READING COMPREHENSION

Directions: The following items (1-44) must be answered by reading the passages that accompany them. Each item has one correct answer, unless otherwise indicated.

ANALYZING LITERARY TEXT

from The Imp of the Perverse
by Edgar Allan Poe

It is impossible that any deed could have been wrought with more thorough deliberation. For weeks, for months, I pondered upon the means of the murder. I rejected a thousand schemes, because their accomplishment involved a *chance* of detection. At length, in reading some French memoirs, I found an account of a nearly fatal illness that occurred to Madame Pilau, through the agency of a candle accidentally poisoned. The idea struck my fancy at once. I knew my victim's habit of reading in bed. I knew, too, that his apartment was narrow and ill-ventilated. But I need not vex you with impertinent details. I need not describe the easy artifices by which I substituted, in his candlestand, a wax-light of my own making, for the one which I there found. The next morning he was dead in his bed, and the verdict was,— "Death by the visitation of God."

Having inherited his estate, all went merrily with me for years. The idea of detection never obtruded itself. Of the remains of the fatal taper, I had myself carefully disposed, nor had I left the shadow of a clue by which it would be possible to convict, or even to suspect me of the crime. It is inconceivable how rich a sentiment of satisfaction arose in my bosom as I reflected upon my absolute security. For a very long period of time, I reveled in this sentiment. It afforded me, I believe, more real delight than all the mere worldly advantages accruing from my sin. There arrived at length an epoch, after which this pleasurable feeling took to itself a new tone, and grew, by scarcely perceptible gradations, into a haunting and harassing thought—a thought that harassed because it haunted. I could scarcely get rid of it for an instant. It is quite a common thing to be thus annoyed by the ringing in our ears, or memories, of the burden of an ordinary song, or some unimpressive snatches from an opera. Nor will we be less tormented though the song in itself be good, or the opera air meritorious. In this manner, at last, I would perpetually find myself pondering upon my impunity and security, and very frequently would catch myself repeating, in a low, under-tone, the phrases "I am safe—I am safe."

One day, while sauntering listlessly about the streets, I arrested myself in the act of murmuring, half aloud, these customary syllables. In a fit of petulance at my indiscretion I re-modelled them thus: —"I am safe—I am safe—yes, *if I do not prove fool enough to make open confession."*

No sooner had I uttered these words, than I felt an icy chill creep to my heart. I had had (long ago, during childhood) some experience in those fits of perversity, whose nature I have been at so much trouble in explaining, and I remembered that in no instance had I successfully resisted their attacks. And now my own casual self-suggestion, that I might possibly prove fool enough to make open confession—confronted me, as if the very ghost of him I had murdered—and beckoned me on to death.

At first, I made strong effort to shake off this nightmare of the soul. I whistled—I laughed aloud—I walked vigorously—faster and still faster. At length I saw—or fancied that I saw—a vast and formless shadow that seemed to dog my footsteps, approaching me from behind, with a cat-like and stealthy pace. It was then that I *ran*. I felt a wild desire to shriek aloud. Every succeeding wave of thought overwhelmed me with new terror, for, alas! I understood too well that to *think*, in my condition, was to be undone. I still quickened my steps. I bounded like a madman through the crowded thoroughfares. But now the populace took alarm, and pursued. Then—then I felt the consummation of my fate. Could I have torn out my tongue, I would have done it—but a rough voice from some member of the crowd now resounded in my ears, and a rougher grasp seized me by the arm. I turned—I gasped for breath. For a moment, I experienced all the pangs of suffocation; I became blind, and deaf, and giddy; and at this instant it was no mortal hand, I knew, that struck me violently with a broad and massive palm upon the back. At that blow the long-imprisoned secret burst forth from my soul.

They say that I spoke with distinct enunciation, but with emphasis and passionate hurry, as if in dread of interruption before concluding the brief but pregnant sentences that consigned me to the hangman and to hell.

Having related all that was necessary for the fullest judicial conviction, I fell prostrate in a swoon.

But why shall I say more? To-day I wear these chains, and am here. Tomorrow I shall be fetterless!—but *where?*

1. The story suggests that the narrator and the victim are connected through family or business ties because-

A. the narrator hates the victim.
B. the narrator is the victim's heir.
C. the narrator knows the victim's nighttime habits.
D. the narrator feels compelled to confess the murder.

2. When contemplating the murder, the narrator's **greatest** fear is-

A. that his victim will attack him instead.
B. that his victim will survive.
C. that he will get caught.
D. that he will burn down the building.

3. The words *candlestand* and *wax-light* in paragraph 1 indicate that this story takes place in-

A. a poor country.
B. a rural area.
C. the future.
D. the past

4. In paragraph 2, the narrator mentions various annoyances, such as ringing in the ears, memories, or music that gets stuck in our heads. The author **most likely** includes this information-

A. to build tension.
B. to change the subject.
C. to imply the narrator is mentally ill.
D. to show that the narrator is average.

5. In paragraph 3, the narrator **surprises** the reader by-

A. talking to himself.
B. thinking that he is safe.
C. wandering in the streets alone.
D. suggesting that he might confess.

6. At the beginning of paragraph 4, what causes the "icy chill" in the narrator's heart?

A. the fear that he had not gotten rid of all the evidence
B. the thought that he might lose all his money
C. the idea that he will confess to the crime
D. the sight of his victim's ghost on the street

7. The phrase "nightmare of the soul" suggests that the narrator-

A. is having a bad dream.
B. is deeply troubled.
C. has been hypnotized.
D. has a vivid imagination.

8. The author's repetition of "I" and his use of dashes at the beginning of paragraph 5 show that the narrator is-

A. missing the person he murdered.
B. forgetting where he hid the candle.
C. losing his composure and state of mind.
D. growing angry at the crowd's reproaches.

9. At the end of paragraph 5, who does the text imply that the narrator **most likely** thought struck him on the back?

A. a madman
B. a police officer
C. a member of the crowd
D. the ghost of his victim

10. In paragraph 5, how does the author **most** build tension?

A. He describes the narrator's growing panic.
B. He uses a flashback to the night of the murder.
C. He suggests that the narrator is having a nightmare.
D. He says the narrator whistled, laughed, and walked.

11. In paragraph 5, which phrase **best** contributes to the narrator's tone of panic and anxiety?

A. "uttered these words"
B. "gasped for breath"
C. "walked vigorously"
D. "formless shadow"

12. In paragraph 8, why does the narrator **most likely** say he will be "fetterless" tomorrow?

A. He will be set free.
B. He will escape from jail.
C. He will be hanged for his crime.
D. He will be sent to a mental hospital.

ANALYZING INFORMATIONAL TEXT

"Empty Bowls"
by Brian Jackson

According to the United Nations Food and Agriculture Organization (FAO), about 870 million people suffer from chronic hunger. That is one in every eight people, or about 13 percent of the world's population. Some people may think this is the result of a food shortage, but that's incorrect. In fact, the world produces enough food to feed everyone. The problem is that nutritious food is not always available where it is needed. Another reason so many people go hungry is economics. Many people simply cannot afford to buy the food they need. Charities and other organizations are needed to help people afford and have access to nutritious food. One of these organizations is the Empty Bowls Project.

In November 1990, an art teacher named John Hartom wanted to raise money for a local food bank. He had an idea: host a soup lunch at his school and ask for donations from other teachers. To make the event unique, he would use ceramic bowls made by the students in his ceramics class to serve the soup. His students got excited about the project and produced all the bowls that would be needed for the luncheon.

On the day of the lunch, after everyone had eaten, Hartom spoke to the group. He talked about the problem of hunger, pointing out that many people had empty bowls every day. He then invited the guests to keep their empty ceramic bowls to remind them of the hungry. "There was a moment of stunned silence," says Hartom, and he knew he had started something big.

People were deeply moved by the symbolism of the empty bowl. The following year, Hartom expanded the idea into the Empty Bowls Project. He and his wife drew up a set of guidelines for others to follow. Organizers of similar luncheons are welcome to use the Emp Bowls name, and they are not required to pay Empty Bowls for this privilege. One hundred percent of the money collected at an Empty Bowls event is given to local food banks, soup kitchens, and shelters. Each sponsoring organization decides where to donate the money. What had started out as a one-time event soon spread throughout the United States and Canada. Over the years, Empty Bowls events have raised tens of millions of dollars to help feed the hungry.

Next week, an Empty Bowls event will be held here in town. More than a dozen local artists donated bowls for the event. Why should you go? Because in the United States, one in six people suffer from hunger or food insecurity. Hungry children are more likely to get sick and do worse in school. If we want to keep this country great, then we need to keep this country full.

13. The author **explicitly** says that-

A. most people who suffer from hunger are children.
B. it costs a lot of money to ship food to areas that lack it.
C. one in every eight people suffers from chronic hunger.
D. the problem of hunger is especially devastating in Africa.

14. Which sentence **best** expresses the author's point of view?

A. John Hartom is a brilliant art teacher who has done much good in the world.
B. The Empty Bowls Project is a good idea that has had very positive results.
C. The problem of hunger in the world will probably never be solved.
D. It is terrible that so many people go hungry each day.

15. By opening with a discussion of world hunger and continuing with a description of the Empty Bowls Project, the author is using the format of

A. opinions and support.
B. compare and contrast.
C. cause and effect.
D. problem and solution.

16. Which sentence best describes the author's purpose in writing this essay?

A. The author wants to get people to organize Empty Bowls events in their communities.
B. The author wants to persuade readers to attend the Empty Bowls event in town.
C. The author wants to persuade artists to contribute to the Empty Bowls Project.
D. The author wants to inform readers about world hunger and possible solutions.

17. What is the connection between the Empty Bowls Project and world hunger?

A. The Empty Bowls Project is well on the way to solving the problem of world hunger.
B. The Empty Bowls Project donates bowls to soup kitchens, food banks, and shelters.
C. The Empty Bowls Project is an example of an organization that feeds the hungry.
D. The Empty Bowls Project produces food that is donated to feed the hungry.

18. Which word **best** describes the tone created by the use of statistics in paragraph 1?

A. formal
B. informal
C. solemn
D. light-hearted

19. Which sentence **best** supports the idea that the Empty Bowls Project is a nonprofit organization?

A. "He invited the guests to keep their empty ceramic bowls to remind them of the hungry."
B. "He and his wife drew up a set of guidelines for others to follow."
C. "Over the years, Empty Bowls events have raised tens of millions of dollars to help feed the hungry."
D. "One hundred percent of the money collected at an Empty Bowls event is given to local food banks, soup kitchens, and shelters."

20. In paragraph 4, the phrase "deeply moved" **most** contributes to-

A. an emotional tone.
B. a mournful tone.
C. a cheerful tone.
D. a serious tone.

21. Which paragraph could **best** be cited to support the idea that an empty bowl is a powerful symbol of hunger?

A. paragraph 1
B. paragraph 2
C. paragraph 4
D. paragraph 5

22. Which word or phrase from paragraph 3 **best** imparts a tone of wonder?

A. "problem of hunger"
B. "stunned silence"
C. "ceramic bowls"
D. "hungry"

23. In describing the evolution of the Empty Bowls Project, the author **most effectively** uses-

A. cause-and-effect order.
B. most important to least important order.
C. chronological order.
D. spatial order.

24. To **best** support the idea that the Empty Bowls Project has been very successful in achieving its goals, the author says that-

A. bowls can be made of glass, metal, and other materials.
B. events have raised tens of millions of dollars.
C. various organizations help feed the hungry.
D. John Hartom had a brilliant idea.

CONSTRUCTED RESPONSE

Directions: Using looseleaf or a computer, write a well-developed response to answer each question about the passages, supporting with evidence from the text(s).

25. Use evidence from the text of "The Imp of the Perverse" to describe how the character of the narrator changes from cold and calculating to guilt-ridden and paranoid.

26. Use the text of "Empty Bowls" to support the inference that John Hartom's motivations were to help others rather than to make money or earn fame for himself. Support your response with evidence from the text.

Part 2: VOCABULARY

Directions: Use context clues to answer the following questions.

27. What does the word *impertinent* mean in the first paragraph of "The Imp of the Perverse"?

A unimportant
B sentimental
C gruesome
D intellectual

28. What does *impunity* mean in the last sentence in paragraph 2 of "The Imp of the Perverse"?

A heavy burdens
B good luck
C lack of problems
D freedom from punishment

29. What does *chronic* mean in the first sentence of "Empty Bowls"?

A occasional
B constant
C weekly
D slight

30. The word *listlessly,* as used in paragraph 3 of "The Imp of the Perverse," suggests that the narrator-

A does not have much energy.
B has a long list of things to do.
C feels confident and strong.
D is in a cheerful mood.

31. The word *shriek,* as used in paragraph 5 of "The Imp of the Perverse," suggests the narrator-

A is apprehensive.
B is nervous.
C is cautious.
D is terrified.

32. The word *stunned*, as used in paragraph 3 of "Empty Bowls," suggests that people were-

A intrigued.
B astounded.
C confused.
D knocked out.

Part 3: REVISING AND EDITING

(1) It was early on a Saturday morning. (2) Unlike on most Saturdays, the hallways at the school bustled with activity. (3) The annual state music contest had arrived. (4) The place was packed with students carrying instruments and sheets of music. (5) Haley was panicked because she was one of the contestants. (6) She had butterflies in her stomach over the idea of singing her solo for the judges. (7) For months, she had practiced her song. (8) Now that the contest was here, though, the worst thing had happened. (9) She felt too nervous to perform!

(10) Haley had always had a nice voice. (11) She just couldn't get behind singing in public. (12) When her choir teacher had persuaded her to enter the contest, she was up for it. (13) Now, she just wanted an excuse to back out.

(14) As Haley paced in the hall, Leah moseyed up to her. (15) Leah was one of Haley's BFFs.

(16)"What's up with you, girl?" Leah cried. (17) "You look awful."

(18)"I can't sing for those judges," Haley replied. (19) "I'm scared. (20) Really scared. (21) Like might faint scared."

(22) Leah pursed her lips. (23) She knew Haley very well. (24) "Haley," she began, "when we were kids, you sang all the time. (25) Why did you do it?"

(26)Haley paused. (27) "Just because I liked it."

(28)"Yes!" Leah exclaimed. (29) "That's what matters. (30) When people realize it, they'll enjoy your singing, too!"

(31) Haley thought this over. (32) As usual, Leah had a point. (33) "You're right," Haley said. (34) "Let's do this thing!"

(35)"That's good," Leah cheered. (36) "Now, you better get warmed up."

(37)Haley started down the hall. (38) She glanced back at Leah with a smile.

(39)Then she charged to the warm-up room, loudly humming her song.

33. Which rewrite of sentence 3 **best** uses a noun clause to clarify the relationship between sentences 2 and 3?

A At last, the annual state music contest had arrived.
B The reason was that the annual state music contest had arrived.
C The annual state music contest had arrived, to everyone's delight.
D The annual state music contest, which everyone enjoyed, had arrived.

34. How might you rewrite sentence 6 to avoid using a colloquialism?

- **A** She had butterflies in her stomach when she thought of singing her solo for the judges.
- **B** She was a nervous Nellie over the idea of singing her solo for the judges.
- **C** She was nervous over the idea of singing her solo for the judges.
- **D** She felt super nervous about singing her solo for the judges.

35. How might you revise sentence 10 to include a noun clause?

- **A** Haley's voice had always been nice.
- **B** Haley had always known that she had a nice voice.
- **C** Haley had always had a nice voice, and everyone knew it.
- **D** Haley's voice, which was very nice, was suited for country music.

36. How might you rewrite sentence 11 to avoid using a colloquialism?

- **A** She just could not get behind singing in public.
- **B** She just couldn't get behind singing in front of people.
- **C** She just couldn't cozy up to the idea of singing in public.
- **D** She just did not like the idea of singing in public.

37. How might you rewrite sentence 12 to eliminate the colloquialism?

- **A** When her choir teacher had persuaded her to sign up for the contest, she was up for it.
- **B** When her choir teacher had suggested that she enter the competition, she was up for it.
- **C** When her choir teacher had persuaded her to enter the contest, she thought she could do it.
- **D** When her choir teacher had persuaded her to enter the contest, she was cool with the idea.

38. Which rewrite of sentence 14 removes the colloquialism?

- **A** As Haley paced the hall, Leah snuck up to her.
- **B** As Haley paced in the hall, Leah walked up to her.
- **C** As Haley paced in the hall, Leah moseyed over to her.
- **D** As Haley walked up and down in the hall, Leah moseyed up to her.

39. How might you rewrite sentence 15 to maintain a formal tone?

- **A** Leah and Haley were tight.
- **B** Leah and Haley were pals.
- **C** Leah and Haley went way back.
- **D** Leah was one of Haley's best friends.

40. How might you rewrite sentence 16 to maintain a formal tone?

A "What's bugging you?" Leah cried.
B "Tell me what's up," demanded Leah.
C "What's wrong with you, Haley?" Leah cried.
D "Turn that frown upside down!" Leah exclaimed.

41. How might you rewrite sentences 19–21 to maintain a formal tone?

A "I'm as scared as a turkey the day before Thanksgiving."
B "I'm so scared that I feel like I might faint."
C "I feel like a rat on a sinking ship."
D "It's so scary!"

42. How might you use a noun clause to clarify sentence 30?

A "When people realize it, they will enjoy your singing more, too!"
B "Because when people realize it, they will give you first prize!"
C "When people realize that you're enjoying what you're doing, they'll enjoy your singing, too!"
D "When people realize you're enjoying singing, they'll enjoy your singing, too!"

43. How might you rewrite sentence 34 to maintain a formal tone?

A "I'm all over it!"
B "I think I can do this!"
C "I'm down with that, for sure!"
D "This will be a piece of cake!"

44. How might you rewrite sentence 35 to include a noun clause?

A "That's good," Leah cheered as Haley smiled broadly.
B "That's good," Leah cheered, patting Haley on the back.
C "That's good," Leah cheered, feeling proud of her friend.
D "I think that's good," Leah cheered as Haley smiled broadly.

TASK 2

RESEARCH SIMULATION

Informative Essay

Your health teacher has asked the students in your class to write an informative essay about outdoor recreation. You have been assigned the topic of geocaching.

First you will review two articles about issues surrounding geocaching. After you have reviewed these sources, you will answer some questions about them. You should first skim the sources and the questions and then go back and read them carefully.

In Part 2, you will write an informative essay about geocaching and the controversy surrounding it.

Time Management: Informative Task

There are two parts to most formal writing tests. Both parts of the tests are timed, so it's important to use your limited time wisely.

Part 1: Read Sources and Answer Questions

Preview the Assignment

35 minutes

35 minutes! That's not much time.

You will have 35 minutes to read two sources about geocaching. You will also answer questions about these two sources.

Preview the questions so you'll know which information you'll need to find as you read.

How Many?

How many pages of reading?	
How many multiple-choice questions?	
How many prose constructed-response questions?	

How do you plan to use the 35 minutes?

Underline, circle, and take notes as you read. You probably won't have time to reread.

This is a lot to do in a short time.

Estimated time to read:	
Source #1: "Geocaching"	minutes
Source #2: "Seattle Firm's GPS Scavenger-Hunt Game Stirs Controversy"	minutes
Estimated time to answer questions?	minutes
Total	**35 minutes**

Any concerns?

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Part 2: Write the Essay

85

How much time do you have? Pay attention to the clock.

Plan and Write an Informative Essay

85 minutes

You will have 85 minutes to plan, write, revise, and edit your essay.

Your Plan

Before you start writing, think about the main idea of your essay. What is the most important point you want to make?

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How do you plan to use the 85 minutes?

Be sure to leave enough time for this step.

Estimated time for planning the essay?		minutes
Estimated time for writing?		minutes
Estimated time for editing?		minutes
Estimated time for checking spelling, grammar, and punctuation?		minutes
Total	**85**	**minutes**

Notes:

Reread your essay, making sure that the points are clear. Check that there are no spelling or punctuation mistakes.

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Your Assignment

You are preparing to write an informative essay on geocaching for health class. In researching the topic, you have identified two sources you will use in planning your essay.

After you have reviewed the sources, you must answer some questions about them. Briefly skim the sources and questions that follow. Then, go back and read the sources carefully so you will have the information you will need to answer the questions. Take notes on the sources as you read. You may refer back to your notes at any time during Part 1 or Part 2 of the performance task.

Part 1 (35 minutes)

You will now read the sources. After carefully reading the sources, use the rest of the time in Part 1 to answer the three questions about them. Though your answers to these questions will help you think about what you have read and plan your essay, they will also be scored as part of the test.

SOURCE #1:
Geocaching

by Amanda Briney,
Geography Guide for *About.com* *August 2, 2009*

Geocaching is a worldwide outdoor hide-and-seek activity where participants use global positioning system (GPS) technology and latitude and longitude coordinates to locate containers, called geocaches or caches, that can be hidden anywhere in the world—from remote cliffs to along major highways. There are currently over 860,000 active geocaches located in over 100 countries on all continents, including Antarctica.

The word geocaching itself is derived from the use of "geo" for geography and "caching" as the process of hiding a cache. Cache is a term used in computer technology terms to mean the storage of information in a computer's memory, but in hiking and camping the same term is applied to a hiding place for supplies. Thus when combined, geocaching means the use of geography, in this case GPS and maps, to find hidden containers.

History of Geocaching

Although similar to the older sports of letterboxing and orienteering in that it requires participants to navigate through unfamiliar terrain, geocaching is a relatively new activity. This is because it uses GPS and satellites to navigate and prior to the year 2000, GPS receivers were not accurate enough to allow users to find small objects with a set of geographic coordinates. Before that year, selective availability, or the intentional disruption of satellite signals to GPS units causing errors of up to 328 feet (100 m), was in place for United States security purposes. On May 1, 2000 though, selective availability was turned off and almost immediately, the accuracy of personal GPS receivers increased.

With the removal of selective availability and increased accuracy with GPS, small objects could be more easily located with a set of geographic coordinates. On May 3, 2000, Dave Ulmer, a computer consultant from Oregon, hid a navigational target (a black bucket containing various prizes and a logbook) in the woods to test the new GPS accuracy. He posted the coordinates of his target which were, N 45° 17.460 and W 122°24.800, online and within three days, two different users found the target.

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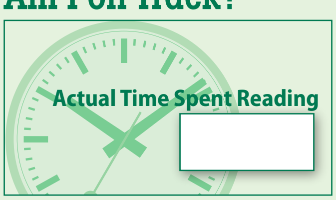
The first person to find Ulmer's target was Mike Teague of Vancouver, Washington. Upon finding this target, he began looking up other newly placed targets around the world documenting them on his website. He then created a mailing list called "GPS Stash Hunt" to inform other users of new targets and the activity quickly grew in popularity.

Shortly thereafter, interested users began discussing different names for the activity because they believed "stash" could have a negative connotation and on May 30, 2000, Matt Stum suggested the name geocaching. "Geo," he said could be used to describe the geographic and global nature of the activity, while cache's meaning as a hiding place for items could be applied to the hiding of a target. In September 2000, geocaching became the official name for the activity and since then participation has grown worldwide.

Am I on Track?



ANCHOR TEXT

SOURCE #2:

Seattle Firm's GPS Scavenger-Hunt Game Stirs Controversy

by James Gunsalus, *Bloomberg News*   *November 14, 2006*

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Aaron McCain and his 9-year-old son rifled through a battered box containing rubber balls, napkin holders and plastic army men high on a pass near Mount Baker.

Using a handheld Global Positioning System device, the two had hiked miles to Excelsior Pass to find the hidden loot as part of a global scavenger hunt run by Seattle-based Geocaching.com. Players post coordinates on the Web site telling where they have hidden objects and challenge others to find the "caches" using GPS devices.

The adventure game, called "geocaching," started six years ago in the Pacific Northwest and now counts more than 328,000 caches in 222 countries, the Web site says. The activity pushes people outdoors, although some parkland managers say they worry about its impact on sites ranging from sensitive forestlands to historic cemeteries.

Geocaching.com is the brainchild of Jeremy Irish, 33, a computer-software programmer who went on GPS scavenger hunts as a hobby. He quit his job at Savishopper.com, an online clothing store, to start the Web site in 2000.

His company, Groundspeak, employs 12 and has 500,000 registered users. He charges $30 a year for membership access to detailed, interactive maps that help gamers navigate rough terrain and rivers.

The closely held company is profitable, though Irish said he isn't getting rich.

"I'm still living a meager lifestyle," he said. "We put the money back into the company."

GPS devices only recently have gone mainstream. The satellite navigation system was developed by the U.S. Defense Department, with the first launch in 1978. The U.S. Air Force disrupted signals for civilian users until 2000.

U.S. sales of the GPS units were $42.3 million last year, compared with $16.7 million in 2002, according to the Boulder, Colo.-based Outdoor Industry Association's Web site.

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Geocaching has stirred some controversy, however.

"If it's done right, it's actually a pretty good tool to introduce people to hiking and learning navigational skills," said the U.S. Forest Service's Gary Walker, lead climbing ranger on Mount St. Helens. "But I've also seen caches put on private property and people tromping all around looking for them."

The 242,000-acre Three Sisters Wilderness Area in Oregon banned geocaching in 2002. South Carolina has proposed fining people $100 for placing caches without permission in cemeteries or at historic sites.

"Land managers get nervous about people wandering around in wilderness and want to keep them on trails," said Robert Speik, 78, a Bend, Ore., climbing instructor who fought a proposed ban in the nearby Badlands forest. "They lose sight of the fact that wilderness is where you wander."

McCain, a 32-year-old engineer who lives in Bellingham, said his family is responsible when hunting for caches.

"Finding the actual cache was pretty low on the list of exciting things that day," McCain said of his recent Excelsior Pass trip. "I got a six-mile hike with my son, I saw the first colors of the fall and a peek at Mount Baker."

But geocaching bothers those who say satellites and computer screens interfere with the outdoors experience. The race to find caches sacrifices the slower pace needed to appreciate nature, said Scott Silver, director of Wild Wilderness, a nonprofit group in Bend.

Custodians for public lands in the Pacific Northwest wrestle with how to accommodate both sides.

The U.S. Bureau of Land Management proposed closing the 32,000-acre Badlands to geocachers in 2003, then yielded after enthusiasts complained. Recreation manager Greg Currie says the bureau may revisit the issue.

"It places a big demand on the land managers to police these things, and we don't have staff or time for it."

Irish's Web site encourages geocachers to "Cache In, Trash Out"—that is, collect litter on trails. Manuals that come with some GPS devices include such tips as respecting private property and staying on trails.

Irish said he isn't worried about outdoor purists curbing the game's growth. Every January he doubles his computer-storage capacity as people receive that new handheld Christmas present.

"The idea of being a tech geek outside seemed like a good idea to me," he said. "I don't think I'm alone there."

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Am I on Track?

Part 1 Questions

Answer the following questions. Your answers to these questions will be scored. You may refer to your reading notes, and you should cite text evidence in your responses. You will be able to refer to your answers as you write your essay in Part 2.

1 **Prose Constructed-Response** Explain what geocaching is and what is required for the activity. Support your response with evidence from both sources.

2 Which of the following statements explains why geocaching is controversial?

a. The word *cache* has a negative connotation.

b. Geocachers have a tendency to take nature for granted.

c. Outdoor purists are curbing the game's growth.

d. Some people are disrespectful when they hide or hunt for caches.

3 Which piece of evidence best supports your answer to Question 2?

a. "Shortly thereafter, interested users began discussing different names for the activity . . ." (Source #1, lines 42–43)

b. "Manuals that come with some GPS devices include such tips as respecting private property and staying on trails." (Source #2, lines 65–66)

c. "Every January he doubles his computer-storage capacity as people receive that new handheld Christmas present." (Source #2, lines 68–69)

d. "Dave Ulmer, a computer consultant from Oregon, hid a navigational target . . . in the woods to test the new GPS accuracy." (Source #1, lines 30–33)

▶ Part 2 (85 minutes)

You will have 85 minutes to review your notes and sources, plan, draft, edit, and revise your essay. While you may use your notes and refer to the sources, your essay must represent your original work. You may refer to your responses to Part 1, but you cannot change those answers. Now read your assignment and the information about how your writing will be scored; then begin your work.

Your Assignment

It is time to start writing your informative essay about outdoor recreation. Your essay should explain what geocaching is and the controversy that surrounds it. When writing your essay, find ways to use information from the two sources to support your thesis. Be sure to present your ideas in a logical order.

Informative Essay Scoring

Your essay will be scored using the following:

1. **Organization/purpose:** How well did you state your thesis and support your thesis with a logical progression of ideas? Did you use a variety of transitions between ideas? Was your focus narrow enough to lead to a well-formed conclusion?
2. **Evidence/elaboration:** How well did you incorporate relevant information from the sources? How well did you elaborate your ideas? Did you use precise language appropriate to your audience and purpose?
3. **Conventions:** How well did you follow the rules of grammar, punctuation, capitalization, and spelling?

Now begin work on your essay. Manage your time carefully so that you can:

- plan your essay, using your notes
- write your essay
- revise and edit your final draft

High School Math Packet

Note: This math packet will help any high school student with the necessary math skills needed in any high school math course, as well as, portions of the LEAP 2025 State Assessment (**Algebra I and Geometry**) and ACT Math Section.

Content Page

Algebra (I, II, and III)

- Equations of a line
- Addition and Subtraction of Radicals
- Factoring by grouping
- Exponents

Geometry

Circle---Chords, Secants and Tangents

Number and Quantity

- Basic Matrix Operation
- Vectors

Trigonometry

- Unit Circle

Additional Topics

- Ratios and Proportions

***Helpful Video(s): Khan Academy, ACT, MathLearnZillion, and Fort Bend Tutoring**

- **These videos can be watch from a computer, cell phone and iPad.**

Equations of a line

Model Problem 1

1) What is the equation of a line with a slope of 3 that goes through the point (2,8)?

Step 1) substitute slope into equation	**$y = mx + b$** **$y = 3x + b$**
Step 2) substitute (2,8) into equation	**$8 = 3(2) + b$**
Step 3) solve for b	**$8 = 6 + b$** **$2 = b$**
Step 4) Insert B into equation	**$y = 3x + 2$**

Model problem 2

What is an equation for the line that passes through the coordinates (4,5) and (8, 3)?

1) Calculate Slope

$$\frac{3-5}{8-4} \quad \frac{-2}{4} \quad -\frac{1}{2}$$

2)Plug it into the slope intercept formula: $y = -\frac{1}{2}x + b$

3) Plug th x and y given in the question into the slope intercept formula

4) Solve for b

$5 = -\frac{1}{2}x + b$

$5 = -\frac{1}{2}(4) + b$

$5 = -2 + b$

$+2 \quad +2$

$7 = b$

5) Rewrite equation in slope intercept form

$y = -\frac{1}{2}x + 7$

Model Problem 3)
Write the equation of a line that is parallel to y = 2x + 3 and passes through the points (6,2).

Step 1) plug slope *the slope intercept formula*:

y = mx + b
y = 2x + b

2) Plug the x and y given in the question into the slope intercept formula 2 = 2(6) + b

3) Solve for b

$2 = 12 + b$
$-12 = -12$
$-10 = b$

5) Rewrite equation with only slope and y-intercept y = 2x – 10

Model Problem 4)

Write the equation of a line that is perpendicular to $y = \frac{1}{2}x - 6$ and passes through the point (6,4)?

Step 1) find the negative reciprocal of the slope

Slope = $\frac{1}{2}$

Negative reciprocal -2

2) Plug the x and y given in the question into slope intercept formula

$4 = -2(6) + b$

3) Solve for b

$$\begin{aligned} 4 &= -12 + b \\ +12 &= +12 \\ \hline 16 &= b \end{aligned}$$

4) Rewrite equation in slope intercept form

$y = -2x + 16$

Mixed Review on Linear Equations

Practice

1) What is the equation of a line with a slope of 3 that goes through the point (2,8)? **(see Model Problem 1 if you're stuck)**

2) What is the equation of a line through the point (1,3) that has a slope of -2?

3) What is the equation of a line through the point (-2, 3) that has a slope of 4?

4) What is the equation of a line through the point (1,3) that has a slope of -2?

5) What is an equation for the line that passes through the coordinates (4,5) and (8, 3)? **(see Model Problem 2 if you're stuck)**

6) What is an equation for the line that passes through the coordinates (-1,2) and (7,6)?

7) Find the equation of the line that passes through the points (1,1) and (3,5)?

8) Write the equation of a line that is parallel to $y = 2x + 3$ and passes through the points (6,2). (**See Model Problem 3 if you're stuck)**

9) Find the equation of line parallel to $y = 2x + 7$ and that goes through the point (4, 12)?

10)Find the equation of a line parallel to $y = 4x + 12$ that goes through the point (1,9)?

11) Write the equation of a line that is perpendicular to $y = \frac{1}{2}x - 6$ that passes through the point (6,4)? (**See Model Problem 4 if you're stuck)**

12) Write the equation of a line that is perpendicular to $y = \frac{3}{2}x - 3$ that passes through the point (6,7) ?

13) Write the equation of a line that is perpendicular to $y = -2x + 4$ that passes through the point (8, 8).

Addition and Subtraction of Radicals

I. Model Problems

In these examples we will practice adding and subtracting radicals.

Example 1: $\mathbf{3\sqrt{2} + 4\sqrt{3} - 5\sqrt{2} + 6\sqrt{3} + 7\sqrt{5}}$

First simplify each term and change subtraction to addition of the opposite. For this example all the terms are simplified.

$$3\sqrt{2} + 4\sqrt{3} + -5\sqrt{2} + 6\sqrt{3} + 7\sqrt{5}$$

Radical expression with the **same radicand** can be combined by adding the coefficients. Identify radical expressions with the same radicand.

$$3\sqrt{2} + 4\sqrt{3} + -5\sqrt{2} + 6\sqrt{3} + 7\sqrt{5}$$

Add the coefficients.

$$(3 + -5)\sqrt{2} + (4 + 6)\sqrt{3} + 7\sqrt{5}$$
$$-2\sqrt{2} + 10\sqrt{3} + 7\sqrt{5}$$

Answer: $-2\sqrt{2} + 10\sqrt{3} + 7\sqrt{5}$

Example 2: $\mathbf{5\sqrt{12} - 8\sqrt{45} - 7\sqrt{20} + 16\sqrt{48} + 17\sqrt{80}}$

First simplify each term and change subtraction to addition of the opposite.

$$5\sqrt{12} - 8\sqrt{45} - 7\sqrt{20} + 16\sqrt{48} + 17\sqrt{80}$$
$$5\sqrt{4\cdot 3} + -8\sqrt{9\cdot 5} + -7\sqrt{4\cdot 5} + 16\sqrt{16\cdot 3} + 17\sqrt{16\cdot 5}$$
$$5\cdot 2\sqrt{3} + -8\cdot 3\sqrt{5} + -7\cdot 2\sqrt{5} + 16\cdot 4\sqrt{3} + 17\cdot 4\sqrt{5}$$
$$10\sqrt{3} + -24\sqrt{5} + -14\sqrt{5} + 64\sqrt{3} + 68\sqrt{5}$$

Radical expression with the same radicand can be combined by adding the coefficients. Identify radical expressions with the same radicand.

$$10\sqrt{3} + -24\sqrt{5} + -14\sqrt{5} + 64\sqrt{3} + 68\sqrt{5}$$

Add the coefficients.

$$(10 + -14)\sqrt{3} + (-24 + -14 + 68)\sqrt{3}$$
$$-4\sqrt{3} + 30\sqrt{5}$$

Answer: $-4\sqrt{3} + 30\sqrt{5}$

II. Practice Problems

Simplify.

1. $5\sqrt{2}+3\sqrt{2}$
2. $4\sqrt{5}-7\sqrt{5}$
3. $2\sqrt{5}+4\sqrt{3}-3\sqrt{5}$
4. $7\sqrt{11}+5\sqrt{13}+4\sqrt{13}-8\sqrt{11}+\sqrt{11}$
5. $-2\sqrt{6}+12\sqrt{5}+4\sqrt{6}-18\sqrt{5}+3\sqrt{3}$
6. $7\sqrt{35}+16\sqrt{5}-8\sqrt{7}+4\sqrt{5}-\sqrt{35}$
7. $2\sqrt{20}+2\sqrt{48}-3\sqrt{3}-3\sqrt{8}$
8. $6\sqrt{27}-5\sqrt{63}-\sqrt{343}+7\sqrt{12}$
9. $-3\sqrt{18}+7\sqrt{75}-6\sqrt{8}+3\sqrt{12}$
10. $3\sqrt{8}+2\sqrt{72}-2\sqrt{20}-9\sqrt{8}$
11. $\sqrt{45}+2\sqrt{8}+2\sqrt{30}$

12. Find and explain the mistake in the following:

$$3\sqrt{5}+6\sqrt{5}$$

$$9\sqrt{10}$$

Factoring by grouping

I. Model Problems

The following example shows factoring by grouping.

Example 1: **Factor**

$\mathbf{6x^2 + 4xb + 15xv + 10bv}$ First group pairs of terms that have common factors. $6x^2 + 4xb + 15xy + 10by$

There may be more than one way to do this.

Factor the GCF from each group. $2x(3x + 2b) + 5y(3x + 2b)$

Factor the common factor which is a binomial. $(3x + 2b)(2x + 5y)$

Answer: $(3x + 2b)(2x + 5y)$

Example 2: **Factor** $\mathbf{a^2bc + ab^2 - acd - bd}$

First group pairs of terms that have common factors. $\mathbf{a^2bc + ab^2 - acd - bd}$

There may be more than one way to do this. Factor the GCF from each group.

Notice the sign changes for the second group. $ab(ac + b) - d(ac + b)$

Factor the common factor which is a binomial. $(ac + b)(ab - d)$

Answer: $(ac + b)(ab - d)$

II. Practice Problems

Factor.

1. xc + xb + yc + yb
2. ax - 2xb + 4a - 8b
3. 10xy + 14x + 15y + 21
4. 24ac + 54ad + 28bc + 63bd
5. 10xz – 65x + 8yz- 52y
6. $18a^2$ -12ac + 21ab – 14bc
7. $24a^2$ + 32a + 6ab +8b
8. $12x^2$ + 21cx + 4x + 7c
9. $9x^2$ + 15ax - 15xy - 25ay

10. Find and explain the error.

Problem:	$\mathbf{8xy - 8z + 7z - 7y}$
Step 1:	$(8xy - 8z) + (7z - 7y)$
Step 2:	$8x(y - z) + 7(z - y)$
Step 3:	$(8x + 7)(y - z)$

Exponents

Overview This exponents worksheet focuses on two of the main rules for exponents and asks students to apply both of these rules (see below) to various types of problems.

Exponent rule 1: multiplying exponents i.e. $x^a \cdot x^b = x^{a+b}$

Exponent rule 2: exponents of exponents i.e. $(x^a)^b = x^{a \cdot b}$

Questions range in difficulty and the concluding questions include higher level thinking about the rules of exponents in math.

Exponents Worksheet

I. Directions: *Rewrite each question below without the exponents and simplify.* ***Exponent Rule one***

1) $2^2 \cdot 2^3 =$

2) $2^2 \cdot 2^4 =$

3) $2^2 \cdot 2^5 =$

4) $2^2 \cdot 2^6 =$

5) $2^3 \cdot 2^5 =$

6) $3^2 \cdot 3^3 =$

From Numbers to letters!

7) $x^2 \cdot x^3 =$

8) $x^4 \cdot x^3 =$

9) $x^{12} \cdot x^3 =$

10) $x^6 \cdot x^{20} =$

GENERAL SUMMARY: Fill in the blank: $x^a \cdot x^b = x^{a+b}$

Part II

Directions: Exponent Rule 2

11) $(x)^2 =$

12) $(2^2)^2 =$

13) $(2^2)^3 =$

14) $(2^2)^4 =$

15) $(3^2)^3 =$

16) $(x^2)^3 =$

17) $(x^5)^2 =$

18) $(x^3)^4 =$

19) $(x^5)^4 =$

20) $(x^{10})^4 =$

GENERAL SUMMARY: Fill in the blank: $(x^a)^b = x^{a \cdot b}$

Putting It all Together!

III. Simplify:

21) $x \cdot (x^2)^3 =$

22) $x^3 \cdot (x^5)^2 =$

23) $z^{12} \cdot (z^6)^5 =$

24) $z \cdot (z^{11})^5 =$

25) Find the product of $(z^3)^2$ and $(z^3)^4$

26) $z \cdot (z^3)^0 =$

Determine what number could replace the question mark

Example: $(x^{10})^2 = x^{17} \cdot x^?$

Example2: $(x^{12})^3 = x^{29} \cdot x^?$

27) $(x^2)^3 = x^2 \cdot x^?$

28) $(x^3)^2 = x^5 \cdot x^?$

29) $(x^5)^2 = x^3 \cdot x^?$

30) $(x^2)^? = x^4 \cdot x^{22}$

31) $(x^3)^? = x^5 \cdot x^7$

32) $(x^4)^? = x^5 \cdot x^{12}$

33) $(x^?)^3 = x^2 \cdot x^{12}$

34) $(x^?)^2 = x^5 \cdot x^{20}$

35) How many different pairs of integers could replace the question marks below?

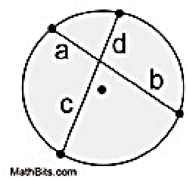
$(x^?)^? = x^{12} \cdot x^6$

Geometry

G.C.A.2: Circle---Chords, Secants and Tangents

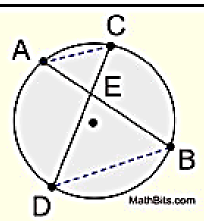
Theorems:

THEOREM: If two chords intersect in a circle, the product of the lengths of the segments of one chord equal the product of the segments of the other.



Intersecting Chords Formula:
(segment piece) x (segment piece) =
(segment piece) x (segment piece)

Formula: $a \bullet b = c \bullet d$



Given: $\overline{AB}$ intersects $\overline{CD}$

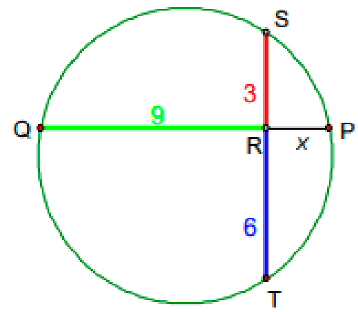
Prove: $AE \times EB = DE \times EC$

Proof:

1. $\overline{AB}$ intersects $\overline{CD}$ — 1. Given
2. Draw $\overline{AC}$, $\overline{BD}$ — 2. Two pts. determine only 1 line.
3. $\angle A \cong \angle D, \angle C \cong \angle B$ — 3. If 2 inscribed $\angle$s intercept the same arc, the $\angle$s are congruent.
4. $\Delta EAC \sim \Delta EDB$ — 4. AA for Similarity of Δs
5. $\frac{EC}{EB} = \frac{AE}{DE}$ — 5. Corresponding sides of $\sim \Delta$s are in proportion.
6. $AE \times EB = DE \times EC$ — 6. In a proportion, product of means = product of extremes.

Ex. 1: Finding Segment Lengths

- Chords $\overline{ST}$ and $\overline{PQ}$ intersect inside the circle. Find the value of x.



$$RQ \cdot RP = RS \cdot RT$$

$$9 \cdot x = 3 \cdot 6$$

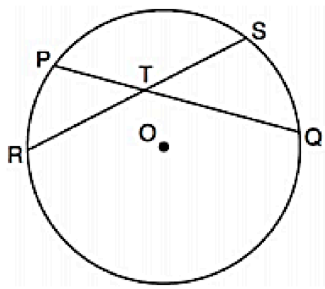
$$9x = 18$$

$$x = 2$$

Practice

Choose the correct numerical choice

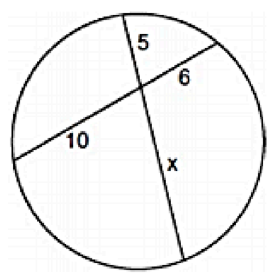
1 In the diagram below, chords $\overline{PQ}$ and $\overline{RS}$ of circle O intersect at T.



Which relationship must always be true?

1) $RT = TQ$
2) $RT = TS$
3) $RT + TS = PT + TQ$
4) $RT \times TS = PT \times TQ$

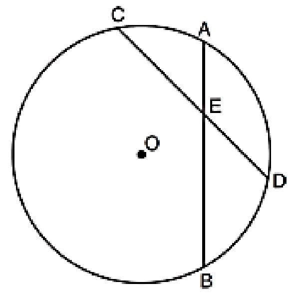
2 The accompanying diagram shows two intersecting paths within a circular garden.



What is the length of the portion of the path marked x?

1) $8\frac{1}{3}$
2) 11
3) 3
4) 12

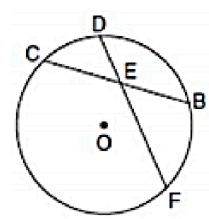
3 In the diagram below of circle O, chords $\overline{AB}$ and $\overline{CD}$ intersect at E.



If $CE = 10$, $ED = 6$, and $AE = 4$, what is the length of $\overline{EB}$?

1) 15
2) 12
3) 6.7
4) 2.4

4 In the diagram below of circle O, chord $\overline{DF}$ bisects chord $\overline{BC}$ at E.



If $BC = 12$ and FE is 5 more than DE, then FE is

1) 13
2) 9
3) 6
4) 4

Basic Matrix Operations

Matrices

A Matrix is an array of numbers:

$$\begin{bmatrix} 6 & 4 & 24 \\ 1 & -9 & 8 \end{bmatrix}$$

A Matrix

(This one has 2 Rows and 3 Columns)

> We talk about one **matrix**, or several **matrices**.

There are many things we can do with them ...

Adding

To add two matrices: add the numbers in the matching positions:

3+4=7

$$\begin{bmatrix} 3 & 8 \\ 4 & 6 \end{bmatrix} + \begin{bmatrix} 4 & 0 \\ 1 & -9 \end{bmatrix} = \begin{bmatrix} 7 & 8 \\ 5 & -3 \end{bmatrix}$$

These are the calculations:

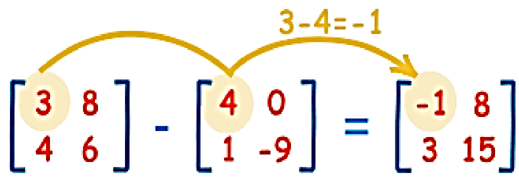
3+4=7	8+0=8
4+1=5	6−9=−3

The two matrices must be the same size, i.e. the rows must match in size, and the columns must match in size.

> Example: a matrix with **3 rows** and **5 columns** can be added to another matrix of **3 rows** and **5 columns**.
>
> But it could not be added to a matrix with **3 rows** and **4 columns** (the columns don't match in size)

Subtracting

To subtract two matrices: subtract the numbers in the matching positions:



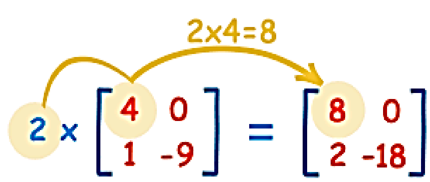
These are the calculations:

3−4=−1	8−0=8
4−1=3	6−(−9)=15

*Note: subtracting is actually defined as the **addition** of a negative matrix: A + (−B)*

Multiply by a Constant

We can multiply a matrix by a **constant** *(the value 2 in this case)*:



These are the calculations:

2×4=8	2×0=0
2×1=2	2×−9=−18

We call the constant a **scalar**, so officially this is called "scalar multiplication".

Basic Matrix Operation

Simplify.   Write "undefined" for expressions that are undefined.

1) $\begin{bmatrix} 3 & 6 \\ -1 & -3 \\ -5 & -1 \end{bmatrix} + \begin{bmatrix} 0 & -1 \\ 6 & 0 \\ 2 & 3 \end{bmatrix}$

2) $\begin{bmatrix} -5 & 2 & -2 \\ 4 & -2 & 0 \end{bmatrix} - \begin{bmatrix} 6 & -5 & -6 \\ 1 & 3 & -3 \end{bmatrix}$

3) $-5\begin{bmatrix} 5 & 6 & -4 \\ 4 & -2 & -1 \end{bmatrix}$

4) $-5\begin{bmatrix} -3 & 0 \\ 0 & 5 \end{bmatrix}$

5) $\begin{bmatrix} 4 & 2 \end{bmatrix} + \begin{bmatrix} -2 & -6 \end{bmatrix}$

6) $5\begin{bmatrix} 4 \\ 3 \end{bmatrix}$

7) $-5\begin{bmatrix} 1 & -2 & -1 & 2 \end{bmatrix}$

8) $5\begin{bmatrix} 5 & 1 \\ 1 & -2 \\ 1 & 2 \end{bmatrix}$

9) $-2u\begin{bmatrix} 7u & 3w^2 & 5u & 5 \end{bmatrix}$

10) $\begin{bmatrix} 2 \\ 4 \end{bmatrix} + \begin{bmatrix} 5 \\ 6 \end{bmatrix}$

11) $4\begin{bmatrix} -4 \\ 3 \\ -5 \end{bmatrix}$

12) $\begin{bmatrix} -4n & n+m \\ -2n & -4n \end{bmatrix} + \begin{bmatrix} 4 & -5 \\ 3m & 0 \end{bmatrix}$

MATHEMATICAL VECTOR ADDITION

Part One: The Basics

When combining two vectors that act at a right angle to each other, you are able to use some basic geometry to find the magnitude and direction of the resultant. What is a resultant? A resultant is the sum of the addition of two vectors. Since the vectors both have magnitude and direction, so does the resultant.

When adding vectors, it is important to make a sketch of the vectors involved so as to visualize the problem. There are some special rules for adding vectors that make it easier to work with them.

1) First of all you can only add vectors that measure the same type of quantity. For example you can add two velocity vectors together or two acceleration vectors together, but you cannot add a velocity vector with an acceleration vector. This is the old adding apples and oranges dilemma.

2) Always draw your vectors as arrows with the point in the direction that the vector is going. Also try to draw your vectors to relative scale. A 4-meter vector should not be longer than a 20-meter vector.

3) You can always move a vector around so long as you follow two important rules.

   You cannot change the magnitude of the vector.
   You cannot change the direction of the vector.

4) When drawing your diagram, always draw the vectors tail to head.

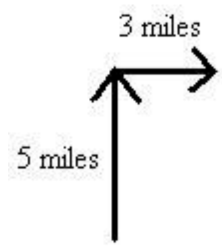
5) The resultant is drawn from the tail of then first vector to the head of the last vector.

Let's do an example.

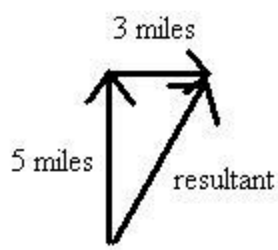
A man walks 5 miles north and 3 miles east.

1 Draw the first vector.

2 Draw the second vector starting at the head of the first.



3. Draw the resultant, starting at the tail of the first and ending at the head of the last.



Now you try some and check your diagrams with the pictures at the bottom of the page.

1) 15 m/s west and 28 m/s south

2) 2.3 m/s^2 west and 4.2 m/s^2 north

3) 3.5 m/s north and 8.5 m/s north

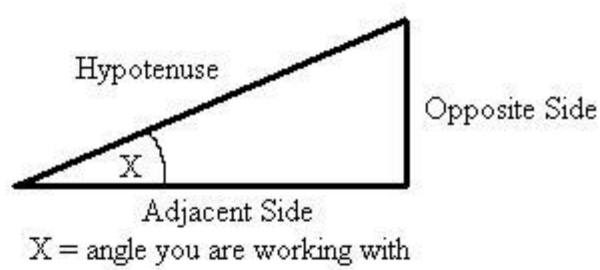
4) 35 miles east and 10 miles west

Part Two: Math and Vectors

If two vectors are in the same direction the resultant is simply the addition of the two magnitudes and the direction of the resultant is the direction they are both heading. This is like an airplane with a tail wind (the wind is blowing in the same direction the plane is traveling) or a boat heading downstream. If the vectors are in opposite directions, the magnitudes are subtracted and the direction of the resultant is the direction of the larger vector. This is like an airplane flying into a head wind (the wind is blowing into the front of the plane) or a boat heading upstream.

You may notice that the other case of vector combination is when the diagram forms a right triangle. Vectors don't always form right triangles, but let's leave that for later – much later. A right triangle is a triangle in which there is a right angle (90°). There are some neat properties of right triangles that make them easy to work with mathematically. So let's look at right triangles.

First, you need to know some definitions. The longest side of the triangle is called the hypotenuse. It is always across from the right angle. Of the two remaining angles, you will pick one to work with. The side that is not a part of that angle is called the opposite side and the side that is a part of the angle is called the adjacent side. Check out the diagram below.



Part Three: Pythagoras and Vectors

If your vectors form aright triangle in the diagram, you can find the magnitude of the resultant by using the Pythagorean Theorem. The Pythagorean Theorem is

$a^2 + b^2 = c^2$, where c is the hypotenuse and a and b are the opposite and adjacent sides. Since you are looking for the magnitude of the hypotenuse, you need to rearrange the

equation to $c^2 = \sqrt{a^2 + b^2}$. Use the steps below to use this equation.

Step 1. Square the length of the opposite side.

Step 2. Square the length of the adjacent side.

Step 3. Add the answers from Steps 1 and 2.

Step 4. Take the square root of the sum from Step 3.

Now try some examples. Find the **magnitudes** or the resultants for the flowing pairs of vectors.

1 12 miles east and 6 miles north

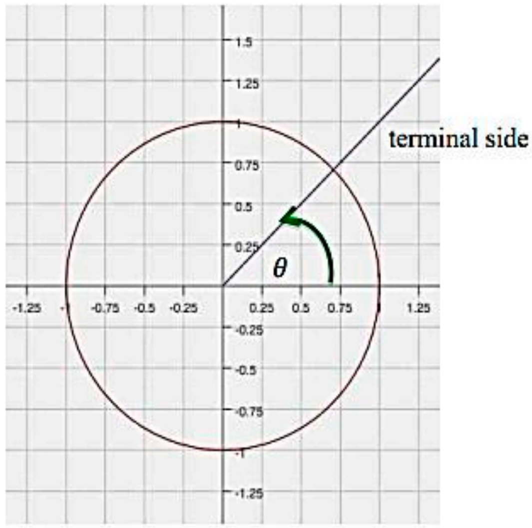
2 8 miles south and 5 miles west

3 11 m/s west and 5 m/s north

4 3.5 m/s^2 west and 6.5 m/s^2 south

Trigonometry: Unit Circle

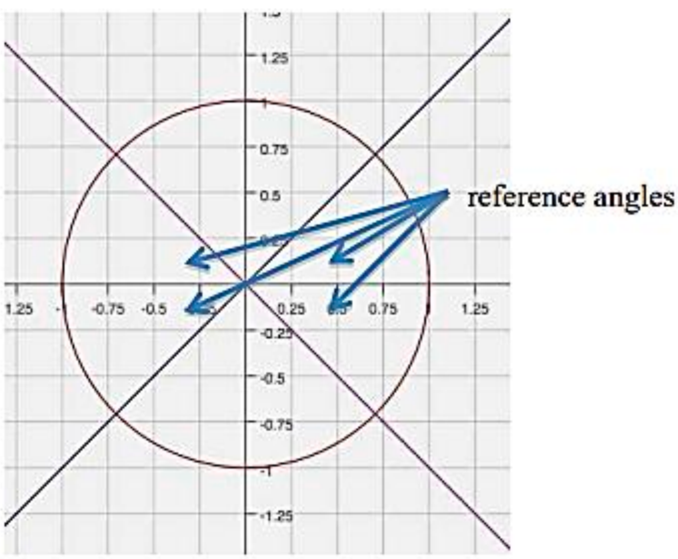
Unit Circle: circle on coordinate plane with center (0,0) with radius equal to 1.



The angel, θ, is positive measured counterclockwise from x- axis counter-clockwise to terminal side. The angel, θ, is negative measured clockwise from x- axis counter-clockwise to terminal side.

Radian measure of an angle is the arc length of angle on a unit circle.

Reference angel is the measure of the angle from terminal side to x-axis. The reference angel is always less than or equal to 90° $\left(\frac{\pi}{2}\right)$.



In these examples we will change from degree to radian measures.

***Example 1*: Change 210° to radian measure.**

$180° = \pi$; Because we want to cancel the degree measure use the conversion factor $\frac{\pi}{180°}$.

$$210°\left(\frac{\pi}{180°}\right)$$

Simplify.

$$210°\left(\frac{\pi}{180°}\right) = \frac{7\pi}{6}$$

Answer: $\frac{7\pi}{6}$

***Example 2*: Change $\frac{\pi}{3}$ to degree measure.**

$180° = \pi$; Because we want to cancel the radian measure use the conversion factor $\frac{180°}{\pi}$.

$$\frac{\pi}{3}\left(\frac{180°}{\pi}\right)$$

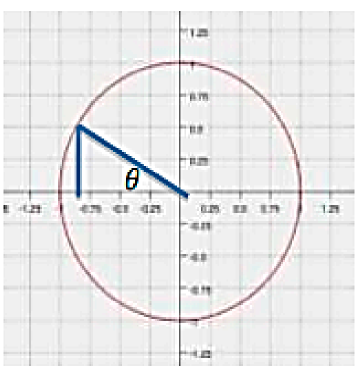
Simplify.

$$\frac{\pi}{3}\left(\frac{180°}{\pi}\right) = 60°$$

Answer: 60°

In this example we will find the angle given the terminal side's endpoint on the unit circle.

***Example 3*: Find the angle determined by a terminal side with endpoint $\left(\frac{-\sqrt{3}}{2}, \frac{1}{2}\right)$.**



Draw triangle of terminal side. Radius equals 1. Height equals $\frac{1}{2}$.

$$\sin\theta = \frac{\left(\frac{1}{2}\right)}{1}$$

$$\sin^{-1}\frac{1}{2} = \theta$$

$$\theta = 30°$$

Find reference angle using trig functions.

The angle is $180° - 30° = 150°$

Answer: 150°

Use reference angle to find angle to terminal side.

II. Practice Problems

Change from degree to radian measure.

1. $240°$
2. $60°$
3. $330°$
4. $135°$
5. $300°$
6. $270°$

Change from radian to degree measure.

7. $\frac{5\pi}{6}$
8. $\frac{5\pi}{4}$
9. 2π
10. $\frac{2\pi}{3}$
11. $\frac{3\pi}{2}$
12. $\frac{7\pi}{4}$

Find the measure of the angle determined by the endpoint of the terminal side on the unit circle.

13. $\left(\frac{\sqrt{2}}{2}, -\frac{\sqrt{2}}{2}\right)$
14. $\left(-\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)$
15. $\left(\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$
16. $(0, -1)$
17. $\left(-\frac{\sqrt{2}}{2}, -\frac{\sqrt{2}}{2}\right)$
18. $\left(\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)$

Given $\sin\theta = \frac{y}{r}$. $\cos\theta = \frac{x}{r}$, and $\tan\theta = \frac{y}{x}$ find the following for the given endpoint of the terminal side.

19. $\sin\theta; \left(\frac{\sqrt{2}}{2}, -\frac{\sqrt{2}}{2}\right)$
20. $\cos\theta; \left(\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$

Ratios and Proportions

I. Model Problems

Ratios are fractions that compare two values. The ratio of x to y can be expressed in the following ways:

$x : y$ $\qquad \frac{x}{y}$ $\qquad x \text{ to } y$

For example, if a recipe requires the 4 cups flour to every 3 eggs added into the batter, the ratio of flour to eggs can be written in the following manner:

$4: 3$ $\qquad \frac{4}{3}$ $\qquad 4: 3$

Example 1 In a class, there are 13 girls and 11 boys. Write the following ratios.

a. The number of girls in the class to the number of boys in the class.

13 girls to 11 boys $\qquad$ 13:11 $\qquad \frac{13}{11}$

b. The number of boys to the total number of students in the class.

11 boys to 24 students total in the class (11 boys +13 girls)
11: 24
$\frac{11}{24}$

c. The number of boys to the number of girls in the class.

11 boys to 13 girls $\qquad$ 11:13 $\qquad \frac{11}{13}$

A **Proportion** is an equation that sets two ratios equal to each other. For example, we stated that 4 cups of flour requires 3 eggs. How many eggs would we need for 8 cups of flour? We would use cross product property to solve the resulting equation.

$\frac{4 \text{ cups of flour}}{3 \text{ eggs}} = \frac{8 \text{ cups of flour}}{x \text{ eggs}}$ $\qquad$ Set up your equation

$4 \cdot x = 8 \cdot 3$	Cross Product Property
$4x = 24$	Multiply
$x = 6$ eggs	Divide by 4 on both sides

So the recipe requires 6 eggs if we use 8 cups of flour.

Example 2 Solve the following equation: $\frac{11}{14} = \frac{5k}{2}$

$\frac{24}{12} = \frac{4k}{3}$	
$24 \cdot 3 = 4k \cdot 12$	Cross Product Property
$72 = 48k$	Multiply both sides
$\frac{72}{48} = k$	Divide by 48 on both sides
$\frac{3}{2} = k = 1.5$	Simplify the fraction.

Example 3 Solve the following equations: $\frac{4}{7} = \frac{2k}{3k-2}$

$\frac{4}{7} = \frac{2k}{3k-2}$	
$4(3k-2) = 2k(7)$	Cross Product Property
$12k - 8 = 14k$	Multiply using distributive Property
$12k - 8 = 14k$	Addition Property of Equality (Subtract 12*k* from both sides)
$-8 = 2k$	Simplify
$-4 = k$	Multiplication Property of Equality (Divide both sides by 2)

Example 4 At the store, 40 pencils cost \$1.10. You need to buy 90 pencils. How much will it cost?

$\frac{40}{1.10} = \frac{90}{x}$	Set up the equation.
$40 \cdot x = 90 \cdot 1.10$	Cross Product
$40x = 99$	Multiply both sides
$x = \frac{99}{40} = \$2.47$	Divide both sides.

90 pencils will cost \$2.47.

Practice

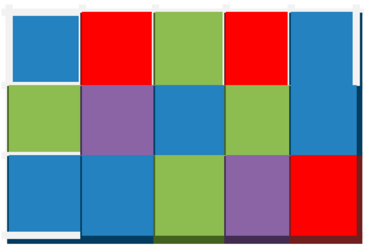
1. In a bag of candy, there are 6 blue candies, 5 yellow candies, 1 red candy, and 12 green candies. Write the following ratios.

a. The number of red candies to the number of blue candies.

b. The number of green and red candies to the number of blue candies.

c. The number of yellow candies to total number of candies.

2. In the picture below, determine the following ratios.



a. Total number of tiles to the number of blue tiles.

b. Number of green and red tiles to the number of purple tiles.

Directions: *Solve the following word problems using proportions*.

3. $\frac{k}{19} = \frac{4}{9}$

4. ½ $= \frac{7y}{42}$

5. $\frac{2y+3}{3} = \frac{y-3}{5}$

6. The ratio of boys to girls in a classroom is 3:5. If there are 35 girls in the class, how many boys are in the classroom?

7. Sally can type 6 pages in 1 hour. How many pages can Sally type in 2 hours 15 minutes?

8. In a study regarding student achievement, 7 out of 12 student participants were successful in improving their grades with a program. How many students are involved in the study if 6,622 students were able to improve their grades?

9. The ratio of the sides of a triangle are 3 inches: 4 inches: 6 inches. The smallest side has a length of 12 inches. What is the perimeter of the triangle?

ACT Science Practice Test pt. 2

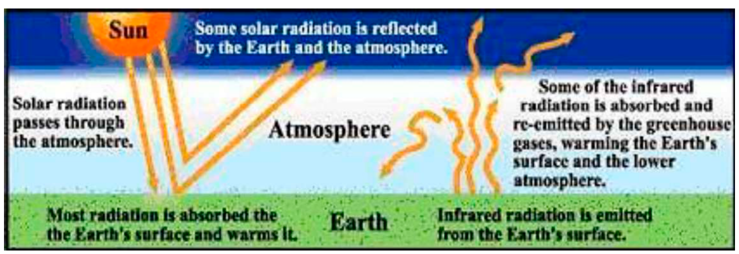
Directions: *The passage below is followed by several questions. After reading the passage, choose the best answer to each ACT Science practice question. You may refer to the passage as often as necessary. Calculators may NOT be used on this test.*

Global Warming

THIS JUST IN: Satellite imagery shows that the Arctic ice cap is shrinking more quickly than was previously thought. Scientists predict this could have a major effect on Earth's climate in the next twenty years . . .

Temperatures on Earth have increased 1°F over the last century. This might not seem like a big change, but even slight global warming can have serious effects. Global warming causes changes in rainfall patterns around the world, resulting in droughts in some areas and floods in others. Global warming also causes the sea level to rise. As glaciers in the Arctic melt, the oceans absorb their extra water. This can cause coastal flooding. It can also seriously affect freshwater biomes as salty water moves inland. Global warming can also be tied to health problems related to air pollution and heat stress.

So what causes global warming? Most scientists point to the Greenhouse Effect. The Greenhouse Effect involves gases, such as carbon dioxide and methane, that surround Earth. Normally, these gases trap just enough heat from the sun to make Earth comfortable for its inhabitants. However, when these harmful gases build up in the atmosphere, too much of the sun's energy is trapped against Earth, causing it to become warmer. Human activities, such as cutting down forests and burning fossil fuels, add these gases to the atmosphere.



As the Earth warms, people need to realize that their actions can contribute to or help prevent global warming. With everyone working together, global warming can be slowed down considerably. What can be done to lesson his problem?

Save Electricity
More often than not, coal is burned to create electricity. When coal is burned, carbon dioxide is released into the environment, which further damages the ozone layer. When people save electricity, they decrease the amount of coal burned to create power for homes. Simple activities, such as turning off lights and weather-stripping windows, can help make a home more energy efficient. Also, running a dishwasher only when it is full and using cold water to wash clothing can help the environment and decrease power bills.
Give Cars a Break
Reduce air pollution by walking, biking, or sharing rides around town. Also, take advantage of mass transit if it is available. Purchase cars that have good gas mileage and keep cars properly maintained.

Plant Trees
Nature can help prevent global warming. Trees and other plants absorb carbon dioxide from the atmosphere. They also provide shade for homes, reducing the temptation to overuse the air conditioner in summer. Planting more trees and preventing the rain forest from being destroyed can help absorb more carbon dioxide and slow the Greenhouse Effect.
Recycle
Reuse and recycle what we can. This helps protect natural resources, such as trees, aluminum, and oil. Buy recyclable products or products that have limited amounts of packaging. Highly decorated packaging is nice, but the welfare of the environment is far more important.

Everyone on Earth can do his or her part to help protect the planet from global warming. These simple suggestions go a long way toward returning our world to the delicate balance that it needs.

1. **What is a pre-reading question for this article?**

Ⓐ How can planting trees help prevent global warming?

Ⓑ What is the atmosphere made up of?

Ⓒ What are fossil fuels?

2. **Look at the diagram in the article. What do the squiggly lines represent?**

Ⓐ infrared radiation

Ⓑ lightning

Ⓒ the atmosphere

3. **What does the graphic contribute to the article?**

Ⓐ It helps the reader visualize how planting trees can help prevent global warming.

Ⓑ It helps the reader visualize different types of radiation in Earth's atmosphere.

Ⓒ It helps the reader visualize how greenhouse gasses trap solar radiation and cause global warming.

Directions: *The ACT Science passage below is followed by several questions. After reading the passage, choose the best answer to each question. You may refer to the passage as often as necessary. Calculators may NOT be used on this test.*

A Whale of a Story

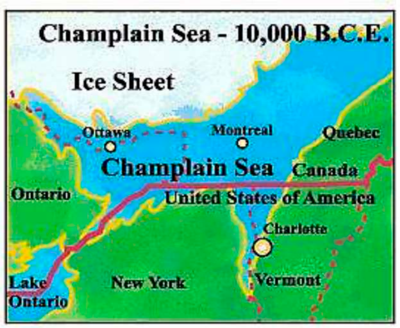
As construction workers for Vermont Railroad were digging and leveling the ground near Charlotte, Vermont, in 1849, their work came to a sudden halt. One of the workers spiked his shovel into the ground, pulled it out, and noticed that the soil was full of large pieces of bone. The workers had discovered a large skeleton buried in their path. Assuming the remains were those of a horse, and with a deadline looming overhead, the men resumed digging.

The crew members talked about their discovery with people living in Charlotte. One area resident, John Thorp, heard the description of the large skeleton and wanted to take a closer look. He made his way to the railroad's work site, where the construction workers showed him the "horse" skeleton. After several minutes of close observation, Thorp realized that the bones were not the remains of a horse but were perhaps something of greater importance. Thorp convinced the railroad to halt construction until a scientist could examine the skeleton.

Zadock Thompson, a scientist at the University of Vermont, made the trip to Charlotte to study the mysterious skeleton. He agreed with Mr. Thorp that it was not a horse's skeleton.

Using precise scientific steps and research, Thompson set out to find the truth. First, he gathered all the bones from the site, including the smallest broken fragments, and took a careful inventory. He took exact measurements and examined the bones thoroughly. Then, Thompson compared the identifying characteristics of the skeleton with the most up-to-date research materials on fossils and bone structures. Eventually, he concluded that the skeleton belonged to an ancient whale, one quite similar to the white whale of today.

The discovery of an ancient whale in Vermont shocked nineteenth-century scientists. "How could a whale's remains turn up 150 miles from a major body of water?" they asked. The notion seemed impossible, so scientists set out to uncover the mystery of the Charlotte whale.

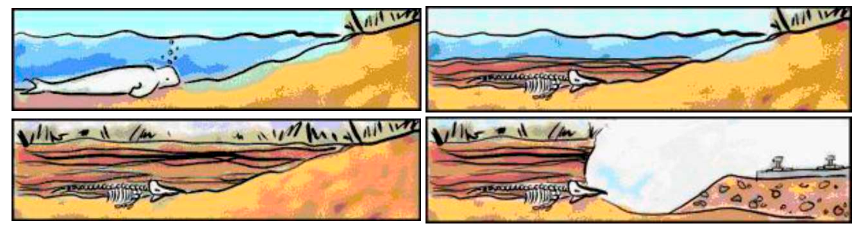


Scientists now believe that the whale just happened to be in the right place at the right time. The time was approximately 12,000 years ago as the last Ice Age was ending. The place was Vermont, which at the time was covered by an enormous saltwater sea. This large body of water extended westward from the Atlantic Ocean, covering most of the northeastern United States and a large portion of southeastern Canada.

The world was encountering many changes near the end of the Ice Age. The gigantic glaciers of North America were receding, and temperatures were rising in the area of the Champlain Sea. The movement of the glaciers scraped Earth's surface, carving deep trenches in some areas and depositing thick layers of soil in others. As the glaciers melted, the Atlantic Ocean rose.

At the same time, the enormous saltwater sea decreased in size as its waters funneled into the ocean. Despite these changes, one large basin from the sea remained. Over time, it filled with glacial freshwater and is today known as Lake Champlain.

During this time, animal life played a difficult game of survival with the changing world. Researchers believe the Charlotte whale traveled to one of the small inlets of the sea that covered Vermont. While there, the whale died, and its body came to rest on the seafloor. As the waters receded over time, the whale's body became covered in layers of silt and sand. Under these conditions, the whale's skeleton was preserved for thousands of years until it was unearthed in 1849.



Thanks to the initiative of John Thorp and the cooperation of the Vermont Railroad, an interesting artifact gave further proof to the existence of the ancient Champlain Sea.

4. **What was the first scientific step used by Zadock Thompson to research the mysterious skeleton?**

Ⓐ He convinced the railroad to halt construction until a scientist could examine the skeleton.

Ⓑ He collected and catalogued all of the bones from the site.

Ⓒ He compared the bones' characteristics to research on fossils and bone structures.

Ⓓ He concluded that the skeleton belonged to an ancient whale.

5. **Why did the Champlain Sea disappear?**

Ⓐ The temperature in that area fell.

Ⓑ The temperature in that area rose.

Ⓒ The gigantic glaciers of North America advanced.

Ⓓ The saltwater sea increased in size.

Directions: *The ACT Science passage below is followed by several questions. After reading the passage, choose the best answer to each question. You may refer to the passage as often as necessary. Calculators may NOT be used on this test.*

The Barringer Meteorite Crater

The sky above the high plateaus of Arizona fills with a blazing ball of fire. The air thins, and the ground trembles. Daylight is replaced by a blinding flash of flames, and an ear-splitting howl roars across the land. A 150-foot long meteorite smashes into the ground, creating an immense crater. Everything within a 100-mile radius of the impact instantly vaporizes along with the meteorite. Within seconds, the landscape is changed forever.

Does this sound like a scene from a summer movie? Actually, it describes a real event that took place near Flagstaff, Arizona, 50,000 years ago. The hole created by the meteorite's impact, known as the Barringer Meteorite Crater, can still be seen today. It is one mile wide and over 550 feet deep—20 football games could be played at the same time on its floor, and more than 2 million people could watch from its sloping sides.

However, when scientists first discovered the crater, they weren't sure if it had been created by a meteorite or by volcanic activity. In 1891, a geologist named Grove K. Gilbert began studying the inner regions of the crater and became confused for two reasons. First, he did not find any evidence of a meteorite in the crater itself. Second, his instruments did not detect the presence of iron, a substance found in meteorites. Gilbert concluded that some sort of volcanic explosion must have created the enormous crater.

Ten years later, a mining engineer named Daniel M. Barringer heard about the crater. Interested in using the area for mining ventures, he began exploring the land around the crater. He discovered that the surrounding plains contained large quantities of meteoritic iron. He also found huge boulders, some the size of houses, scattered around the crater. After reviewing Gilbert's findings, Barringer realized that they might be invalid when compared to these new discoveries. Barringer searched the area for signs of volcanic rock. When he found no evidence of any past volcanic activity, he concluded that a meteorite had, in fact, created the crater.

Convinced that Gilbert must have missed meteoritic iron deposits beneath the surface, Barringer began to mine the crater. This venture lasted for 27 years, but it produced nothing. However, his hard work laid the foundation for future scientists, who now believe that the meteorite disintegrated on impact because of the immense heat that it created. They have concluded that the meteorite's impact was equal to the explosion of 20 million tons of dynamite. This explains why the iron was sprayed across the plains and not deposited in the crater.

Barringer's family still owns the land surrounding the Barringer Meteorite Crater. A popular tourist attraction, the crater is used by NASA to train astronauts because its terrain resembles the surface of the moon. In fact, scientists now conclude that meteorites also created the many craters covering the moon's surface. They think that the holes and crevices, which create the appearance of a "man in the moon," are actually a series of impact sites.

Today, scientists continue to study meteorites and craters. They believe that tiny meteorites, weighing less than a pound each, hit Earth thousands of times a year. They have also identified over 150 craters as large as the Barringer Meteorite Crater. In addition, scientists are studying several mysterious events, such as a blast that cleared an area of the Siberian forest equal to the size of Rhode Island. Could this have been the result of a meteorite? Can people expect to witness a similar event in the near future? Today, we have the technology that helps scientists predict when, where, and how these meteorites might fall.

6. Read the following sentence.

A popular tourist attraction, the crater is used by NASA to train astronauts because its terrain resembles the surface of the moon.

Which word has the same root word as the word terrain?

Ⓐ determine

Ⓑ terrible

Ⓒ territory

7. Which is the purpose of this article?

Ⓐ to explain the effects of the impact of a meteorite

Ⓑ to demonstrate a lesson about the importance of scientific research

Ⓒ to describe new technology that scientists use to study meteorites

8. Which would be the most useful graphic to include with this passage?

Ⓐ a photograph of Daniel M. Barringer

Ⓑ an illustration of a how a meteorite hits Earth and creates a crater

Ⓒ a map of Arizona that shows where the Barringer Meteorite Crater is located

Objectives

- ➔ Describe Earth's layers and the properties that separate them.
- ➔ Explain how convection transfers energy.
- ➔ Explain what generates Earth's magnetic field.

Key Terms

Radioactive decay
Seismic waves
P-wave
S-wave
Convection
Magnetic field
Plate tectonics
Plate boundaries
Transform boundary
Divergent boundary
Convergent boundary

Figure 1
The body that hit Earth almost 4.5 billion years ago had enough energy not only to eject the material to form the Moon, but also to help melt and differentiate Earth's materials into distinct layers.

Energy and Earth's Systems

Earth's systems are constantly changing. Volcanos erupt, shorelines change shape, and mountains can grow in one area and shrink in another. All these processes require energy. Many surface processes are driven by energy from the Sun, but what happens under the surface? It was not until the late 1800s that scientists began to piece together enough data and evidence to understand what Earth's interior looks like, the processes occurring there, and the energy sources that drive these processes.

Earth's Interior

Relatively soon after Earth formed 4.6 billion years ago, Earth heated up and its materials melted. The energy for this heating came from two sources—**radioactive decay** in Earth's interior and impacts from other bodies in space. Radioactive decay is the spontaneous release of energy from unstable elements as they change to stable elements. Unstable elements throughout Earth's layers, such as uranium-238, are constantly undergoing radioactive decay and releasing energy. Meteorites, asteroids, and planetesimals (early materials that formed planets) were constantly colliding with Earth's surface early in its history. These impacts transferred a lot of energy to Earth, particularly the impact that led to the Moon as it ejected enough material for its formation (Figure 1).

Once Earth was heated to a molten or partially molten state from its outer edge to its core, it began to differentiate; heavier elements (such as iron and nickel) sank toward the interior, and lighter elements (such as silicon, oxygen, and aluminum) rose toward its surface. This process was driven by Earth's gravitational pull and **density** differences. Density is the amount of matter per volume of a substance or material.

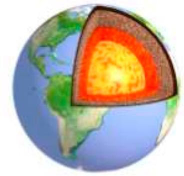


Figure 2
Earth's interior can be separated into layers based on density, composition, and state of matter or on how materials flow.

This led to four distinct layers: the inner core, outer core, mantle, and crust. These different layers were based on differences in physical properties such as density, composition, and state of matter (Figure 2). How do scientists know what these properties are from the surface all the way to Earth's center? Collecting rock samples, performing lab experiments under controlled conditions, and collecting and analyzing seismic data have all supported the theory of four distinct layers with distinct physical properties.

Another way scientists separate the upper portion of Earth is based on how materials flow, if at all. This splits the upper Earth into the lithosphere, which consists of the rigid, solid crust and rigid top of the mantle, and the asthenosphere, which is a part of the upper mantle, a solid with the ability to be molded or to slowly flow.

Data from Lab Experiments

Oceanic, continental, and even mantle rock samples can be collected at Earth's surface or from deep probes or cores drilled into continental or oceanic crust. A variety of lab experiments on rock samples have provided an enormous amount of data that scientists have used to understand Earth's interior.

Simple lab measurements, such as density measurements, of a variety of rocks and minerals are critical to understanding Earth's composition. Crust and mantle rock samples collected from Earth's surface range in densities from 2.5 to 3.0 g/cm^3. However, scientists know that Earth's density, based on calculations of mass and volume, is close to 6.0 g/cm^3. Therefore, Earth's interior has to be different and denser than its surface.

Seismic lab experiments on a variety of rock samples allow scientists to create a database of how rock type affects seismic wave speed. They can then compare their lab seismic measurements to what they analyze at seismic stations to determine the composition, density, and structure of the materials inside Earth.

The Nature of Science in Action

Scientific Knowledge Is Based on Empirical Evidence

Science knowledge is based on empirical evidence.

Empirical evidence can be collected in the field or the laboratory. Data from as early as 1930 has contributed to the agreed-upon model of Earth's layers.

Scientists also perform high-temperature and high-pressure experiments in specialized high-pressure chambers to understand what happens to the structure, phase, and composition of rocks, minerals, and pure elements at different depths in Earth's interior.

Mass spectrometers are used in labs to determine the elemental composition of rock samples before and sometimes after experiments. Scientists can also use these instruments to determine the age of samples, using principles of radioactive decay.

These samples and data have provided extensive information about not only the crust, but also the mantle and core. However, it is currently impossible to drill deep enough to collect rock samples directly from the mantle and core (the deepest core is about 12 km [not even halfway through the crust] and is known as the Kola Superdeep Borehole in Russia); therefore, other data was needed to understand what's happening in Earth's depths.

Data from Seismic Waves

The discovery of **seismic waves** was a major breakthrough in understanding Earth's interior. Seismic waves are vibrations that travel through Earth's interior. They are generated by earthquakes, but they can also be man-made through explosions. There are two types of seismic waves: primary waves (**P-waves**) and secondary waves (**S-waves**). They are named after the order they arrive at a location—P-waves arrive first, followed by S-waves. P-waves are compressional or longitudinal waves. With P-waves, the particles in the rock they travel through move in the same direction that the wave is going as the wave compresses and expands. S-waves are transverse waves. With S-waves, the particles in the rock move perpendicular to the direction the wave is going (Figure 3). P-waves travel faster than S-waves and can travel through any type of medium (solid, liquid, or gas), while S-waves can only travel through solids.

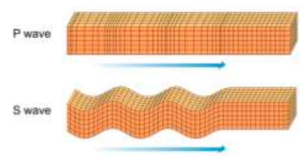


Figure 3
P-waves are longitudinal waves, while S-waves are transverse waves.

Scientists have seismic stations with seismometers set up all over the world and are able to study seismic data. Some data studies include the time it takes for waves from earthquakes at different locations to arrive at a station. This is used to determine the properties of Earth's interior. From this data, scientists are able to see that the velocity of P-waves and S-waves changes at certain depths in Earth, called seismic discontinuities (Figure 4). Based on the measurements, scientists have determined that the changes in speed indicate where one layer begins and another layer ends. The inner core-outer core boundary is around 5,155 km below Earth's surface, and the mantle-core boundary is around 2,900 km below Earth's surface. The crust-mantle boundary varies in depth from 7 to 40 km, depending on location and the type of crust (oceanic or continental).

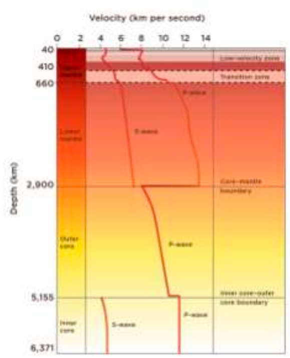


Figure 4
Large changes in seismic wave velocities mark the boundaries between layers. These changes are caused by waves moving between materials of different phases, densities, or compositions.

Energy and Earth's Systems

The Nature of Science in Action

Scientific Knowledge Is Based on Empirical Evidence

Science disciplines share common rules of evidence used to evaluate explanations about natural systems.

Seismologists, geologists, physicists, and chemists all work together to help explain the different data collected on Earth's many processes.

Earth's Layers

The Core

Earth's core is about the size of the Moon, with a diameter close to 3,500 km. Scientists determined that the core is actually split into two distinct layers: the inner and outer cores. Because of the properties of P-waves and S-waves and seismic data collected from earthquakes, scientists were able to determine not only where the boundary between these layers is, but also that the outer core is liquid and the inner core is solid.

Inner Core

Earth's innermost layer is the inner core. The inner core's density is the largest of any of Earth's layers, estimated to be between 12.8 and 13.1 g/cm^3. This layer is made up of a solid iron-nickel alloy. It is solid, despite being 6,000°C, because the pressure is so high in this region. The melting point of iron increases as pressure increases; therefore, even at 6,000°C, the iron in the inner core has not hit its melting point yet. Much of the energy in the core is residual thermal energy from radioactive decay that occurred during Earth's early formation.

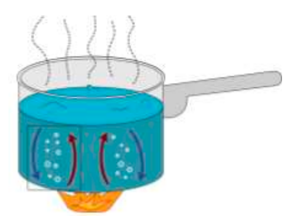


Figure 5
Changes in density from heating and cooling drive the circulation of materials in the mantle and core, known as convection.

Outer Core

Earth's next layer is the outer core. The outer core is composed of an iron alloy that is liquid, with densities ranging from 9.9 to 12.2 g/cm^3. When scientists analyzed seismic data at stations on the opposite side of where an earthquake was generated, they noticed that they never received S-wave data, but received only P-waves (Figure 4). Since S-waves cannot travel through liquids, scientists were able to conclude that the outer core is liquid.

Because the outer core is liquid, it helps transfer energy from Earth's center to its surface through **convection** (Figure 5). Materials closer to Earth's inner core are heated by conduction, the transfer of energy through contact. This heating allows for more movement of the particles, allowing them to move farther apart, become less dense, and rise. As they rise to the mantle-core boundary, these materials transfer energy to their surroundings, and the kinetic energy now decreases. As this slower motion produces a cooler temperature, they become

Energy and Earth's Systems

denser and begin to sink. This cycle continuously transfers energy from the core up to the mantle.

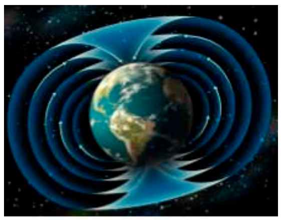


Figure 6
Movement in Earth's liquid core creates an electric current that generates Earth's magnetic field.

This movement of the liquid iron nickel in the outer core is also responsible for generating Earth's **magnetic field** (Figure 6). Magnetic fields are regions around a magnet or moving electric charge that can exert a magnetic force. They can be created by moving electrons or electric currents. Since the outer core is a liquid, flows extremely fast, and is composed of iron and nickel, which are strong electrical conductors, it acts like an electromagnet, in which current generates a magnetic field. Scientists call this current responsible for Earth's magnetic field the geodynamo.

The history of Earth's magnetic field, called paleomagnetism, is recorded in the geologic record. Igneous rock samples collected from all over the world, both oceanic and continental samples, can be dated, and their magnetic strength and direction can be measured using a magnetometer. As igneous rocks cool and solidify, their magnetic atoms align with Earth's magnetic field, becoming a record of the magnetic properties of Earth at the time the rock formed. Earth's magnetic strength and polarity have respectively changed many times over Earth's history. These changes are driven by changes in the convection currents in the outer core.

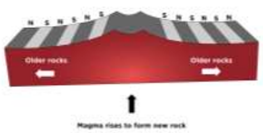


Figure 7
The rock record in the Atlantic basin shows that rock age and polarity are the same as you move away from the Mid-Atlantic Ridge.

Magnetic anomaly measurements taken across the Atlantic basin in the 1960s showed not only that Earth's magnetic field has reversed over time, but also that the pattern in the Atlantic basin is one of the critical pieces of evidence supporting the theory of **plate tectonics**. As you move away from the Mid-Atlantic Ridge parallel to it, rocks get older, and the same-aged rocks (on both sides of the ridge) have the same magnetic polarity (Figure 7). The symmetry in the pattern of age and polarity on either side of the ridge shows that new crust comes up from the mantle at the ridge and pushes older crust farther away from the ridge.

The Mantle

Above the core lies the mantle, which contains most of Earth's mass and volume. It is primarily composed of magnesium and iron silicate rocks and has densities ranging from 3.4 to 5.6 g/cm^3. The mantle is a ductile, or plastic solid, meaning it has the ability to be stretched or, in the case of Earth, it will slowly flow. A small portion of the top of the mantle resides in the lithosphere, and below that is the asthenosphere.

Energy and Earth's Systems

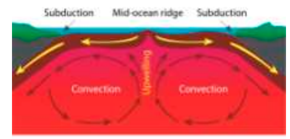


Figure 8
Convection currents in the mantle create new crust at mid-ocean ridges and release energy to Earth's surface.

Convection currents in the mantle are responsible for plate tectonics, which leads to the cycling of matter and energy in the crust and mantle. These currents are driven by energy released from radioactive decay as well as residual thermal energy from Earth's early history. Similar to the convection currents in the outer core, hot mantle rock at the mantle-core boundary becomes less dense, rises to the lithosphere-asthenosphere boundary, cools, and sinks back down (Figure 8). Near the very top of the asthenosphere, rocks are partially molten, which is the source of magma for making new crust at the surface. Convection currents lead to the release of energy at Earth's surface as the rising molten rock cools, releasing this energy and forming new crust. Hence, these currents in the mantle are the driver for plate tectonics.

It is important to note the differences in convection of the outer core and the mantle. The outer core is liquid with low viscosity, while the mantle is a molten solid with high viscosity, so the flow of the currents is very different. The inner core contains materials that conduct electricity, while the outer core contains materials that are poor conductors. Therefore, a magnetic field can only be produced by the inner core.

Figure 9
Earth's lithosphere is split into plates that move due to convection in the mantle.

The Crust

Earth's outermost layer, which, therefore, is lowest in density (2.2–2.9 g/cm^3), is the crust. The crust is solid and rigid and ranges in thickness from 6 to 10 km in areas of oceanic crust to 25 to 70 km on the continents. Oceanic crust is made up of igneous rocks, such as basalt, with high amounts of magnesium and iron; it is very similar in composition to the mantle. Continental crust is more heterogeneous, as it is made up of all types of rock (sedimentary, metamorphic, and igneous). In general, continental crust has less magnesium and iron than oceanic crust and more aluminum and potassium, making it less dense. Density of the crust becomes a key factor to processes that occur at **plate boundaries**. The crust and upper mantle are split into lithospheric plates that float on top of the asthenosphere and move due to the convection currents in the mantle, which is the theory of plate tectonics (Figure 9).

Plate Tectonics

Plate tectonics, the movement of rigid, lithospheric plates on Earth's surface over the plastic asthenosphere, cycles matter and energy between Earth's surface and interior. There are three different types of boundaries between lithospheric plates: transform, divergent, and convergent (Figure 10).

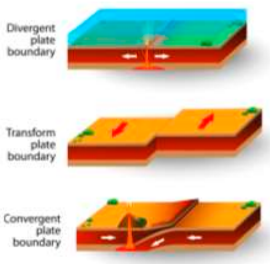


Figure 10
There are three types of plate boundaries where lithospheric plates move apart, collide, or slide past each other.

Along **transform boundaries**, plates slide or scrape along each other. The San Andreas fault in California is an example of a transform boundary.

Divergent boundaries generally occur in oceans and as plates move away from each other, allowing matter from the mantle to rise up, cool, and form new oceanic crust. Convection currents upwelling in the mantle is what pushes these plates apart. These spreading centers are called mid-ocean ridges, an example being the Mid-Atlantic Ridge previously discussed.

Convergent boundaries can lead to either the recycling of crust into the mantle or the building of mountains. Oceanic-to-oceanic and oceanic-to-continental convergent boundaries lead to oceanic crust being moved under the other plate, or subducted. Oceanic crust is always subducted, because it is denser than continental crust and dense enough to sink into the mantle. In the mantle, the sinking of cooler material in convection currents near these boundaries helps move the lithospheric plate down farther into the mantle. The subducted plate melts as it is moved into the mantle. This melting rock can rise and lead to the formation of volcanic mountain arcs (like the Andes Mountains) or volcanic island arcs (like the Aleutian Islands).

At continental-to-continental convergent boundaries, neither plate can subduct into the dense mantle, so they instead crumple together and push up to form mountains, like the Himalayas. Through these plate boundaries and tectonic processes, rock is recycled and energy is released at Earth's surface.

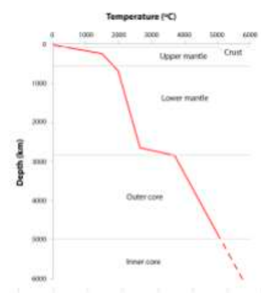


Figure 11
This is an estimate of Earth's geothermal gradient from its surface to its core, which shows Earth cools from the core to the surface.

Outward Flow of Energy

Generally, temperature decreases from Earth's core to its surface as energy flows up via conduction and convection currents and is released. How quickly temperature changes as depth changes (in °C/km) is known as the geothermal gradient (Figure 11). Scientists use crust temperature as well as seismic and laboratory data to estimate Earth's internal temperatures and geothermal gradient. Direct temperature measurements have been made for the crust, using deep probes and mines. Igneous rock samples from volcanic eruptions or mid-ocean ridges are used for deeper temperature estimates. Beyond this, scientists use laboratory experiments to determine the temperatures and pressures that different materials melt as well as phase, density, and composition data inferred from seismic data to estimate Earth's internal temperatures. From this collective data, scientists have estimated that temperatures reach as high as 1,400°C at the bottom of the lithosphere, 3,000°C at the mantle-core boundary, and 6,000°C near Earth's center. In other words, Earth's energy is highest at its core and is flowing outward to its surface through convection currents in its outer core and mantle, leading to a decrease in temperature as you move toward the surface.

Today's Energy Sources

It's been billions of years since Earth formed, so why has the entire Earth, from the surface to the center, not cooled to a solid? Not only does there continue to be residual thermal energy from early asteroid and planetesimal impacts, but also radioactive decay of elements in Earth's interior continually releases energy. Both of these are a continuous source of energy for the convection currents in Earth's interior. Hence, there is a constant source of energy for Earth's systems, and it is not going to run out anytime soon.

Energy and Earth's Systems

Energy and Earth's Systems Review

Reviewing Key Terms

Use each of the following terms in a separate sentence.

1. Differentiation
2. Plasticity
3. Radioactive decay
4. Electrical conductors
5. Lithosphere

Use the correct key term to complete each of the following sentences.

1. _______ is the transfer of thermal energy due to differences in density.
2. The area where a magnetic force can be experienced is the ____________.
3. When atoms spontaneously change from unstable elements to stable elements while releasing energy, it is called _____________.

Reviewing Main Ideas

1. What type of boundary recycles crust into the mantle?
    a. Transform boundary
    b. Convergent boundary
    c. Plate boundary
    d. Divergent boundary

2. What type of boundary produces new crust and releases energy from Earth's interior at its surface?
    a. Transform boundary
    b. Convergent boundary
    c. Plate boundary
    d. Divergent boundary

3. Which layer is the densest?
    a. Crust
    b. Mantle
    c. Inner core
    d. Outer core

Making Connections

1. Describe the relationships between mantle convection and plate tectonics.
2. Describe the relationship between Earth's energy and radioactive decay.
3. Compare and contrast the crust, mantle, and core.

Open-Ended Response

1. What data supports the idea that Earth's outer core is liquid?
2. What evidence was used to find the boundaries between layers?
3. How is energy from Earth's interior lost at the surface?
4. What evidence is there of polarity reversals? How do they occur?

Space For Work:

Objectives
- Explain how humans are impacting the environment
- Describe biodiversity and the changes occurring
- Explain ways we can reduce the human footprint on Earth

Key Terms
Anthropogenic change
Deforestation
Overexploitation
Overfishing
Climate change
Biodiversity
Speciation
Human footprint

Minimizing Human Impact on Earth

Humans depend on the living world for the resources and other benefits provided by our planet. Over six billion people live on Earth today. As our populations continue to grow, we are using more and more of the world's natural resources. Human activity has adverse effects on our planet through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. How are we impacting our Earth and what can we do to reduce that impact?

Anthropogenic Change

Changes that are induced by human activity are called **anthropogenic changes**. Examples of anthropogenic changes include habitat destruction, pollution, introduction of invasive species, overexploitation, deforestation, and climate change. All anthropogenic changes can disrupt an ecosystem and threaten the survival of some of its species. The examples below describe different types of anthropogenic changes that disrupt the environment.

Habitat Destruction

Figure 1

When an ecosystem is no longer able to support an organism that lives there, habitat destruction has occurred. Animal habitats are destroyed for a variety of reasons such as the need for additional farmland, increased need for roads or bridges, new housing or business developments, etc. When a habitat is destroyed, the populations of many native species will decrease significantly. Some more examples of habitat destruction include deforestation, urbanization, overfishing, and harvesting fossil fuels. One of the biggest threats to animals and organisms is caused by habitat loss. Figure 1 shows what happens as new developments are built. Generally, ecosystems are destroyed resulting in displacement of many different organisms.

Deforestation

When a massive amount of forest is destroyed for non-forest use and used for other resources, it is called **deforestation**. This occurs most often tropical rain forests. Tropical rain forests house over 50% of Earth's species. Their trees are a large reservoir for carbon dioxide. Destruction of these forests on a large scale is a huge contributor to global warming.

Introduction of Invasive Species

Connect to Your World

In what ways could humans be seen as invasive species?

Animals or plants that are not native to a particular area and seem to "take over" when introduced to it, are considered invasive species. Some invasive species are introduced intentionally by humans (ex: planting things from their native countries to feel more at home), while others happen accidentally (ex: a box being shipped across the world, accidentally carrying beetles). Regardless of how they are introduced, the invaders take away the resources that native species need to survive.

Overexploitation

When a piece of land is overfarmed or overgrazed, the soil loses its nutrients and becomes useless. This is called **overexploitation**. When an area is overexploited by humans, the area is stripped of its resources and ability to keep living organisms in balance. Without this balance, the ecosystem collapses. **Overfishing** is another example of overexploitation. When the fish population can't keep up with the amount of fishing, this causes a depletion in resources. This has such a huge impact on the marine ecosystem. For example, overfishing has caused an increase in algae which directly affects the health of the coral reef. Coral reefs are the planet's most diverse ecosystem and they protect the coastlines from damaging storms.

The Nature of Science in Action

Stability and Change

Much of science deals with constructing explanations of how things change and how they remain stable.

Earth is undergoing changes due to overpopulation, overexploitation, habitat destruction, pollution, invasive species, and climate change. Scientists are experimenting and observing to construct explanations and seek alternatives to protect the planet we call home.

Pollution

Connect to Your World

How would the world be different if pollution was not an issue?

Air pollution is often seen as smog in our cities. But did you know that pollution in our air is also invisible? The cars we drive, the houses we live in, and the planes we fly all burn fossil fuels such as gasoline and natural gas, thus releasing too much carbon dioxide into our environment. Carbon dioxide is the biggest contributor to the warming of our planet. Factories also release gaseous waste, such as sulfur, sulfur oxides, and nitrous oxides, which cause air pollution. Not only does air pollution damage our ozone, but poor air quality can also permanently damage many organisms including humans. Air pollution causes major health problems in humans which include respiratory disease, cardiovascular disease, congestion, and chest pain.

Water pollution is another major issue. Water pollution occurs when bodies of water such as rivers, lakes, groundwater, aquifers, and the ocean are contaminated directly or indirectly by toxic substances. For example, oil from roads, fertilizers from crops, oil spills from tankers, and other contaminants run off and pollute the water. Have you ever contributed to a trash clean-up in your community? Plastic is one the most common waste products that washes up on our shorelines, as seen in figure 2. Even though water is vital to our lives, water pollution occurs in many different ways and is a huge threat to our ecosystem. Water pollution can harm animal and plant species and, in some cases, wipe them out completely from an area.

Figure 2

Climate Change

A change in the common weather patterns of an area constitutes **climate change.** Some indicators of climate change are increased frequency of weather disasters, unseasonably cold or hot conditions, natural disasters occurring in locations in which they typically never do, etc. Some of the human activities discussed earlier have been linked to climate change, which is commonly called global warming. Figure 3 shows an example of how drought conditions impact land.

Figure 3

The saying, “no man is an island,” means that people need each other to survive. Everyone on Earth is interconnected in some way. This is not only true of human beings but all living and many nonliving things on Earth. In an ecosystem, individual organisms, populations, and entire communities interact with each other and their environments. In fact, much of the behavior of living things is in response to changes in their environment.

Climate change and biodiversity go hand-in-hand. Any change in the climate will have a direct effect on organisms in the area; some species may be able to withstand the change while others cannot. Because of human impact, water resources are decreasing, which is causing a drier climate in some areas. Drier climates, in turn, change which species are suited to live there. Some species may not adjust to the change and thus, become extinct, resulting in decreased biodiversity.

The Nature of Science in Action

Scientific Knowledge is Open to Revision in Light of New Evidence

Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.

Scientific argumentation occurs quite often in terms of climate change. Individuals, even within the scientific community, have different ideas regarding the strength of the evidence resulting in various explanations and arguments.

Biodiversity

Another major impact of anthropogenic changes is Earth’s biodiversity. **Biodiversity** is the term we use to describe the variety of different species found on Earth. Humans depend on the living world for the resources and other benefits provided by biodiversity. Biodiversity involves not only the number of different species, but the variability in genetics, the ecosystems in which the organisms live, and the natural resources found in the ecosystems. A lush rainforest, for example, has much more biodiversity than a barren desert. When a new species is formed, by a process called **speciation**, its biodiversity increases. Alternatively, when an entire species becomes extinct, the biodiversity of the ecosystem decreases.

Biodiversity is necessary in an environment because it protects against a single disease destroying an entire species which can impact the ecosystem in which the species lives. The more diverse an area is, the healthier it is. In fact, ecosystems with a greater biodiversity tend to have a greater resistance and resilience to change. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. We see this most often in the protected areas of our national parks and preserves. All natural resources are connected, and all organisms are dependent on them. Therefore, it is safe to assume that any change, positive or negative, will have an impact on more than just one species or organism. Why is biodiversity important? All living things depend on each other, and high biodiversity helps the sustainment of species and strengthens their ability to withstand environmental change.

Connect to Your World

The Fish and Wildlife Management maintain biodiversity with national parks and forests. What animals have been protected or reintroduced in your area?

Food Webs

Removing one species from a food web has a dramatic effect on the health and stability of that food web and its ecosystem. Plenty of evidence demonstrates the effects of predator and prey populations in food webs when one species becomes extinct. For example, consider the removal of the lion, a top predator, from the savannah (which has been the unfortunate target of poachers). What do you think will happen? The animals that typically fall prey to these lions, such as zebras and gazelles, will increase in population. However, the land that supports these animals cannot handle so many at once. A problem is now created, and there is an imbalance in this ecosystem.

It is important that food webs maintain a balance to support a healthy ecosystem. An invasive species can move into an area that it is not naturally a part of and cause harm to its new home. Native species, or species that are naturally from that area, already have an established food web. Introducing a new species will throw off the balance of the food web, causing competition for food, habitat, and other resources.

Adaptations

When environmental changes occur, species that cannot adapt to the changes die out. Only those that can reproduce survive. Imagine when new buildings and roads are built in the middle of an ecosystem with diverse plant and animal life. What happens to those plants and animals? Where do they go? How do they adapt? Changes to Earth's physical environment whether they are caused by humans or natural causes, have contributed to the expansion of some species, the emergence of new, distinct species, and the decrease and even extinction of other species. For example, the Asian carp which is considered to be a an invasive species was introduced in the United States to control weeds and parasites in water. However, they are changing the water quality and decreasing the population of the native fish**.** This has a direct effect on the biodiversity of those waters.

The decrease and even extinction of some species continues to rise, and one of the major contributors that we discussed earlier in this chapter is caused by habitat destruction and loss. Polar bears are one of the most endangered animals right now due to the melting ice. The warming temperatures are melting their homeland, leaving them nowhere to go. Figure 4 shows just one scenario that has occured as the ice continues to melt. If the polar bears are unable to adapt to the changing ecosystem, their numbers will continue to decrease, leading to extinction.

Figure 4

Impact of Technology

Biodiversity is important to us because it provides us with materials that we use daily, such as wood, clothing, and paper. Nitrogen-fixing bacteria turn nitrogen into a nontoxic chemical, which is beneficial for us because we breathe in some nitrogen from the air. We even use resources for decoration, gifts, cleaning products, and many other things. Diversity has allowed us to move forward and take advantage of wonderful things technology can bring us. In addition to these natural resources, we have also used biodiversity to make chemicals, produce excess carbon, and make fertilizers and toxic bug sprays. These things, made by resources, can also harm our natural environment. Our waste, produced by excessive littering and improper waste removal, has increased pollution and hurt animals.

Reducing the Human Footprint

The **human footprint** is the lasting effect humans are having on the world and the many living and nonliving resources in it. One of the ways to reduce the human footprint is to become conscious of all we do as humans. Although the three r's (reduce, reuse, and recycle) may seem cliché, they may be the only solution we have. Simple changes in the areas of transportation, energy uses and sources, and taking action can have a positive impact on our human footprint.

Transportation

Changing how we get around because our current transportation modes account for one-half of air pollution, one-third of greenhouse gas emissions, one-quarter of air contamination, and one-fifth of water toxicity. Finding ways to carpool or use public transportation is one alternative. Another is using low-impact transportation such as energy efficient cars. Electric cars, as shown in figure 5, use electricity to run instead of gasoline. Transportation is vital to our lives today, but are there other ways you could get to your destination while still reducing your human footprint?

Figure 5

Energy Usage and Sources

You may be used to hearing that you should turn off the lights when you leave a room. That may just sound like an adult concerned about the electric bill, but in reality, being aware of what energy is used in the home from the light bulbs to the types of appliances, can make an overall impact to the total amount of energy being used. Switching to a compact fluorescent or LED bulb will result in approximately using only 25% of the amount of energy needed for an incandescent light bulb. It will also decrease the amount of heat being produced by the lights, thereby decreasing the amount of energy needed for cooling a room. Energy Star rated appliances have been determined to use less energy and be more efficient. Any of these kinds of changes can make an overall impact on the human footprint you and your house may be leaving.

Minimizing Human Impact on Earth

Do you know where the energy comes from to power the many household conveniences we have come to rely on? Today, power companies offer options for the type of energy used to power your home. Wind, solar, and geothermal are all types of energy that are renewable and responsible choices. Use of fossil fuels is still very common but not the best choice when trying to reduce your human footprint. Figure 6 shows an example of an energy facility that uses wind and solar resources.

Figure 6

Taking Action

Supporting energy policies and legislation can have an impact on the overall human footprint. Become aware of any policies that regulate efficient, alternative, and environmentally-friendly energy production. Does your town provide grocery bags when you go shopping or do you have to pay for each bag you use? This is one example of local policy that cities and towns have implemented to help reduce waste.

It is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, as well as any social, cultural, and environmental effects of the potential solution. This is because effective solutions to curb anthropogenic changes may be too expensive to be implemented. Solutions that are not safe or reliable are obviously discounted as well. What are some ideas you can think of to help combat the negative impacts that are currently occurring in our environment? When developing solutions, creating a computer model can help with planning out the solution and addressing the constraints listed above.

There are many different ways humans are impacting the planet, and it is happening very quickly. There are various ways in which humans can help reduce these negative impacts on our planet. When looking for solutions, one must keep in mind how biodiversity and the environment are impacted. There will always be costs and constraints that must be considered when evaluating the solutions. Computational models can be used to help predict what impact certain changes could have. The ultimate goal should always be to embrace the world around us while accepting responsibility for our choices and minimizing our impact.

Minimizing Human Impact on Earth Review

Reviewing Key Terms
Use each of the following terms in a separate sentence.

1. Biodiversity
2. Ecosystem
3. Climate Change
4. Overpopulation
5. Recycle

Use the correct key term to complete each of the following sentences.

1. ________ species are brought to an area by man; they compete for resources and cause problems for the native species within an ecosystem.
2. Overuse of wildlife and plant species by people for their own needs is called ________.
3. We can reduce our ________ by making smart purchasing decisions that result in less waste and packaging.

Reviewing Main Ideas

1. Harmful chemicals that contaminate a natural environment–
   a. Invasive species
   b. Overexploitation
   c. Pollution
   d. Speciation
2. __________ is important to us because it provides us with materials that we use daily.
   a. Biodiversity
   b. Environment
   c. Invasive species
   d. Climate
3. The term used to describe the increasing temperatures on Earth is which if the following?
   a. Pollution
   b. Climate change
   c. Global warming
   d. Human footprint
4. One of the biggest threats to the biodiversity of animals and organisms is caused by–
   a. Overpopulation
   b. Habitat destruction
   c. Overexploitation
   d. Climate change

Making Connections

1. How do anthropogenic changes disrupt an ecosystem?
2. How does human impact influence biodiversity?

Open-Ended Response

1. Describe three positive reasons for sustaining the environment's biodiversity.
2. Describe three ways humans are negatively impacting the environment.
3. Explain how humans can help reduce the negative impacts on Earth.

Space For Work:

Objectives

- ➔ Describe the structure of an atom.
- ➔ Use the periodic table as a model to predict the relative properties of elements.
- ➔ Use the periodic table to predict trends in size, reactivity, and electronegativity.
- ➔ Distinguish between ionic, covalent, and metallic bonds.

Key Terms
Atoms
Electron
Protons
Nucleus
Neutrons
Isotope
Energy levels
Valence electrons
Groups
Periods
Octet
Ions
Ionic bonding
Covalent bonding
Metallic bonding
Electronegativity
Atomic radii

Periodic Table and Element Structure

Everything in the universe, including all matter on Earth, is formed from unique combinations of tiny, neutral particles called **atoms**. These particles are so small that they cannot be seen with even the best microscope. Atoms of the same kind come together to form elements. To this date, there are 118 elements that have been discovered. The elements' names have been placed in a chart called the periodic table. The placement of each element in this "warehouse" is based on characteristics of that particular atom.

The Atom

Even though atoms cannot be seen by the naked eye, the concept has been in existence for over 2,000 years. Around 442 BC, the Greek theorist Democritus proposed a theory on the premise that if a stone were continuously cut in half you would eventually come to a point at which the stone would be too small to halve. He called this an *atomos*, which translates to mean "indivisible." An atom is defined as the smallest component of an element that has the properties of that element.

Later theories led the way to the discovery of subatomic particles, or substructures. Today we understand that the atom consists of **electrons**, **protons**, and **neutrons**. Each subparticle was discovered by different investigations.

Electrons

Electrons were discovered in 1897 by the British physicist J. J. Thomson in his cathode ray experiment. Thomson discovered the negatively charged particle that orbits the atom's center by sending an electric current through an empty glass cathode tube. The rays were bent toward the positively charged plate and away from the negatively charged plate. This led to the theory that atoms consisted of a very small particle with a negative charge, called the electron. An electron is defined as a negatively charged subatomic particle with no known substructure.

Protons
A proton is the positively charged particle found in the center of the atom. They were discovered in 1911 by Ernest Rutherford, using the gold foil experiment. This experiment shot a beam of alpha particles at a thin, gold foil sheet. His theory was that particles should pass through the gold foil. However, a small percentage of the atoms was deflected. Figure 1 shows how the gold foil experiment was set up.

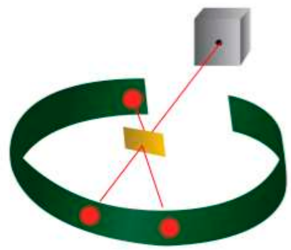


Figure 1

This led to the theory that a very small region of an atom has a positive charge, leading to the subparticle called a proton. He further theorized that these protons were in a dense region of the atom he termed the **nucleus**.

Neutrons
In 1932, James Chadwick, an English physicist who worked closely with Rutherford, discovered neutrons. He based his findings on his and others' work that measured the mass of atoms; yet when compared to the number of protons, those numbers were different. He proposed that a neutron was another particle in the nucleus that had a mass similar to the proton but no charge.

The Nature of Science in Action

Scientific Investigations Use a Variety of Methods

Scientific inquiry is characterized by a common set of values that include logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.

The inquiry of these scientists set the stage for further investigation of the atom, including structure and energy resources.

Isotopes
There are elements with atoms that are not completely identical. These atoms have the same number of electrons and protons and, therefore, possess the same chemical properties, but the mass of the atoms differs. This is due to the number of neutrons found in the atoms' nuclei. These are called **isotopes**. Isotopes are atoms of the same element that differ in number of neutrons. Figure 2 shows the two naturally occurring isotopes of helium. Not all elements have known isotopes. Those that do have isotopes can have as few as one, such as lithium, ^{6}Li and ^{7}Li (stated as lithium 6 and lithium 7). Tin currently has the most known isotopes, with 10.

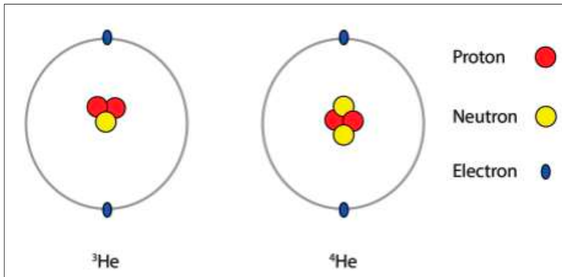


Figure 2

Atomic Structure

Once scientists understood the parts of an atom, it was only a matter of time before there was inquiry into the movement, shape, and structure of its parts. During the late 19th century, scientists began to theorize about the shape and structure of the atom.

The Bohr Model
Niels Bohr's model was developed in 1913 with concentric circles around a central nucleus. He proposed that these concentric circles would have set energies and electrons would travel in those orbits, or **energy levels**, much like planets orbiting the Sun. An energy level was defined as a discrete region around the nucleus where electrons can exist. A diagram of a carbon atom Bohr model can be seen in Figure 3. Electrons were able to move from one energy level to another if the atom was exposed to enough energy to allow for the movement. He also hypothesized

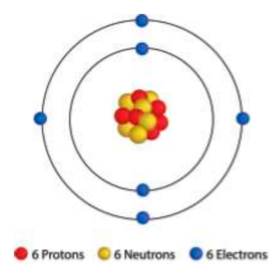


Figure 3

that as these electrons moved to a lower energy level, that energy was emitted in the form a photon, thus emitting light.

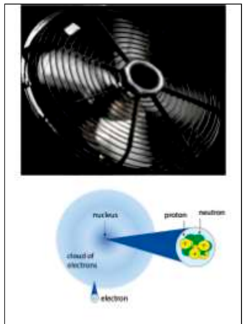


Figure 4

Although Bohr's model seemed to answer most questions about atomic behavior for hydrogen, there were still questions about atoms with more than one electron. Through the work of Louis de Broglie, Werner Heisenberg, and Erwin Schrödinger, the quantum model of the atom was established. The quantum model states that there are regions within the atom where there is a high probability of finding the electrons. These regions are referred to as electron orbitals. The electron cloud is the region where there is the highest probability of finding an electron within an orbital. Electrons do not follow a set path, like the planets do, but instead move within the area of the electron cloud at extremely high speeds. A good illustration is a fan's moving blades (see Figure 4). When turned on, the moving blades look like one continuous blade instead of the individual ones. You know the blades are moving within that area; however, you cannot say for certain where a specific blade is at any precise moment. This is how you can describe electrons and their movement in the electron cloud. We know they travel in a confined area (the electron cloud), but we cannot say for certain where each one is found at any specific time. This is known as the Heisenberg uncertainty principle.

The accepted modern atomic theory states that an atom consists of a positively charged, centrally located nucleus containing protons and neutrons. Negatively charged electrons are found in the area around the nucleus in the electron cloud. Protons are used to determine the atom's identity, while the **valence electrons** will determine the atom's reactivity. Valence electrons are found in the outermost energy level of an atom.

Figure 5

Organization of the Elements

Dmitri Mendeleev

As atoms of elements were being studied in the late nineteenth century, several scientists were looking for a way to organize the elements to keep track of known elements and add new ones as they were discovered. The person given credit for developing this organization was a scientist and teacher named Dmitri Mendeleev (see Figure 5). In 1869, Mendeleev began by writing the physical and chemical properties of each element on a card. When he organized them by atomic mass, he began to see a pattern. Certain characteristics occurred periodically, or in a predictable manner. As he continued to place the 60 elements that were known at

the time, he realized there were some open "spaces" on the table. He predicted that elements would be discovered that would fill those spots, and he even went so far as to describe what properties those elements would have. When gallium (1875) and germanium (1886) were discovered and their properties were a close match to what Mendeleev predicted, the scientific community realized the organization of the table was a powerful tool.

The Modern Periodic Table

So, does the periodic table today look like the one Mendeleev made in 1869? Although Mendeleev's organization made sense, there were a few elements that seemed out of place. In 1913, a British scientist, Henry Moseley, used X-rays to investigate properties of the elements. He found that as you moved up one element on Mendeleev's chart of elements, there was a slight change in the wavelength. He thus proposed an increase in charge. This would correlate to the number of protons in each atom. Later that year, the term *atomic number* was coined and designated to represent the number of protons found in an atom.

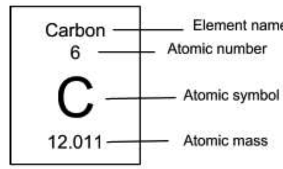


Figure 6

When organizing the elements using the the atomic number, the anomalies of reactivity in Mendeleev's table were resolved. The modern periodic table has been organized by atomic number since then. Figure 6 shows how elements are represented with atomic numbers on the periodic table.

Periodic Law

As elements were arranged by atomic number in the rows and columns of the table, a pattern of properties emerged. The columns of the table were referred to as **groups**, and the elements in those groups had similar chemical properties. The rows of the table were referred to as **periods**. The repeating pattern of properties as you go across a period is a reflection of the periodic law. The periodic law states that the physical and chemical properties of the elements are periodic functions of their atomic numbers.

The Periodic Table

As the elements were organized by atomic number, the patterns of behavior became very obvious. That allowed for some generalized classifications of the elements. As seen in Figure 7, there are three main classifications: metals (blue), nonmetals (white) and metalloids (yellow). It is very clear that most elements on the periodic table are metals.

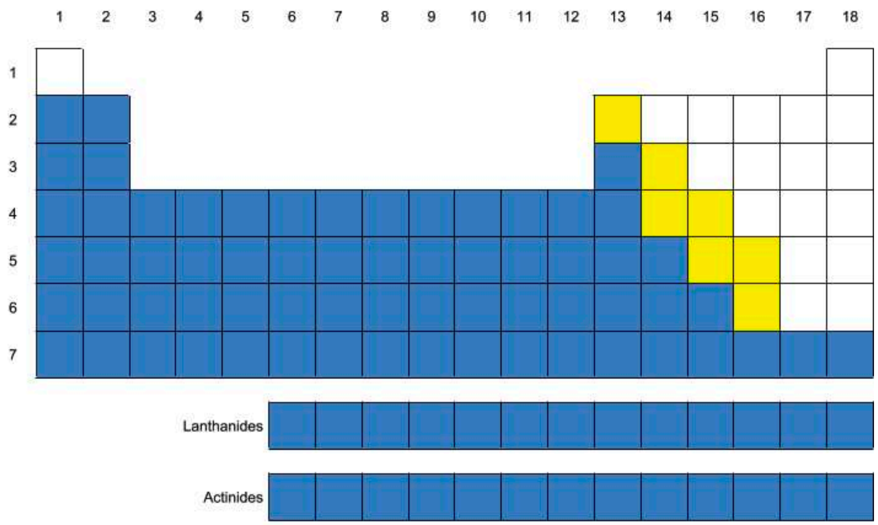


Figure 7

The Nature of Science in Action

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.

Periodic law continues to be proven as more elements are discovered and added to the periodic table.

Periodic Table and Element Structure

Silver Bars, a Metal

Sulfur, a Nonmetal

Silicon (crystallized), a Metalloid

Metals are located to the left of the stairstep of the periodic table and are shown in blue in Figure 7. Most metals share similar properties; they are generally dense, shiny solids (except one) with high melting points. Metals are malleable and ductile, meaning that they can be hammered thin or pulled into thin wires without breaking. Metals are also good conductors of both heat and electricity.

Nonmetals may be found to the right side of the periodic table and are shown in white in Figure 7. They are very different from metals. The surface of most nonmetals is dull, and they are poor conductors of both heat and electricity. Most nonmetals will melt at low temperatures, and they also have a low density. Unlike metals, nonmetals are brittle and will break when stretched or hammered.

Metalloids are elements that have properties of both metals and nonmetals and are located in the stairstep area between the metals and nonmetals. They are shown in yellow in Figure 7. Like metals, metalloids may be shiny. However, metalloids may also be dull, like many nonmetals. They can conduct both heat and electricity, but not as well as metals.

Valence Electrons and Groups

As the elements were organized on the periodic table, a pattern emerged with reactivity as well. Chemical reactivity is based on the outer electrons of an atom, referred to as valence electrons, as shown in Figure 8. As the elements move across the period, the number of electrons increased by one. This pattern allowed for elements in a group to have the same number of valence electrons and thus the same reactivity. This holds true for the main group elements (1, 2, 13, 14, 15, 16, 17, 18). The transition metals behave a little differently based on their electron configuration.

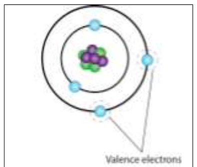
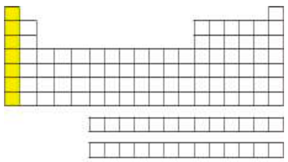


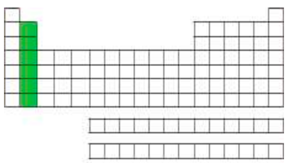
Figure 8



Group 1 - Alkali Metals

Group 1: Alkali Metals

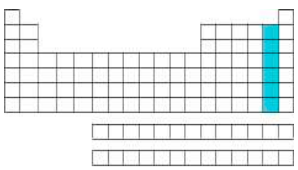
These elements have similar physical properties related to their metallic appearance. They are silver-colored, soft metals that have never been found in elemental form in nature due their high reactivity. Some alkali metals are involved in many biological functions. They have one valence electron that is readily transferred to other atoms.



Group 2 - Alkaline Earth Metals

Group 2: Alkaline Earth Metals

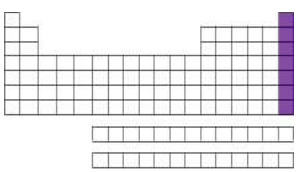
The metals in this group are also silver-colored, soft metals, but they are slightly less reactive than the alkali metals. Alkaline earth metals are also important in many biological processes. They have two valence electrons that can be readily transferred to other atoms.



Group 17 - Halogens

Group 17: Halogens

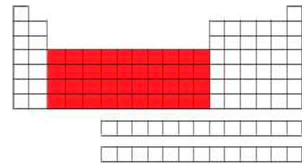
The elements found in this group are highly reactive nonmetals that are rarely found in elemental form in nature. They have seven electrons in the outermost shell and will readily gain an electron. Halogens are the only periodic table group that contains elements in all three familiar states of matter at standard temperature and pressure.



Group 18 - Noble Gases

Group 18: Noble Gases

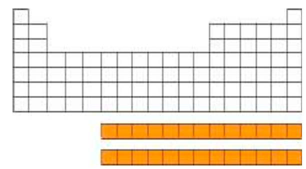
The elements in this group consist of nonreactive gases that are always found in elemental form in nature. They are known as the noble gases and are odorless, colorless, and monatomic. They have eight valence electrons in their outer shell, except for helium, which only has two. All the elements in this group have a full energy level, or **octet**, of valence electrons. This full set of valence electrons is what makes these elements nonreactive, as they have very little or no tendency to gain or lose electrons. There are many modern-day applications for noble gases. As these gases emit different colors of light when exposed to electrical discharge, they are often used as decorative lighting in buildings or in signs. Examples include helium, neon, argon, krypton, and xenon.



Groups 3 - 12 Transition Metals

Transition Metals

These elements include the transition metals found in the middle columns of the periodic table, groups 3–12. They have a variable number of outer electrons present in more than one shell, leading to a variety of possible charges for each element. Even though these elements have a variable number of valence electrons, they share many similar chemical and physical properties. As with all metals, the transition elements are both ductile and malleable, are good conductors of both electricity and heat, and have high density and high melting-boiling points. Examples include iron, nickel, copper, gold, and silver. Compounds of transition metals are usually colored.



Inner Transition Metals

Inner Transition Metals

This includes the lanthanide and actinide series. They are located at the bottom of the periodic table and are called the **inner transition metals**. It is rare to find these elements in a pure form in nature. As a result, they are very expensive to obtain. There are several modern-day industries and applications that depend on rare earth metals, such as the glass-polishing industry, certain computer applications, and production of some magnets. All the actinides are radioactive, and most do not occur naturally on Earth. Instead, they can only be created in laboratories under very specific conditions, and most have incredibly short half-lives.

Periodic Trends

Predict Properties with Trends

As stated earlier, the elements on the periodic table follow periodic law. The characteristics can be used to determine trends. These characteristic properties of elemental families can be attributed to the valence electrons in the outermost electron orbital of each element. All periodic trends can be explained by three simple concepts: attraction of the nucleus for the valence electrons (opposite charges attract), the repulsion of the electrons from each other (like charges repel), and the energy levels within the atom.

Atomic Radii

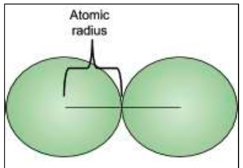


Figure 9

The **atomic radius** is the measurement from the nucleus of one atom to the nucleus of the same atom it is touching, then divided in half. The atomic radii of atoms will decrease when moving from left to right on the periodic table. This is due to the increasing number of protons within the nuclei pulling on the electrons. As you move down a group, the atomic radii will increase. This is due to the addition of electron orbitals. With more electrons farther away from the nucleus, there is greater repulsion, resulting in a larger radius. Figure 10 shows the overall trend in atomic radii on the periodic table.

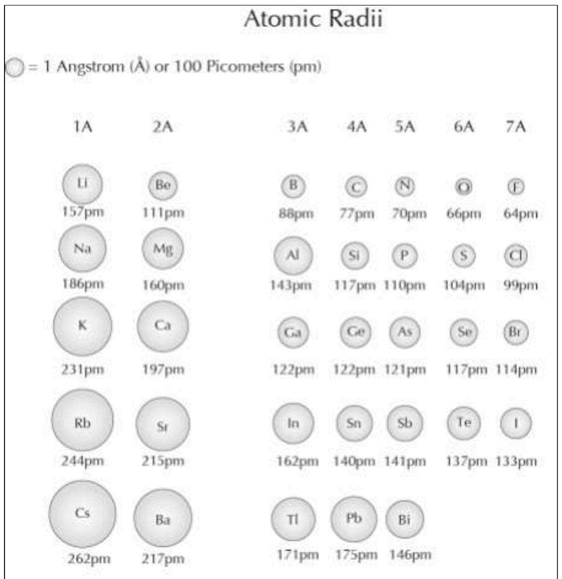


Figure 10

Ions

Atoms are neutral because they have the same number of protons and electrons. However, based on valence electrons, some atoms will easily gain or lose electrons to other atoms, creating an **ion**. An ion is an atom with a charge. This charge is determined by the number of electrons either gained or lost. In the case of atoms in group 1, they easily transfer their one valence electron to other elements. This creates an atom with more protons than electrons, thus a positively charged ion called a cation. The opposite occurs when an atom gains an electron. In this case, the atom now has more electrons than protons, creating a negatively charged ion called an anion. Figure 11 shows a chlorine atom and a chlorine ion.

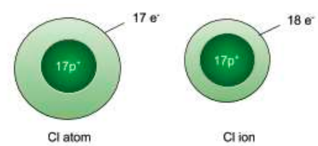


Figure 11

Ionization Energy

Another important periodic trend is ionization energy, which is the amount of energy required to remove an electron from a neutral atom. The ionization energy of elements within the same chemical family decreases with increasing atomic number. Ionization energy generally increases as you move from left to right across a period and as you move up a group.

Ionic Radii

As with the atomic radius, there is a trend with the ionic radius. As you move down a group, in general, the **ionic radii** will increase due to the addition of an electron orbital. As you go across a period, there is a decrease in the ionic radii of cations, then you will see a jump in the ionic radii as anions are formed. But as you continue across the period, the anion radii will decrease as well. Refer to Figure 12.

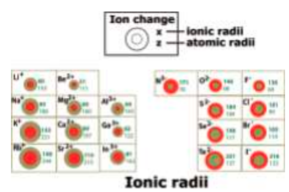


Figure 12

This trend makes sense when you look at the forces occurring in the ions. The positively charged ion will become smaller due to larger attractive forces between the protons in the nucleus and the electrons. The negatively charged ion will become larger due to an increased number of electrons and the resulting electron repulsion, thereby increasing the ionic radius.

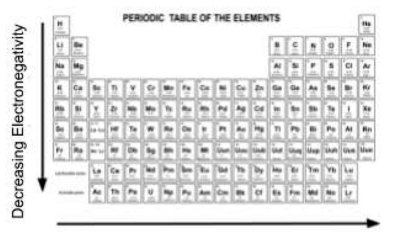


Figure 13

Electronegativity
The **electronegativity** of an element reflects its ability to attract electrons to itself in a chemical bond. Electronegativity generally increases when moving from left to right across a period and decreases when moving down a group. This makes fluorine the most electronegative element and francium the least electronegative element.

Atomic Bonding

When stating that atoms lose or gain electrons, the reality is that electrons are being transferred or shared with other atoms, creating a bond. In atomic bonding, there are three main types of bonds: ionic, covalent, or metallic. The nature of these bonds is based on the behavior of the electrons in each atom.

Ionic Bonding
In **ionic bonds,** electrons are generally transferred from a metal to a nonmetal, creating an ion. The atom that loses electrons becomes a positively charged ion, or cation. The atom that gains electrons becomes a negatively charged ion, or anion. The attraction between the newly formed cation and anion results in the formation of an ionic bond. The basic unit of ionic bonds is known as a formula unit. Therefore, the formula unit of sodium chloride is a sodium cation and a chloride anion.

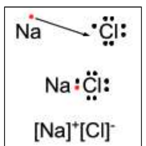


Figure 14

Figure 14 shows the ionic bond formation between sodium and chlorine. Sodium has one valence electron, while chlorine has seven valence electrons. The goal is to reach an octet, so sodium will transfer its one valence electron to chlorine, creating a cation (sodium) and an anion (chlorine). The two ions will attract each other, creating an ionic compound, sodium chloride.

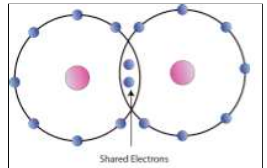


Figure 15

Covalent Bonding
In **covalent bonds**, the valence electrons of each atom are shared and localized between two atoms (see Figure 15). Starting with the central atom, the electrons are placed around each atom in order to fulfill the octet rule. Important exceptions to the octet rule include hydrogen and helium, as both atoms only require two valence electrons to have a full outer electron orbital.

Sharing two electrons between two atoms is considered a single bond. In many cases, however, covalent compounds cannot form through single bonding.

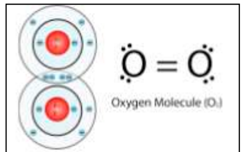


Figure 16

Double Bonds
Molecules can also form between atoms that share more than one electron pair. For example, in a molecule of oxygen gas (O_2), each oxygen atom (O) has six valence electrons, so each atom needs two electrons to complete its valence orbital (see Figure 16). Thus, two electron pairs are shared between the two oxygen atoms. The sharing of two electron pairs between atoms creates a double bond that is represented by two parallel lines in Lewis diagrams.

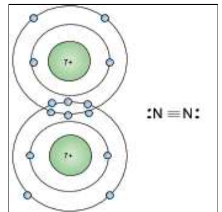


Figure 17

Triple Bonds
In another example, the nitrogen atoms (N) in a molecule of nitrogen gas (N_2) share three electron pairs (see Figure 17). This type of covalent bond is known as a triple bond. Double and triple bonds can also occur between different elements. Triple bonds are represented by three parallel lines in Lewis diagrams.

Trends and Bonding
Most often, ionic bonds occur between metals and nonmetals, while covalent bonds occur between two nonmetals. The electronegativity of the elements, however, can actually provide a more accurate prediction of the type of bond. To determine what type of bond will occur, you will need to look at the difference in electronegativities. If the electronegativity difference is greater than 1.67, the bond will be ionic, meaning the electrons have been transferred between the elements, creating ions and an ionic bond. If the electronegativity is less than 0.2, the electrons will be shared equally and considered nonpolar covalent. If the difference in electronegativity is between 0.2 and 1.6, the electrons will be shared unequally and considered polar covalent.

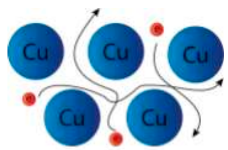


Figure 18

Metallic Bonding

In **metallic bonding**, the electrons in the substance are delocalized, which means that they do not remain attached to any one atom. Metallic bonding is formed from the attraction of the electrons to the metal cations. The valence electrons of metals, while in the solid state, are free to move around the cations within the metals, as shown in Figure 18. This freedom of electron movement forms something called the electron sea. Examples of substances that contain metallic bonds include gold bars, sheets of aluminum foil, iron pans, and copper wires.

As a result of the electrons' ability to move freely among the cations, metals are good thermal and electrical conductors. The structure of the electron sea in a metallic bond provides many other properties observed in metals. The abilities of the electrons to move throughout the electron sea and of the cations to slide past each other make metallic bonds more flexible than ionic or covalent bonds. This flexibility makes metals both malleable (able to be hammered and bent into shapes) and ductile (able to be stretched into long, thin wires).

The properties of elements are determined by their structure. This structure allows for organization on the periodic table. The periodicity of the elements helps predict how elements will interact with each other, including the number and types of bonds.

Periodic Table and Element Structure Review

Reviewing Key Terms

Use each of the following terms in a separate sentence.

1. Valence electrons
2. Ionic bonding
3. Nucleus
4. Period

Use the correct key term to complete each of the following sentences.

1. _______ is the name for the columns on the periodic table.
2. _______ are characterized as being brittle.
3. Most of the elements on the periodic table are classified as ___________.

Reviewing Main Ideas

1. Which element has the smallest radius?
   a. Fluorine
   b. Iodine
   c. Chlorine
   d. Bromine

2. Which of the following represents the subparticles for magnesium?
   a. 12p, 12e, 13n
   b. 12p, 13e, 14n
   c. 12p, 13e, 14n
   d. 12p, 12e, 12n

3. Which type of bond will share electrons?
   a. Ionic
   b. Covalent
   c. Metallic
   d. All of these

Making Connections

1. Explain the difference between an ionic compound and a covalent compound, and give two elements that would combine to form each.
2. Describe the difference between Al^{3+} and N^{3-}.

Open-Ended Response

1. Explain how metallic bonding supports the properties of metals.
2. Describe at least two types of tests you could perform to determine if a substance was a metal or nonmetal.
3. Choose a group from the periodic table that you encounter the most in your everyday life.
4. Compare and contrast ^{1}H, ^{2}H, and ^{3}H.

Space For Work:

Time Required: 20 minutes

Wishful Wants or Necessary Needs?

LESSON 11: STUDENT ACTIVITY SHEET

Case Study 1:

Casey is preparing to leave for college in the fall. She lives in New York, but will be going to school in California, so she is planning on buying a car to get her there. She wants to buy something reliable, so she is deciding between a new car that will cost $17,000 with zero miles and a navigation system and a three-year-old car with 7,000 miles and no navigation system for $12,000. She has $10,000 in savings that she will use for the purchase and she'll take out a loan for the remaining amount.

What are the wants?

What are the needs?

What decision would you make and why?

Case Study 2:

Tom has been saving for a new laptop for the past six months. He's done his research and found a model that experts say will more than meet his needs. But new, it costs $3,000. He also found a refurbished version of the same computer with all of the same features online for $1,500. The refurbished laptop comes with a warranty and Tom bought a refurbished portable music player from the same company with no problems. Tom's third option is a brand new laptop that costs $1,800 and has all of the features he needs but not all of the ones he wants.

What are the wants?

What are the needs?

What decision would you make and why?

Continued on the next page.

Wishful Wants or Necessary Needs?

LESSON 11: STUDENT ACTIVITY SHEET

Case Study 3:

Stephanie received $500 from her grandparents for her high school graduation. She's been longing to buy a new watch and update her wardrobe because she's starting a new job in two weeks, but next month she's moving out on her own and will need to pay three months rent in advance, which totals $1,500. If she uses the money to buy the watch and clothes, she thinks she can save enough money from her new job to pay for rent, but she's not sure.

What are the wants?

____

____

What are the needs?

____

____

What decision would you make and why?

____

____

Case Study 4:

Michelle's been invited to go to a three-day concert with her friends. The only catch is that it's a 9-hour drive, and traveling for an entire weekend means she'll need lots of cash. She estimates that gas, food, tickets and camping will cost around $400. She has a car payment of $250 coming up and her $89 cell phone bill is due at the end of the month. She also needs to buy her mom a birthday gift, which she thinks will cost $50. She has $700 in savings.

What are the wants?

____

____

What are the needs?

____

____

What decision would you make and why?

____

____

This Land Is Your Land

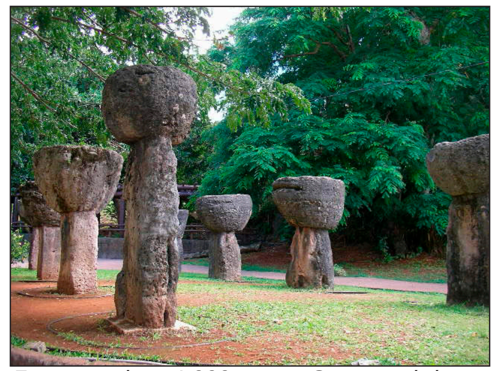
Name:

Fifty United States

Where in the world is the United States? (Can you spot it on this map? Is all of it on this map?) Most of the U.S. is part of the continent called North America. It is in the northern hemisphere of the globe, which means it lies north of the equator. The U.S. is divided into two kinds of smaller areas: states and territories. Each state and territory has its own capital city, its own government, and its own geographical features. There are fifty states. States send representatives to the U.S. Congress, and U.S. citizens who live in a state may vote in presidential elections. Can you name all fifty states?

United States Territories

In addition to the states, there are five U.S. **territories** that are governed by the U.S. but have not been incorporated as states. All of the territories were acquired over time from other countries. Spain gave both **Puerto Rico** and **Guam** to the U.S. after the Spanish-American War in 1898. The **U.S. Virgin Islands** were purchased from Denmark in 1917. **American Samoa** is part of a group of islands that the U.S. and Germany argued over and eventually divided up in 1899. The **Northern Mariana Islands** came under U.S. administration after World War II, and in the 1970s its people voted to become a U.S. territory instead of becoming independent. Each territory is governed by the U.S. federal government, and each one also has its own government with executive, legislative, and judicial branches. Residents of U.S. territories cannot vote in presidential elections.



For more than 4,000 years, Guam and the Mariana Islands have been home to the Chamorro people, who used these latte stones as building supports. Each U.S. territory has its own history and culture. Source: Wikimedia

The Rocky Mountains were a challenge for American settlers headed west. Source: Wikimedia

From Sea to Shining Sea...

...and beyond! The **continental United States** is the 48 states that are contiguous, meaning they are touching. This part of the United States shares borders with two neighbors: Canada to the north and Mexico to the south. It stretches from the Atlantic Ocean in the east to the Pacific Ocean on the west, and has many different kinds of terrain in between. There are major mountain ranges, vast prairies, scorching deserts, and lush woodlands. Two states, Alaska and Hawaii, are not part of the continental U.S. Alaska is much farther north, and part of it lies inside the Arctic Circle! The state of Hawaii and the five U.S. territories, on the other hand, are all tropical islands.

America's Special Places

The United States has lots of special places! But some places have special significance to the U.S. as a nation. One is its capital—the city of Washington, located in the District of Columbia. This is where you'll find the White House, the U.S. Capitol Building, the U.S. Supreme Court, as well as memorials to Washington, Lincoln, and many different wars. Another special place is the Statue of Liberty, located in New York Harbor outside New York City. The statue was a gift from France to the United States in the 1880s, and it has become a worldwide symbol of American e and freedom.

The Statue of Liberty was seen by thousands of immigrants in the late 1800s and early 1900s as they arrived in America looking for a better life. Source: Dept. of Homeland Security

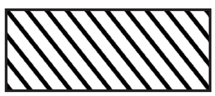
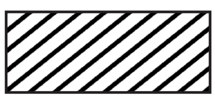
This Land Is Your Land

Name:

A. Water, Water Everywhere. Label these bodies of water on the map:

1. The Pacific Ocean is on the west coast of the United States. Label it on the map.
2. The Atlantic Ocean is on the east coast of the United States. Label it on the map.
3. The Gulf of Mexico is south of the United States. Label it on the map.
4. The Great Lakes lie between the U.S. and Canada.

B. Good Neighbors. The U.S. shares borders with two other countries:

1. Mexico lies to the south, and Canada lies to the north. Label them on the map.
2. Find every state that borders Canada. Label each state with its name and draw lines through it like this: 
3. Find every state that borders Mexico. Label each state with its name and draw lines through it like this: 

C. Raging Rivers. Label America's two longest rivers on the map:

1. Missouri River: Starts in Montana and flows into America's second longest river…
2. Mississippi River: Starts in Minnesota and flows south, emptying into the Gulf of Mexico.

Now label these other famous rivers:

3. Colorado River: Starts in Colorado and flows south along the Arizona border to Mexico.
4. Rio Grande: Starts in Colorado and flows south to the Gulf of Mexico.
5. Columbia River: Starts in Canada, flows south into Washington, then west to the Pacific Ocean.
6. Yukon River: Starts in Canada and flows west through Alaska.
7. Ohio River: Starts in Pennsylvania and flows

D. Majestic Mountains. Draw and label these American mountains:

Rocky Mountains. Sketch a straight line from Idaho's border with Canada to the middle of northern New Mexico. Draw *jagged* mountain peaks on both sides of this line.

Appalachian Mountains. Sketch a straight line the middle of northern Alabama to the top of Maine. Draw *rounded* mountain peaks on both sides of this line.

Mt. Kilauea. Draw a *volcano* on the south side of Hawaii's biggest island!

E. Our Nation's Capital. The president, the U.S. Congress, and the Supreme Court all work here.

1. Find where our capital should be on the map. Draw a star there.
2. Label the star with the name of our capital. (You might need to write the name out in the ocean and draw an arrow.)

F. Home Sweet Home. Do you know where you are? If not, you'd better find out!

1. Find your state or territory. Trace or circle its border with a decorative pattern.
2. Label the city or town where you live with a dot and its name.
3. Label your state's capital city with a star and the city's name.

G. Territorial Terrain. All of the five U.S. territories are made up of islands. But where are they? Follow the clues below to find them. Write the letter that marks each territory next to its clue.

____ 1. Puerto Rico: A large island directly east of the Dominican Republic.

____ 2. American Samoa: A group of islands way out in the ocean east of Australia.

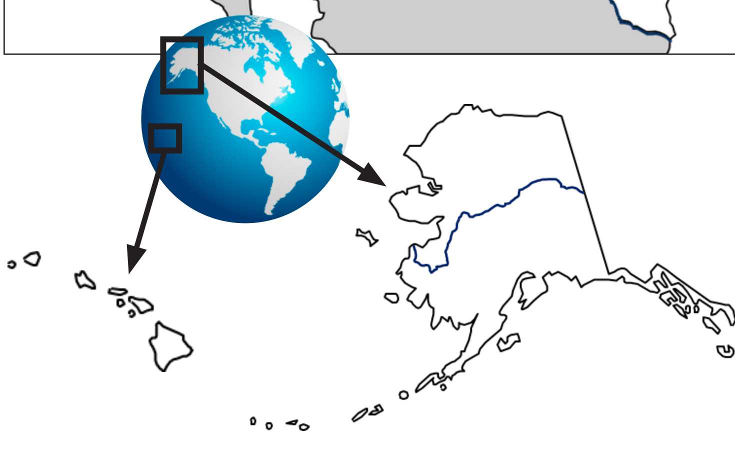
____ 3. Northern Mariana Islands: A curved chain of islands east of the Philippines.

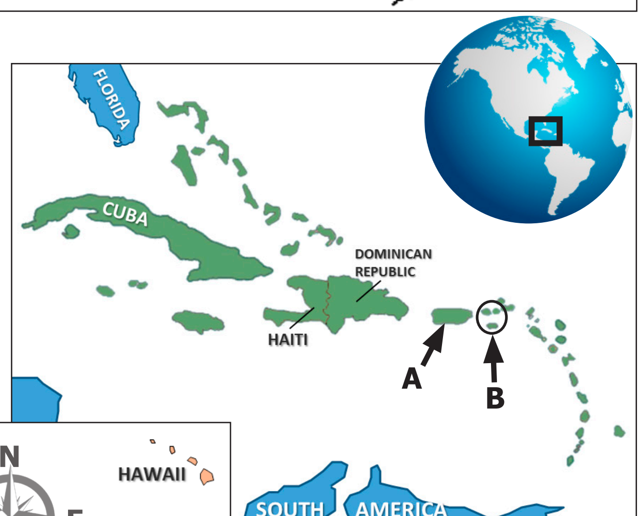
____ 4. U.S. Virgin Islands: Three small islands east of Puerto Rico.

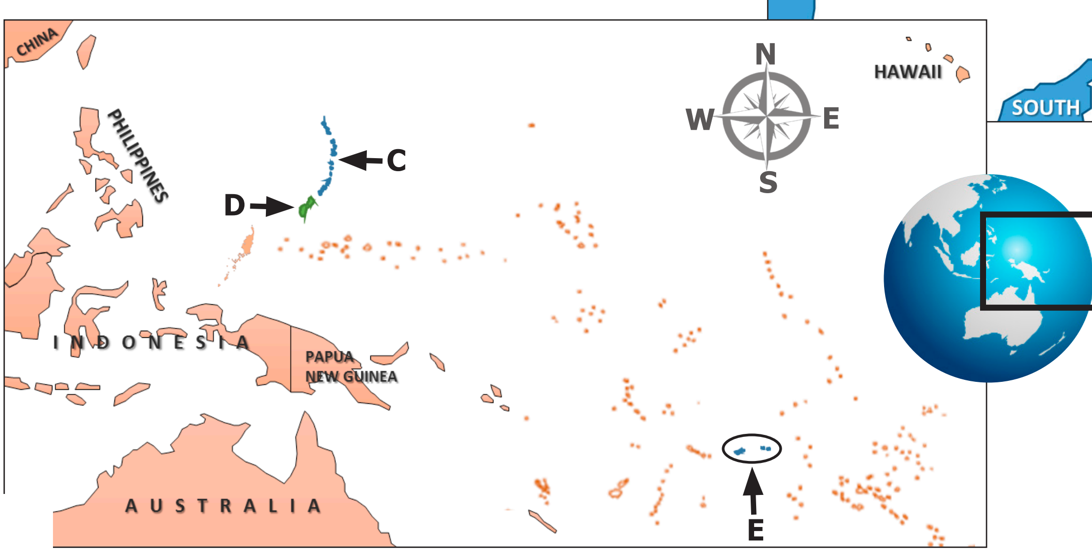
____ 5. Guam: A peanut-shaped island south of the Northern Mariana Islands.

This Land Is Your Land

Name:

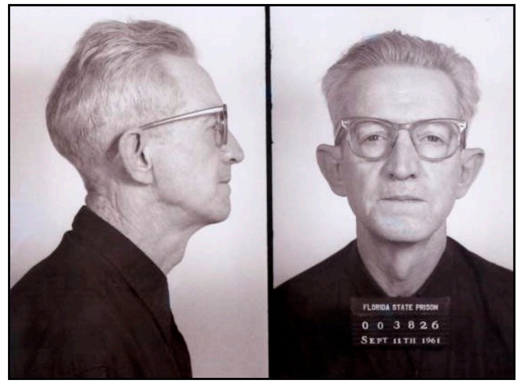






Gideon v. Wainwright (1963) Name:

Being Your Own Lawyer



Mug shot of Clarence Earl Gideon.
Credit: State Archives of Florida

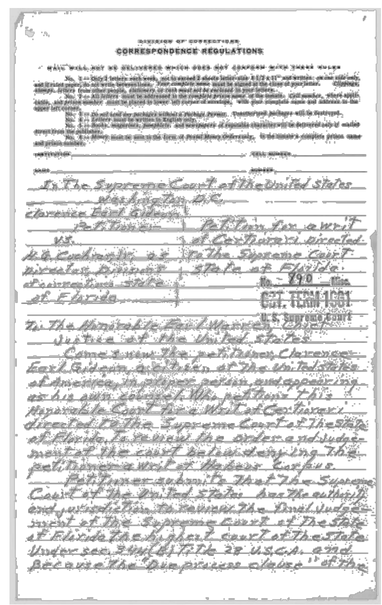
If you had to represent yourself in court, would you know what to do? Would you be successful if the other side had a lawyer? In 1961, Clarence Earl Gideon was charged with breaking into a Florida pool hall and stealing some beverages and about $5 in cash. He could not afford a lawyer, so he asked the court to appoint one for him. The court refused. Under Florida law, only a person charged with a crime that could result in the death penalty could have a free, court-appointed lawyer.

Gideon defended himself in front of the jury. He examined witnesses and made legal arguments, but it wasn't enough. The jury found him guilty and sentenced him to five years in prison.

ISSUE
Is it constitutional for states to deny a lawyer to criminal defendants who can't afford one?
DECISION
No. A fair criminal trial requires that the defendant be given a lawyer.

The Argument

While in prison, Gideon petitioned the U.S. Supreme Court about his case. He argued that the 6th Amendment to the U.S. Constitution guaranteed him the right to a lawyer. The 6th Amendment says that "in all criminal prosecutions, the accused shall enjoy the right . . . to have the assistance of counsel for his defense." The Supreme Court had already said that in federal courts, this meant people accused of a crime must be given a lawyer even if they can't afford one. Gideon argued the same thing should be true in state courts.



DIVISION OF CORRECTIONS
CORRESPONDENCE REGULATIONS

In The Supreme Court of The United States
Washington D.C.
Clarence Earl Gideon, Petitioner
vs.
H.G. Cochran, Jr., as Director, Divisions of Corrections State of Florida
Petition for a writ of Certiorari directed to The Supreme Court State of Florida
No. 890 Misc.
OCT. TERM 1961
U.S. Supreme Court

To: The Honorable Earl Warren, Chief Justice of the United States

Comes now the petitioner, Clarence Earl Gideon, a citizen of the United States of America, in proper person, and appearing as his own counsel. Who petitions this Honorable Court for a Writ of Certiorari directed to The Supreme Court of The State of Florida, To review the order and Judgement of the court below denying The petitioner a writ of Habeus Corpus.

Petitioner submits That The Supreme Court of the United States has The authority and jurisdiction to review The final Judgement of The Supreme Court of The State of Florida the highest court of The State Under sec. 344(B) Title 28 U.S.C.A. and Because The "Due process clause" of the

Gideon's handwritten petition to the Supreme Court

The Decision

The Supreme Court agreed. The Constitution is a federal document, which means that legally, the rights it contains only protect people when dealing with the federal government. The Court had already ruled that states do not need to give people those same rights unless the right is fundamental to a fair trial.

The Court now said the right to a lawyer is a fundamental right. A person cannot be assured of a fair trial without one. The Court wrote, "Even the intelligent and educated layman . . . lacks both the skill and knowledge adequately to prepare his defense," even if that person's defense would prove he or she is not guilty. People accused of a crime need a lawyer because they don't understand all the rules and procedures that take place during a trial.

States now have state-funded public defender offices

So What?

When the Supreme Court sent Gideon's case back to the lower court, Gideon received a lawyer and a new jury trial. This time, the lawyer presented evidence that proved Gideon was not guilty.

Because of this case, states must now provide a lawyer to criminal defendants who cannot afford one. **Public defenders** are lawyers employed by the state to represent these criminal defendants. Public defenders work to make sure people accused of a crime get a fair trial. Criminal defendants have certain rights under the Constitution and public defenders make sure those rights are protected.

Gideon v. Wainwright (1963) Name:

But Doesn't the Constitution Say...? In 1833, the Supreme Court said the rights listed in the Bill of Rights in the Constitution only applied at the national (federal) level—not at the state level. One by one, over time, the Court has decided that certain rights do apply at the state level. Match the following rights with the cases that applied them to the state level:

☐ **1st Amendment**
Freedom of the Press

☐ **1st Amendment**
Freedom of Speech

☐ **2nd Amendment**
Right to Bear Arms

☐ **4th Amendment**
Right Against Unreasonable Search & Seizure

☐ **5th Amendment**
Right Not to be Tried Twice for the Same Crime (Double Jeopardy)

☐ **6th Amendment**
Right to a Speedy Trial

☐ **6th Amendment**
Right to a Public Trial

A) **Near v. Minnesota** (1931)

Minnesota passed a law saying scandalous newspapers could be shut down. J.M. Near published a paper that was shut down for running stories about police corruption.

B) **In re Oliver** (1948)

A Michigan judge investigated a crime by calling in witnesses to testify in secret. Oliver testified, but the judge didn't believe him. Still acting in secret, the judge punished Oliver by sentencing him to 60 days in jail.

C) **McDonald v. Chicago** (2010)

The City of Chicago passed a law banning all handguns. McDonald and others could no longer keep handguns in their homes.

D) **Klopfer v. North Carolina** (1967)

Mr. Klopfer was charged with criminal trespass. After a mistrial, his case was put on hold indefinitely, but could be reopened at any time.

E) **Benton v. Maryland** (1969)

At trial, John Benton was found guilty of burglary but innocent of larceny. But the jurors had been chosen unconstitutionally, so he was offered a second trial. He was again charged with both burglary and larceny.

F) **Mapp v. Ohio** (1961)

Police forced their way into Dollree Mapp's house looking for a fugitive. They didn't find the fugitive, but they did find a box of inappropriate books and photos. They took it and used it to convict Mapp of possessing obscene material.

G) **Gitlow v. New York** (1925)

Benjamin Gitlow had been convicted of a crime in New York for distributing pamphlets about his extreme political beliefs.

Now add Gideon's case:

______ **Amendment**

Right to ________________

____

________________ **v.** ________________ (________)

Clarence Gideon ______________________________________

____

____

____

Miranda v. Arizona (1966)

Name:

You Have the Right to Remain Silent...

Ernesto Miranda was arrested for a violent crime in Phoenix, Arizona and was taken to a police station for questioning. Officers put him into an interrogation room, where they questioned him for two hours. They came out with a written confession Miranda had signed. The confession form included a typed paragraph saying the confession had been made voluntarily. The typed paragraph said Miranda had signed the confession "with full knowledge of my legal rights, understanding any statement I make may be used against me." Miranda's confession was used against him in court, and he was convicted of a serious crime.

ISSUE

Do the police need to inform a suspect of his 5th and 6th Amendment rights in order to use the suspect's confession at the trial?

DECISION

Yes, because this will prevent police from illegally forcing confessions from people.

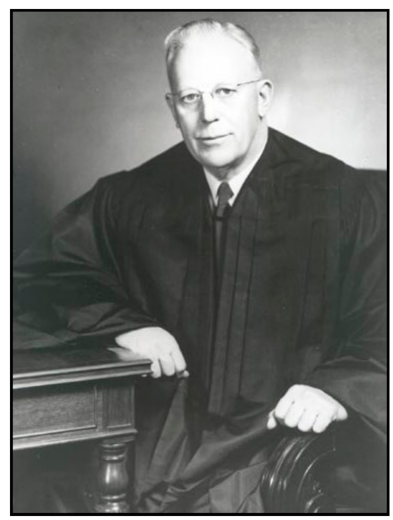
The Argument

The 5th Amendment to the U.S. Constitution says that a person involved in a criminal case cannot be forced to be a witness against himself. In other words, only statements that are made voluntarily may be used. Miranda argued that his confession was not voluntary because he had not been told about his right to remain silent. He was also not told about his right to a lawyer under the 6th Amendment, so a lawyer was not present during the questioning. For these reasons, Miranda argued that his confession should not have been used in court.

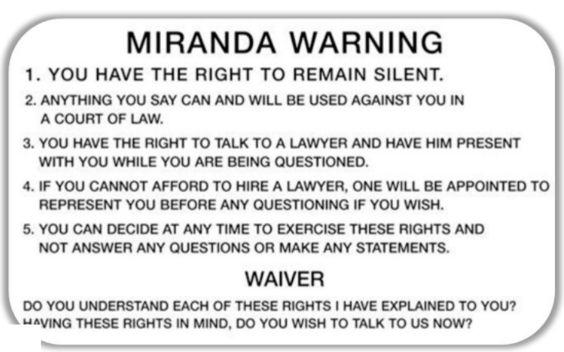
The Decision

The Supreme Court agreed. It said that the 5th Amendment right to remain silent is so basic that it doesn't even matter if a person already knows about this right—the right is not safeguarded unless officers tell people about it before interrogation begins. The Court said this is especially true because the interrogation techniques used by law enforcement officers can be very intimidating.

The Court also said police must inform suspects of the right to have a lawyer present during the questioning. Technically, the right to a lawyer is a 6th Amendment right. But the Court said that a lawyer is absolutely necessary to protect a suspect's 5th Amendment right not to testify against himself or herself. That's because a lawyer can advise a suspect about what to say and what not to say during the questioning. Because Miranda's 5th Amendment right was violated, the Court reversed his conviction.



Chief Justice Earl Warren wrote the opinion for Miranda's case.



MIRANDA WARNING

1. YOU HAVE THE RIGHT TO REMAIN SILENT.
2. ANYTHING YOU SAY CAN AND WILL BE USED AGAINST YOU IN A COURT OF LAW.
3. YOU HAVE THE RIGHT TO TALK TO A LAWYER AND HAVE HIM PRESENT WITH YOU WHILE YOU ARE BEING QUESTIONED.
4. IF YOU CANNOT AFFORD TO HIRE A LAWYER, ONE WILL BE APPOINTED TO REPRESENT YOU BEFORE ANY QUESTIONING IF YOU WISH.
5. YOU CAN DECIDE AT ANY TIME TO EXERCISE THESE RIGHTS AND NOT ANSWER ANY QUESTIONS OR MAKE ANY STATEMENTS.

WAIVER

DO YOU UNDERSTAND EACH OF THESE RIGHTS I HAVE EXPLAINED TO YOU? HAVING THESE RIGHTS IN MIND, DO YOU WISH TO TALK TO US NOW?

So What?

The famous "Miranda warning" you hear on detective shows (and that officers recite in real life) came from this case. Now, if officers question you without reading your rights first, nothing you say during the questioning can be used against you in court. (Failing to read your rights does *not* mean your case will be automatically dismissed.) As for Miranda, he was put on trial a second time and convicted even without his confession.

Miranda v. Arizona (1966)

Name: ____________________

A. Why Must They Say That? The Miranda warning has several parts. The Supreme Court had many good reasons for requiring all these warnings. Read the list of reasons below. Decide which part of the warning each reason explains. Write the number of the warning next to each reason that explains it.

Miranda Warning

1. You have the right to remain silent.
2. Anything you say can and will be used against you in a court of law.
3. You have the right to talk to a lawyer and to have a lawyer present with you while you are being questioned.
4. If you cannot afford to hire a lawyer, one will be appointed to represent you before any questioning if you wish.
5. You can decide at any time to exercise these rights and not answer any questions or make any statements.

This part of the Miranda warning is important because…

____ When seeking justice, officers must not take advantage of the fact that someone has a low income.

____ Some people might not know they have the right not to speak to the authorities.

____ Having a lawyer present during questioning helps protect a person's 5th Amendment right to remain silent.

____ A person needs to understand not just the basic right, but also the consequences of not exercising that right.

____ If at any point the person says they don't want to talk, any statement taken after that must have been forced.

____ Being reminded of this basic right makes a person less likely to give up their right if investigators make it seem like silence proves the person is guilty.

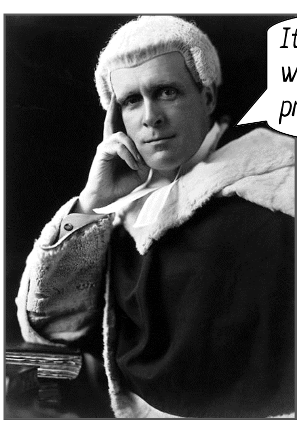
____ Someone could think the right to talk to a lawyer means only if you can afford to hire one.

____ It helps people realize the questioning is a stage of the legal system and officers are not on their side.

____ A lawyer can help make sure any statements made to law enforcement are accurately reported during a trial.

____ Telling someone the basic right up front lets the person know authorities recognize the right exists.

B. Justice at Any Cost? The Supreme Court quoted Viscount Sankey, Lord Chancellor of England from 1929 -1935, for the idea that it's not okay to get justice for a crime by committing a wrong act.



ı Sankey,
Viscount Sankey

It is not admissible to do a great right by doing a little wrong. It is not sufficient to do justice by obtaining a proper result by irregular or improper means.

Do you agree with Lord Sankey and the Supreme Court?

❍ Yes ❍ No

Write 2 sentences explaining your opinion:

1. ____

____

____

2. ____

____

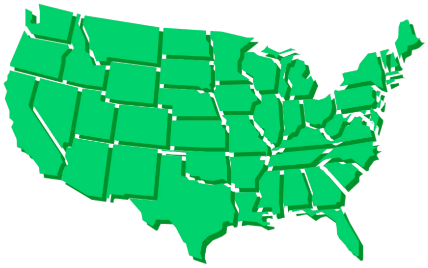
____

iCivics

A

Power to the States!

Name:



Fifty Sovereign Nations?

The United States is exactly what its name says: a group of states united together to form a single nation. But what are these states? Are they independent nations? Just areas of land with boundaries drawn around them? A **state** is a geopolitical unit that has *sovereignty*—the authority to govern itself. Mexico and China are states, but so are Georgia and Pennsylvania. The difference is, Mexico and China have complete authority inside their borders, just like all sovereign nations do. Georgia and Pennsylvania could have had that, too, but they chose not to. After winning independence from Great Britain and basically becoming a group of sovereign nations, the states in the U.S. gave some of their authority away by agreeing to a little contract called the United States Constitution.

Power Sharing

The Constitution is really just an agreement that the original states put together in order to form a nation they could all be part of. That nation needed a government, and that government needed power. There was only one place that power could come from: the states. Each state already had its own leaders, laws, and legal system. Each state had also developed its own constitution years before the U.S. Constitution was written. The states held all the power, and in order to empower a central government, states would have to give up some of their own. Generally speaking, states did not love this idea. They worried that a government too far from the people, with too much power, could destroy individual liberty.

State power is a big deal because state governments are closest to the people.

Let's Just Be Clear...

In the Constitution, the states created a **federalist system** where they would share power with a central government and give it a specific list of powers. Because states were so freaked out about giving away any power at all, the **10th Amendment** to the Constitution makes it super clear how the power-sharing between the states and the federal government was supposed to work:

> The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people.

In other words, if the Constitution doesn't specifically give a power to the U.S. government or prohibit states from having it, then state governments (or the people) keep that power. Powers the states kept are called **reserved powers**.

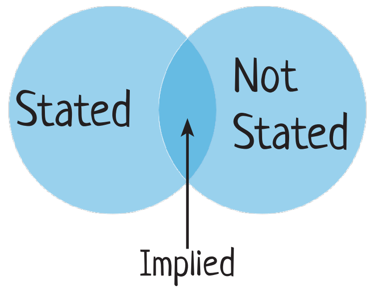
What the States Gave Up

The list of powers the states gave the federal government in the Constitution are called **expressed powers** because they are directly stated. Even though states didn't like giving up power, some things just made sense—for example, it would be pretty messy to have thirteen different states declaring war, so that power went to the federal government. Other examples include the power to maintain a military, make treaties with other nations, coin money, and make rules about who gets to be a U.S. citizen. Ultimately, the states tried to give the federal government only the powers that were absolutely necessary for a strong nation that could run smoothly.

One of the first United States coins

Power to the States!

Name: ______________________________



Not Stated, but Not Reserved

In addition, there are **implied powers** hidden within the express federal powers. For example, the power to make rules about citizenship *implies* the power to monitor the flow of people through the nation's borders. The Constitution lets the federal government do things that aren't specifically stated but are "necessary and proper" for carrying out the other federal powers.

There are also **concurrent powers** that both states and the federal government have, and that both can can exercise at the same time — as long as they don't interfere with each other. Normally, interference isn't an issue because federal and state governments operate as two separate systems. For example, both have the power to tax, spend, and borrow money because both levels of government need money to function and provide services. Both levels have the power to define crimes and determine the punishment for those crimes, so both levels have the power to create a justice system. But the states put one big limit on themselves in the Constitution: If state and federal laws do interfere with each other, federal laws are supreme.

Source: TX Dept. of Public Safety

Police Power: Not What it Sounds Like

The biggest power the states kept for themselves is one you won't find defined in any constitution: the **police power**. This is a sweeping power that lets states do things like this:

- Protect the health, safety, and morals of the community
- Pass and enforce laws that promote the general welfare
- Limit private rights for the good of the public
- Address major needs in the community

While the police power is the reason police departments can exist, this power is about a lot more than police officers. Laws based on the police power can be wildly different from state to state, and they can cover everything from the kind of electrical wire allowed in new construction to noise ordinances that limit how loud motorcycle pipes can be. Each state has its own needs and priorities, and states use their police powers to address issues in ways that make sense for their own citizens.

MORE Power to the States?

When the states agreed to the Constitution, the states were the only ones with power to keep or give away. Because the states also have the power to amend the Constitution, the states could—in theory—strip the federal government of its powers by changing the Constitution. Changing the Constitution is really difficult because it requires getting a huge portion of people and states to agree on something that will become "the law of the land." America also has over 200 years of history built on the system of federal-state power-sharing that the Founders created, along with a history of respecting that system instead of trying to change it. So a state-power revolution ›ably won't happen. But it could, and that's the point.

Federal Power Cheat Sheet

Article I, Section 8 of the U.S. Constitution

The Congress shall have power to lay and collect taxes, duties, imposts and excises, to pay the debts and provide for the common defense and general welfare of the United States; but all duties, imposts and excises shall be uniform throughout the United States;

To borrow money on the credit of the United States;

To regulate commerce with foreign nations, and among the several states, and with the Indian tribes;

To establish a uniform rule of naturalization, and uniform laws on the subject of bankruptcies throughout the United States;

To coin money, regulate the value thereof, and of foreign coin, and fix the standard of weights and measures;

To provide for the punishment of counterfeiting the securities and current coin of the United States;

To establish post offices and post roads;

To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries;

To constitute tribunals inferior to the Supreme Court;

To define and punish piracies and felonies committed on the high seas, and offenses against the law of nations;

To declare war, grant letters of marque and reprisal, and make rules concerning captures on land and water;

To raise and support armies, but no appropriation of money to that use shall be for a longer term than two years;

To provide and maintain a navy;

To make rules for the government and regulation of the land and naval forces;

To provide for calling forth the militia to execute the laws of the union, suppress insurrections and repel invasions;

To provide for organizing, arming, and disciplining, the militia, and for governing such part of them as may be employed in the service of the United States, reserving to the states respectively, the appointment of the officers, and the authority of training the militia according to the discipline prescribed by Congress;

To exercise exclusive legislation in all cases whatsoever, over such District (not exceeding ten miles square) as may, by cession of particular states, and the acceptance of Congress, become the seat of the government of the United States, and to exercise like authority over all places purchased by the consent of the legislature of the state in which the same shall be, for the erection of forts, magazines, arsenals, dockyards, and other needful buildings;--And

To make all laws which shall be necessary and proper for carrying into execution the foregoing powers, and all other powers vested by this Constitution in the government of the United States, or in any department or officer thereof.

Power to the States!

Name: ____________________

A. Implied Power or State Power? Use your Federal Power Cheat Sheet to decide whether each power listed in the table could be an implied power of the U.S. Congress or is probably a state power.

Power	This is probably a...	Why? If implied, which power might imply it?
1. Print paper money	❍ State power ✓ Implied power	*ex: The power to coin money implies the power to print paper money also*
2. Establish rules about who is allowed to drive	❍ State power ❍ Implied power	
3. Print and sell postage stamps	❍ State power ❍ Implied power	
4. Determine the unit of measure for electricity sold as fuel for electric cars	❍ State power ❍ Implied power	
5. Build a system of public transportation for a metropolitan area	❍ State power ❍ Implied power	
6. Punish crimes committed by boaters in lakes and rivers	❍ State power ❍ Implied power	
7. Punish people who make counterfeit I.D. cards	❍ State power ❍ Implied power	
8. Build and maintain nuclear weapons	❍ State power ❍ Implied power	
9. Launch a website with information about how to obtain a copyright	❍ State power ❍ Implied power	
10. Provide and operate a lottery	❍ State power ❍ Implied power	

B. Power Diagramming. Think about the sources of state and federal power. In the space below, draw and label a diagram that would help you explain to someone younger than you where state and federal power comes from.

Power to the States!

Name: ____________________

C. Police Power vs. Police Officers. To be sure you understand that the "police power" isn't about the powers of police officers, decide whether each activity below is an example of states' police power or a law enforcement activity.

	States' Police Power	Law Enforcement Activity
1. Searching a vehicle during a traffic stop	❑	❑
2. Restricting the number of animals allowed in a residence	❑	❑
3. Arresting someone for drug possession	❑	❑
4. Questioning a suspect who is in custody	❑	❑
5. Requiring vaccinations in order to enroll in school	❑	❑
6. Limiting the number of trailers a semi truck can pull	❑	❑
7. Chasing someone fleeing the scene of a crime	❑	❑
8. Requiring vehicle owners to have insurance	❑	❑

D. Summarize the System. Write a paragraph explaining the division of power between states and the federal government. Use all of the phrases in the checklist in your answer. Underline each phrase in your answer.

Word & Phrase Checklist

(use these in any order you want!)

- ❍ delegated (or delegate)
- ❍ 10th Amendment
- ❍ reserved powers
- ❍ expressed powers
- ❍ implied powers
- ❍ concurrent powers
- ❍ police powers
- ❍ sovereignty

Power to the States!

Name: ____________________

Rights vs. the Public Good

A state's police power lets the state limit individual rights in order to protect the general public in four main categories: **Health**, **Safety**, **Morals**, and General **Welfare**. Take a look at the following real-life examples of different ways the police power has been used. First, decide which category of protection you think each law falls under and circle the appropriate letter. Then, rate how much you think each one limits individual rights and benefits the public.

1) People riding motorcycles on public roads and highways are not required to wear a helmet.

H M W S

How much does this law limit individual rights?

Little 1 2 3 4 5 Lots!

How much could this law benefit the public?

Little 1 2 3 4 5 Lots!

2) Residents in "slum areas" may be forced to move and sell their homes to the city for redevelopment.

H M W S

How much does this law limit individual rights?

Little 1 2 3 4 5 Lots!

How much could this law benefit the public?

Little 1 2 3 4 5 Lots!

3) The first time a person is arrested for a DUI, his or her driver's license will be suspended for 1 year.

H M W S

How much does this law limit individual rights?

Little 1 2 3 4 5 Lots!

How much could this law benefit the public?

Little 1 2 3 4 5 Lots!

4) Fast food workers must offer children milk or water before asking if they want soda.

H M W S

How much does this law limit individual rights?

Little 1 2 3 4 5 Lots!

How much could this law benefit the public?

Little 1 2 3 4 5 Lots!

5) It is a crime to hold a public exhibition of a person who has an unusual physical characteristic.

H M W S

How much does this law limit individual rights?

Little 1 2 3 4 5 Lots!

How much could this law benefit the public?

Little 1 2 3 4 5 Lots!

6) A person expected to die within 6 months may ask a doctor for medicine to end his or her own life.

H M W S

How much does this law limit individual rights?

Little 1 2 3 4 5 Lots!

How much could this law benefit the public?

Little 1 2 3 4 5 Lots!

Power to the States!

Rights vs. Public Good Discussion Sheet

Assigned Law # _____

Group Members:

1. Compare the categories you each assigned to this law. Record the number of group members who chose each category:

____ H ____ M

____ W ____ S

2. Compare how you each ranked this law's limits on individual rights. Then, discuss these questions. Write down your group members' ideas.

In what ways might this law limit people's rights?

In what ways might this law not affect people's rights?

3. Now, compare how you each ranked this law's benefit to the public. Then, discuss these questions. Write down your group members' ideas.

In what ways might this law benefit the public?

In what ways might this law have little benefit for the public?

Power to the States!

4. As a group, decide what you think this law's objective is. What do you think lawmakers hoped to accomplish by using the police power in this way? Write your group's answer here:

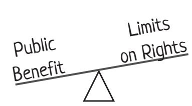
This law's objective:

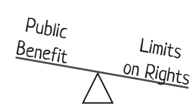
5. As a group, discuss what changes you could make to this law to increase the public benefit and/or decrease limits to individual rights. Write your group's ideas in the table:

Proposed Change (A limit, condition, requirement, time frame—anything!)	Effect (OK if it's both)	How the change will create the effect(s):
	❑ ↑ Public Benefit ❑ ↓ Limits on Rights	
	❑ ↑ Public Benefit ❑ ↓ Limits on Rights	
	❑ ↑ Public Benefit ❑ ↓ Limits on Rights	

6. Discuss ways you could test whether this law is meeting its objective. Write your group's ideas here: (Make sure your tests don't trample anyone's rights!)

7. Does this law's benefits outweigh its limitations on individual rights? Circle the diagram that best shows a view your group agrees on. *(If there is strong disagreement in your group, check the TWO diagrams that best represent the differing views.)*

A.


B.


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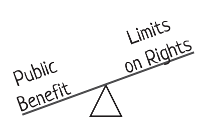

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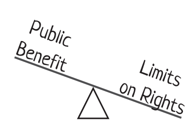
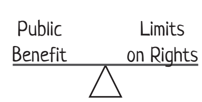


E.


F. Something else? Draw or explain:

8. Finally, poll your group: Is this law a good use of a state's police power?

_____ Yes, as-is

_____ Yes, with our proposed changes

_____ No