then, mark the following statements as true (T) or false (F).

1 ___ SRAM has replaced DRAM as the standard primary memory unit.

2 ___ According to the article, experts' predictions about nonvolatile memory were inaccurate.

3 ___ Solid-state devices are gaining popularity over magnetic discs for secondary memory.

Vocabulary

3 Match the words or abbreviations (1-7) with the definitions (A-G).

1 ___ DIMM
2 ___ SIMM
3 ___ DRAM
4 ___ memory
5 ___ cache memory
6 ___ primary memory
7 ___ nonvolatile memory

A a circuit board that has chips on only one side

B memory in the form of a chip that needs to be refreshed periodically

C a circuit board that has chips on both sides

D fast memory that stores recent or frequently requested data

E memory that retains data with or without constant power

F data storage for computers

G volatile memory used to store active programs

4 Read the sentence pairs. Choose the sentence that uses the underlined part correctly.

1 A SRAM does not need to be refreshed.
B A SIMM has DRAM chips on both sides.

2 A Old data is often stored in secondary memory.
B Cache memory is used for long-term data storage.

3 A DRAM is a circuit board with chips on one side.
B Volatile memory needs constant power to retain data.

5 🎧 **Listen and read the journal article again. Why doesn't SRAM replace DRAM as the standard primary memory?**

Listening

6 🎧 **Listen to a conversation between two engineers. Choose the correct answers.**

1 What is the conversation mostly about?

- **A** a broken SIMM unit
- **B** problems with cache memory
- **C** the advantages of DIMMs
- **D** a new type of memory module

2 What will the woman likely do next?

- **A** write a report about nonvolatile memory trends
- **B** install more memory in her office computer
- **C** look up information about the new type of DRAM
- **D** replace a defective cache memory unit

7 🎧 **Listen again and complete the conversation.**

Engineer 1: Have you heard about the new **1** _____ modules? They're using them in the X39 units.

Engineer 2: I've heard a bit. It's just a new type of **2** _____, isn't it?

Engineer 1: That's right. It seems to be a lot more efficient.

Engineer 2: I don't know. **3** _____ _____ _____ to be worth the cost to me.

Engineer 1: Well, it doesn't have to be refreshed as often. That's a major advantage.

Engineer 2: I know that. But at that price, I think it **4** _____ _____ _____ to switch to SRAM.

Engineer 1: Well, the problem with **5** _____ is that it has more transistors per bit.

Engineer 2: Yeah, I guess that's true.

Engineer 1: Using SRAM in standard **6** _____ is great for casual users. But on a large scale, it's not sustainable.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Have you heard ...?
It seems to be ...
You're right ...

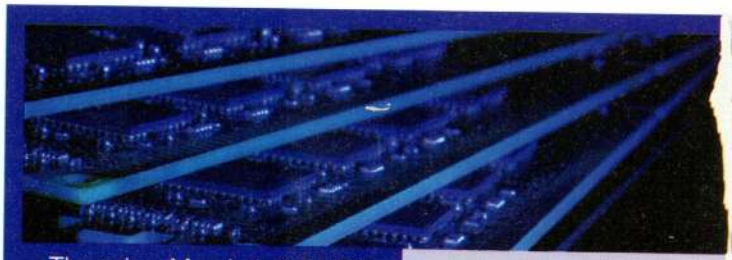
Student A: You are an engineer. Talk to Student B about:

- a new type of memory module
- the advantages of the new memory module
- your opinion about the new memory module

Student B: You are an engineer. Talk to Student A about a new memory module.

Writing

9 **Use the conversation from Task 8 to fill out the tech blog post.**



Thursday, March 1, 8:34 PM

New DRAM memory modules

A conversation with my coworker prompted me to learn more about the new DRAM units.

What I thought at first: _____

_____

_____

_____

What I discovered: _____

_____

_____

_____

14 Chips

Get ready!

1 Before you read the passage, talk about these questions.

1 What is the difference between VLSI and ULSI?
2 How are integrated circuits made?

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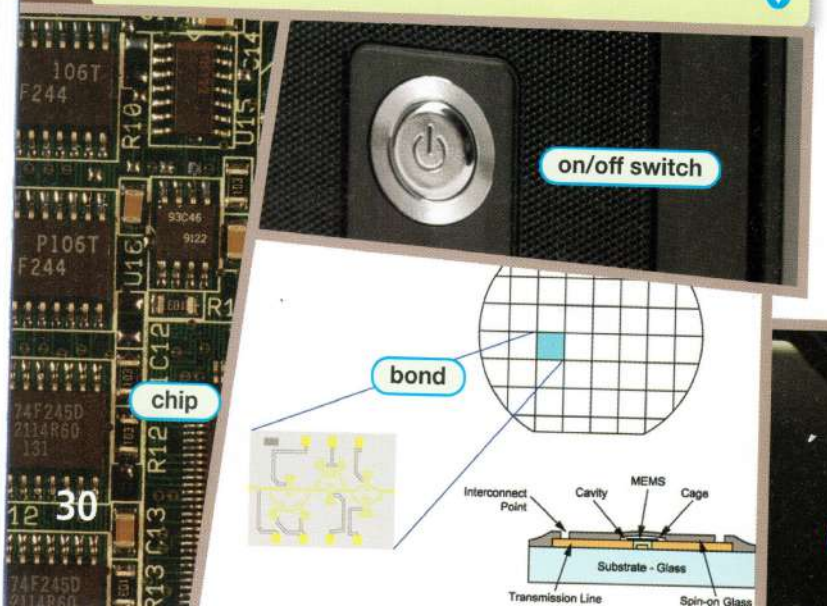
Seed Microelectronics

How does Seed build superior integrated circuits?

Integrated circuits, also called **chips**, begin with **silicon** crystal. The manufacturing process is the same for both **VLSI** and **ULSI** chips. The difference between VLSI and ULSI is the number of **transistors**. Transistors are like tiny **on/off switches** powered by electricity.

A machine slices the silicon crystal into thin, round **wafers**. Then, we apply a **pattern** of chemicals to the wafer. This process forms the basis of conductors, **insulators**, and transistors. A dicing machine cuts the wafer into multiple small **dies**. Inconsistencies in the silicon material make some dies unusable. We inspect the dies for **defects** and **discard** dies with major imperfections.

The dies that pass inspection move on to the bonding process. We **bond** the die to the I/O connectors of the packaging. Then, we test the chips to make sure they function properly. The finished integrated circuits are now ready for consumer use.



Reading

2 Read the webpage. Then, choose the correct answers.

1 What is the webpage mostly about?
- **A** a comparison of different types of integrated circuits
- **B** why integrated circuits are made of particular materials
- **C** the types of chemicals used to make integrated circuits
- **D** the manufacturing process for integrated circuits

2 Which is NOT a part of a finished chip?
- **A** I/O connectors
- **B** silicon dies
- **C** patterned wafers
- **D** electric transistors

3 What happens during the bonding process?
- **A** the die is attached to the packaging
- **B** the wafer is cut into multiple dies
- **C** the defective dies are discarded
- **D** the integrated circuits are tested

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ chip
2 __ VLSI
3 __ wafer
4 __ discard
5 __ defect
6 __ silicon
7 __ insulator
8 __ on/off switch

- **A** a device that completes or interrupts a circuit
- **B** a thin slice of crystal
- **C** a way of building chips with hundreds of thousands of transistors
- **D** a naturally occurring semiconductor
- **E** a flaw or inconsistency
- **F** an electronic circuit mounted on a piece of semiconductor material
- **G** a material that does not conduct electricity
- **H** to throw something away

4 **Fill in the blanks with the correct words or phrases from the word bank.**

WORD BANK

integrated circuit die pattern
bond transistor ULSI

1 _____ technology incorporates millions of on/off switches into one chip.
2 Machines _____ the flawless dies to the packaging.
3 If a(n) _____ contains a defect, it is discarded before it is attached to connectors.
4 Most system memory exists in the form of a(n) _____.
5 Chemicals can transform an area of silicon into a(n) _____.
6 After the wafer is sliced, a(n) _____ of chemicals and metals is applied.

5 **Listen and read the webpage again. Why are some dies discarded?**

Listening

6 **Listen to a conversation between a manager and an employee. Mark the following statements as true (T) or false (F).**

1 __ The company is using ULSI manufacturing technology.
2 __ The man discarded the defective dies.
3 __ The current batch of dies is being bonded.

7 **Listen again and complete the conversation.**

Manager: Manny, what's the status on the new batch of **1** _____ _____?
Employee: Well, Josie, we just finished dicing the **2** _____.
Manager: Great. It sounds like things are moving ahead of schedule. Did you have any problems with the new machinery?
Employee: None at all. It's the best **3** _____ manufacturing technology I've ever used.
Manager: That's good to hear. Are the **4** _____ ready for bonding?
Employee: Well, first we have to inspect the dies for defects. Then we'll **5** _____ the defective ones.
Manager: Ah, I see. I thought you did that already.
Employee: Not yet. The dies are **6** _____ _____ _____ to inspection right now.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

What's the status ...?
Did you have ...?
First ... then ...

Student A: You are a manager. Talk to Student B about:

- progress on a batch of integrated circuits
- problems he or she encountered
- what steps are left in the process

Student B: You are an employee. Talk to Student A about the current batch of chips.

Writing

9 **Use the conversation from Task 8 to fill out the progress report.**

Seed Microelectronics
Manufacturing Progress Update

Date: _____

Type of chip: _____

Have you encountered any problems? **Y / N**

What is the current status of the chips?

_____

_____

15 Internet Security

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some different Internet security methods?

2 Why is Internet security important?

From:	s.medina@fosterwatson.com
To:	jeff@greentechwizards.com
Sub:	Network Security (Help!)

Jeff,

We have a real problem with network **security** at our office. The main concern is with the **firewall** on the router. Some of our new machines can't access the network. Even with the network **password**, it doesn't seem to work. I think we need to change the permissions settings. We want to **deny** unauthorized users, but **permit** our own machines!

I'm also looking for a new way to **encrypt** our email. We're using an outdated **SSL connection** and we need to upgrade. I'm worried that it can't **authenticate** communications from our mail server. I tried to check the **audit log**, but I couldn't **log in**.

Finally, I want to update our **anti-virus software**. Some of my employees found malware on their machines. We're worried about **viruses** entering our local network. How much damage could a virus cause to our network?

I'd really appreciate if you could come down to the office. Does Friday afternoon work for you?

Thanks,
Sally

Reading

2 Read the email. Then, complete the table.

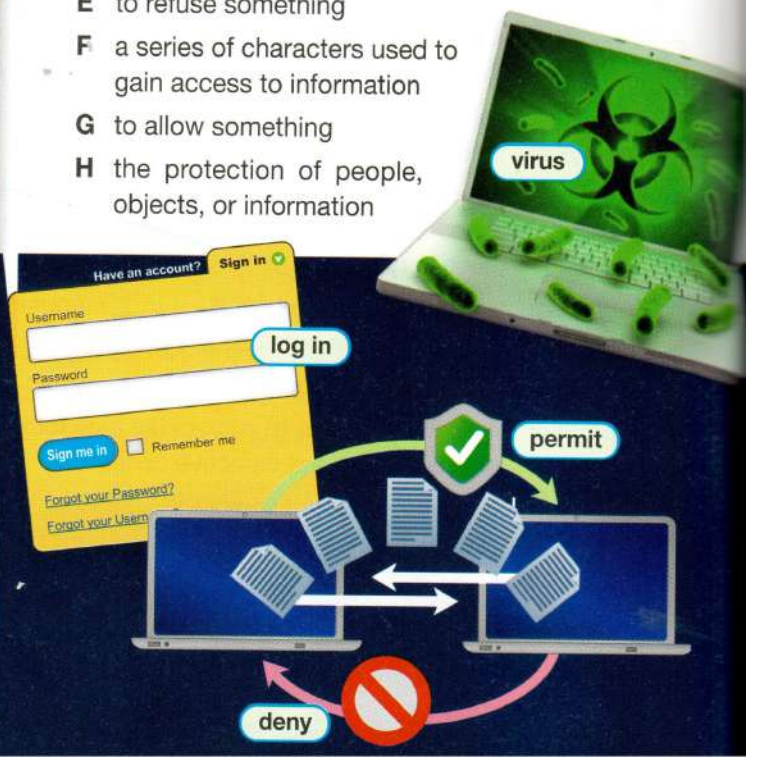
Problem	Solution
1 _____ _____	Change firewall permissions settings
Server has insufficient email encryption.	2 _____ _____
3 _____ _____	Update the anti-virus software.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ deny
2 __ virus
3 __ permit
4 __ security
5 __ password
6 __ authenticate
7 __ SSL connection
8 __ anti-virus software

A to prove that something is correct or legitimate
B a program to protect computers from damaging software
C an Internet connection protected by a cryptographic protocol
D a program designed to replicate itself and spread to other machines
E to refuse something
F a series of characters used to gain access to information
G to allow something
H the protection of people, objects, or information



4 **Read the sentence pairs. Choose which word or phrase best fits each blank.**

1 **firewall / audit log**

A A(n) _____ protects a local network from unauthorized users.

B We checked the _____ for signs of suspicious activity.

2 **log in / encrypt**

A Kathryn had to _____ to use the student forum.

B We _____ our emails so other people can't read them.

5 **Listen and read the email again. Why is the writer concerned about viruses on the local network?**

Listening

6 **Listen to a conversation between a computer engineer and a business owner. Mark the following statements as true (T) or false (F).**

1 __ The woman found an unauthorized user in the audit log.

2 __ The man recommends resetting SSL permissions.

3 __ The woman will pay extra to upgrade the anti-virus software.

7 **Listen again and complete the conversation.**

Engineer: Did you check the **1** _____ _____ like I suggested?

Owner: I tried to **2** _____ _____ with the password you sent me. But it still didn't work.

Engineer: Okay, I'll have to **3** _____ _____ _____ at it myself.

Owner: Based on what you've seen, what changes do you recommend?

Engineer: Well, first of all, **4** _____ _____ _____ upgrading your anti-virus software.

Owner: I had a feeling you would say that. Is it going to be expensive?

Engineer: Don't worry, you can upgrade for free. I'd also like to change your **5** _____ _____.

Owner: Okay. That sounds like a good idea.

Engineer: After that, I can reset the permissions on your **6** _____ Does that sound good to you?

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

I understand ...

I tried to ...

I highly recommend ...

Student A: You are an engineer. Talk to Student B about:

- his or her security concerns
- what steps he or she already took
- what changes you recommend

Student B: You are a business owner. Talk to Student A about your security concerns.

Writing

9 **Use the conversation from Task 8 to fill out the engineer's notes.**

Green Tech Wizards!

Assessment and Estimate Notes

Client Name: _____

What is the main security problem?

_____

_____

_____

Is this an urgent problem? Y / N

How will we solve the problem?

_____

_____

_____

Glossary

abstract [ADJ-U8] If something is **abstract**, it exists in the form of a thought, but not as a real object or event.

algorithm [N-COUNT-U12] An **algorithm** is a set of precise rules describing the process for performing calculations.

anti-virus software [N-UNCOUNT-U15] **Anti-virus software** is a type of security software that removes malware, or prevents its installation.

assemble [V-T-U11] To **assemble** something is to put its parts together.

audit log [N-COUNT-U15] An **audit log** is a record of all user interactions with a protected system.

authenticate [V-T-U15] To **authenticate** something is to prove that it is correct or legitimate.

automata theory [N-UNCOUNT-U8] **Automata theory** is the study of abstract machines and the problems they are theoretically able to solve.

automated [ADJ-U12] If an action is **automated**, it is done by a machine.

availability [N-UNCOUNT-U6] **Availability** is the proportion of time that a computer system is functional and able to complete a task.

bandwidth [N-COUNT-U6] A **bandwidth** is a measurement of a computer network's ability to transmit information.

binary [ADJ-U4] If something is **binary**, it uses a number system based on two.

bit/s [N-COUNT-U6] A **bit/s**, or bit per second, is a unit that measures the rate of data transmission.

bond [V-T-U14] To **bond** two or more objects is to cause them to adhere to each other.

byte [N-COUNT-U4] A **byte** is a very small unit of computer data.

cache memory [N-UNCOUNT-U13] **Cache memory** is small, fast memory that stores recent or frequently-used data for fast access.

calculation [N-COUNT-U12] A **calculation** is the process of analyzing a mathematical problem and determining its solution.

charge carrier [N-COUNT-U10] A **charge carrier** is a free subatomic particle that carries an electrical charge.

chip [N-COUNT-U14] A **chip**, also called an integrated circuit, is an electronic circuit consisting of a large number of small devices mounted on one solid piece of semiconductor material.

closed system [N-COUNT-U3] A **closed system** is a system that does not gain or lose mass.

compact [ADJ-U6] If something is **compact**, it occupies a very small amount of space and its parts are usually closely joined or compressed.

compression ratio [N-COUNT-U6] A **compression ratio** is the difference between a file's actual size and its size while compressed.

computability theory [N-UNCOUNT-U8] **Computability theory** is the study of abstract machines and the computational problems they can solve.

computational complexity theory [N-UNCOUNT-U8] **Computational complexity theory** is the study of the resources computers need to solve problems.

conclusion [N-COUNT-U2] A **conclusion** is a decision or determination that is made after an experiment.

confined [ADJ-U10] If an object is **confined**, its movement is restricted to a certain area.

conservation [N-UNCOUNT-U7] **Conservation** is a principle that prevents the total value of a quantity in a system from changing.

constant [N-COUNT-U7] A **constant** is a number that never changes.

constraint [N-COUNT-U11] A **constraint** is a restricting condition.

construct [V-T-U11] To **construct** something is to build it.

consumption [N-UNCOUNT-U3] **Consumption** is the amount of an extensive quantity that is destroyed during a particular period of time.

control group [N-COUNT-U2] A **control group** is a part of an experiment that does not receive the action or treatment that is being tested.

control system [N-COUNT-U9] A **control system** is a device or set of devices that regulates the actions of other devices.

correspond [V-I-U5] To **correspond** to something is to have a direct relationship or similarity with it.

criteria [N-PLURAL-U11] **Criteria** are standards or requirements that must be met.

critical thinking [N-UNCOUNT-U1] **Critical thinking** is the ability to draw logical conclusions based on facts and evidence.

crystalline [ADJ-U10] If a material is **crystalline**, it has the structural characteristics of a crystal.

curious [ADJ-U1] If someone is **curious**, he or she wants to know more about something.

data compression [N-UNCOUNT-U6] **Data compression** is a process of encoding information so that it occupies a smaller space on a computer.

data decompression [N-UNCOUNT-U6] **Data decompression** is a process that returns compressed data to its original size.

data transmission [N-UNCOUNT-U6] **Data transmission** is the exchange of information between computers.

decidable [ADJ-U12] If a problem is **decidable**, its solution can be reached by logical or algorithmic methods.

decision problem [N-COUNT-U12] A **decision problem** is a formal question with a yes or no answer, the most famous of which is a logical challenge to create an algorithm that will determine conclusively whether a statement is inherently true or false.

decline [N-COUNT-U5] A **decline** is the process of becoming worse or smaller in amount.

decrease [V-I-U5] To **decrease** is to become smaller.

dedicated [ADJ-U1] If someone is **dedicated**, he or she is devoted to a task or cause.

defect [N-COUNT-U14] A **defect** is a flaw or inconsistency.

deny [V-T-U15] To **deny** something is to refuse it.

derivative [ADJ-U9] If an action is **derivative**, it is a mathematical function that measures the variation in the value of an error over time.

detailed design [N-COUNT-U11] A **detailed design** is an in-depth version of a design, usually updated from the preliminary design with the results of research and analysis.

detail-oriented [ADJ-U1] If someone is **detail-oriented**, he or she is capable of focusing on small, specific parts of something.

determine [V-T-U12] To **determine** something is to decide conclusively based on the available evidence.

die [N-COUNT-U14] A **die** is a small piece of a wafer.

DIMM [ABBREV-U13] A **DIMM** (Dual Inline Memory Module) is a circuit board that has DRAM chips on both sides and plugs into the memory slot of a motherboard.

discard [V-T-U14] To **discard** something is to throw it away.

double [V-I-U5] To **double** is to become twice as large or abundant.

DRAM [ABBREV-U13] **DRAM** (Dynamic Random Access Memory) is memory in the form of an integrated circuit that can provide random access to any data, but needs to be refreshed periodically.

effective method [N-COUNT-U12] An **effective method** is a process for solving a problem that always produces the correct answer in a limited number of steps.

efficient [ADJ-U1] If someone is **efficient**, he or she works in a quick and organized way.

Glossary

efficiently [ADV-U8] If something occurs **efficiently**, it operates using a minimum amount of time and resources.

electromagnetism [N-UNCOUNT-U7] **Electromagnetism** is the interaction between electrical currents and magnetic fields.

electromechanical [ADJ-U10] If a device is **electromechanical**, it operates on electrical current and also has moving parts.

electron hole [N-COUNT-U10] An **electron hole** is the concept of a positively charged space that lacks an electron where an electron could conceivably exist.

elegance [N-UNCOUNT-U12] **Elegance** is the compactness of an algorithm within a computer program.

encrypt [V-T-U15] To **encrypt** information is to apply an algorithm to it that makes it unreadable to those without a key.

equilibrium [N-COUNT-U7] An **equilibrium** is a state in which there is a balance between two opposing forces.

error [N-COUNT-U9] An **error** in a control system is the difference in value between the current PV and the required SP.

estimate [V-T-U11] To **estimate** a value is to make an educated guess about it based on the available facts.

evaluation [N-COUNT-U2] An **evaluation** is a conclusion that someone reaches after thinking carefully about something.

expand [V-I-U5] To **expand** is to become larger in size.

experiment [N-COUNT-U2] An **experiment** is a scientific process that is designed to reveal the effect of something.

experimental group [N-COUNT-U2] An **experimental group** is a part of an experiment that receives the action or treatment that is being tested.

exponential [ADJ-U4] If an amount is **exponential**, its rate of growth increases as it becomes larger.

extensive quantity [N-COUNT-U3] An **extensive quantity** is an amount that changes based on the size of a system and that can be counted.

factor [N-COUNT-U4] A **factor** is a number that an amount of something is repeatedly multiplied by.

feasibility study [N-COUNT-U11] A **feasibility study** is a period of research to determine whether a proposition is possible and likely to be successful, based on realistic conditions.

final [ADJ-U3] If something is **final**, it is related to the status of something at the end of a process or period of time.

finite [ADJ-U12] If a number is **finite**, it has definite limits on its value.

firewall [N-COUNT-U15] A **firewall** is a type of security software that screens network transmissions to prevent unauthorized access to a system.

fluctuate [V-I-U5] To **fluctuate** is to change regularly.

focus on [V-T-U1] To **focus on** something is to watch it closely or give full attention to it.

function [N-COUNT-U12] A **function** is a mathematical relationship between two or more sets of values.

gas-discharge tube [N-COUNT-U10] A **gas-discharge tube** is an insulated glass or ceramic tube filled with ionized gas that creates electrical signals.

generation [N-UNCOUNT-U3] **Generation** is the amount of an extensive quantity that is created during a particular period of time.

goodness [N-UNCOUNT-U12] **Goodness** is the speed and efficiency of an algorithm when performed by a computer.

gravity [N-UNCOUNT-U7] **Gravity** is a force that attracts bodies with mass towards each other.

hypothesis [N-COUNT-U2] A **hypothesis** is an idea, statement, or prediction that explains something, but which has not been tested or proven correct.

identify [V-T-U11] To **identify** something is to recognize or establish it.

IEC [ABBREV-U4] The **IEC** (International Electrotechnical Commission) is a global organization that establishes standards for electrical and technological units of measurement.

increase [V-I-U5] To **increase** is to grow larger in amount or numbers.

independent variable [N-COUNT-U2] An **independent variable** is the factor in an experiment that is changed.

initial [ADJ-U3] If something is **initial**, it is related to the status of something at the beginning of a process or period of time.

innovative [ADJ-U1] If something is **innovative**, it is new, creative, and advanced.

input [N-UNCOUNT-U3] **Input** is the amount of an existing extensive quantity that is added to a system during a particular period of time.

insulator [N-COUNT-U14] An **insulator** is a material that does not conduct electricity.

integral [ADJ-U9] If an action is **integral**, it is a mathematical function that makes increasing adjustments to a control signal until the error is reduced to zero.

integrated circuit [N-COUNT-U14] An **integrated circuit**, also called a chip, is an electrical circuit consisting of a large number of small devices mounted on one solid piece of semiconductor material.

intensive quantity [N-COUNT-U3] An **intensive quantity** is an amount that does not change based on the size of a system, which can be measured, but cannot be counted.

kibi- [PREFIX-U4] **Kibi-** is a binary prefix equivalent to 1,024 of the units it is attached to.

kilo- [PREFIX-U4] **Kilo-** is an SI prefix equivalent to 1,000 of the units it is attached to.

ladder logic [N-UNCOUNT-U9] **Ladder logic** is a way of expressing relay logic in the form of a diagram.

law [N-COUNT-U7] A **law** is an explanation of a natural process that is always true.

linear control [N-UNCOUNT-U9] **Linear control** is a type of a control system that produces a constant, variable control signal based on one or more inputs.

log in [PHRASAL V-U15] To **log in** to a computer system or website is to gain access to it by proving one's identity.

logic control [N-UNCOUNT-U9] **Logic control** is a type of a control system that can be constructed using relays or microcontrollers and is characterized by binary inputs and outputs.

logical [ADJ-U1] If something is **logical**, it is based on evidence and reason.

machine [N-COUNT-U8] A **machine** is a mechanical or electrical device with several parts that performs a certain task.

magnetism [N-UNCOUNT-U7] **Magnetism** is a force of attraction or repulsion and is caused by moving electrically charged particles.

mastery [N-UNCOUNT-U1] **Mastery** is expert knowledge or skills in a particular subject or area.

mebi- [PREFIX-U4] **Mebi-** is a binary prefix equivalent to 1,048,576 of the units it is attached to.

mega- [PREFIX-U4] **Mega-** is an SI prefix equivalent to 1,000,000 of the units it is attached to.

memory [N-UNCOUNT-U13] **Memory** is temporary or long-term data storage.

momentum [N-UNCOUNT-U7] **Momentum** is a measure of the motion of an object equal to the product of its mass and velocity.

Moore's law [PHRASE-U5] **Moore's law** is an indistinct rule that states that computer power doubles about once every two years.

motion [N-UNCOUNT-U7] **Motion** is the act of moving.

moving part [N-COUNT-U10] A **moving part** is a part of a mechanical device that changes its position.

narrow down [PHRASAL V-U11] To **narrow** something **down** is to eliminate the less feasible or less desirable options.

negative feedback [N-UNCOUNT-U9] **Negative feedback** is a state in which the control system reacts to an input condition in a way that reverses the condition.

Glossary

nonvolatile memory [N-UNCOUNT-U13] **Nonvolatile memory** is long-term data storage that does not require sustained power in order to retain data.

observation [N-COUNT-U2] An **observation** is a fact that is discovered by watching something closely.

obsolescence [N-UNCOUNT-U5] **Obsolescence** is the state of being no longer used because something more effective is available.

on/off control [N-COUNT-U9] An **on/off control** is a type of simple control system that activates or deactivates a device depending on certain criteria.

on/off switch [N-COUNT-U14] An **on/off switch** is a device that either completes or interrupts an electronic circuit.

open system [N-COUNT-U3] An **open system** is a system that allows mass to enter and leave it.

oscillation [N-COUNT-U9] An **oscillation** is a repeated movement or variation in signal.

output [N-UNCOUNT-U3] **Output** is the amount of an extensive quantity that is removed from a system, but not destroyed, during a particular period of time.

password [N-COUNT-U15] A **password** is a unique series of characters used to gain access to protected information.

pattern [N-COUNT-U14] A **pattern** is a repeated design, layout, or sequence of events.

pay close attention [PHRASE-U1] If someone **pays close attention** to something, they carefully watch, listen to or focus on it.

permit [V-T-U15] To **permit** something is to allow it.

PID control [N-UNCOUNT-U9] **PID** (proportional-integral-derivative) **control** is a type of a control system that uses mathematical functions to make proportional controls more precise and efficient.

prefix [N-COUNT-U4] A **prefix** is a word placed at the beginning of a word or number to alter its meaning.

preliminary design [N-COUNT-U11] A **preliminary design** is an initial, conceptual design meant to explore the general idea of a design.

primary memory [N-UNCOUNT-U13] **Primary memory** is volatile memory that is used to hold active programs.

problem [N-COUNT-U2] A **problem** is a question or situation that needs to be answered or resolved.

process [V-T-U8] To **process** data is to organize it or change it from one form into another during a computer operation.

process variable [N-COUNT-U9] A **process variable** (PV) is the condition that is being monitored by the control system.

proportional control [N-UNCOUNT-U9] **Proportional control** is a type of linear control system that directs devices to act in proportion to a constant input.

prototype [N-COUNT-U2] A **prototype** is an original or early version of something, usually for the purposes of analysis and development.

rate [N-COUNT-U6] A **rate** is a measure of the speed or number of times that something happens during a fixed period of time.

resource [N-COUNT-U6] A **resource** is something with a limited supply or availability.

response time [N-COUNT-U6] A **response time** is the amount of time it takes for a computer to respond to an input signal.

result [N-COUNT-U2] A **result** is something that occurs because of something else.

rise [N-COUNT-U5] A **rise** is the process of increasing in quality or amount.

scientific method [N-UNCOUNT-U2] A **scientific method** is a system of observation, measurement, and experimentation used to form and test hypotheses.

secondary memory [N-UNCOUNT-U13] **Secondary memory** is a nonvolatile memory that is used to store inactive programs and data.

security [N-UNCOUNT-U15] **Security** is the protection of people, objects, or information.

semiconductor [N-COUNT-U10] A **semiconductor** is a material that has less electrical conductivity than a conductor, but more conductivity than an insulator.

sequence [N-COUNT-U12] A **sequence** is a set of actions, objects, or numbers arranged in a specific order.

set point [N-COUNT-U9] A **set point** (SP) is the desired value of a PV.

SI unit [N-COUNT-U4] An **SI unit** is a unit of measurement with a prefix based on factors of ten.

silicon [N-UNCOUNT-U14] **Silicon** is a naturally occurring semiconductor used in microelectronics.

SIMM [ABBREV-U13] A **SIMM** (Single Inline Memory Module) is a circuit board that has DRAM chips on only one side and plugs into the memory slot of a motherboard.

sketch [N-COUNT-U11] A **sketch** is a rough drawing that is not usually intended to be a finished product.

solid [ADJ-U10] If an object is **solid**, it has no cavities, breaks, or inconsistencies.

solid-state [ADJ-U10] If an electronic device is **solid-state**, it is constructed entirely from solid parts.

solvable [ADJ-U8] If a problem is **solvable**, finding its solution is possible.

space complexity [N-UNCOUNT-U8] **Space complexity** is the amount of memory or space a computer requires to solve a given problem.

SRAM [ABBREV-U13] **SRAM** (Static Random Access Memory) is memory that can provide random access to any data, and does not need to be refreshed.

SSL connection [N-COUNT-U15] An **SSL** (Secure Sockets Layer) **connection** is an Internet connection protected by a cryptographic protocol.

stabilize [V-I-U5] To **stabilize** is to reach a state in which changes are small and infrequent.

steady [ADJ-U5] If something is **steady**, it doesn't change or changes at a slow and constant rate.

step-by-step [ADJ-U12] If something is **step-by-step**, it follows a specific sequence of actions.

system [N-COUNT-U3] A **system** is a set of connected things that work together to produce a result.

talented [ADJ-U1] If someone is **talented**, he or she does something very well.

tebi- [PREFIX-U4] **Tebi-** is a binary prefix equivalent to 1,099,511,627,776 of the units it is attached to.

tera- [PREFIX-U4] **Tera-** is an SI prefix equivalent to 1,000,000,000,000 of the units it is attached to.

terminal [N-COUNT-U6] A **terminal** is a place where a user enters and receives information from a computer system.

testable [ADJ-U2] If something is **testable**, it can be proven or disproven by performing an experiment.

theory of computation [N-UNCOUNT-U8] The **theory of computation** is a branch of computer science that deals with efficient computation and computer modeling.

thermodynamics [N-UNCOUNT-U7] **Thermodynamics** is a branch of science that deals with the relationships between heat and other forms of energy.

thorough [ADJ-U1] If someone is **thorough**, he or she is careful not to miss any tasks or details.

time complexity [N-UNCOUNT-U8] **Time complexity** is the amount of time a computer requires to solve a given problem.

transistor [N-COUNT-U14] A **transistor** is an electronic semiconductor device used to switch or amplify electrical signals.

trend [N-COUNT-U5] A **trend** is a consistent change or development.

Turing machine [N-UNCOUNT-U8] A **Turing machine** is an abstract machine that has an infinite amount of memory and can perform any computation.

ULSI [ABBREV-U14] **ULSI** (Ultra Large Scale Integration) is the process of creating integrated circuits with over a million transistors per chip.

Glossary

Universal Accounting Equation [N-UNCOUNT-U3] The **Universal Accounting Equation** (UAE) is an equation that is used to measure changes in extensive quantities over particular periods of time.

vacuum [N-COUNT-U10] A **vacuum** is a space without air or other matter.

verify [V-T-U11] To **verify** information is to make sure it is correct or valid.

vibration [N-COUNT-U7] A **vibration** is a repeated movement in a substance or field of energy.

virus [N-COUNT-U15] A **virus** is a damaging computer program that is designed to replicate itself and spread to other machines.

VLSI [ABBREV-U14] **VLSI** (Very Large Scale Integration) is the process of creating integrated circuits with hundreds of thousands of transistors per chip.

volatile memory [N-UNCOUNT-U13] **Volatile memory** is temporary data storage that requires sustained power in order to retain data.

wafer [N-COUNT-U14] A **wafer** is an extremely thin slice of silicon crystal.

wave [N-COUNT-U7] A **wave** is a disturbance that moves through a substance without permanently changing it.

CAREER PATHS

COMPUTER ENGINEERING

Book 3

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Express Publishing

Scope and Sequence

Unit	Topic	Reading context	Vocabulary	Function
1	Computer Languages 1	Textbook chapter	assembler, assembly language, binary digit, C, compiler, human-readable programming language, Java, machine language, programmer, systems software, translate	Expressing confusion
2	Computer Languages 2	Textbook chapter	address, basic block, bit, concept, conditional branch, data, data transfer instruction, instruction, instruction set, register, stored-program, word	Giving a reminder
3	Arithmetic for Computers 1	Textbook chapter	base 2, base 10, leading 0, leading 1, least significant bit, most significant bit, number base, sign bit, signed number, subscript, two's complement, unsigned number	Asking for clarification
4	Arithmetic for Computers 2	Textbook chapter	addition, bit-wise shift, borrow, carry-out, division, exception, ignore, interrupt, multiplication, operand, overflow, recognize, result, subtraction, value	Making a realization
5	Arithmetic for Computers 3	Webpage	accurate, approximation, double precision, exponent, floating point, guard digits, infinite, integer, normalized, round, scientific notation, significand, single precision, sticky bit, ulp, underflow	Confirming information
6	Assessing Performance 1	Report	clock cycle, clock rate, CPI, CPU time, execution time, metric, performance, system CPU time, throughput, user CPU time, wall-clock time	Describing mixed results
7	Assessing Performance 2	Webpage	Amdahl's law, application, arithmetic mean, benchmark, diminishing returns, MIPS, reproducibility, SPEC CPU benchmark, SPEC ratio, weighted arithmetic mean, weighting factor, workload	Checking for understanding
8	Datapaths and Control	Textbook chapter	adder, ALU, arithmetic-logical, branch, control, data selector, datapath, destination, implementation, instruction class, memory-reference, multiplexer, PC, source	Explaining a process
9	Pipelining 1	Journal article	branch hazard, branch prediction, control hazard, concurrently, data hazard, forwarding, hazard, latency, load-use data hazard, pipeline stall, pipelining, stage, structural hazard, untaken branch	Describing possibility
10	Pipelining 2	Textbook chapter	branch delay slot, branch history table, branch prediction buffer, branch target buffer, bubble, correlating predictor, dynamic branch prediction, flush instructions, NOP, tournament branch predictor	Asking for an explanation
11	Memory Hierarchy 1	Message board	access time, block, hit, hit rate, hit time, memory hierarchy, miss penalty, miss rate, principle of locality, reference, spatial locality, temporal locality	Making comparisons
12	Memory Hierarchy 2	Encyclopedia entry	access, cache, cache miss, consistent, direct-mapped cache, fully associative cache, handle, parallel, queue, set-associative cache, split cache, tag, valid bit, write-back, write buffer, write-through	Asking for help
13	Virtual Memory	Textbook chapter	address space, address translation, LRU replacement scheme, page, page fault, page table, protection, physical address, reference bit, segmentation, share, swap space, TLB, virtual address, virtual memory	Explaining terms
14	Disk Storage	Journal article	controller time, cylinder, disk controller, hot swapping, magnetic disk, mirroring, protection group, rotational latency, RAID, seek, seek time, sector, standby spare, striping, track	Disagreeing with an opinion
15	Buses	Online encyclopedia entry	asynchronous, backplane bus, bus, bus transaction, FireWire, handshaking protocol, parallel bus, processor-memory bus, read transaction, SCSI, serial bus, split transaction protocol, synchronous, USB, write transaction	Clarifying information

Table of Contents

1 Computer Languages 1

Get ready!

1 Before you read the passage, talk about these questions.

1 What does a programmer do?

2 How does translation affect computer function?

Chapter 3 27

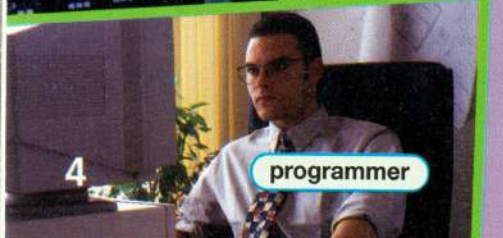
How computers process information

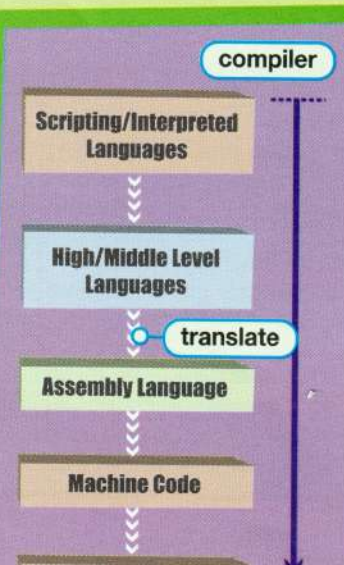
Computers are constantly processing large amounts of information. Operating a computer involves sending and receiving complex sets of instructions. Computers have their own language, called **machine language**. Machine language is made up of **binary digits** that are represented by the numbers 0 and 1. Every possible computer operation is encoded with different combinations of these two numbers.

However, **programmers** usually do not send commands in machine language. They write software in **human-readable programming languages**. This allows programmers to write software quickly and efficiently. These languages, like **C** and **Java**, are more compatible with the way humans think. However, computers still require instructions in machine language.

Systems software facilitates this communication within the computer. A **compiler** is a software component that **translates** human-readable language into an **assembly language**. This language is simpler than a human-readable language. But it still uses letters and words. The computer needs an **assembler** to turn those instructions into the binary translation.

For example the programmer might write the command "A + B." Then, a compiler converts it into an assembly language: "Add A,B." Finally, an assembler translates it into machine language: "1000110010100000." The computer uses these instructions to perform the command.





Reading

2 Read the textbook chapter. Then, choose the correct answers.

1 What is the main idea of the chapter?

A how to write a computer program

B recent changes in computer software

C how computers send and receive information

D a comparison of different programming theories

2 Which language does NOT need translation before a computer reads it?

A assembly language

B machine language

C Java

D human-readable programming language

3 What is true of binary digits?

A They are also called assembly language.

B They are most commonly used by programmers to write instructions.

C They are not complex enough for most computer operations.

D They are used to encode all computer functions.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ assembly language

2 __ Java

3 __ C

4 __ programmer

5 __ machine language

6 __ compiler

7 __ assembler

8 __ translate

A a program that converts complicated operations into simpler letters and words

B a program that changes written instructions into a binary translation

C a set of instructions written in numerical form

D a human-readable programming language that is object-oriented and simple

E to convert something from one form to another

F written instructions that have not been converted to a binary translation

G a person who writes and develops software

H a human-readable programming language that is focused on procedures

4 Write a word or phrase that is similar in meaning to the underlined part.

1 Computers can only understand commands written in <u>a system that uses a combination of zeros and ones</u>.
_ i _ _ r _ d _ g _ _ s

2 In order to write programs quickly and efficiently, we use <u>words that are designed to send instructions to computers</u>.
h _ _ a _ - r _ _ _ a b _ _ p _ o _ _ _ m m _ _ g
_ a n _ u _ g _ s

3 Computers are built with <u>a program that provides basic functions</u> in order to facilitate operation.
s _ _ _ e _ s s _ f _ w _ _ e

5 Listen and read the textbook chapter again. Why is human-readable programming language useful?

Listening

6 Listen to a conversation between a student and an instructor. Mark the following statements as true (T) or false (F).

1 __ The man completed a Java assignment.

2 __ The woman recommends strategies for learning different languages.

3 __ According to the woman, having many languages helps engineers build faster computers.

7 Listen again and complete the conversation.

Student: I'm having a hard time **1** _____ _____ _____ _____ straight. There are so many.

Instructor: There are quite a few. Which ones are you having trouble with?

Student: All of them. I think it's **2** _____ _____ _____ all these languages.

Instructor: I see where you're coming from. It's a lot to learn.

Student: But why are there **3** _____ _____ _____ languages?

Instructor: The first reason is that it makes **4** _____ _____ _____.

Student: **5** _____ _____ _____?

Instructor: The computer only understands **6** _____ _____ _____ _____, or binary digits. It would take programmers a long time to write programs in binary format.

Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

USE LANGUAGE SUCH AS:

I'm having a hard time understanding ...

There are quite a few ...

How does that help?

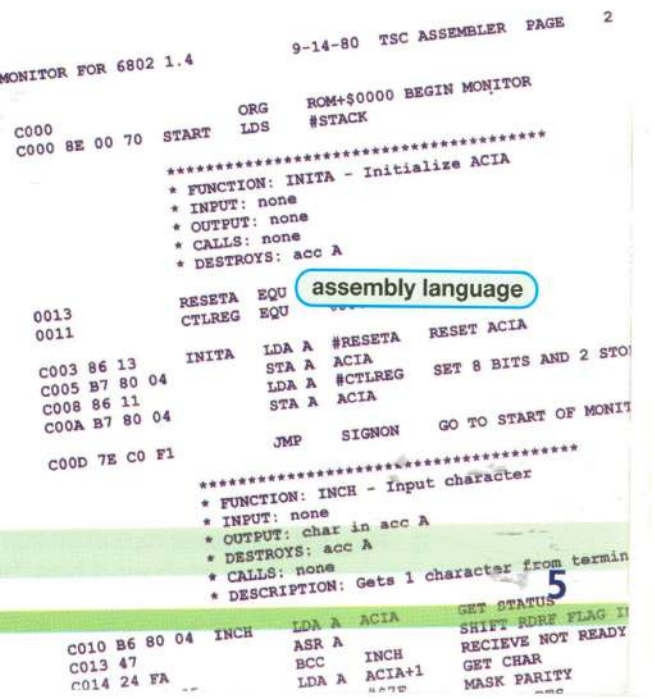
Student A: You are a student. Talk to Student B about:

- the different kinds of programming languages
- why you are confused
- the uses of different languages

Student B: You are an instructor. Talk to Student A about the uses of different programming languages.

Writing

9 Use the textbook chapter and the conversation from Task 8 to write a student's notes on programming languages. Include: at least two different programming languages, their functions, and their benefits.



2 Computer Languages 2

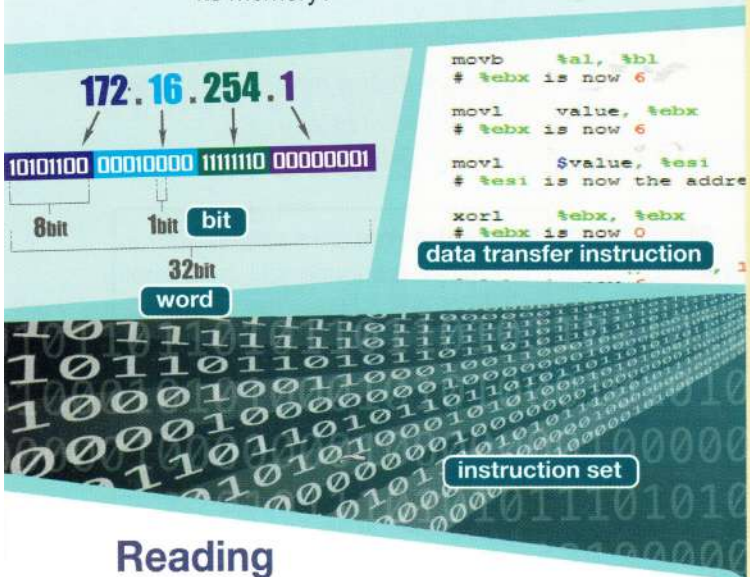
Chapter 4

Get ready!

1 Before you read the passage, talk about these questions.

1 What determines a computer's actions?

2 How does a computer retrieve information from its memory?



How computers Process Information

A computer's function is to follow specific commands, or **instruction sets**. However, processing multiple commands can be time-consuming. The **stored-program concept** allows **instructions** to be efficiently stored in machine language.

Storing instructions in the machine's **register** allows information to be accessed more quickly. Registers are made of **bits**, or binary digits. Since bits are so small, they are typically used in groups. A **word** is the most commonly used grouping of bits. It is often made up of 32 or 64 bits, depending on the system. The speed at which **data** is accessed depends upon the available number of bits.

Information stored in the long-term memory of the computer must also be available. A **data transfer instruction** allows data to transfer from the memory to the registers. Then it becomes easily accessible and can be retrieved more quickly. The data must have a destination, or **address**, that is also sent by the data transfer instruction.

When data is put into the computer, various instructions are executed. A **basic block** is the most fundamental set of instructions. More complex sets include **conditional branches**. Unlike basic blocks, these can only execute after previous instructions are complete.

Reading

2 Read the textbook chapter. Then, choose the correct answers.

1 What is the main idea of the article?

- **A** the history of computer languages
- **B** how a computer stores and transfers data for use
- **C** the benefits of different programming languages
- **D** a comparison of typical instructions that computers must execute

2 What is true about a computer's registers?

- **A** They are a type of long term memory.
- **B** They are the only devices on a computer that store data.
- **C** They are used for temporary storage.
- **D** They are not necessary for computer operation.

3 What can you infer about basic blocks?

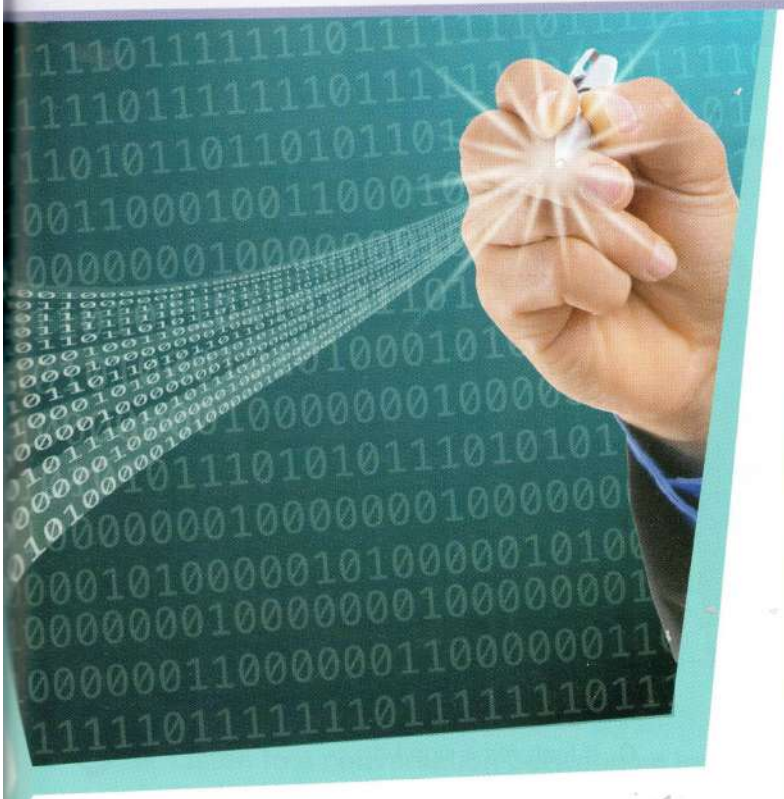
- **A** They do not depend on the completion of previous instructions.
- **B** They are not as important as conditional branches.
- **C** They are rarely used.
- **D** They are the fastest type of instruction.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ stored-program concept
2 __ basic block
3 __ data transfer instruction
4 __ conditional branch
5 __ bit
6 __ register
7 __ word
8 __ instruction

- **A** a series of instructions that does not have branches
- **B** a command that is part of a computer language
- **C** an action that is only completed if other actions are completed first
- **D** the theory that instructions can be stored as numbers in the computer's memory
- **E** a part of the computer's hardware that temporarily stores instructions
- **F** an operation on a computer that moves data from one type of storage to another
- **G** a standard group of units of information
- **H** the smallest unit of information on a computer



4 **Read the sentence pairs. Choose which word or phrase best fits each blank.**

1 **instruction set / word**

A A(n) _____ is a series of commands.

B A(n) _____ can be part of a command.

2 **data / address**

A The information is transferred to a particular _____.

B _____ from the long term memory goes to a register for temporary use.

5 **Listen and read the textbook chapter again. What is the importance of a data transfer instruction?**

Listening

6 **Listen to a conversation between an instructor and a student. Mark the following statements as true (T) or false (F).**

1 __ The speakers discuss the woman's score on an exam.

2 __ According to the woman, instructions help to control the computer's hardware.

3 __ The man identifies stored-program concept incorrectly.

7 **Listen again and complete the conversation.**

Instructor: All right. Tell me what you know about instructions.

Student: Those are the computer's language. **1** _____ _____ _____ to the computer in order to control its hardware.

Instructor: Good. Next question. Why is the **2** _____ - _____ _____ _____?

Student: It's the idea that **3** _____ _____ _____ _____ in the computer's memory.

Instructor: Why is that necessary?

Student: It makes **4** _____ _____ _____, right?

Instructor: Correct. And how does the machine retrieve data **5** _____ _____ _____?

Student: Let's see. That requires a data transfer instruction. Then data moves **6** _____ - _____ _____ to the registers.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Don't forget to ... / I'll remember ...

Please explain ...

Student A: You are an instructor. Talk to Student B about:

- the quiz on computer languages
- the definitions of important terms

Student B: You are a student. Talk to Student A about computer languages.

Writing

9 **Use the textbook chapter and the conversation from Task 8 to write an exam answer about computer languages. Include: the importance of instructions, how data is stored, and how data is transferred.**

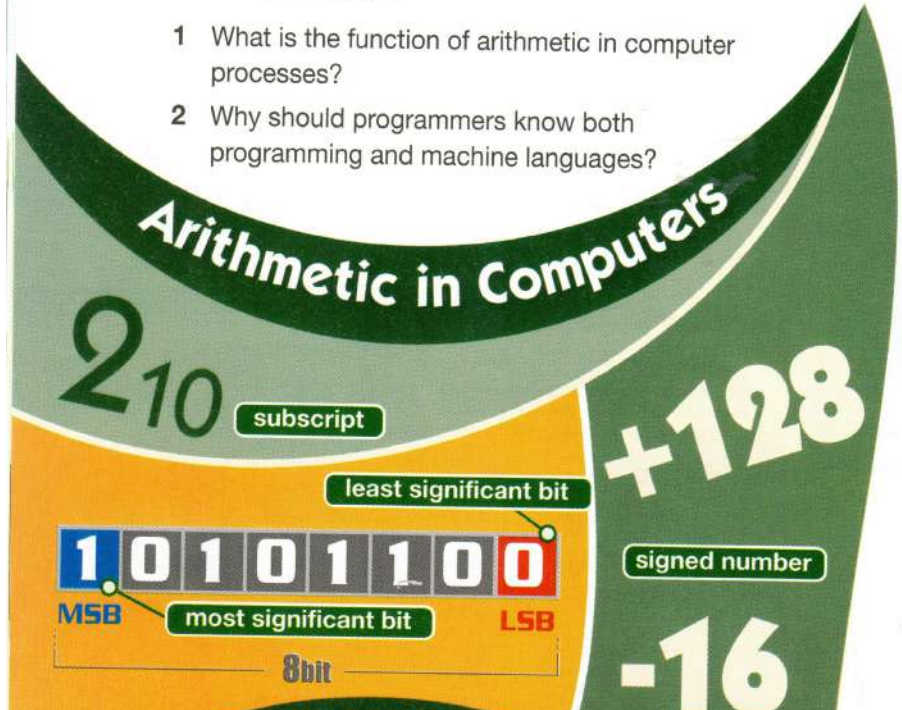
3 Arithmetic for Computers 1

Get ready!

1 Before you read the passage, talk about these questions.

1 What is the function of arithmetic in computer processes?

2 Why should programmers know both programming and machine languages?



Bits determine the fundamental functions of computers. Each word contains a set number of bits, and each combination corresponds to a number. These numbers are represented in one of several **number bases**. Although we typically think in **base 10**, computers function best in **base 2**. Each number set is **subscripted** with a ten or a two to indicate to whether it is decimal or binary.

Computers use arithmetic to signal various functions. Computers must distinguish between positive and negative numbers in order to operate the hardware. A **signed number** refers to a number that has a negative or positive sign. An **unsigned number** does not have a sign, so it must be zero or a positive number. **Two's complement** is a representation of signed binary numbers that uses **leading 0's** and **leading 1's**. If the word has a leading 0, it is positive. If it has a leading 1, it is negative.

The hardware is programmed to test the **sign bit** for positivity or negativity. The sign bit is also the **most significant bit,** which is farthest to the left. The bit with the highest value is the digit to the right of the sign bit. The rightmost bit is the **least significant bit**, or the bit with the lowest value.

base 10

$\{0,1,2,3,4,5,6,7,8,9\}$

$\{0,1\}$ base 2

Reading

2 Read the textbook chapter. Then, choose the correct answers.

1 What is the main idea of the article?

A benefits of different number systems

B the way numbers are represented in programming

C how to translate information between number systems

D practical applications for computer arithmetic

2 Which of the following is NOT true of the two's complement representation?

A It uses binary numbers.

B It can contain a leading 0.

C It features a sign bit.

D It occurs in base 10.

3 What tells a computer whether a number is positive or negative?

A sign bit

B number base

C least significant bit

D subscript

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ two's complement
2 __ sign bit
3 __ base 2
4 __ number base
5 __ base 10
6 __ signed number
7 __ subscript
8 __ unsigned number

A the leading digit that is tested by the hardware to indicate whether a number is positive or negative

B the representation of binary numbers using leading 0 and leading 1

C a number that does not have a negative or a positive sign

D to add a distinguishing number or character to a larger number or character

E the indication of how many numbers are used in a certain system

F a number system, also called the decimal system, that uses the numbers 1 through 10

G a number that is either positive or negative

H a number system, also called the binary system, that uses the numbers 0 and 1

4 **Read the sentence pairs. Choose which phrase best fits each blank.**

1 **leading 0 / leading 1**

A Since this word has a _____, it is negative.

B On the other hand, a _____ indicates that the number is positive.

2 **most significant bit / least significant bit**

A The _____ is also known as the sign bit.

B The bit farthest to the right is the _____.

5 🎧 **Listen and read the textbook chapter again. What is the difference between base 10 and base 2?**

Listening

6 🎧 **Listen to a conversation between an instructor and a student. Mark the following statements as true (T) or false (F).**

1 __ The woman identifies the number bases incorrectly.

2 __ According to the man, positive and negative numbers can be difficult to identify.

3 __ According to the man, two's complement is a better system than signed numbers.

7 🎧 **Listen again and complete the conversation.**

Student: I don't have a good grasp of how **1** _____ _____ _____ _____ can be represented.

Instructor: There are several ways that they can be identified.

Student: I'm just **2** _____ _____ _____ about it.

Instructor: As you know, there are **3** _____ _____ _____ _____ numbers.

Student: Isn't there a problem with using signs to **4** _____ _____?

Instructor: Yes, there is. That's why we use the two's complement representation.

Student: Can you **5** _____ _____ _____ _____?

Instructor: Basically, it is a way of **6** _____ _____ _____ as binary digits. It uses leading 0s and leading 1s to indicate whether it is positive or negative.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

I'm confused about ...

There are several ...

Can you clarify that for me?

Student A: You are a student. Talk to Student B about:

- computer arithmetic
- what you need explained
- how numbers are represented

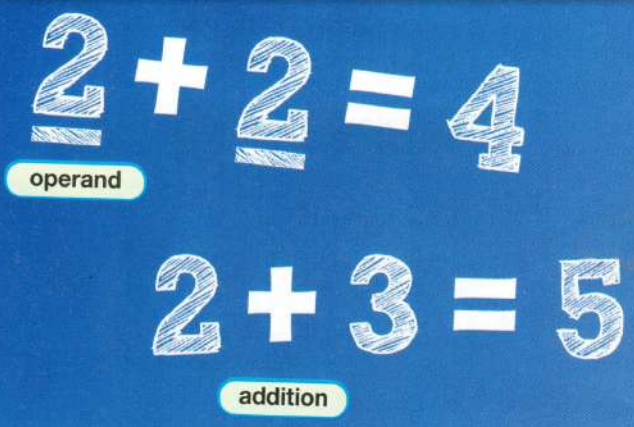
Student B: You are an instructor. Talk to Student A about how numbers are represented.

Writing

9 **Use the textbook chapter and the conversation from Task 8 to write a student's notes on computer arithmetic. Include: at least two different ways of identifying numbers, how they function, and which is more commonly used.**

4 Arithmetic for Computers 2

Arithmetic in Computers: Part II



Computers perform arithmetic that is similar to the operations that we perform by hand. **Addition** is a basic operation. The sum of two **operands** is used to execute a specific instruction. In computing, addition is also used to perform **subtraction**. In common subtraction, sometimes a **value** from the next higher digit must be **borrowed**. This ensures that the **result** is a positive value. However, computer arithmetic simply adds a negative value to a positive value for the same result.

Many calculations require **carry-outs**. This number is taken from the right column to the left in order to complete an operation. **Multiplication** and **division** are related operations that computers perform to complete instructions. A **bit-wise shift** helps computers complete these operations more quickly.

Occasionally, a calculation will produce **overflow**. Overflow occurs when an operation produces more digits than the hardware can handle. Some computer programs **ignore** overflow, while others must **recognize** it. When overflow is detected, an **exception** or **interrupt** occurs. This suspends the current program until the issue is resolved. If programmed correctly, the computer jumps to a predetermined address to handle the exception. It can then resume its normal operations.

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some common mathematical operations?

2 How is math used by computers?

Reading

2 Read the textbook chapter. Then, choose the correct answers.

1 What is the main idea of the article?

A instructions for completing mathematical operations

B a comparison of different mathematical operations

C how computers execute mathematical operations

D sample equations for different mathematical operations

2 Which of the following is NOT a possible result of overflow?

A An exception occurs.

B Hardware is damaged.

C The program ignores it.

D The occurrence is recognized.

3 What is true of bit-wise shifts?

A They help reduce overflow.

B They improve the efficiency of multiplication.

C They are used in subtraction.

D They are operations that add extra bits.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 ___ overflow
2 ___ bit-wise shift
3 ___ exception
4 ___ recognize
5 ___ carry-out
6 ___ value
7 ___ operand
8 ___ borrow

A an event that disrupts the execution of a program.

B a number that is used in a mathematical equation

C a condition that occurs when the result of a calculation is too large for the storage system of the computer

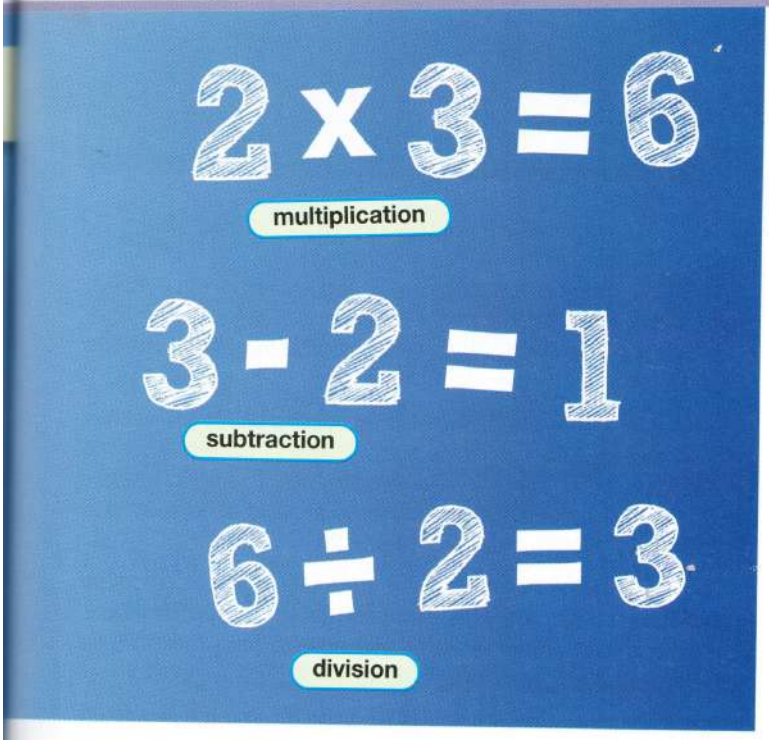
D to notice something

E to take a number, usually 10, from the next higher digit column

F a number, either positive or negative

G a number that is carried from the right column to the left in an equation

H an operation that moves the value of bits left or right



4 **Read the sentence pairs. Choose which word best fits each blank.**

1 **addition / subtraction**

A The process of _____ involves deducting one amount from another.

B The computer uses _____ to combine sums.

2 **multiplication / division**

A "Two times seven equals fourteen" is an example of _____.

B _____ is used to find out how many times two goes into four.

3 **result / interrupt**

A A(n) _____ is a temporary pause in the program.

B We see the _____ when all operations are complete.

5 **Listen and read the textbook chapter again. What does an exception do?**

Listening

6 **Listen to a conversation between two students. Mark the following statements as true (T) or false (F).**

1 ___ The man identifies an error in the math.

2 ___ The program will require minor adjustment.

3 ___ The students find an interrupt in the program.

7 **Listen again and complete the conversation.**

Student 1: Hey, Annie. Did you have a chance to look **1** _____ _____ _____ _____?

Student 2: I was actually **2** _____ _____ _____ _____. I could use some help.

Student 1: Great. I'll give you a hand.

Student 2: In looking it over, I **3** _____ _____ _____.

Student 1: What **4** _____ _____ _____?

Student 2: There must be an error in the math somewhere. The computer isn't able to **5** _____ _____ _____.

Student 1: Well, the math looks good. I don't **6** _____ _____ _____ _____.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Did you have a chance ...?

I noticed ...

I see what happened ...

Student A: You are a student. Talk to Student B about:

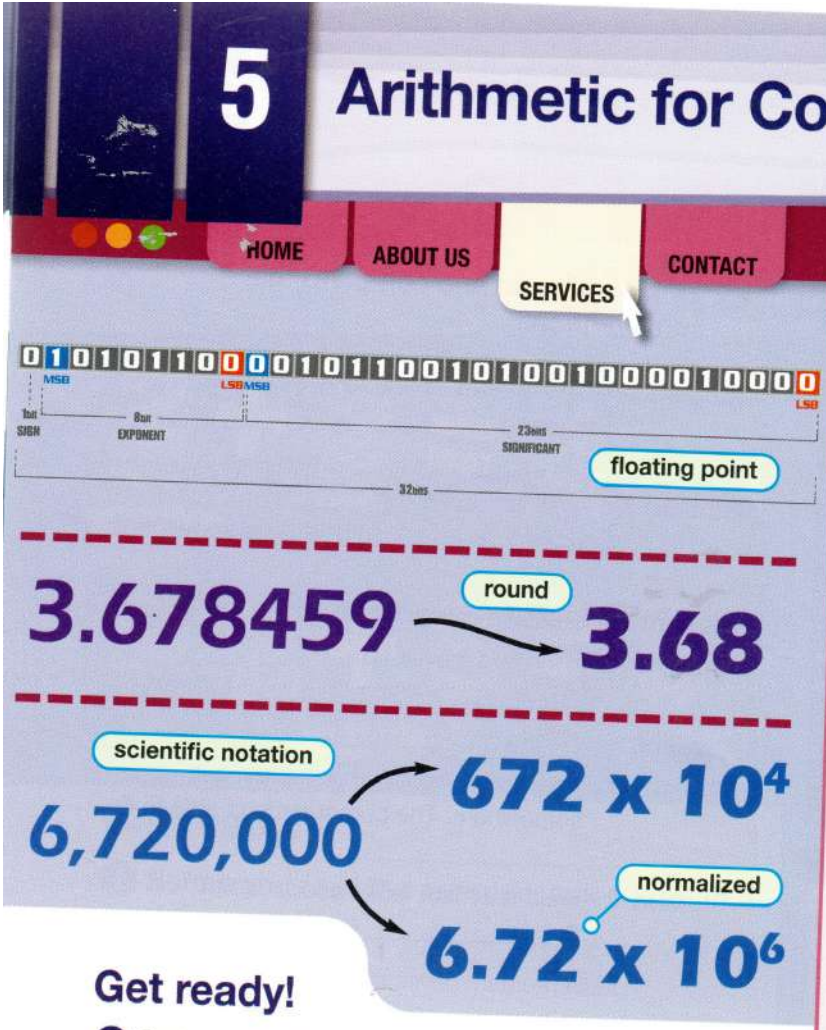
- a new computer program
- problems you noticed
- possible solutions

Student B: You are a student. Talk to Student A about problems with a new program.

Writing

9 **Use the textbook chapter and the conversation from Task 8 to write a student's review of a new computer program. Include: what arithmetic was used, an identification of the problem, and a possible cause of the problem.**

5 Arithmetic for Computers 3



Q: What is **floating point** notation?

A: Floating point notation is closely related to the concept of **scientific notation**. It is a way of expressing very large or very small numbers. With floating point notation, we can express large numbers in 32-bit words.

Like scientific notation, **normalized** floating point notation has a **significant** and an **exponent**. In scientific notation, the standard format is $a \times 10^b$. The significand a can be an **integer** or any real number. Since floating point notation is used with the binary system, the format is $a \times 2^b$.

We use floating point because computers cannot calculate **infinite** numbers. The closest we can get is an **approximation**. There are a number of tools available to help make these approximations **accurate**.

In some cases, the exponent is too large for a **single precision** word. **Double precision** minimizes occurrences of overflow and **underflow**. There are also a number of rounding tools that are commonly used. **Guard digits** allow for greater accuracy during intermediate addition. In some situations, a **sticky bit** is added before the number is finalized. The sticky bit ensures that numbers are **rounded** accurately. In ideal circumstances, the numbers are accurate within one-half **ULP**.

Get ready!

1 Before you read the passage, talk about these questions.

1 Why do computer engineers use floating point arithmetic?
2 What extra bits are used to make approximations more accurate?

Reading

2 Read the webpage. Then, choose the correct answers.

1 Why do engineers use approximations in computer arithmetic?
- **A** Computers are not able to process infinite numbers.
- **B** Single precision words are too small for some exponents.
- **C** Double precision cannot completely eliminate underflow and overflow.
- **D** Numbers must be accurate within one-half ULP.

2 What is the purpose of a sticky bit?
- **A** to avoid underflow and overflow
- **B** to implement more accurate rounding
- **C** to join double precision words
- **D** to round numbers to the nearest integer

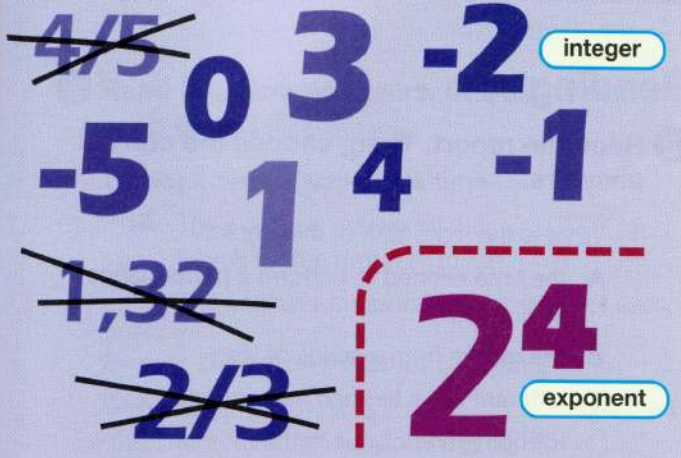
3 Which is NOT mentioned in the passage?
- **A** Scientific notation has a significand and an exponent.
- **B** Some tools increase accuracy in rounding.
- **C** Floating point makes it easy to express large numbers.
- **D** Approximations are usually not accurate.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ ULP
2 __ guard
3 __ integer
4 __ exponent
5 __ underflow
6 __ floating point
7 __ single precision
8 __ double precision

- **A** a natural number, the negative of a natural number, or zero
- **B** a number that indicates to what power another number is raised
- **C** a situation in which a negative exponent is too large for a 32-bit word
- **D** the expression of a value in a 32-bit word
- **E** the expression of a value in two 32-bit words
- **F** a type of computer arithmetic using a moveable binary point
- **G** a measure of the margin of error in rounding
- **H** an extra bit added to the right of the binary point



4 **Fill in the blanks with the correct words or phrases from the word bank.**

word BANK

round infinite sticky bit accurate
scientific notation normalized approximation

1 The numbers we provided were only a rough _____ .

2 A(n) _____ is sometimes added to make rounding more accurate.

3 In _____ numbers, there are no leading zeroes.

4 _____ is a convenient way of writing very large and very small numbers.

5 The engineer decided to _____ up to the nearest dollar on the project budget.

6 The error was caused by a calculation that was not _____ .

7 Computers cannot compute or store _____ values.

5 **Listen and read the webpage again. How can engineers avoid situations in which the exponent is too large for a single precision word?**

Listening

6 **Listen to a conversation between an instructor and a student. Mark the following statements as true (T) or false (F).**

1 __ The woman asks the man to explain scientific notation to the class.

2 __ The man confuses underflow and overflow.

3 __ The man got a high score on the floating point exam.

7 **Listen again and complete the conversation.**

Instructor: Todd, can you tell the class why we use **1** _____ _____ arithmetic?

Student: We use it so large numbers will fit in a 32-bit word.

Instructor: That's right. How about an **2** _____ that's too large for the exponent field? Do you remember what that's called?

Student: It's called **3** _____ .

Instructor: Close, but not quite. It's called **4** _____ .

Student: That's right, I always get those **5** _____ _____ . Underflow is when a negative exponent is too large.

Instructor: Correct. And what can we do to avoid overflow and underflow?

Student: Well, sometimes we can use **6** _____ _____ .

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Can you tell us ...? / That's right.
Close, but not quite ...

Student A: You are an instructor. Talk to Student B about:

- floating point concepts
- what he or she knows about the subject
- what concepts will be on an upcoming exam

Student B: You are a student. Talk to Student A about floating point concepts.

Writing

9 **Use the webpage and the conversation from Task 8 to write an essay on floating point concepts. Include: why computers use floating point arithmetic, how to ensure accurate calculations, and why computers use approximations instead of precise values.**

6 Assessing Performance 1

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some ways to measure computer performance?

2 Why are computer performance tests important?

AJC Computers

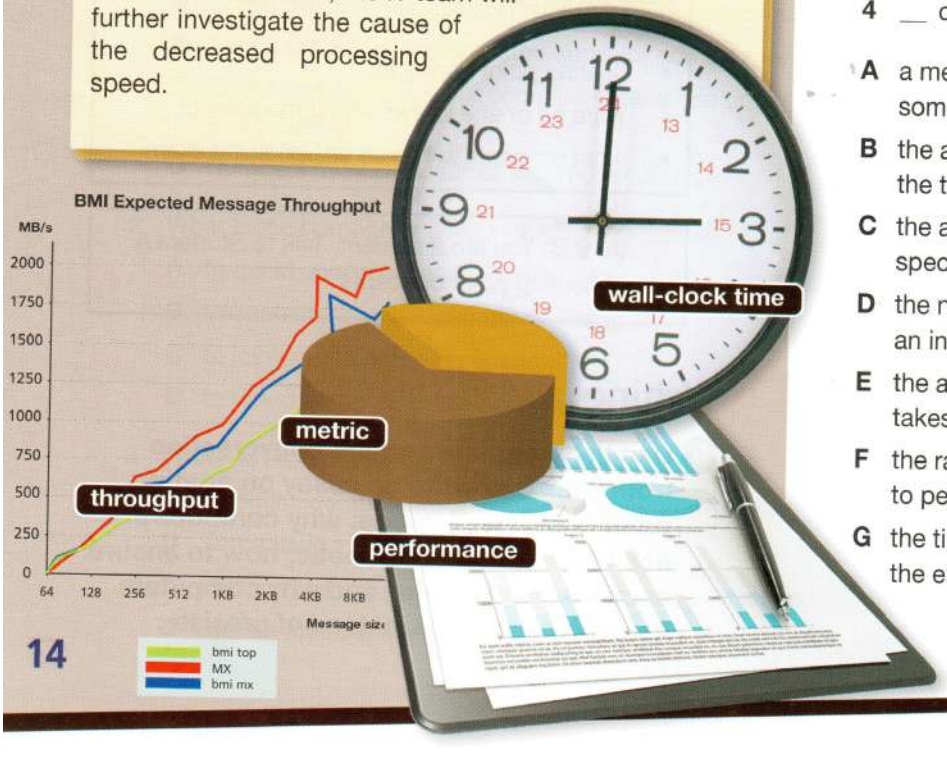
Computer Performance Report

Client: LewsTech industries
Report Date 8/24 **Report Time:** 1:17 pm

On Friday, we ran several routine tests on the central office computer. Since the last evaluation, a few users complained about slow processing speeds. We used a variety of **metrics** to measure system **performance**. This included several types of time measurements. The goal of the tests was to assess the system's **execution time** and **throughput**. Most metrics were normal, but we will need to perform a few more tests.

We first tested the central processing units for each computer. This involved both the **wall-clock time** and the total **CPU time**. Each CPU was functioning at an expected level. We also evaluated the processors' ability to run programs with minimal resources. Both **user CPU time** and **system CPU time** were tested. According to the results, all programs are running smoothly.

We also looked at the processor itself. We examined the speeds of the **clock cycles**. We found that the **clock rate** is slower than normal. Each cycle was measured to determine overall **CPI**, or clock cycles per instruction. Based on our results, the IT team will further investigate the cause of the decreased processing speed.



Reading

2 Read the report. Then, choose the correct answers.

1 What is the main idea of the article?
- **A** the time needed to perform a performance evaluation
- **B** the results from a series of tests
- **C** different ways to improve computer performance
- **D** a comparison of different testing methods

2 Which is NOT true of clock cycles?
- **A** They measure the speed of a processor.
- **B** They have different lengths.
- **C** They are used to determine CPI.
- **D** They increase program efficiency.

3 How will the IT team address the system issues?
- **A** overhaul the system
- **B** uninstall several programs
- **C** install new processors
- **D** investigate the problems further

Vocabulary

3 Match the words or phrases (1-7) with the definitions (A-G).

1 __ performance
2 __ CPI
3 __ execution time
4 __ clock rate
5 __ CPU time
6 __ metric
7 __ throughput

- **A** a measurement of a certain aspect of something's performance
- **B** the amount of work that something can do and the time it takes to accomplish it
- **C** the amount of work a computer can do in a specific amount of time
- **D** the number of clock cycles it takes to complete an instruction
- **E** the amount of time the central processing unit takes to complete a task
- **F** the rate of cycles per second a computer takes to perform
- **G** the time that elapses from the start of a task to the end

4 **Read the sentence pairs. Choose which phrase best fits each blank.**

1 **clock cycle / wall-clock time**

A The engineer measured the _____ it took for the program to run.

B The engineer measured the duration of each _____.

2 **user CPU time / system CPU time**

A _____ runs the background structure that supports a program.

B The performance of the processor, while running programs, is measured by _____.

5 **Listen and read the report again. How is the speed of a processor measured?**

Listening

6 **Listen to a conversation between two engineers. Mark the following statements as true (T) or false (F).**

1 __ The test results showed strong CPI performance.

2 __ The users of the computers complained about slow performance.

3 __ According to the woman, the computer's throughput level was disappointing.

7 **Listen again and complete the conversation.**

Engineer 2: A few people complained that their computers were slow. So I used **1** _____ _____ _____ _____ both the speed and capacity of the processor.

Engineer 1: What metrics did you use?

Engineer 2: I started with the central processing unit. I tested it for **2** _____ _____ _____ _____.

Engineer 1: Good thinking. What did you find?

Engineer 2: Well, there's **3** _____ _____ _____ _____ _____.

Engineer 1: What's the good news?

Engineer 2: The throughput is still fairly high. The computer still processes large amounts of information in a **4** _____ _____ _____ _____.

Engineer 1: Well, that is good. We need the computers to **5** _____ _____ _____.

Engineer 2: However, there were some **6** _____ _____ _____ _____.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Did you get ...?

There is good news ...

However, there is also ...

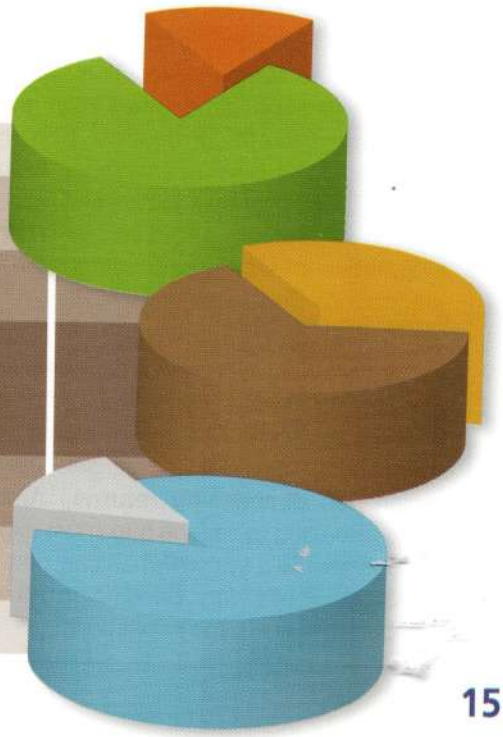
Student A: You are an engineer. Talk to Student B about:

- a test that he or she just ran
- what metrics were used
- the results of the test

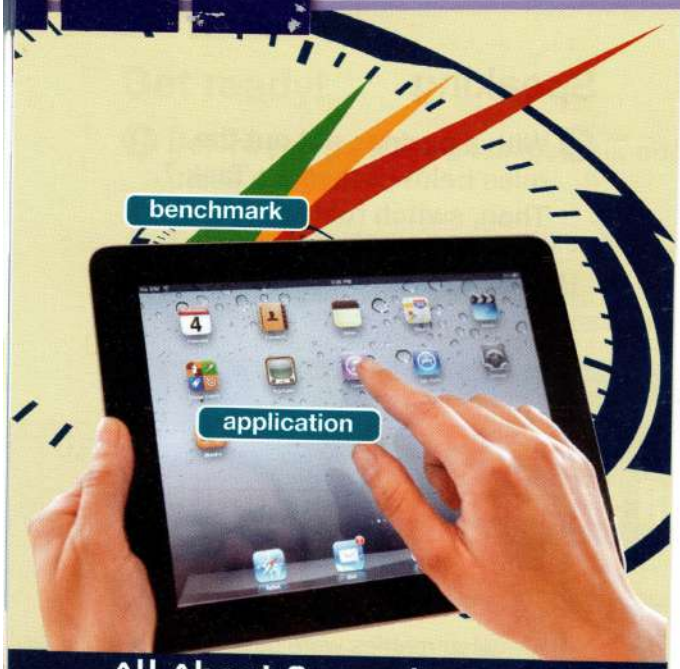
Student B: You are an engineer. Talk to Student A about a computer performance test.

Writing

9 **Use the report and the conversation from Task 8 to write a computer performance report. Include: two metrics that were tested, the results of the test, and further recommendations.**



7 Assessing Performance 2



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All About Computers: Performance Assessments

Manufacturers like to talk about the **workload** their computers can handle. But those claims aren't always reliable. At All About Computers, we assess computer systems and evaluate manufacturers' claims. We use a variety of **benchmarks** to measure computer performance. We use real **applications** that you use every day and measure their performance in **MIPS**. We follow the **reproducibility** rule. We also use **SPEC CPU benchmarks** and the **SPEC ratio**. This is how we test the execution times of the machine's central processing unit. We take steps to ensure the best, most reliable results.

Our Process

Performance assessments require many calculations. The first is **arithmetic mean**. This compares the average execution time to the overall execution time. We also evaluate **weighting factors**. Programs with higher percentages of use have higher weighting factors. The weighting factor and execution times are used to calculate the **weighted arithmetic mean**. That yields the total performance of the workload.

Why We Do It

Some manufacturers claim that a new version of a product is significantly faster. And they'll increase the price. But there's a limit to how much faster a system can get. (See our explanation **diminishing returns**.) **Amdahl's law** is also used to find the maximum expected improvement to a system when only part of it is improved. That's why bringing in All About Computers is worth the investment.

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some ways to evaluate the performance of a computer?
2 How is arithmetic used to evaluate computer performance?

Reading

2 Read the webpage. Then, choose the correct answers.

1 What is the main idea of the webpage?
- **A** which manufacturers' machines have the best performance
- **B** ways to improve a machine's performance
- **C** a company's methods for evaluating a computer's performance
- **D** how consumers can test computer performance at home

2 Which of the following is part of Amdahl's law?
- **A** high percentages of program use
- **B** a measure of the CPU
- **C** decreasing performance over time
- **D** changing one aspect to improve overall performance

3 How does the company assist its customers?
- **A** testing manufacturers' statements
- **B** increasing processing speed
- **C** creating processing benchmarks
- **D** comparing different weighting factors

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ workload
2 __ MIPS
3 __ reproducibility
4 __ weighting factor
5 __ SPEC CPU benchmark
6 __ SPEC ratio
7 __ arithmetic mean
8 __ weighted arithmetic mean

- **A** the ability to duplicate something
- **B** the average of execution times compared with total execution time
- **C** the percentage of usage that a program in a workload has
- **D** a measurement of the execution speed of a program by the millions of instructions
- **E** the sum of the weighting factors and execution times
- **F** the measurement of the execution time of a computer compared to that of another
- **G** a set of real programs that measure the performance of the central processing unit
- **H** the set of programs that a computer runs on a daily basis

4 **Read the sentence pairs. Choose which word or phrase best fits each blank.**

1 **benchmarks / applications**

A _____ are the programs that a computer executes every day.

B One way to evaluate computer performance is to use _____.

2 **Amdahl's law / diminishing returns**

A According to _____, adjusting one element of a computer can help to find the maximum expected improvement to a whole system.

B According to _____, increasing a production element can decrease production in the long run.

5 🎧 **Listen and read the webpage again. What is the function of benchmarks?**

Listening

6 🎧 **Listen to a conversation between an engineer and an intern. Mark the following statements as true (T) or false (F).**

1 ___ The woman made an error when she tested the computer speed.

2 ___ The manufacturer made illegal claims about the new computers.

3 ___ The weighted arithmetic mean shows a small difference in speed.

7 🎧 **Listen again and complete the conversation.**

Engineer: Let's **1** _____ _____ _____ _____. I think you'll be surprised.

Intern: Really? Why is that?

Engineer: Well, this manufacturer **2** _____ _____ _____ _____ were fifteen percent faster, right?

Intern: Right. Is that not true?

Engineer: Not according to our tests. It failed to meet **3** _____ _____ _____.

Intern: So they lied about their product? Isn't that illegal?

Engineer: They didn't lie, exactly. See, the **4** _____ _____ _____ _____. But only under certain conditions.

Intern: I'm not sure I get **5** _____ _____ _____.

Engineer: Let me explain. They **6** _____ _____ _____ with a light workload.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Is that not true?

What do you mean?

I'm not sure ...

Student A: You are an engineer. Talk to Student B about:

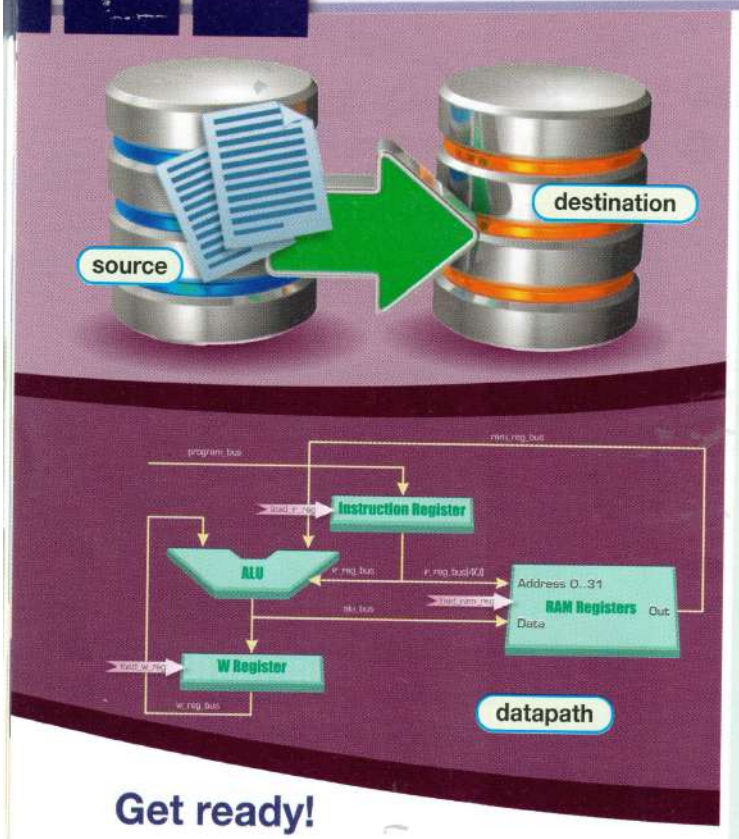
- a performance test
- how results are gathered
- challenges when assessing computer performance

Student B: You are an intern. Talk to Student A about a performance test.

Writing

9 **Use the webpage and the conversation from Task 8 to write an evaluation of a computer's performance. Include: types of measurements that were used.**

8 Datapaths and Control



Get ready!

1 Before you read the passage, talk about these questions.

1 What devices are used in datapaths?
2 What are the three instruction classes?

Reading

2 Read the textbook chapter. Then, choose the correct answers.

1 What is the chapter mostly about?
- **A** the physical construction of a standard datapath
- **B** the components and implementation of datapaths
- **C** new advances in the hardware used in datapaths
- **D** troubleshooting common datapath errors

2 Which is NOT a component of the datapath?
- **A** ALU
- **B** multiplexer
- **C** memory
- **D** PC

3 Which device stores the address of the next instruction?
- **A** program counter
- **B** instruction register
- **C** data selector
- **D** control unit

Computer Design

Datapaths

The term ***datapath*** refers to a series of devices that perform calculations. A **control** distributes program instructions to the datapath, memory, and I/O devices. We discussed control units previously in Chapters 1 and 3. Standard datapaths consist of a **PC** (program counter) and various small registers. Arithmetic logic units (**ALUs**) and simple **adders** perform basic arithmetic tasks. In some cases, there are multiple adders and ALUs performing calculations simultaneously. However, it is impractical to wire every possible I/O connection. Many datapaths solve this problem with a **multiplexer**, or **data selector**. Multiplexers transfer data from the correct input **source** to its **destination**.

The address of the current instruction is stored in an instruction register. Be careful not to confuse the instruction register with the PC. The PC stores the address of the next planned instruction, like a bookmark.

In order to understand **implementation**, we must understand the three **instruction classes**:

- **memory-reference** instructions read from memory or write data to memory
- **arithmetic-logical** instructions perform calculations
- **branch** instructions provide the PC with a new instruction address

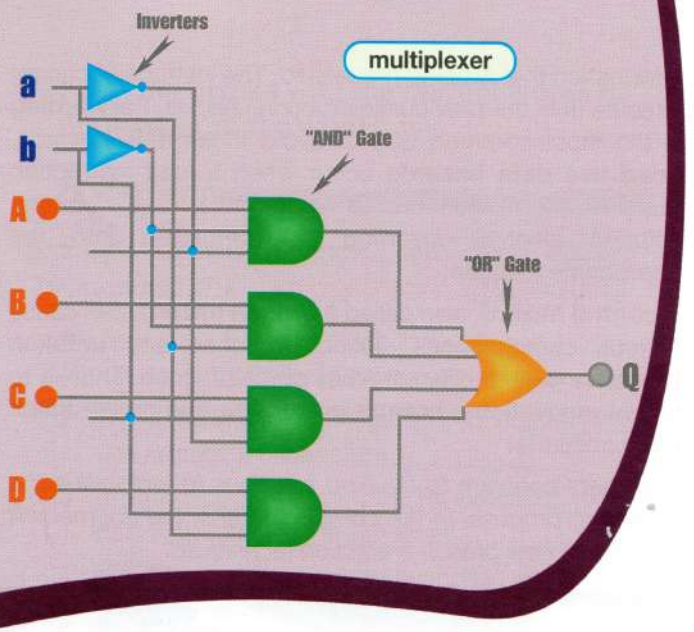
Note that all three instruction classes make use of ALUs! Don't let the term 'arithmetic-logical' fool you.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ PC
2 __ ALU
3 __ adder
4 __ branch
5 __ datapath
6 __ multiplexer
7 __ implementation
8 __ arithmetic-logical

- **A** an instruction that tells the datapath to perform mathematical operations
- **B** a device that chooses from several inputs and sends to a single output
- **C** a circuit that carries out arithmetic and logical operations
- **D** a register that stores the address of the next instruction
- **E** the process of carrying out a task in a certain way
- **F** a series of units that perform data processing tasks
- **G** an instruction that changes the instruction address in the PC
- **H** a circuit that performs addition operations



4 **Read the sentence pairs. Choose which word or phrase best fits each blank.**

1 **control / instruction class**

A The _____ gives instructions to the datapath.

B _____ is a category for types of instructions.

2 **memory-reference / data selector**

A A _____ chooses the right input and sends it to its destination.

B A _____ instruction reads or writes information.

3 **source / destination**

A The _____ is where information comes from.

B The _____ is where the information is going.

5 **Listen and read the textbook chapter again. Why do datapaths use a multiplexer?**

Listening

6 **Listen to a conversation between a student and an instructor. Mark the following statements as true (T) or false (F).**

1 __ The woman is confused about the purpose of the control.

2 __ The woman correctly identifies the first step in datapath instructions.

3 __ The man recommends that the woman read the chapter on ALUs again.

7 **Listen again and complete the conversation.**

Student: Well, I know that the **1** _____ gives the instructions. But I don't really understand the data flow.

Instructor: Like you said, the control gives instructions to the **2** _____. Do you know what the first step is?

Student: No, I don't.

Instructor: **3** _____ _____ _____.

Student: Is it having the **4** _____ fetch the next instruction?

Instructor: That's right. See, you understand better than you think you do. From there, we usually have to follow a **5** _____-_____ instruction.

Student: Okay. Then what?

Instructor: Well, all **6** _____ _____ use the ALU. So that's where the data goes next.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

The first step is that ...

From there ...

I thought ...

Student A: You are a student. Talk to Student B about:

- datapath implementation
- units involved in data processing
- concepts you are confused about

Student B: You are an instructor. Talk to Student A about datapath implementation.

Writing

9 **Use the textbook chapter and the conversation from Task 8 to write a teacher evaluation. Include: how an instructor helped you understand datapaths, what you were confused about, and what you learned.**

9 Pipelining 1

Pipeline Hazards

Article from the Journal of Computer Programming and Engineering

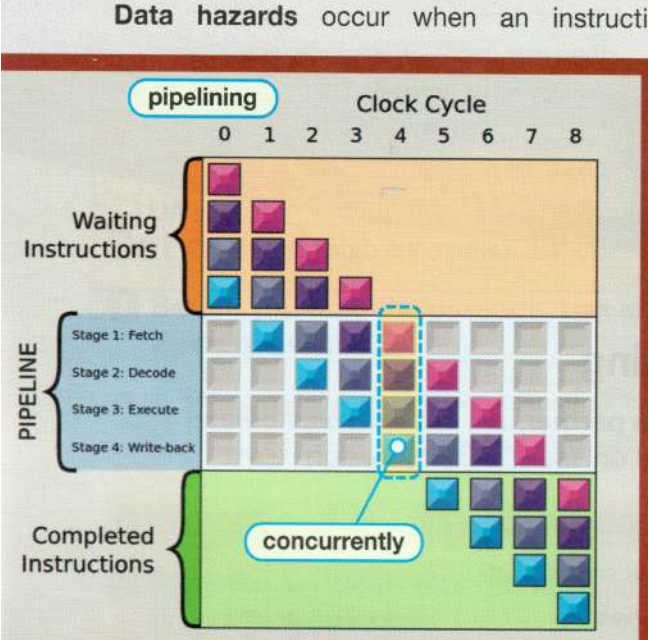
Pipelining is a standard technique for improving throughput. It works by **concurrently** operating all **stages** of an instruction set. Though it does not decrease **latency**, it dramatically reduces throughput time. However, concurrent operations create a number of potential **hazards** in the pipeline:

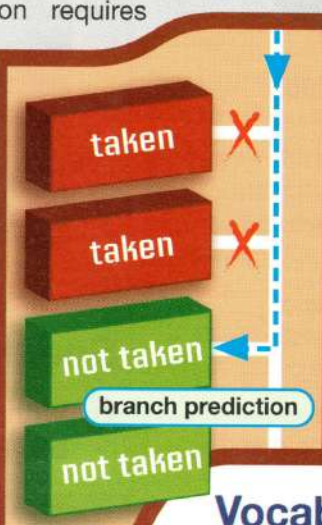
Structural hazards occur when the hardware is insufficient to accommodate all instructions. Unfortunately, it is impossible to predict what machines private users will own. **Pipeline stalls** can reduce the risk of structural hazards.

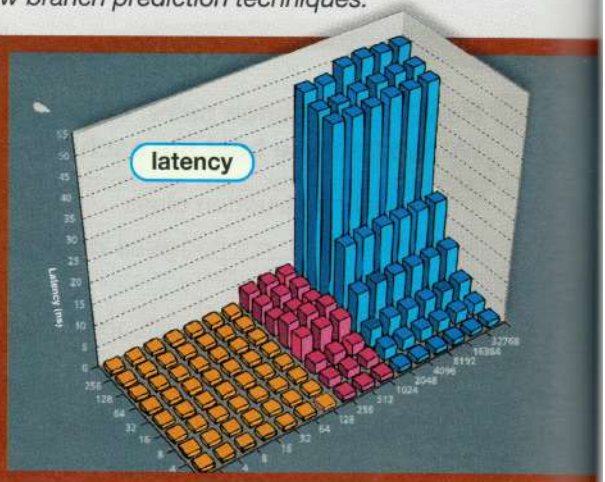
Data hazards occur when an instruction requires information that is being processed. The instruction cannot execute until the previous instruction finishes. **Forwarding** is the most common way to avoid these data hazards. **Load-use data hazards** occur when a load instruction requires information that is unavailable. One common solution involves inserting pipeline stalls into the appropriate location.

A **control hazard**, also called a **branch hazard**, can cause serious complications. Taken branches and **untaken branches** lead to different areas of the program. Thanks to recent innovations, **branch prediction** has grown much more accurate.

Engineers continue to develop solutions to streamline the pipelining process. In the coming months, the Journal will investigate new branch prediction techniques.







Get ready!

1 Before you read the passage, talk about these questions.

1 What is the purpose of pipelining?
2 What types of hazards occur in pipelining?

Reading

2 Read the journal article. Then, mark the following statements as true (T) or false (F).

1 __ Pipelining dramatically reduces latency.
2 __ According to the article, forwarding is the most common way to avoid load-use data hazards.
3 __ Branch prediction helps prevent control hazards.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 __ stage
2 __ latency
3 __ pipelining
4 __ concurrently
5 __ data hazard
6 __ control hazard
7 __ branch prediction
8 __ load-use data hazard

A a specific task or action in an overall process
B a situation in which the data needed for an instruction is not available
C the time required to execute an individual instruction
D at the same time
E a situation in which the information needed for a branch is not available
F the act of guessing whether a branch will be taken
G a technique for implementing multiple instructions simultaneously
H a situation in which the data for a load instruction is not available

4 **Fill in the blanks with the correct words or phrases from the word bank.**

WORD BANK

hazard untaken branch structural hazard
branch hazard pipeline stall forwarding

1 A(n) _____ occurred when there were not enough adders to carry out instructions.
2 When the information needed for a branch is unavailable, it causes a(n) _____.
3 In a(n) _____, the PC proceeds to the next instruction in the sequence.
4 A(n) _____ is a situation in which the planned instruction cannot be executed.
5 In order to avoid data hazards, most systems use _____.
6 The engineers encountered a structural hazard, so they implemented a(n) _____.

5 **Listen and read the journal article again. When do computer programmers implement pipeline stalls?**

Listening

6 **Listen to a conversation between two computer engineers. Choose the correct answers.**

1 What is the conversation mostly about?
A a hazard in a data pipeline
B a sudden increase in latency
C a new pipelining approach
D an error in forwarding

2 What will the man likely do next?
A draw a diagram of a new pipeline
B research control hazard solutions
C implement an additional pipeline stall
D use more effective branch prediction

7 **Listen again and complete the conversation.**

Engineer 1: Hey, April. It looks like we've got some kind of **1** _____ here.
Engineer 2: That's not good. Where did you find the problem?
Engineer 1: It's the program we worked on yesterday. We just implemented the **2** _____ and it's not working correctly.
Engineer 2: Well, that's not uncommon. Which **3** _____ failed to execute?
Engineer 1: The first problem is with this load instruction. It looks like a **4** _____-_____ _____ _____.
Engineer 2: Did you add a **5** _____ _____?
Engineer 1: Yeah, but it didn't seem to change anything. That's why I'm confused.
Engineer 2: Hmm. May I **6** _____ _____ _____ _____?

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

It looks like ...
It might have been ...
That makes sense.

Student A: You are an engineer. Talk to Student B about:

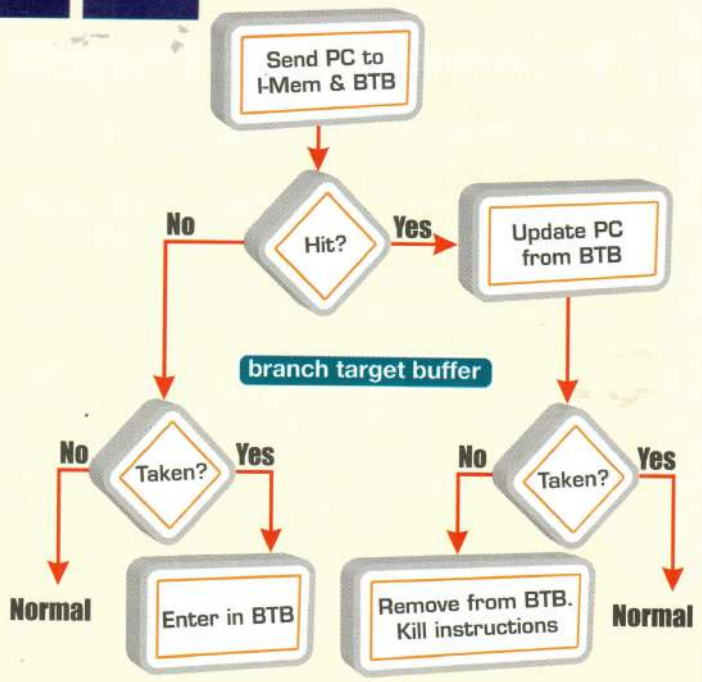
- a hazard in a pipeline
- what type of hazard occurred
- how to resolve the problem

Student B: You are an engineer. Talk to Student A about a pipeline hazard.

Writing

9 **Use the journal article and the conversation from Task 8 to write an error resolution report. Include: a type of hazard that occurred, what steps were taken to correct it, and whether or not the issue was resolved.**

10 Pipelining 2



Pipelines (CONTINUED)

As indicated in previous chapters, the challenge of pipelining is avoiding hazards. In addition to **bubbles**, we can also use **NOPs**. In essence, a NOP (No Operation) is an instruction that does nothing. In this respect, it functions very much like a pipeline stall. However, constantly bubbling the pipeline does not ensure smooth execution of instructions. In the case of branch instructions, we need to use branch prediction.

Branch prediction allows us to guess whether a branch will be taken. When the prediction is wrong, we simply **flush instructions** and start over. But flushing instructions takes up valuable time. Fortunately, there are a number of advanced branch prediction methods.

Dynamic branch prediction involves looking up whether a branch was recently taken. This information is stored in a **branch history table**, or **branch prediction buffer**. A **correlating predictor** operates similarly, but also looks up global branch data. **Tournament branch predictors** are the most useful because they provide more options.

But even an advanced predictor will never be totally accurate. Keeping a NOP in the **branch delay slot** can help eliminate penalties. Another approach is to store the branch destination in a **branch target buffer**. This reduces the time needed to retrieve branch information.

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some types of branch prediction?
2 What is the purpose of a NOP?

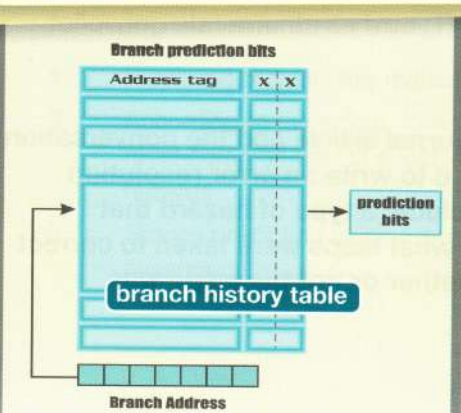
Reading

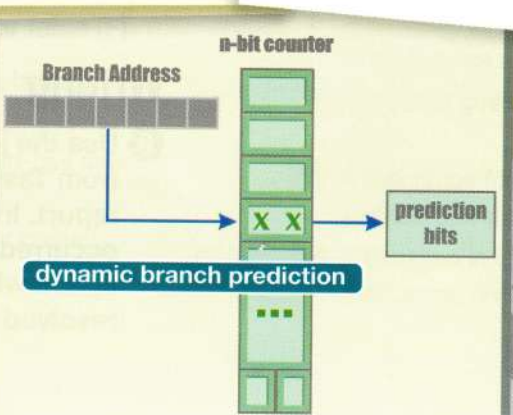
2 Read the textbook chapter. Then, choose the correct answers.

1 What is the chapter mostly about?
- A problems with early methods of branch prediction
- B ways to avoid flushing instructions from the pipeline
- C how branch prediction makes pipelining more efficient
- D the differences between NOPs and pipeline stalls

2 What is the function of a branch history table?
- A It looks up global data about recently taken branches.
- B It stores data about whether a branch was recently taken.
- C It records the destination of the next branch.
- D It calculates the accuracy of branch prediction.

3 Which idea is NOT mentioned in the passage?
- A Instructions are flushed from the pipeline when a prediction is wrong.
- B Tournament branch predictors are more versatile than other predictors.
- C Correlating predictors use local and global data about taken branches.
- D NOP instructions are executed in inactive stages of the pipeline.





Vocabulary

3 Match the words or phrases (1-7) with the definitions (A-G).

1 __ NOP
2 __ flush instructions
3 __ correlating predictor
4 __ branch target buffer
5 __ branch delay slot
6 __ branch history table
7 __ tournament branch predictor

A a cache that stores the next instruction for a taken branch
B a branch predictor that uses local and global data
C a space containing the first instruction that will be executed after a branch
D a small memory that records whether a branch was recently taken
E an instruction that does nothing
F a branch predictor that has multiple prediction types to choose from
G to discard all current instructions

4 Read the sentence and choose the correct words or phrases.

1 The **branch prediction buffer / correlating predictor** contains information about whether a branch was recently taken.
2 Some hazards can be resolved by inserting a **bubble / branch delay slot** into the pipeline.
3 **Branch target buffer / Dynamic branch prediction** uses information about recently taken branches.

5 Listen and read the textbook chapter again. Why is a branch target buffer useful?

Listening

6 Listen to a conversation between an instructor and a student. Mark the following statements as true (T) or false (F).

1 __ The man used too many bubbles.
2 __ The woman suggests using dynamic branch prediction.
3 __ The woman advises the man to flush instructions.

7 Listen again and complete the conversation.

Instructor: I can see that you have **1** _____ inserted in all the right places. But you need to use better branch prediction.
Student: Okay. How do I do that? Should I use **2** _____ _____ _____?
Instructor: In this case, that's the best option. It'll look up information from the **3** _____ _____ _____.
Student: All right.
Instructor: But don't forget, you'll still have to **4** _____ _____ when the branch prediction is wrong.
Student: **5** _____ _____ _____ _____ by that?
Instructor: Well, the program might execute instructions based on a wrong prediction. So you have to **6** _____ _____ _____ those instructions.
Student: Oh, I see.

Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

USE LANGUAGE SUCH AS:

How do I do that?
Don't forget to ... / What do you mean ...?

Student A: You are an instructor. Talk to Student B about:

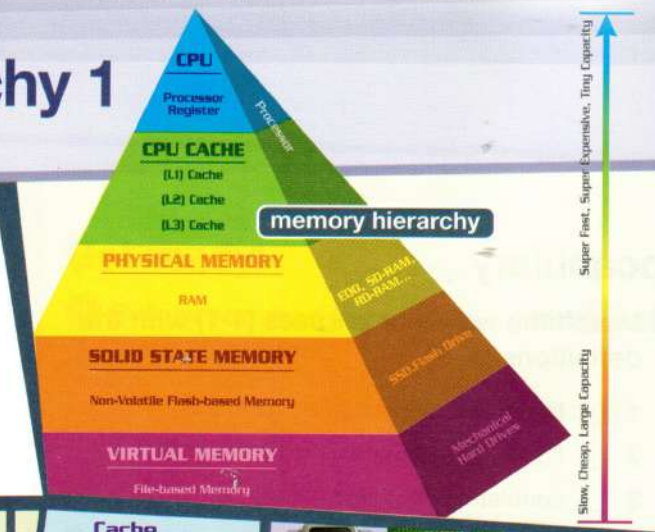
- a pipelining assignment
- what problems he or she encountered
- your advice for resolving the problem

Student B: You are a student. Talk to Student A about a pipelining assignment.

Writing

9 Use the textbook chapter and the conversation from Task 8 to write a student assessment. Include: a review of the student's pipelining assignment, problems he or she had with a pipeline, and how he or she resolved the problems.

11 Memory Hierarchy 1



Get ready!

1 Before you read the passage, talk about these questions.

1 What is a memory hierarchy?
2 What are the principles of temporal and spatial locality?

CompDIY The do-it-yourself computer forum

Topic: Memory Hierarchy

Post

JackieN I'm currently building my first computer. Some of my friends told me to create a **memory hierarchy**. What is memory hierarchy, and how does it work?

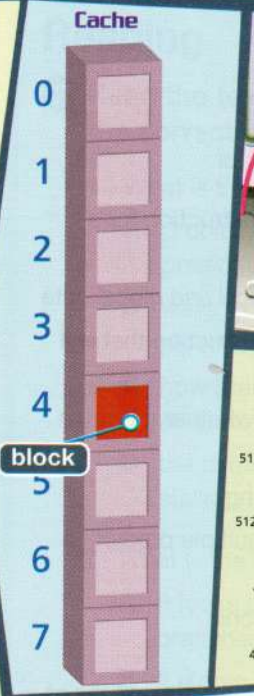
Total Replies: 2

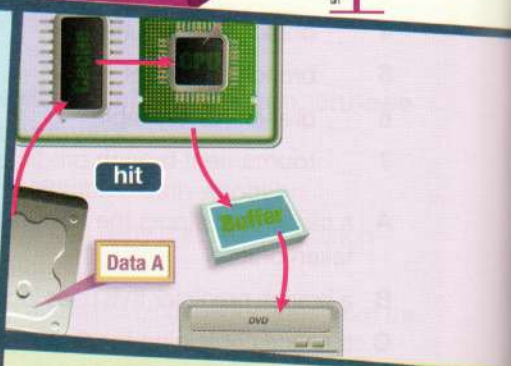
Craig32 A memory hierarchy is a way of arranging memory into multiple levels. The top level is SRAM, followed by layers of DRAM. The bottom level is your magnetic disk.

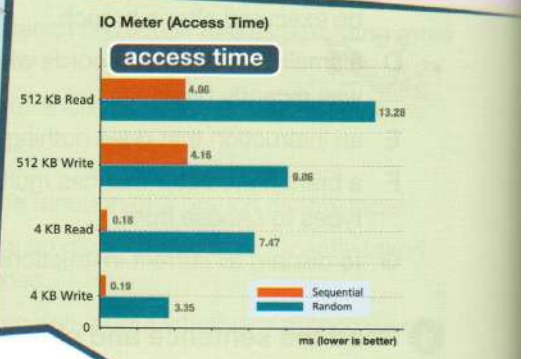
At any one time, we only use a small percentage of the memory. (This is the **principle of locality**.) So we put the data we're most likely to need in the cache. Programs will fill the cache based on **temporal locality** and **spatial locality**. That way, we can **reference** the data we need quickly. Without the memory hierarchy, the **access time** would be a lot longer.

Hope that answers your question. :)

TRalston1991 You should also look up memory accesses. A memory access is classified as either a **hit** or a miss. A miss occurs when the **block** you need isn't in the cache. You want your **hit rate** to be as high as possible. Make sure the **miss rate** isn't higher than the hit rate. **Miss penalties** can slow down your processor by a lot. You also want to keep your **hit time** down. Good luck!







Reading

2 Read the message board. Then, mark the following statements as true (T) or false (F).

1 ___ The original post explains how a memory hierarchy works.
2 ___ According to the message board, computer users want high hit rates.
3 ___ The second reply corrects an error in the first reply.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 ___ hit
2 ___ block
3 ___ hit rate
4 ___ miss rate
5 ___ reference
6 ___ miss penalty
7 ___ memory hierarchy
8 ___ principle of locality

A a situation in which the requested data is present in the cache
B a concept that states that only a small amount of memory is used at one time
C the smallest unit of data that can exist in a level of memory
D the extra time required to retrieve data from lower levels of memory
E a system for organizing memory into multiple tiers
F the percentage of memory accesses found in the cache
G to open or recall something from its data location
H the percentage of memory accesses not found in the cache

4 **Read the sentence pairs. Choose which phrase best fits each blank.**

1 **access time / hit time**

A The _____ is the time needed to determine if a block is in the cache.

B The _____ is the time required to retrieve data from memory.

2 **temporal locality / spatial locality**

A We place recently used addresses in the cache based on _____.

B Sequential addresses are in the cache based on _____.

5 **Listen and read the message board again. According to the first reply, why is a memory hierarchy important?**

Listening

6 **Listen to a conversation between two engineers. Choose the correct answers.**

1 What is the conversation mostly about?

A the differences between types of localities

B a problem with the function of a program's memory

C an upcoming presentation about reducing access time

D recent improvements in hit and miss rates

2 What will the man likely do next?

A adjust the program to use more spatial locality

B install an extra cache in the memory hierarchy

C send a report to a colleague about the hit rate

D calculate the program's average hit time

7 **Listen again and complete the conversation.**

Eng. 1: I had a feeling that might be the case. Did the **1** _____ _____ go up, at least?

Eng. 2: Nope. The hit rate is **2** _____ _____ than it was before. The miss penalties are really slowing things down.

Eng. 1: Well, it sounds like we've got a problem there. Are we using **3** _____ _____ to fill the cache?

Eng. 2: Yeah, but in this case it doesn't seem to be a good choice.

Eng. 1: Well, let's improve the **4** _____ _____. Is that what you were thinking?

Eng. 2: Yes, that's exactly what I was thinking.

Eng. 1: With luck, that'll bring the **5** _____ _____ down. Aside from that, how do things look?

Eng. 2: It's hard to say at this point. The **6** _____ _____ is reasonable, though.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

How's the program ...?
It's even higher/lower than ...
It sounds like ...

Student A: You are an engineer. Talk to Student B about:

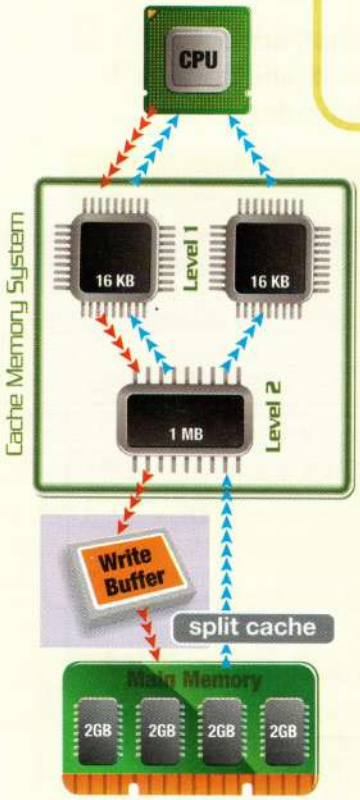
- a program that he or she is currently working on
- problems with the memory that he or she encountered
- how to solve the problem

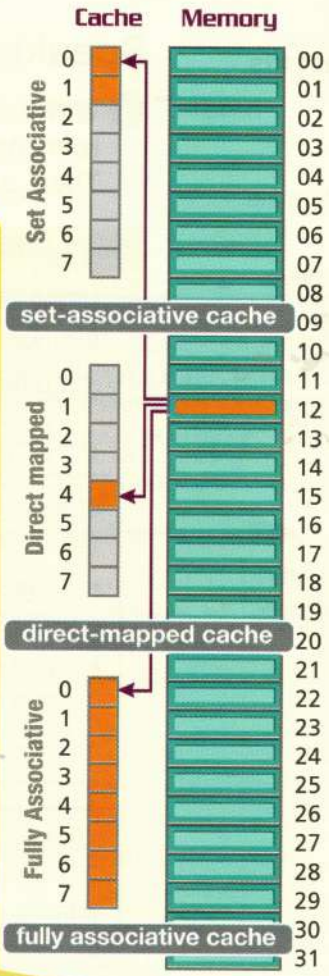
Student B: You are an engineer. Talk to Student A about a problem with the program's memory.

Writing

9 **Use the message board and the conversation from Task 8 to write a post on a computer engineering forum. Include: a problem an engineer encountered, what measures were already taken, and what the results were.**

12 Memory Hierarchy 2





Cache (computing)

A **cache** is a small, fast memory unit that stores instructions and active program data. The cache allows the CPU to **access** relevant information quickly and efficiently. There are several different cache setup schemes, each useful in different scenarios.

A **direct-mapped cache** assigns each memory location to a specific cache location. In a **fully associative cache**, any block may be placed in any location. A **set-associative cache** is the middle ground between the two extremes. A set-associative cache assigns a set number of potential block locations. Blocks of data are identified by **tags**, and verified by a **valid bit**. The valid bit indicates whether or not the tag is current.

A **split cache** is a memory setup that utilizes two **parallel** caches. One cache only **handles** instructions, while the other handles data. While split caches increase cache bandwidth, they increase the rate of **cache misses**.

Memory hierarchies have various ways to keep data **consistent** between the cache and the main memory. One method is **write-through**, in which both are updated simultaneously. Write-through is effective, but slow. Some systems utilize a **write buffer** (a small **queue**) to streamline the process. Another solution is **write-back**. A write-back scheme updates the memory only after the cache entry is replaced with new information.

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some different types of caches?

2 How can programmers ensure that the cache and the memory are consistent?

Reading

2 Read the encyclopedia entry. Then, mark the following statements as true (T) or false (F).

1 ___ A tag identifies the valid bit as current or not current.

2 ___ Cache misses are increased when a programmer uses a split cache setup.

3 ___ In a write-back, the cache and memory are updated at the same time.

Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

1 ___ tag
2 ___ cache miss
3 ___ split cache
4 ___ write-back
5 ___ write-through
6 ___ direct-mapped cache
7 ___ set-associative cache
8 ___ fully associative cache

A a cache that assigns each block to a specific cache location
B a memory setup that uses two parallel caches
C a marker that identifies the contents of a block
D a cache in which any block can be placed in any location
E a process for updating the cache and the memory simultaneously
F a situation when the requested block is not in the cache
G a cache in which a block can be placed in a fixed number of locations
H a process for updating memory only when the cache block is replaced

4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 **queue / cache**

A A _____ is the small, fast memory closest to the CPU.

B A _____ is a series of blocks waiting to be processed.

2 **valid bit / write buffer**

A The _____ helps to prevent processor stalls.

B The _____ identifies a cache entry as current.

3 **handle / access**

A The control will _____ information from the memory.

B The processor couldn't _____ the request.

4 **consistent / parallel**

A The memory and the cache should be _____ with one another.

B A split cache uses two _____ caches.

5 Listen and read the encyclopedia entry again. What does the valid bit do?

Listening

6 Listen to a conversation between two computer engineers. Choose the correct answers.

1 What is the conversation mostly about?

A the implementation of a direct-mapped cache

B the challenges of working with a split cache

C a new development in the use of write buffers

D a problem with cache-memory consistency

2 What will the woman likely do next?

A reset the valid bits for the program

B install a fully-associative cache

C implement a write buffer with the program

D switch the program to a write-through scheme

7 Listen again and complete the conversation.

Engineer 1: Ray, I was hoping you could **1** _____ _____ _____ _____.
I know you have a lot more experience with this than I do.

Engineer 2: Sure, Nell. Are you still having problems with that **2** _____?

Engineer 1: Yeah, I'm getting a lot of cache misses. And sometimes the processor can't **3** _____ _____ _____ at all.

Engineer 2: Let's have a look. Is this a **4** _____ _____ _____?

Engineer 1: No, it's a **5** _____ - _____ _____.

Engineer 2: Ah, I see. Okay, it looks like the cache and the memory aren't **6** _____.

Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

USE LANGUAGE SUCH AS:

I was hoping you could give me a hand.

It looks like ...

Should I ...?

Student A: You are an engineer. Talk to Student B about:

- a problem with cache function
- the cause of the problem
- his or her recommended solution

Student B: You are an engineer. Talk to Student A about a problem with cache function.

Writing

9 Use the encyclopedia entry and the conversation from Task 8 to write an email to a senior engineer. Include: the original problem, the measures taken to solve it, and the resolution to the problem.

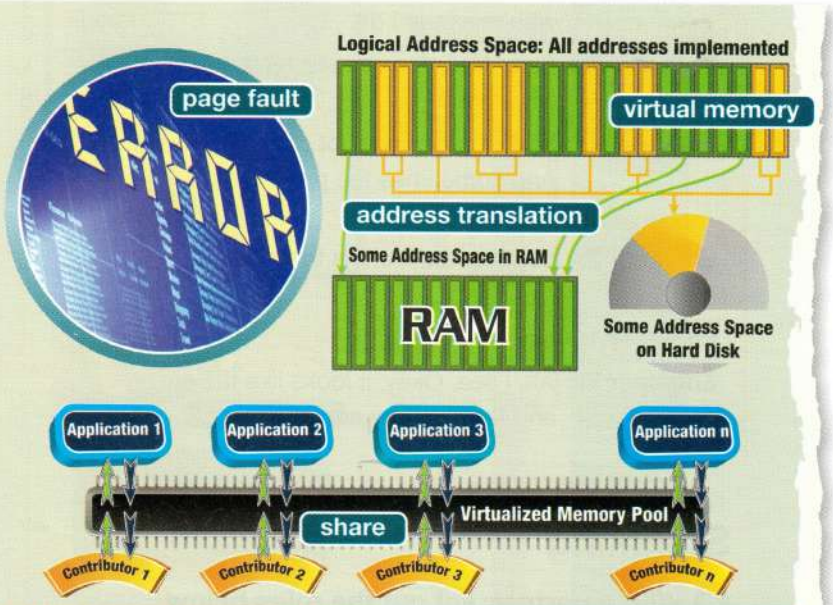
13 Virtual Memory

Get ready!

1 Before you read the passage, talk about these questions.

1 Why do programmers use virtual memory?

2 How does address translation work?



Unit 5.3 Virtual Memory & Paging

What is virtual memory?

Virtual memory allows multiple programs to **share** memory safely and effectively.

> *Remember: Like caches, virtual memory operates on the principle of locality.*

In order to keep programs isolated, each program receives its own **address space**. Virtual memory translates the **virtual addresses** into the real or **physical addresses**. **Address translation** provides **protection** from interference by other programs.

An individual block of virtual memory is referred to as a **page.** To locate a page, the processor references the program's **page table**. This index of address translations is different for every program. The OS creates a **swap space** to store all pages for a program. This data structure is often included in the page table. Some processors use a **TLB** (translation-lookaside buffer) to streamline memory access by avoiding the page table.

> *The alternative to paging is **segmentation**, which we will discuss in Unit 5.4.*

In virtual memory, a miss is known as a **page fault**. To avoid costly page faults, we must replace pages effectively. An **LRU** (least recently used) **replacement scheme** is the most widely used method. Most machines use a **reference bit** to calculate LRU more accurately. While LRU is not the most accurate replacement scheme, it is efficient.

Reading

2 Read the textbook chapter. Then, mark the following statements as true (T) or false (F).

1 What is the passage mostly about?

- **A** troubleshooting problems with virtual memory
- **B** the purposes of different virtual memory elements
- **C** a comparison of types of virtual memory
- **D** how to improve virtual memory on older machines

2 According to the passage, what is NOT true of page tables?

- **A** They contain a list of address translations.
- **B** They may contain an index of the swap space.
- **C** They keep ongoing records of page faults.
- **D** They are unique to a particular program.

3 How can programmers minimize page faults?

- **A** implement LRU replacement
- **B** reference the TLB instead of the page table
- **C** create a well-defined swap space
- **D** update the page table regularly

Vocabulary

3 Match the words or phrases (1-9) with the definitions (A-I).

1 __ TLB
2 __ share
3 __ protection
4 __ swap space
5 __ reference bit
6 __ segmentation
7 __ address space
8 __ physical address
9 __ LRU replacement scheme

- **A** a field that indicates whether a page was recently accessed
- **B** a memory location for a specific program
- **C** an area of the disk set aside for virtual pages of a process
- **D** to allow others to use something at the same time
- **E** a variable-size address mapping setup
- **F** a cache containing recent address translations
- **G** the process of ensuring processes cannot interfere with each other
- **H** a memory address within the main memory
- **I** a method for changing out blocks or pages in a cache based on use

4 **Write a word or phrase that is similar in meaning to the underlined part.**

1 The basis of virtual memory is <u>the process of converting a virtual address to a physical address</u>. _d__e_s t__ns___i_n]

2 In order to find a page, we reference the <u>index of virtual and physical addresses</u>. __g_ _ab__

3 <u>The act of using main memory as a cache</u> makes programming easier. v___ua_ ___or_

4 The processor found the <u>block of virtual memory</u> in the main memory. ___e

5 The <u>address that the program sees</u> is not the actual memory location. _ir_u_l __dr_s_

6 <u>A situation in which the requested page is not in the memory</u> comes with a high penalty. p_g_ _au__

5 **Listen and read the textbook chapter again. How are programs kept isolated?**

Listening

6 **Listen to a conversation between two students. Mark the following statements as true (T) or false (F).**

1 __ The students are reviewing the results of a recent test.

2 __ Processors access virtual addresses from the page table.

3 __ LRU replacement schemes use reference bits.

7 **Listen again and complete the conversation.**

Student 1: I don't think so. Professor Brown said it would only cover **1** _____.

Student 2: That's good. Will you quiz me on these **2** _____ _____ terms?

Student 1: Sure. What is the process of converting a virtual address to a **3** _____ _____?

Student 2: That's **4** _____ _____.

Student 1: Right. Okay, I have a question. What exactly is a **5** _____ _____?

Student 2: **6** _____ _____ _____ the address that the program sees. It corresponds to the physical address in the memory.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Do you think ...?

I have a question ...

That refers to ...

Student A: You are a student. Talk to Student B about:

- an upcoming exam
- what concepts will be on the exam
- what concepts you are confused about

Student B: You are a student. Talk to Student A about an upcoming exam.

Writing

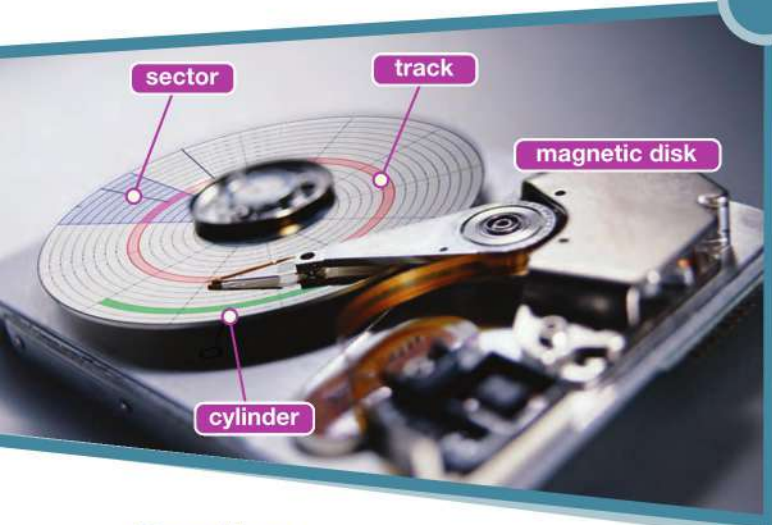
9 **Use the textbook chapter and the conversation from Task 8 to write an email from a student to an instructor. Include: the concepts that will be on the upcoming test, what the student has studied, and what concepts are still unclear.**

14 Disk Storage

Get ready!

1 Before you read the passage, talk about these questions.

1 How do magnetic disks organize data?
2 What kind of redundancy schemes are there for magnetic disks?



Excerpts from:

Magnetic **Disk Storage** and **RAID Configurations**

*by **Dr. Gerald Hart, Ph.D***
*Article from the **International Journal of Computer Hardware and Engineering***

Despite advancement in SSDs, **magnetic disks** are still the standard for secondary memory. With fast **seek times** and low **rotational latency**, disk storage is highly efficient.

One of the advantages of magnetic disk storage is its data organization. The disk is divided into **tracks**, and tracks are divided into **sectors**. Some older machines also reference **cylinders**. A **seek** positions the read/write head over the correct track or cylinder. Most magnetic disks have a dedicated **disk controller** to improve performance. Magnetic disks will remain useful as long as **controller time** remains low.

Redundancy schemes for magnetic disks are called **RAIDs** (redundant arrays of inexpensive disks). RAID configurations are largely responsible for the practicality of magnetic disks. RAID 1, known as **mirroring**, is the most expensive RAID configuration. Mirroring requires a check disk for every active data disk. Other RAID configurations arrange data disks into **protection groups** to minimize hardware requirements. **Striping**, though referred to as RAID 0, has no actual redundancy.

No matter how efficient the RAID configuration, disks will fail and need replacement. While RAIDs usually prevent system failures, **hot swapping** is a risky process. In order to avoid shutting down the system, some machines use **standby spares**. The standby spares remain inactive until a primary disk fails.

Reading

2 Read the journal article. Then, mark the following statements as true (T) or false (F).

1 What is the main idea of the article?
- **A** changes in disk storage methods over the years
- **B** the advantages of magnetic disk storage methods
- **C** challenges of using magnetic disk storage for secondary memory
- **D** ways to prevent disk storage failures

2 Which is NOT true of RAID configuration?
- **A** It is an efficient alternative to striping.
- **B** It sometimes requires hot swapping.
- **C** It uses standby spares to replace failed disks.
- **D** Its disks can be organized into protection groups.

3 Why is mirroring so expensive?
- **A** It requires the organization of additional protection groups.
- **B** It makes hot swapping necessary when disks fail.
- **C** It requires a duplicate disk for every data disk.
- **D** It is usually combined with the use of standby spares.

Vocabulary

3 Match the words (1-7) with the definitions (A-G).

1 __ seek
2 __ track
3 __ cylinder
4 __ striping
5 __ mirroring
6 __ magnetic disk
7 __ rotational latency

- **A** all tracks that are underneath the read/write head
- **B** a type of nonvolatile memory that records data to rotating platters
- **C** the time required to move the correct sector under the read/write head
- **D** the process of distributing sequential blocks to separate disks
- **E** a single concentric circle on the surface of a disk
- **F** the process of recording identical data to two disks
- **G** the act of moving the read/write heads over the right track

4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 **sector / seek time**

A As disk technology advances, _____ decreases.

B Most magnetic disks can find the requested _____ quickly.

2 **RAID / disk controller**

A _____ is a method for increasing performance and reliability.

B A _____ handles instructions and operations for the disk.

3 **protection group / controller time**

A The engineers arranged redundancy with three disks to a _____ .

B A high _____ can slow down the processor considerably.

4 **hot swapping / standby spare**

A A _____ remains inactive until a data disk fails.

B _____ places high demands on the system during replacement.

5 Listen and read the journal article again. What is the advantage of using standby spares?

Listening

6 Listen to a conversation between two computer engineers. Mark the following statements as true (T) or false (F).

1 __ The engineers are deciding on a RAID scheme.

2 __ The woman would prefer to use mirroring.

3 __ The project will use standby spares instead of hot swapping.

7 Listen again and complete the conversation.

Engineer 1: Yeah, that's right. We know we'll be using **1** _____ _____ . But we need to decide on the level of redundancy.

Engineer 2: Right. So we have to decide what **2** _____ scheme to use?

Engineer 1: Yes. What are your thoughts?

Engineer 2: Well, I think we should use **3** _____ . It's the most reliable.

Engineer 1: **4** _____ _____ . I don't think we can justify the cost of mirroring.

Engineer 2: But isn't it in budget? I **5** _____ _____ the budget proposal just a few minutes ago.

Engineer 1: You're forgetting about the **6** _____ _____ . Part of that budget is needed for spare disks.

Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

USE LANGUAGE SUCH AS:

We need to decide ...

I disagree ...

You're forgetting ...

Student A: You are an engineer. Talk to Student B about:

- disk storage for a new project
- what redundancy scheme to use
- why another scheme is not practical

Student B: You are an engineer. Talk to Student A about disk storage for a new project.

Writing

9 Use the reading passage and conversation from Task 8 to write a report to a senior engineer. Include: the status of the new project, what disk configuration you plan to use, and why you chose that configuration.

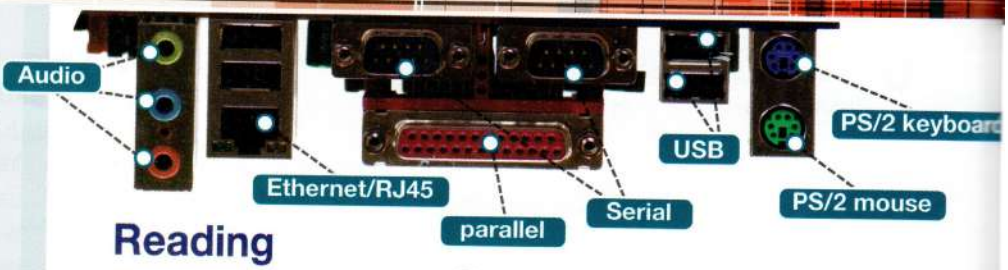
15 Buses

Get ready!

1 Before you read the passage, talk about these questions.

1 What are some different types of buses?

2 What is the difference between synchronous and asynchronous buses?



Reading

2 Read the online encyclopedia article. Then, choose the correct answers.

1 What is the purpose of the article?

A to explain the history of buses in computers
B to compare buses made by two different companies
C to define some of the most common types of buses
D to give instructions for troubleshooting bus errors

2 According to the article, what is NOT true of buses?

A Parallel buses are more common than serial buses.
B Buses perform read and write transactions.
C Handshaking protocols are used in asynchronous buses.
D Processor-memory buses only connect two devices.

3 What is the advantage of synchronous buses?

A They are highly efficient.
B They use a handshaking protocol.
C They are designed to connect multiple peripherals.
D They use a split-transaction protocol.

Buses (computing)


Ethernet/RJ45


Modem/RJ11

This is an article about computer interfaces.
For the transportation method, see Bus (vehicle).


Serial


Parallel


SCSI

In computing, a **bus** is an interface between different devices and subsystems. Buses are classified as either **serial buses** or **parallel buses**. The two types of buses transmit data differently. Some buses may be either parallel or serial. For example, an **SCSI** bus is typically parallel, but its protocol is sometimes implemented with serial buses.

Bus Transactions


HDMI


PS/2

A bus transaction begins with a request. It may contain several communications. Bus transactions can be grouped into two categories: **read transactions** and **write transactions**. The specifics of the transaction depend on the devices using the bus. Some devices, for instance, can only accommodate read transactions.

Types of Buses


eSata


FireWire 400/Mb/s


FireWire 800/Mb/s

Processor-memory buses are short, fast buses optimized for processor-memory communications. Despite their high speeds, they are only used to connect two devices. I/O buses are designed to connect many different peripherals and internal devices. I/O buses usually communicate with memory using a **backplane bus**.

Bus Communications


FireWire


USB

Bus communications are either **synchronous** or **asynchronous**. Synchronous buses are highly efficient. Devices connected to a synchronous bus must use the same clock rate.

Asynchronous buses use a **handshaking protocol** to coordinate data transmission. **FireWire** and **USB** 2.0 are common examples of asynchronous clocking. Some asynchronous buses use a **split transaction protocol** to increase effective bandwidth.

Are you an expert in this subject? You can help by expanding this article.

Vocabulary

3 Match the words or phrases (1-9) with the definitions (A-I).

1 __ USB
2 __ FireWire
3 __ backplane bus
4 __ bus transaction
5 __ read transaction
6 __ write transaction
7 __ handshaking protocol
8 __ processor-memory bus
9 __ split-transaction protocol

A a communication that records data to memory
B a system in which both devices agree when to move to the next step
C a bus that connects processors, memory, and I/O devices
D a communication that requests data from memory
E a high-speed bus that only connects two particular computer components
F a system that can handle multiple requests to use the bus at one time
G a standard interface for high-speed communications
H a standard interface that is ideal for peripheral devices
I a series of communications that begins with a request

4 **Read the sentence pairs. Choose which word or phrase best fits each blank.**

1 **bus / SCSI**

A A(n) _____ is a communication link between devices.

B The disk drives in the PC use _____ connections.

2 **parallel bus / serial bus**

A A _____ sends data one bit at a time.

B A _____ sends multiple bits at a time.

3 **synchronous bus / asynchronous bus**

A A(n) _____ uses a handshaking protocol.

B A(n) _____ times communications with an internal clock.

5 **Listen and read the online encyclopedia article again. What is the difference between an I/O bus and a processor-memory bus?**

Listening

6 **Listen to a conversation between an intern and a computer engineer. Mark the following statements as true (T) or false (F).**

1 __ The man incorrectly identifies the purpose of asynchronous buses.

2 __ USB is a type of asynchronous bus.

3 __ The woman gives examples of parallel buses.

7 **Listen again and complete the conversation.**

Engineer: Okay. Synchronous buses are what we use for **1** _____ - _____ _____.

Intern: Right. And when do we use **2** _____ _____?

Engineer: Well, asynchronous buses are useful for a wider variety of purposes. **3** _____ is a good example.

Intern: So would **4** _____ also be an asynchronous bus?

Engineer: Yes. And that also uses a **5** _____ _____.

Intern: I can't remember how a handshaking protocol works.

Engineer: The two devices have to agree that the **6** _____ _____ is finished. One purpose of a handshaking protocol is to verify this.

Speaking

8 **With a partner, act out the roles below based on Task 7. Then, switch roles.**

USE LANGUAGE SUCH AS:

Do you have ...?

What do you need?

Let me get this straight ...

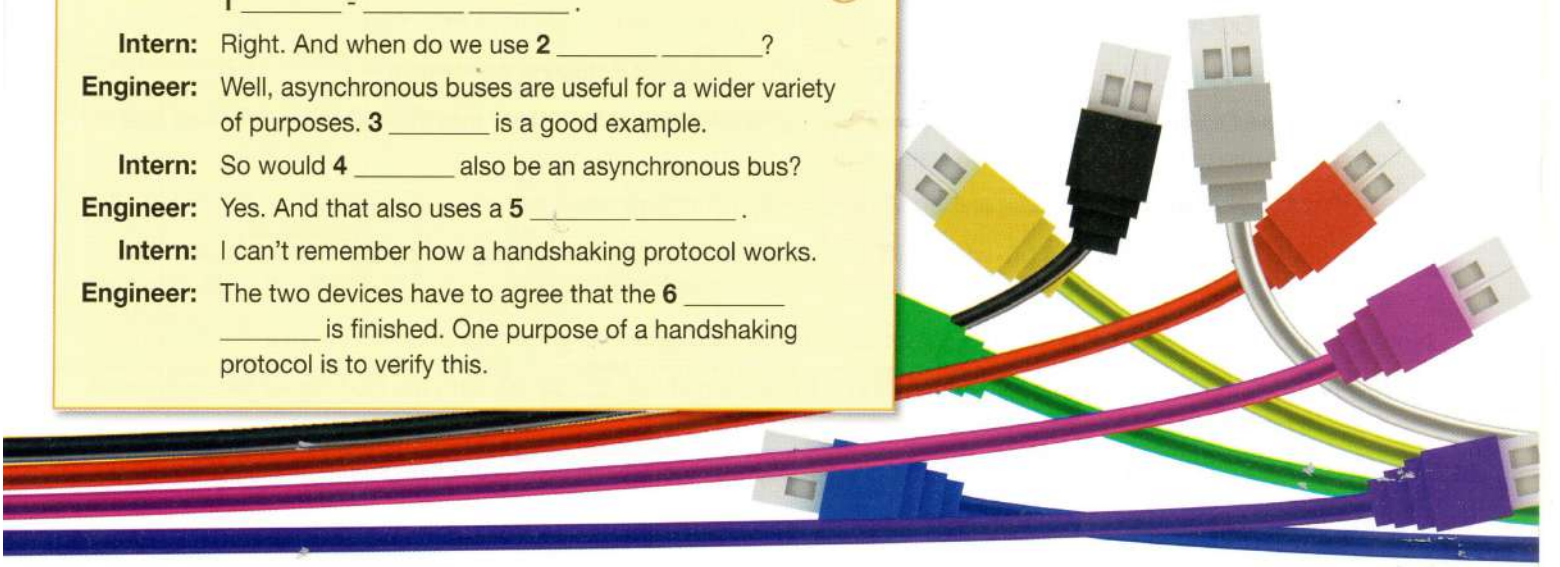
Student A: You are an intern. Talk to Student B about:

- bus communications
- the differences between types of buses
- when particular buses are used

Student B: You are an engineer. Talk to Student A about bus communications.

Writing

9 **Use the online encyclopedia article and the conversation from Task 8 to write an email to a supervising engineer. Include: topics from a previous conversation, concepts that are clear, and concepts that are still unclear.**



Glossary

access [V-T-U12] To **access** something is to locate it and make it available for use.

access time [N-COUNT-U11] An **access time** is the amount of time required to obtain information from a computer's memory.

accurate [ADJ-U5] If a calculation is **accurate**, it is correct and exact.

adder [N-COUNT-U8] An **adder** is a digital circuit that carries out addition operations.

addition [N-COUNT-U4] **Addition** is the process of finding the sum of two or more numbers.

address [N-COUNT-U2] An **address** is the location of specific information within the computer's memory.

address space [N-COUNT-U13] An **address space** is a designated list of memory locations that are available only to a specific program.

address translation [N-UNCOUNT-U13] **Address translation** is the process by which a virtual address is redirected to a physical address.

ALU [ABBREV-U8] An **ALU** (Arithmetic Logic Unit) is a type of digital circuit that carries out arithmetic and logical operations.

Amdahl's law [N-UNCOUNT-U7] **Amdahl's law** is an equation that determines the maximum overall improvement to a system if only one aspect of the system is changed.

application [N-COUNT-U7] An **application** is a real program that is part of a benchmark.

approximation [N-COUNT-U5] An **approximation** is a useful representation of a number that is not exact, but comes as close as possible under the circumstances.

arithmetic mean [N-COUNT-U7] An **arithmetic mean** is the average of execution times compared with total execution time.

arithmetic-logical [N-UNCOUNT-U8] **Arithmetic-logical** is a category of instruction that tells the CPU to carry out mathematical and logical operations.

assembler [N-COUNT-U1] An **assembler** is a program that changes written instructions into the binary translation.

assembly language [N-COUNT-U1] An **assembly language** is a form of written instructions for a computer that is simpler than high-level or human-readable programming languages but has not been converted to a binary translation.

asynchronous [ADJ-U15] **Asynchronous** is a bus that does not have a clock and instead relies on a handshaking protocol to time transactions.

backplane bus [N-COUNT-U15] A **backplane bus** is a single bus that connects processors, memory, and I/O devices.

base 10 [N-UNCOUNT-U3] **Base 10** is a number system, also called the decimal system, that uses the digits 0 through 9.

base 2 [N-UNCOUNT-U3] **Base 2** is a number system, also called the binary system, that uses the digits 0 and 1.

basic block [N-COUNT-U2] A **basic block** is a series of instructions that do not have branches.

benchmark [N-COUNT-U7] A **benchmark** is a workload that measures computer performance.

binary digit [N-COUNT-U1] A **binary digit** is a number, represented by either 0 or 1, that makes up the language that computers use to transmit and receive instructions.

bit [N-COUNT-U2] A **bit** is the smallest unit of information on a computer.

bit-wise shift [N-UNCOUNT-U4] A **bit-wise shift** is an operation that performs multiplication and division quickly by shifting the value of bits left or right.

block [N-COUNT-U11] A **block** is the smallest unit of information that can be present or absent within a level of memory.

borrow [V-T-U4] To **borrow** a number in subtraction is to take a number, usually 10, from the next higher digit column in order to produce a positive difference as a result.

branch [N-UNCOUNT-U8] **Branch** is a category of instruction that alters the next instruction stored in the PC based on the result of a previous instruction.

branch delay slot [N-COUNT-U10] A **branch delay slot** is an instruction slot that comes after a delayed branch instruction and contains an instruction that does not have any effect on the branch.

branch hazard [N-COUNT-U9] A **branch hazard**, also called a control hazard, is a situation in which a branch instruction is dependent on information that is not available yet, and the correct instruction is not carried out.

branch history table [N-COUNT-U10] A **branch history table**, also called a branch prediction buffer, is a small memory that records whether or not a branch was recently taken.

branch prediction [N-UNCOUNT-U9] **Branch prediction** is the act of guessing whether a branch will be taken or untaken in order to avoid branch hazards.

branch prediction buffer [N-COUNT-U10] A **branch prediction buffer**, also called a branch history table, is small memory that records whether or not a branch was recently taken.

branch target buffer [N-COUNT-U10] A **branch target buffer** is cache memory that stores the necessary destination instructions for a branch.

bubble [N-COUNT-U10] A **bubble**, also called a pipeline stall, is an intentional delay implemented to resolve hazards.

bus [N-COUNT-U15] A **bus** is a communication link that is shared between multiple devices.

bus transaction [N-COUNT-U15] A **bus transaction** is a series of bus communications that always contains a request and may or may not contain a response.

C [ABBREV-U1] **C** is a human-readable programming language that is focused on procedures and used for general purposes.

cache [N-COUNT-U12] A **cache** is a small memory that contains the data most likely to be requested.

cache miss [N-COUNT-U12] A **cache miss** is a situation in which a cache request cannot be completed because the requested data is not in the cache.

carry-out [N-COUNT-U4] A **carry-out** is a number that is carried from the right column to the left in a mathematical equation that is needed to get the final result of the operation.

clock cycle [N-COUNT-U6] A **clock cycle** is an interval of time that is used to measure the performance of a computer processor.

clock rate [N-COUNT-U6] A **clock rate** is the number of cycles per second a computer runs at.

compiler [N-COUNT-U1] A **compiler** is a computer program that converts complicated operations into simple computer instructions.

concurrently [ADV-U9] If two or more things are happening **concurrently**, they are happening at the same time.

conditional branch [N-COUNT-U2] A **conditional branch** is an instruction that is only completed if certain conditions are first met.

consistent [ADJ-U12] If two sources are **consistent**, they contain the same information.

control [N-COUNT-U8] A **control** is the part of a computer processor that delivers instructions to the datapath, memory, and other devices.

control hazard [N-COUNT-U9] A **control hazard**, also called a branch hazard, is a situation in which a branch instruction is dependent on information that is not available yet, and the correct instruction is not carried out.

controller time [N-UNCOUNT-U14] The **controller time** is the time required for a controller to receive and act on its instructions.

correlating predictor [N-COUNT-U10] A **correlating predictor** is a type of branch predictor that uses information about recently taken branches on the local and global scale to predict whether a branch will be taken.

CPI [ABBREV-U6] **CPI** (Clock Cycles Per Instructions) is the number of clock cycles needed for a computer to complete an instruction.

Glossary

CPU time [N-UNCOUNT-U6] **CPU time** is the amount of time the central processing unit (CPU) of a computer takes to complete a task.

cylinder [N-COUNT-U14] A **cylinder** is all of the tracks that are underneath a magnetic disk's read/write heads at any given time.

data [N-UNCOUNT-U2] **Data** is information stored in a computer.

data hazard [N-COUNT-U9] A **data hazard** is a situation in which a pipeline stalls because the data needed for an instruction is still being processed.

data selector [N-COUNT-U8] A **data selector**, also called a multiplexer, is a device that chooses one of several input signals and routes it to a single available output line.

data transfer instruction [N-COUNT-U2] A **data transfer instruction** is an operation on a computer that allows data to be transferred from memory to registers.

datapath [N-COUNT-U8] A **datapath** is a series of units that are involved in data processing operations.

destination [N-COUNT-U8] A **destination** is the location to which information is sent.

diminishing returns [N-UNCOUNT-U7] **Diminishing returns** is the principle that performance or production will decrease when a production factor is increased too much.

direct-mapped cache [N-COUNT-U12] A **direct-mapped cache** is a cache in which individual memory locations are assigned a specific location in the cache.

disk controller [N-COUNT-U14] A **disk controller** is a device that handles the physical operations of a magnetic disk and the transfer of data from disk to memory.

division [N-COUNT-U4] **Division** is the process of splitting a quantity into a particular number of equal parts.

double precision [N-UNCOUNT-U5] **Double precision** is the expression of a floating point value in two 32-bit words in order to avoid overflow and underflow.

dynamic branch prediction [N-UNCOUNT-U10] **Dynamic branch prediction** is the process of predicting whether or not a branch will be taken by finding out if the branch was taken the last time the instruction was executed.

exception [N-COUNT-U4] An **exception**, also called an interrupt, is an event that disrupts the execution of a program.

execution time [N-UNCOUNT-U6] **Execution time** is the time that elapses from the start of a task to the end.

exponent [N-COUNT-U5] An **exponent** is a number that indicates how many times a quantity is multiplied by itself.

FireWire [N-UNCOUNT-U15] **FireWire** is a standard serial bus interface that is optimized for high-speed communications.

floating point [N-UNCOUNT-U5] **Floating point** is a kind of computer arithmetic that uses a variable binary point.

flush instructions [PHRASE-U10] To **flush instructions** is to discard all current instructions from a pipeline, usually done in when an unexpected branching event occurs.

forwarding [N-UNCOUNT-U9] **Forwarding** is a process that avoids data hazards by retrieving missing data from internal buffers before it is available in registers or memory.

fully associative cache [N-COUNT-U12] A **fully associative cache** is a cache in which any block can be placed in any location within the cache.

guard digit [N-COUNT-U5] A **guard digit** is an extra bit to the right of the binary point that allows for more accurate rounding.

handle [V-T-U12] To **handle** a task is to perform the necessary actions to complete it.

handshaking protocol [N-COUNT-U15] A **handshaking protocol** is a system of coordination for asynchronous buses in which devices only proceed to the next step of the process after both have agreed that the current step is finished.

hazard [N-COUNT-U9] A **hazard** is a pipelining situation in which the next instruction cannot be executed in the next CPU clock cycle.

human-readable programming language [N-COUNT-U1] A **human-readable programming language** is a computer language that is compatible with the way people think and is used by programmers to write instructions for a computer.

hit [N-COUNT-U11] A **hit** is a situation in which requested data is present in a block in the upper level of a memory hierarchy.

hit rate [N-COUNT-U11] A **hit rate** is the percentage of memory accesses found on the upper level of a memory hierarchy, usually expressed as a fraction.

hit time [N-COUNT-U11] A **hit time** is the amount of time needed to access a level of the memory and determine whether the requested data is present in that level.

hot swapping [N-UNCOUNT-U14] **Hot swapping** is the act of replacing a hardware device while the rest of the machine is still running.

ignore [V-T-U4] To **ignore** something is to intentionally disregard it.

implementation [N-COUNT-U8] **Implementation** is the process of carrying out a task in a certain way.

infinite [ADJ-U5] If a number is **infinite**, it has no limitations on its value.

instruction [N-COUNT-U2] **Instructions** are the words that make up computer language.

instruction class [N-COUNT-U8] An **instruction class** is the general category under which an instruction falls.

instruction set [N-COUNT-U2] An **instruction set** is a specific set of words that prompts a computer to perform an action.

integer [N-COUNT-U5] An **integer** is a natural number, the negative of a natural number, or zero.

interrupt [N-COUNT-U4] An **interrupt**, also called an exception, is an event that disrupts the execution of a program.

Java [N-UNCOUNT-U1] **Java** is a human-readable programming language that is similar to C but modified to be object-oriented and simpler.

latency [N-UNCOUNT-U9] **Latency** is the time required to execute an individual instruction.

leading 0 [N-COUNT-U3] A **leading 0** is a digit at the beginning of a signed binary number that indicates it is positive.

leading 1 [N-COUNT-U3] A **leading 1** is a digit at the beginning of a signed binary number that indicates it is negative.

least significant bit [N-COUNT-U3] A **least significant bit** is a binary digit that is farthest to the right in a word.

load-use data hazard [N-COUNT-U9] A **load-use data hazard** is a situation that occurs when a load instruction requests data that is not available yet.

LRU replacement scheme [N-COUNT-U13] An **LRU** (Least Recently Used) **replacement scheme** is a method for replacing blocks in the cache that involves removing the block that has been unused for the longest amount of time.

machine language [N-COUNT-U1] A **machine language** is a set of instructions written in numerical form.

magnetic disk [N-COUNT-U14] A **magnetic disk** is a form of nonvolatile memory that records data to multiple rotating magnetic platters.

memory hierarchy [N-COUNT-U11] A **memory hierarchy** is a system for organizing memory in which multiple tiers of memory are used, with each level increasing in size and access time relative to the distance from the CPU.

memory-reference [N-UNCOUNT-U8] **Memory-reference** is a category of instruction that tells the CPU to either retrieve data from or store data to memory.

metric [N-COUNT-U6] A **metric** is a measurement of a certain aspect of something's performance.

MIPS [ABBREV-U7] **MIPS** (Million Instructions Per Second) are a measurement of the execution speed of a program by the millions of instructions that are executed every second.

mirroring [N-UNCOUNT-U14] **Mirroring** is the process of recording identical data to both a primary disk and a redundant disk to increase data availability.

miss penalty [N-COUNT-U11] A **miss penalty** is the amount of time required to locate and transfer a block from a lower level of a memory hierarchy to an upper level, including the time needed to send the data to the processor.

Glossary

miss rate [N-COUNT-U11] A **miss rate** is the percentage of memory accesses not found on the upper level of a memory hierarchy, usually expressed as a fraction and calculated as 1 minus the hit rate.

most significant bit [N-COUNT-U3] The **most significant bit** is the binary digit that is farthest to the left in the word.

multiplexer [N-COUNT-U8] A **multiplexer** (MUX), also called a data selector, is a device that chooses one of several input signals and routes it to a single available output line.

multiplication [N-COUNT-U4] **Multiplication** is the process of adding a quantity to itself a particular number of times.

NOP [ABBREV-U10] An **NOP** (No Operation) is an instruction that has no effect and is used to avoid hazards and provide instructions to unused stages of the pipeline.

normalized [ADJ-U5] If a number in scientific notation is **normalized**, it does not have a leading zero.

number base [N-COUNT-U3] A **number base** is the indication of how many digits or numerals are used in a certain system.

operand [N-COUNT-U4] An **operand** is the number that is used in a mathematical equation.

overflow [N-UNCOUNT-U4] **Overflow** is a condition that occurs when the result of a calculation is too large for the storage system of the computer.

page [N-COUNT-U13] A **page** is a fixed-size block of virtual memory.

page fault [N-COUNT-U13] A **page fault** is an occurrence in which a requested page is not present in the main memory.

page table [N-COUNT-U13] A **page table** is a table stored in the memory that contains a list of virtual addresses and the corresponding physical addresses.

parallel [ADJ-U12] If two things are **parallel**, they correspond to each other or exist side-by-side.

parallel bus [N-COUNT-U15] A **parallel bus** is a bus that sends two sets of data simultaneously on parallel wires.

PC [ABBREV-U8] A **PC** (Program Counter) is a small register that keeps track of progress through program instructions by storing the address of the next instruction.

performance [N-UNCOUNT-U6] **Performance** is the amount of work something can do and the time needed to accomplish it.

physical address [N-COUNT-U13] A **physical address** is a memory address within the main memory.

pipeline stall [N-COUNT-U9] A **pipeline stall**, also called a bubble, is an intentional delay implemented to resolve hazards.

pipelining [N-UNCOUNT-U9] **Pipelining** is a technique for implementing instructions in which multiple instructions are executed simultaneously.

principle of locality [N-UNCOUNT-U11] The **principle of locality** is a concept that states that programs only use a small percentage of the available memory address space at any one time.

processor-memory bus [N-COUNT-U15] A **processor-memory bus** is a short, high speed bus that is optimized to connect processors to memory.

programmer [N-COUNT-U1] A **programmer** is a person who writes and develops software and programs for computers.

protection [N-UNCOUNT-U13] **Protection** is a series of measures taken to ensure that the different processes that share a device cannot interfere with each other.

protection group [N-COUNT-U14] A **protection group** is a collection of disks that share the same redundant or check disk.

queue [N-COUNT-U12] A **queue** is a series of objects or blocks of information that are processed in sequential order.

RAID [ABBREV-U14] **RAID** (Redundant Arrays of Independent Disks) is a way of organizing disk space by using several small, independent disks as opposed to a smaller number of large disks to improve reliability and performance.

read transaction [N-COUNT-U15] A **read transaction** is a bus transaction that retrieves data from memory.

recognize [V-T-U4] To **recognize** something is to notice or acknowledge it.

reference [V-T-U11] To **reference** something is to open or recall it from its data location.

reference bit [N-COUNT-U13] A **reference bit** is a field in the cache that indicates whether or not a block of memory has been accessed recently.

register [N-COUNT-U2] A **register** is a part of the computer's hardware that temporarily stores instructions sent to the computer, allowing instructions to be accessed more quickly.

reproducibility [N-COUNT-U7] **Reproducibility** is the ability to duplicate something.

result [N-COUNT-U4] A **result** is the final product or answer after a process is complete.

rotational latency [N-COUNT-U14] **Rotational latency** is the amount of time required for a correct sector to rotate under the read/write head after it is positioned over the right track.

round [V-T-U5] To **round** a number is to express it as a number that is as close as possible, but only as accurate as is useful.

scientific notation [N-COUNT-U5] **Scientific notation** is a way of writing a number with only one digit to the left of the decimal point, multiplied by ten raised to an exponent. For example, $4{,}000 = 4.0 \times 10^3$.

SCSI [ABBREV-U15] The **SCSI** (Small Computer System Interface) is a set of standards for communication between computers and peripheral devices.

sector [N-COUNT-U14] A **sector** is the smallest unit of a track that can contain data, and is usually 512 bytes in size.

seek [N-COUNT-U14] A **seek** is the act of physically moving a read/write head over the correct track on a disk.

seek time [N-COUNT-U14] A **seek time** is the amount of time required to move a read/write head into the correct position.

segmentation [N-COUNT-U13] **Segmentation** is a variable-size address mapping setup in which the address consists of a segment number and a segment offset.

serial bus [N-COUNT-U15] A **serial bus** is a bus that sends data one bit at a time.

set-associative cache [N-COUNT-U12] A **set-associative cache** is a cache that has a set number of locations in which any particular block can be placed.

share [V-T-U13] To **share** something is to allow others to use or experience it.

sign bit [N-COUNT-U3] A **sign bit** is the leading bit that is tested by computer hardware to indicate whether the number is positive or negative.

signed number [N-COUNT-U3] A **signed number** is a number that is marked as either positive or negative.

significand [N-COUNT-U5] A **significand** is part of a number in scientific notation or a floating point number consisting of its significant digits.

single precision [N-UNCOUNT-U5] **Single precision** is the expression of a floating point value in one 32-bit word.

source [N-COUNT-U8] A **source** is the location from which information originates.

spatial locality [N-UNCOUNT-U11] **Spatial locality** is the principle that indicates that when a data location is referenced, addresses near it will likely be referenced soon.

SPEC CPU benchmark [N-COUNT-U7] A **SPEC CPU benchmark** is a set of real programs that measures the performance of the central processing unit.

SPEC ratio [N-COUNT-U7] A **SPEC ratio** is the measurement of the execution time of one computer compared to the execution time of another computer.

split cache [N-COUNT-U12] A **split cache** is a memory hierarchy in which a level of memory consists of two parallel caches, one for instructions and one for data.

split transaction protocol [N-COUNT-U15] A **split-transaction protocol** is a system that allows other requesters to access the bus while a previous requester is waiting for data to be sent.

Glossary

stage [N-COUNT-U9] A **stage** is one specific task or action in an overall process.

standby spare [N-COUNT-U14] A **standby spare** is a hardware device, usually a magnetic disk, that is already installed in the system but remains inactive unless the primary disk fails.

sticky bit [N-COUNT-U5] A **sticky bit** is an extra bit used in rounding whenever there is a number other than zero to the right of the round bit.

stored-program concept [N-COUNT-U2] The **stored-program concept** is a computing theory that states that instructions can be stored as numbers in the computer's memory.

striping [N-UNCOUNT-U14] **Striping** is the process of distributing sequential blocks of data onto separate disks with no redundancy.

structural hazard [N-COUNT-U9] A **structural hazard** is a situation in which hardware cannot accommodate the combination of instructions that are supposed to execute in a given time period.

subscript [V-T-U3] To **subscript** something is to add a distinguishing number or character to it.

subtraction [N-COUNT-U4] **Subtraction** is the process of deducting the amount of one number from the amount of another.

swap space [N-COUNT-U13] A **swap space** is an area of a disk that is designated for the virtual pages of a process.

synchronous [ADJ-U15] **Synchronous** is a bus that contains a clock and performs transactions relative to the clock.

system CPU time [N-COUNT-U6] A **system CPU time** is the amount of time a computer processor spends running the support system of a program.

systems software [N-UNCOUNT-U1] **Systems software** is a type of computer program, such as a compiler or assembler, that enables computer functions.

tag [N-COUNT-U12] A **tag** is a field in a memory hierarchy that identifies the contents of a block.

temporal locality [N-UNCOUNT-U11] **Temporal locality** is the principle that indicates that when a data location is recently referenced, it will likely be referenced again soon.

throughput [N-COUNT-U6] **Throughput** is the amount of work a computer can do in a specific amount of time.

TLB [ABBREV-U13] A **TLB** (Translation-Lookaside Buffer) is a cache that keeps record of recently used address translations in order to reduce use of the page table.

tournament branch predictor [N-COUNT-U10] A **tournament branch predictor** is an elaborate branch predictor that has multiple prediction types from which the program can choose.

track [N-COUNT-U14] A **track** is a single concentric circle on the recording surface of a magnetic disk.

translate [V-T-U1] To **translate** something is to convert it from one form to another.

two's complement [N-UNCOUNT-U3] **Two's complement** is a system of signed binary numbers using leading 0 and leading 1.

ULP [ABBREV-U5] A **ULP** (Unit of Least Precision) is the measure of the degree of error in rounding.

underflow [N-COUNT-U5] **Underflow** is an occurrence in which a negative exponent is too large to fit in the exponent field of a 32-bit word.

unsigned number [N-COUNT-U3] An **unsigned number** is a number that does not have a negative or a positive sign, so it can only represent zero or a positive number.

untaken branch [N-COUNT-U9] An **untaken branch** is a branch instruction that yields to the next sequential instruction rather than routing to a new instruction address.

USB [ABBREV-U15] A **USB** (Universal Serial Bus) is a standard serial bus interface that is ideal for lower-performance peripheral devices.

user CPU time [N-COUNT-U6] A **user CPU time** is the amount of time a computer processor spends running a program.

valid bit [N-COUNT-U12] A **valid bit** is a field in a memory hierarchy that is set when the block contains a valid address.

value [N-COUNT-U4] A **value** is a number, and can be either positive or negative.

virtual address [N-COUNT-U13] A **virtual address** is an address that matches up to a virtual memory space and redirects to a physical address when the memory is requested.

virtual memory [N-UNCOUNT-U13] **Virtual memory** is a data storage technique that uses the main memory as a cache for a secondary memory storage system.

wall-clock time [N-UNCOUNT-U6] **Wall-clock time** is the most commonly accepted notion of the passage of time, consisting of measurements in minutes and seconds.

weighted arithmetic mean [N-COUNT-U7] A **weighted arithmetic mean** is a sum of weighting factors and execution times that is used to evaluate the performance of the workload.

weighting factor [N-COUNT-U7] A **weighting factor** is the percentage of usage that a program in a workload has.

word [N-COUNT-U2] A **word** is a group of 32 bits.

workload [N-COUNT-U7] A **workload** is a set of programs that a computer runs on a daily basis.

write buffer [N-COUNT-U12] A **write buffer** is a queue that holds data that is already written to the cache but is waiting to be written to memory.

write transaction [N-COUNT-U15] A **write transaction** is a bus transaction that records data to memory.

write-back [N-COUNT-U12] **Write-back** is a process in which new data is only written to the cache, and is written to the memory when the block in the cache is replaced.

write-through [N-COUNT-U12] **Write-through** is a process in which the cache and the memory are updated at the same time to ensure they are consistent with each other.

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