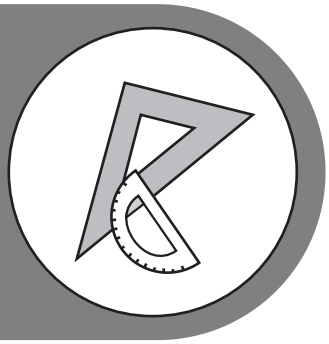
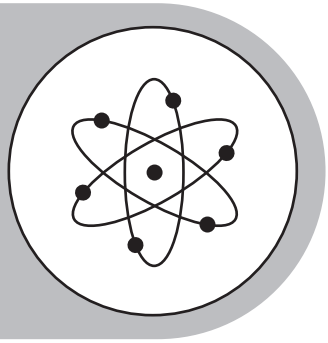
PHYSICAL SCIENCE

Study Guide





Georgia End-Of-Course Tests

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Georgia Department of Education
Kathy Cox, State Superintendent of Schools
January 2004

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INTRODUCTION

This study guide is designed to help students prepare to take the Georgia End-of-Course Test (EOCT) for ***Physical Science***. This study guide provides information about the EOCT, tips on how to prepare for it, and some suggested strategies students can use to perform their best.

What is the EOCT? The EOCT program was created to improve student achievement through effective instruction and assessment of the standards in the Quality Core Curriculum specific to the eight EOCT core high school courses. The EOCT program also helps to ensure that all Georgia students have access to a rigorous curriculum that meets high performance standards. The purpose of the EOCT is to provide diagnostic data that can be used to enhance the effectiveness of schools' instructional programs.

The Georgia End-of-Course Testing program is a result of the A+ Educational Reform Act of 2000, O.C.G.A. §20-2-281. This act requires that the Georgia Department of Education create end-of-course assessments for students in grades nine through twelve for the following core high school subjects:

Mathematics

- Algebra I
- Geometry

Social Studies

- United States History
- Economics/Business/Free Enterprise

Science

- Biology
- Physical Science

English Language Arts

- Ninth Grade Literature and Composition
- American Literature and Composition

Getting started: The HOW TO USE THE STUDY GUIDE section on page 2 outlines the contents in each section, lists the materials you should have available as you study for the EOCT, and suggests some steps for preparing for the ***Physical Science*** **EOCT**.

HOW TO USE THE STUDY GUIDE

This study guide is designed to help you prepare to take the ***Physical Science*** **EOCT**. It will give you valuable information about the EOCT, explain how to prepare to take the EOCT, and provide some opportunities to practice for the EOCT. The study guide is organized into three sections. Each section focuses on a different aspect of the EOCT.

The **OVERVIEW OF THE EOCT** section on page 4 gives information about the test: dates, time, question format, and number of questions that will be on the ***Physical Science*** **EOCT**. This information can help you better understand the testing situation and what you will be asked to do.

The **PREPARING FOR THE EOCT** section that begins on page 5 provides helpful information on study skills and general test-taking skills and strategies. It explains how to prepare before taking the test and what to do during the test to ensure the best test-taking situation possible.

The **TEST CONTENT** section that begins on page 11 explains what the ***Physical Science*** **EOCT** specifically measures. When you know the test content and how you will be asked to demonstrate your knowledge, it will help you be better prepared for the EOCT. This section also contains some test-taking strategies for successfully answering questions on the EOCT.

With some time, determination, and guided preparation, you will be better prepared to take the ***Physical Science*** **EOCT**.

GET IT TOGETHER

In order to make the most of this study guide, you should have the following:

Materials:
- ✓ This study guide
- ✓ Pen or Pencil
- ✓ Highlighter
- ✓ Paper

Resources:
- ✓ Dictionary
- ✓ Physical Science textbook
- ✓ A teacher or other adult

Study Space:
- ✓ Comfortable (but not too comfortable)
- ✓ Good lighting
- ✓ Minimal distractions
- ✓ Enough work space

Time Commitment:
- ✓ When are you going to study?
- ✓ How long are you going to study?

Determination:
- ✓ Willingness to improve
- ✓ Plan for meeting goals

SUGGESTED STEPS FOR USING THIS STUDY GUIDE

1 Familiarize yourself with the structure and purpose of the study guide. (You should have already read the INTRODUCTION and HOW TO USE THE STUDY GUIDE. Take a few minutes to look through the rest of the study guide to become familiar with how it is arranged.)

2 Learn about the test and expectations of performance. (Read OVERVIEW OF THE EOCT.)

3 Improve your study skills and test-taking strategies. (Read PREPARING FOR THE EOCT.)

4 Learn what the test will assess by studying each domain and the strategies for answering questions that assess the standards in the domain. (Read TEST CONTENT.)

5 Answer the sample questions at the end of each domain section. Check your answers against the annotated answers to see how well you did. (See TEST CONTENT.)

OVERVIEW OF THE EOCT

Good test takers understand the importance of knowing as much about a test as possible. This information can help you determine how to study and prepare for the EOCT and how to pace yourself during the test. The box below gives you a "snapshot" of the ***Physical Science*** **EOCT**.

THE EOCT AT A GLANCE

Administration Dates:

The EOCT will be given three times a year: once in the spring, once in the summer, and once in the winter.

Administration Time:

Each EOCT is comprised of two sections; each section will take 45 to 60 minutes to complete. You will have 100 to 135 minutes to complete each EOCT. You will be given a 5-minute stretch break between the two sections of the test.

Question Format:

All the questions on the EOCT are multiple choice.

Number of Questions:

Each section of the EOCT contains 45 questions; there are a total of 90 questions on the EOCT.

If you have additional administrative questions regarding the EOCT, please visit the Georgia Department of Education website at www.doe.k12.ga.us, see your teacher, or see your school test coordinator.

PREPARING FOR THE EOCT

WARNING!

You cannot prepare for this kind of test in one night. Questions will ask you to apply your knowledge, not list specific facts. Preparing for the EOCT will take time, effort, and practice.

In order to do your best on the ***Physical Science*** **EOCT**, it is important that you take the time necessary to prepare for this test and develop those skills that will help you take the EOCT.

First, you need to make the most of your classroom experiences and test preparation time by using good **study skills**. Second, it is helpful to know general **test-taking strategies** to ensure that you will achieve your best score.

Study Skills

A LOOK AT YOUR STUDY SKILLS

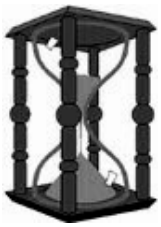
Before you begin preparing for this test, you might want to consider your answers to the following questions. You may write your answers here or on a separate piece of paper.

1. How would you describe yourself as a student?
   Response: _____
2. What are your study skills strengths and/or weaknesses as a student?
   Response: _____
3. How do you typically prepare for a physical science test?
   Response: _____
4. Are there study methods you find particularly helpful? If so, what are they?
   Response: _____
5. Describe an ideal study situation (environment).
   Response: _____
6. Describe your actual study environment.
   Response: _____
7. What can you change about the way you study to make your study time more productive?
   Response: _____

Effective study skills for preparing for the EOCT can be divided into three categories.

- **Time Management**
- **Organization**
- **Active Participation**

Time Management



Do you have a plan for preparing for the EOCT? Often students have good intentions for studying and preparing for a test, but without a plan, many students fall short of their goals. Here are some strategies to consider when developing your study plan. (See Appendices A–D for SAMPLE STUDY PLAN SHEETS that you can use to help you create your study plan.)

- Set realistic goals for what you want to accomplish during each study session and chart your progress.
- Study during your most productive time of the day.
- Study for reasonable amounts of time. Marathon studying is not productive.
- Take frequent breaks. Breaks can help you stay focused. Doing some quick exercises (e.g., sit-ups or jumping jacks) can help you stay alert.
- Be consistent. Establish your routine and stick to it.
- Study the most challenging test content first.
- For each study session, build in time to review what you learned in your last study session.
- Evaluate your accomplishments at the end of each study session.
- Reward yourself for a job well done.

Organization

You don't want to waste your study time. Searching for materials, trying to find a place to study, and debating what and how to study can all keep you from having a productive study session. Get organized and be prepared. Here are a few organizational strategies to consider.

- Establish a study area that has minimal distractions.
- Gather your materials in advance.
- Develop and implement your study plan (See Appendices A–D for SAMPLE STUDY PLAN SHEETS).

Active Participation

Students who actively study will learn and retain information longer. Active studying also helps you stay more alert and be more productive while learning new information. What is active studying? It can be anything that gets you to interact with the material you are studying. Here are a few suggestions:

- Carefully read the information and then DO something with it. Mark the important points with a highlighter, circle them with a pen, write notes on them, or summarize the information in your own words.
- Ask questions. As you study, questions often come into your mind. Write them down and actively seek the answers.
- Create sample test questions and answer them.
- Find a friend who is also planning to take the test and quiz each other.

Test-taking Strategies

There are many test-taking strategies that you can use before and during a test to help you have the most successful testing situation possible. Below are a few questions to help you take a look at your test-taking skills.

A LOOK AT YOUR TEST-TAKING SKILLS

As you prepare to take the EOCT, you might want to consider your answers to the following questions. You may write your answers here or on your own paper.

1. How would you describe your test-taking skills?
   Response: _____
2. How do you feel when you are taking a test?
   Response: _____
3. List the strategies that you already know and use when you are taking a test.
   Response: _____
4. List test-taking behaviors you use when preparing for and taking a test that do not contribute to your success.
   Response: _____
5. What would you like to learn about taking tests?
   Response: _____

Suggested Strategies to Use to Prepare for the EOCT

Learn from the Past. Think about your daily/weekly grades in your science classes (past and present) to answer the following questions.

- In which specific areas of science were you or are you successful?

  Response: _____

- Is there anything that has kept you from achieving higher scores?

  Response: _____

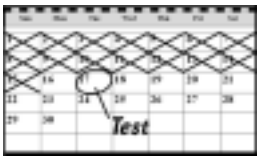
- What changes should you implement to achieve higher scores?

  Response: _____

Before taking the EOCT, work toward removing or minimizing any obstacles that might stand in the way of you performing your best. The test preparation ideas and test-taking strategies in this section are designed to help guide you to accomplish this.

Be Prepared. The best way to perform well on the EOCT is to be prepared. In order to do this, it is important that you know what standards/skills will be measured on the ***Physical Science*** **EOCT** and then practice understanding and using those standards/ skills. The standards that will be measured in this EOCT are located in the **Physical Science Quality Core Curriculum** (QCC). The OVERVIEW OF THE EOCT and TEST CONTENT sections of this study guide are designed to help you understand which specific standards are on the ***Physical Science*** **EOCT** and give you suggestions for how to study the standards that will be assessed. Take the time to read through this material and follow the study suggestions. You can also ask your science teacher for any suggestions he or she might offer on preparing for the EOCT.

Start Now. Don't wait until the last minute to start preparing. Begin early and pace yourself. By preparing a little bit each day, you will retain the information longer and increase your confidence level. Find out when the EOCT will be administered, so you can allocate your time appropriately.



Suggested Strategies to Use the Day Before the EOCT

✓ **Review what you learned from this study guide**

1. Review the general test-taking strategies discussed in the TOP 10 SUGGESTED STRATEGIES TO USE DURING THE EOCT on page 10.
2. Review the content domain-specific information discussed in the section, TEST CONTENT beginning on page 11.
3. Focus your attention on the domain, or domains, that you are most in need of improving.

✓ **Take care of yourself**

1. Try to get a good night's sleep. Most people need an average of 8 hours, but everyone's sleep needs are different.
2. Don't drastically alter your routine. If you go to bed too early, you might lie in bed thinking about the test. You want to get enough sleep so you can do your best.

Suggested Strategies to Use the Morning of the EOCT

Eat a good breakfast. Eat some food that has protein in it for breakfast (and for lunch if the test is given in the afternoon). Some examples of foods high in protein are peanut butter, meat, and eggs. Protein gives you long-lasting, consistent energy that will stay with you through the test to help you concentrate better. Some people believe it is wise to eat some sugar before a test, claiming it gives them an energy boost. In reality, the energy boost is very short lived, and you actually end up with less energy than before you ate the sugar. Also, don't eat too much. A heavy meal can make you feel tired. So think about what you eat before the test.

Dress appropriately. If you are too hot or too cold during the test, it can affect your performance. It is a good idea to dress in layers, so you can stay comfortable, regardless of the room temperature, and keep your mind on the EOCT.

Arrive for the test on time. Racing late into the testing room can cause you to start the test feeling anxious. You want to be on time and prepared.

TOP 10

Suggested Strategies to Use During the EOCT

These general test-taking strategies can help you do your best during the EOCT.

1. **Focus on the test.** Try to block out whatever is going on around you. Take your time and think about what you are asked to do. Listen carefully to all the directions.

2. **Budget your time.** Be sure that you allocate an appropriate amount of time to work on each question on the test.

3. **Take a quick break if you begin to feel tired.** To do this, put your pencil down, relax in your chair, and take a few deep breaths. Then, sit up straight, pick up your pencil, and begin to concentrate on the test again. Remember that each test section is only 45 to 60 minutes.

4. **Use positive self-talk.** If you find yourself saying negative things to yourself like, "I can't pass this test," it is important to recognize that you are doing this. Stop and think positive thoughts like, "I prepared for this test, and I am going to do my best." Letting the negative thoughts take over can affect how you take the test and your test score.

5. **Mark in your test booklet.** Mark key ideas or things you want to come back to in your test booklet. Remember that only the answers marked on your answer sheet will be scored.

6. **Read the entire question and the possible answer choices.** It is important to read the entire question so you know what it is asking. Read each possible answer choice. Do not mark the first one that "looks good."

7. **Use what you know.** Draw on what you have learned in class, from this study guide, and during your study sessions to help you answer the questions.

8. **Use content domain-specific strategies to answer the questions.** In the TEST CONTENT section, there are a number of specific strategies that you can use to help improve your test performance. Spend time learning these helpful strategies, so you can use them while taking the test.

9. **Think logically.** If you have tried your best to answer a question but you just aren't sure, use the process of elimination. Look at each possible answer choice. If it doesn't seem like a logical response, eliminate it. Do this until you've narrowed down your choices. If this doesn't work, take your best educated guess. It is better to mark something down than to leave it blank.

10. **Check your answers.** ☑ When you have finished the test, go back and check your work.

A WORD ON TEST ANXIETY

It is normal to have some stress when preparing for and taking a test. It is what helps motivate us to study and try our best. Some students, however, experience anxiety that goes beyond normal test "jitters." If you feel you are suffering from test anxiety that is keeping you from performing at your best, please speak to your school counselor who can direct you to resources to help you address this problem.

TEST CONTENT

Up to this point in this study guide, you have been learning various strategies on how to prepare for and take the EOCT. This section focuses on what will be tested. It also includes a section of sample questions that will let you apply what you have learned in your classes and from this study guide.

UNDERSTANDING THE STANDARDS

One way to think about **content domains** and **standards** is to think about a supermarket. Supermarkets often group similar foods in the same aisles or areas of the store. For example, the section of the store marked "Fresh Fruits" will be a section filled with apples, oranges, and bananas, to name just a few. So the part of the store called "Fresh Fruits" is like the domain name, and all the various items—apples, oranges, bananas—are the standards that fall under that domain.

The Georgia End-of-Course Test (EOCT) for ***Physical Science*** is designed to test seven major areas of knowledge, called **content domains**. The content domains are broad categories. Each of the content domains is broken down into smaller ideas. These smaller items are called content standards, or just **standards**. Each content domain contains standards that cover different ideas related to its content domain. Each question on the EOCT measures an individual standard within a content domain.

The seven content domains for the ***Physical Science*** **EOCT** are important for several reasons. Together they represent the ability to understand what you read and communicate with others regarding physical science concepts. Another, more immediate reason that the content domains are important has to do with test preparation. The best way to prepare for any test is to study and know the material measured on the test. Since the ***Physical Science*** **EOCT** covers the seven content domains and nothing else, isn't it a good idea to learn as much about these domains as you can? The more you understand about these domains, the greater your chances are of getting a good score on the EOCT.

The chart below lists the seven content domains for the ***Physical Science*** **EOCT**.

CONTENT DOMAINS

I. Scientific Processes and Problem Solving
II. Chemistry—Properties and Behavior of Matter
III. Chemistry—Atomic Theory and Periodicity
IV. Chemistry—Nomenclature and Patterns of Reaction
V. Physics—Force and Motion
VI. Physics—Energy, Work, and Power
VII. Physics—Waves, Electricity, and Magnetism

Studying the Content Domains

You should plan to study/review the standards for ALL the content domains. To learn what the EOCT will cover, work through this TEST CONTENT section. It is organized by the Content Domains into the following areas:

- **A Look at the Content Domain:** an overview of what will be assessed in the content domain
- **Spotlight on the Standards:** information about the specific standards that will be assessed (Note: The names of the standards may not be the exact names used by the Georgia Department of Education. Some of the names in this study guide may have been modified to reflect the fact that this book is designed for students and not for professional educators.)
- **Sample Questions:** sample questions *similar* to those that appear on the EOCT
- **Answers to the Sample Questions:** in-depth explanations of the answers to the sample questions

Read All About It

Physical science is a very broad subject. To provide you with most of the information related to physical science would take hundreds of pages. Instead, this guide will provide you with some specific information that you will need to know for the *Physical Science* EOCT and help to direct your study efforts. Your physical science textbook will be your best source of additional information.

Content Domain I: Scientific Processes and Problem Solving

A LOOK AT CONTENT DOMAIN I

Test questions in this content domain will measure your ability to use scientific processes and solve problems. Your answers to the questions will help show how well you perform on the following standards:

* Describe the science process skills used in laboratory investigations
* Use reference materials
* Use standard safety practices in laboratory investigations

Spotlight on the Standards

✶ *Describe the Science Process Skills Used in Laboratory Investigations* ✶

Scientists try to understand and explain the natural world. Scientists use common processes when asking and answering questions during their scientific studies. Their answers are based on the same kinds of reasoning and problem solving processes you use to answer questions in your daily life. When you observe, classify, communicate, measure, predict, and infer, you are thinking like a scientist. Something as simple as changing from one type of shampoo to another in hopes of an improved effect is a type of simple experiment.

For the ***Physical Science*** **EOCT**, it is important that you understand the process skills used in laboratory investigations. Test questions will measure your ability to understand and apply the skills and knowledge needed to perform and interpret scientific experiments. A scientific experiment usually begins with **observations** (the information gathered using any of your senses), but observations are made throughout the scientific experiment. These observations may lead you to ask a question or identify a problem. Before any experiment is designed or conducted, background information is gathered regarding what is already known about the topic in question. Scientists will use the information to form a **hypothesis**, which is a possible answer to the question that can be tested by an experiment.

To test a hypothesis, an experiment is designed. When designing an experiment, several variables are identified. **Variables** are the factors that affect the experiment. For example, the variable that is being tested and is intentionally changed is the **manipulated variable**, also known as the independent variable. The variable that might be affected as a result of that intentional change is the **responding variable**, also known as the dependent variable. All other variables that need to remain constant are the **controlled variables**. Data are gathered and recorded from the experiment.

If the data collected involve observations without measurements or numbers, then it is referred to as **qualitative** data. **Quantitative** data involves numbers or measurements.

METRIC MEASUREMENT

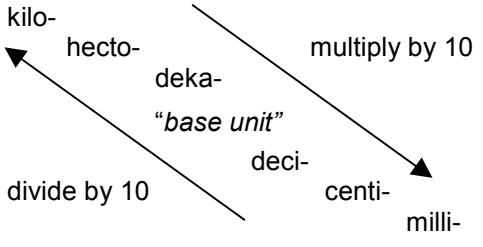
Each type of measurement has a base unit.

Quantity	Base Unit
length/distance	meter
mass	gram
time	second
temperature	degrees Celsius
volume	liter

Common prefixes used in measurements:

Prefix	Symbol	Multiple of base unit
kilo-	k	1000
hecto-	h	100
deka-	da	10
deci-	d	0.1
centi-	c	0.01
milli-	m	0.001

You can convert from one unit to the next by multiplying or dividing by 10.



Scientists use the metric system when representing data. The questions that address this standard may ask you to convert from one metric measurement to another.

On the ***Physical Science*** **EOCT**, you may be given a laboratory situation and be asked to identify the different types of variables or the parts and sequence of the scientific process.

INVESTIGATING LIKE A SCIENTIST

- State the problem – ask a question
- Do background research – gather information
- Form a hypothesis – suggest an answer
- Design an investigation – perform an experiment to test the answer
- Collect data – record the results of the experiment; make a data table if necessary
- Analyze data – interpret the results of the experiment
- Draw conclusions – explain your results
- Identify new questions raised by the conclusions for further investigation
- Communicate results – share your results

Data can be gathered with a variety of tools. Meter sticks, balances, stopwatches, etc. can all be used to gather data. Scientists make repeated measurements to increase the validity and reliability of the results. The data collected can be organized in a data table so that others can understand it.

To make the data significant, it must be analyzed and interpreted. Displaying the data as a graph in order to understand and communicate is an effective method of organization. Types of graphs include the **line graph** when showing how variables are related, the **bar graph** when comparing groups in terms of one characteristic, and the pie or **circle graph** when showing percentages or fractions. Patterns in the data are identified. Mathematical relationships may be established and predictions can be made. A model may even be created that explains the results. On the ***Physical Science*** **EOCT**, you may be asked to identify the appropriate use of graphs to represent the results of an experiment.

STRATEGY BOX – Graphs

When working with graphs, carefully read the title and the label on each axis. Check for any other information that might be included on the graph. When you think you have the answer, double check the information given in the graph.

After analyzing and interpreting the data, scientists draw **conclusions**, explanations based on scientific data and observations. Conclusions answer the question as to whether or not the data and observations support the hypothesis. Sometimes the conclusions may indicate that more information is needed which creates more questions to investigate. Occasionally, inferences are made to reach a conclusion. An **inference** is an explanation of the data based on facts but not on direct observation.

In order for others to understand and evaluate the experiment, the results need to be shared. Communication gives others an opportunity to learn from the experiment and gain new knowledge. Communication also allows the investigator to see if any errors

were made in the experimental design, the calculations, or the analysis and interpretation of the data.

Not only will learning the various process skills help you understand more about the natural world, they will help you answer questions on the ***Physical Science*** **EOCT** like:

SCIENTIFIC PROCESSES

When answering questions on the ***Physical Science*** **EOCT**, the following process skills may be used.

Classify	*Formulate Hypothesis*	*Measure*
Communicate	*Identify Variables*	*Observe*
Control Variables	*Infer*	*Predict*
Define Operationally	*Interpret Data*	*Question*
Experiment	*Make a Model*	*Record Data*

If you are unfamiliar with any of these terms, use your physical science textbook to check their meanings.

When leaving a movie theater, a person notices that the sidewalk is now wet. If the person assumes it rained while watching the movie, the person is making

A a hypothesis
B an inference
C an observation
D a prediction

If you know the meaning of the various process skills, then you know that you are making an inference. The answer is B. An inference is an explanation of an event that is not based on direct observation. A hypothesis is a possible explanation that can be tested by an experiment. Since an experiment cannot be used to determine if it rained, then choice A is not possible. An observation involves using your five senses. Since you did not actually see it raining, you could not make an observation, so choice C is incorrect. A prediction is the foretelling of a future event. Since the event had already occurred, choice D is incorrect.

STRATEGY BOX – Think Like a Scientist

As you answer questions on the EOCT, it is helpful to think like a scientist. A scientist is trying to find answers and convince others that the answer is correct. The steps in the investigation process are designed to accomplish this.

✶ *Use Reference Materials* ✶

The ***Physical Science*** **EOCT** will require you to know how to use reference materials that may be used for scientific research. You should be familiar with encyclopedias, dictionaries, and scientific magazines. These reference materials may be available in either print or electronic form. Knowing the appropriate use of reference materials will help you find quality information related to research problems. Questions on this standard may ask you to analyze small quantities of information from a reference source.

When investigating the answer to a question, scientists gather information to determine what is already known about the subject. Sometimes you need to research a particular science topic for a report or class presentation. Information can be found at the school library, at your community library, or the Internet. However, not all information may be relevant or useful to your particular science topic. When evaluating scientific information, ask yourself some questions regarding the information.

- Is the information outdated?
- Is the information from a reputable source?
- Is the information scientifically accurate or just someone's opinion?
- Who is the intended audience?
- Can the information be verified elsewhere?
- Why is this the best source to use?
- How can the information be used?

★ *Use Standard Safety Practices in Laboratory Investigations* ★

Hands-on activities and experiments are an integral part of learning science. They provide an opportunity to explore and actively study scientific principles. It is important that you are familiar with safe laboratory practices while using laboratory equipment. Some areas of laboratory safety are listed in the box at the right.

LABORATORY SAFETY

- Conduct and Preparation in the Laboratory
- Eye Safety
- Safety Equipment
- Dress Code and Neatness
- Working with Sharp Instruments
- Working with Chemicals
- Working with Glassware
- First Aid and Handling Emergencies
- Waste Disposal and Cleanup

On the ***Physical Science*** **EOCT**, you may be given a lab situation and be asked to identify safe and unsafe procedures. You may also be asked to identify the warning symbols used in labs and the appropriate safety equipment and clothing. A question might look something like this:

When planning an experiment to separate a mixture by evaporating the water, which piece of safety clothing or equipment is MOST appropriate for this experiment?

A latex gloves
B gas mask
C fume hood
D eye protection

Safety goggles (eye protection) should be worn when an experiment involves heating chemicals, so D is the correct answer. Since water is the substance being evaporated, a fume hood is not necessary, so C is incorrect. Choices A and B would not be appropriate for this experiment.

Sample Questions for Content Domain I

This section has some sample questions for you to try. After you have answered all of the questions, check your answers in the "Answers to the Content Domain I Sample Questions" section that follows. This section will give you the correct answer to each question, and it will explain why the other answer choices are incorrect.

1 **To make sure experimental results are valid, a scientist will**

A conduct many trials
B consider two hypotheses
C alter the control group
D add uncertainties

2 **Where would a student MOST likely find the answer to the question "Why are rain clouds dark?"**

A an almanac
B a dictionary
C a current astronomy journal
D the World Wide Web

3 **If an experiment conducted in a classroom laboratory has the possibility of producing dangerous gases, which of the following procedures should be followed?**

A The students should wear a breathing apparatus or mask.
B The experiment should be performed under a fume hood.
C The activity should be conducted away from open flames.
D The teacher should assist the student with the experiment.

4 **A student wants to determine the effect of salt on the freezing point of water. A student adds 200 mL of pure water to three identical containers. To one container, 2 g of the salt is added; in the second container, 4 g of the salt is added; and in the third container no salt is added. The three containers are placed in the same freezer. The temperature of the water is measured every 10 min for one hour, and the observations are recorded in a data table. What is the independent variable in this experiment?**

A the amount of salt added
B the temperature measured
C the type of salt used
D the type of container used

Answers to the Content Domain I Sample Questions

1. Answer: **A** Standard: *Describe science process skills in laboratory investigations*

It is important to perform multiple trials, which increases your chance of getting accurate results (validity), so **A** is correct. Choices **B**, **C**, and **D** introduce sources of error that can contribute to invalid results.

2. Answer: **D** Standard: *Use reference materials*

The reference materials in **A** and **B** are sources of facts, words, or short phrases, while **C** is a resource that is not on the topic. Since the question requires a longer, more detailed explanation, **D** would be the correct answer.

3. Answer: **B** Standard: *Use standard safety practices in laboratory investigations*

Choice **B** is the correct answer because substances that produce dangerous gases should be handled under a fume hood to trap the vapors. For **A**, **C**, and **D**, none of these will keep the dangerous gases from diffusing into the classroom and/or hallway and affecting others.

4. Answer: **A** Standard: *Describe the science process skills used in laboratory investigations*

The independent, or manipulated, variable is the variable that is being changed; therefore, **A** is the correct answer. Choice **B** is the variable that is responding to the change, or the dependent variable. Choices **C** and **D** are variables that are not being changed, or the controlled variables.

Content Domain II: Chemistry—Properties and Behavior of Matter

A LOOK AT CONTENT DOMAIN II

Test questions in this content domain will measure your ability to understand physical and chemical properties of matter. Your answers to the questions will help show how well you can perform on the following standards:

- Identify and describe the characteristics of matter
- Describe physical properties and distinguish between physical and chemical properties
- Identify and describe physical and chemical changes

Spotlight on the Standards

Identify and Describe the Characteristics of Matter

You are made of matter. Your clothes are made of matter. The air you breathe is made of matter. In fact, everything in the universe is made of matter. **Matter** is defined as anything that has mass and takes up space. **Mass** is the measure of the amount of matter in an object. The amount of space that matter takes up is called **volume**.

Each kind of matter has characteristics or properties that help identify it. Mass, volume, and density are properties common to all matter. Some properties, such as color, boiling temperature, chemical reactivity, and electrical conductivity, are specific properties that describe the differences among the different kinds of matter. A particular kind of matter, such as gold, water, or salt, is called a **substance**.

Why are there different kinds of matter? Different kinds of matter are made of identical particles but the different arrangement of the particles results in different properties. For example, diamonds and coal are made of carbon particles but each has very different properties. Another reason for the different kinds of matter is the motion of the particles. If the temperature increases, then the speed of the particles increases. Particle motion determines whether matter exists as a solid, liquid, or a gas. These are the three recognizable states of matter.

Matter that has a definite shape and a definite volume, like a rock, is called a **solid**. Particle motion is minimal so the particles are packed close together. A **liquid** has a definite volume but no definite shape. A liquid, like water, takes on the shape of its container because the particles do not stay in a fixed position even though the particles

are close together. Matter that has no definite shape and no definite volume, like air, is a **gas**. Gases will expand to fill any available space. Depending on the temperature and pressure, most substances can exist in all three states. For example, water in its solid state is called ice, in its liquid state is called water, and in its gaseous state is called water vapor.

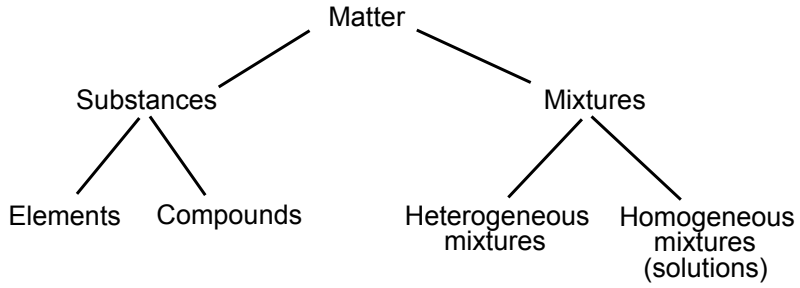
STATES OF MATTER

	Shape	Volume
Solids	definite	definite
Liquids	not definite	definite
Gases	not definite	not definite

Substances are made of smaller particles called atoms. **Atoms** are the building blocks of all matter. Sometimes atoms become negatively or positively charged. These charged particles are called **ions**. When a sample of matter contains one type of atom, it is called an **element**. Hydrogen and oxygen are elements. If a sample of matter contains two or more elements chemically combined in a certain ratio, it is called a **compound**. The compound water is made of two hydrogen atoms chemically combined with one oxygen atom. A **molecule** is the smallest particle of a compound. Elements and compounds are referred to as **pure substances**. Other matter is referred to as mixtures or solutions. On the ***Physical Science*** **EOCT**, you may be asked to distinguish between atoms, molecules, and ions, or to interpret properties of matter at the atomic level.

Mixtures are made of more than one kind of matter that is physically combined. There is no particular ratio and each part of the mixture keeps its own properties. Examples of mixtures are perfume, potting soil, salad dressings, and tea. If the substances in the mixture are not evenly "mixed," it is called a **heterogeneous mixture**. Salad dressings and potting soil are heterogeneous mixtures. In a **homogeneous mixture** the substances are in the same amount in all parts of the mixture. Tea and perfume are examples of homogeneous mixtures. Homogeneous mixtures are also known as solutions. The following diagram summarizes the classification of matter.

CLASSIFICATION OF MATTER



A solution is made up of two parts—a solute and a solvent. A **solute** is the substance being dissolved, while a **solvent** is the substance doing the dissolving. For example, in a saltwater solution, salt is the solute and water is the solvent. The ability of a substance to dissolve in another substance is called **solubility**.

Structure of Water

Oil and water don't mix, but there are thousands of substances that do mix in water. This is why water is sometimes called the universal solvent. Water's structure enables it to dissolve many substances. Look at the box to the right. This type of structure causes the oxygen to take on a slightly negative charge, while the hydrogen atoms take on a slightly positive charge resulting in a polar molecule. Water's polarity allows water to act like small magnets attracting many kinds of molecules.

On the ***Physical Science*** **EOCT**, you may be asked to identify the characteristics of matter and to classify matter. You may also be asked questions about solutions or the characteristics of water. A question for this standard might look like this:

What is the term for matter that is made of two physically combined substances?

A compound
B element
C mixture
D substance

Matter that consists of two substances physically combined is a mixture, so C is correct.

STRATEGY BOX – Analyze the Word by Its Parts

When studying physical science, look for familiar prefixes, suffixes, and word roots when faced with an unknown term. Knowing the meaning of these word parts will help you determine the meaning of the unknown word. For example, *atom* can be broken down into the following word parts:

a- means "not" *-tomos* means "cutting"

Therefore, an *atom* is a particle that cannot be cut (separated) any further and still retain the properties of the particular element. When the atom was named, it was thought that it could not be divided further. We now know this is not true.

★ *Describe Physical Properties and Distinguish Between Physical and Chemical Properties* ★

Physical properties can be observed or measured without changing the identity of the substance. For example, color, shape, and odor are physical properties that can be observed using your senses. Other physical properties, like mass, weight, volume, density, and conductivity can be measured. The physical properties for a sample of a pure substance remain constant. For example, pure water is always a colorless liquid that boils at 100 °C at sea level. It doesn't matter if you have 10 milliliters or one liter.

For the ***Physical Science*** **EOCT**, it is important that you are able to answer questions involving physical properties, such as mass, weight, volume, density, conductivity, and temperature. Let's take a brief look at some of these physical properties.

Some Physical Properties

- Boiling Point
- Color
- Conductivity
- Density
- Malleability
- Mass
- Melting Point
- Odor
- Shape
- State of Matter
- Weight

We know that **mass** is the amount of matter in an object. Mass is measured in grams (g) or kilograms (kg). But mass is different than weight. **Weight** is the measure of the force of gravity on matter. Gravity is the force of attraction between any two objects. For example, you would weigh less on the Moon than you do on Earth, but your mass would be the same on both of them. The Moon's force of gravity is less than Earth's force of gravity because the Moon is less massive than Earth. The unit for weight is the newton (N). This is also the unit for force. Weight can be calculated using this formula:

$F_w = ma_g$ or weight = mass × acceleration due to gravity

On Earth, the acceleration due to gravity is 9.8 m/s^2. For example, an object with a mass of 1 kg is pulled toward Earth with a force of 9.8 N. Therefore, the weight of the object is 9.8 N. What would be the weight of an object with a mass of 10 kg? That's right, 98 newtons! The object is pulled with a force of 10 kg x 9.8 m/s^2, or 98 N.

Density is the amount of mass in a given volume. For example, if you had a baseball in one hand and the same size foam ball in the other hand, you would know that the baseball is denser than the foam ball. Density is a property that can be used to identify a substance. Density can be calculated using this formula:

$$D = \frac{m}{V} \quad \text{or} \quad \text{density} = \frac{\text{mass}}{\text{volume}}$$

If mass is expressed in grams (g) and volume is expressed in milliliters (mL) or cubic centimeters (cm^3), then density is expressed in grams per milliliter (g/mL) or grams per cubic centimeters (g/cm^3). One milliliter of water has a mass of one gram; therefore, the density of water is 1 g/mL.

Density can also determine whether a substance will float or sink in water. For example, if you combine oil and water in a container, the oil will float in a layer above the water. In other words, the oil is less dense than the water. If you look up the density of cooking oil you'll see it has a density of 0.82 g/mL. What happens to corn syrup, with a density of 1.38 g/mL, if it is added to the container with water and oil? If you said it sinks, you're right!

Temperature is a measure of how hot or how cold a substance is and is measured in degrees Celsius (°C). If the temperature is enough to change a substance from a solid to a liquid, the temperature is called the **melting point**. If there is enough heat energy to change a substance from a liquid to a gas, the temperature is called the **boiling point**. Melting point and boiling point are physical properties that remain constant for pure substances and can be used to help determine the identity of a substance.

Physical properties help determine how useful a substance is to humans. For example, copper is used to make electrical wiring and cooking pans because the element copper allows electricity or heat to move through it easily. This ability is called **conductivity**.

Sometimes physical properties are not enough to determine the identity of a substance. At times, a substance's reactivity with other substances is used to identify it. The property that describes how a substance can change to form new substances is called a **chemical property**. Some examples of chemical properties include the ability to burn (also known as flammability), the ability to corrode, and the ability to react with chemicals. On the ***Physical Science* EOCT**, you may be asked to distinguish between physical and chemical properties.

Some Chemical Properties

- Ability to Burn
- Ability to Corrode
- Ability to Support Burning
- Reactivity with Chemicals
- Reactivity with Light

A question for this standard might look like this:

Which state of matter has a definite volume but not a definite shape?

A gas
B liquid
C plasma
D solid

Liquids have a definite volume but not a definite shape, so B is the correct answer. Gases have no definite shape or volume, and solids have both a definite shape and volume, so A and D are incorrect. Plasma is a state of matter found in stars that consists of electrically charged particles.

* *Identify and Describe Physical and Chemical Changes* *

Tearing paper, chopping wood, and melting ice are examples of substances that have changed their size, shape, or state of matter. These are physical changes. A **physical change** alters the form of a substance, but not the composition of the substance. The paper pieces are still paper, and the liquid water has the same composition as the ice, H_2O.

Some Physical Changes

- Boiling
- Condensation
- Dissolving
- Evaporation
- Freezing
- Melting
- Sublimation

Any change in the state of matter is a physical change. In a lab situation, you may have been directed to bring a substance to boil. Whether you are boiling, melting, or freezing a substance, the substance is undergoing a physical change. The state of matter of a substance usually changes from a solid to a liquid to a gas. However, some substances change from a solid directly to a gas. Have you ever seen dry ice, the solid state of carbon dioxide? Dry ice

changes from a solid to a gas in a process called **sublimation**. Dry ice is used to cool substances without the mess of melting ice.

Mixtures, including solutions, can be separated by physical change. For example, if you wanted to remove the sugar from a sugar solution, you could heat the mixture and boil the water away. The sugar will be left in the container.

When paper is burned, smoke rises and heat and light are released. Afterwards, ashes remain instead of paper. The substances in the paper have been changed into new compounds that rise into the air or are left behind as ashes. The paper has been altered by a chemical change. In a **chemical change**, one or more substances combine or break down to form new substances. Sometimes energy in the form of heat, light, or electricity is given off. In some chemical changes, energy is required for the chemical change to take place. For the ***Physical Science*** **EOCT**, you may be given a laboratory situation and be asked to distinguish between physical and chemical changes.

STRATEGY BOX – Is the Change Permanent?

To help you remember the difference between physical change and chemical change, ask yourself this question, "Can I get the original substances back after the change?" If so, it is a physical change. If not, it is changed forever and is a chemical change.

Physical Change	Chemical Change
Substances can return to original state	Substances are changed forever

When a substance is combined with oxygen and heat or light is released, the chemical change is referred to as **combustion**. Burning paper is an example of combustion. Combustion also occurs in the engines of cars, motor scooters, tractors, and buses.

Some chemical changes occur in living things. Through various chemical changes, the food that you eat is broken down during digestion to form new substances. In the process of digestion, energy is released and used by your body to carry out activities like moving or growing. This use of energy is called **metabolism**.

SOME CHEMICAL CHANGES

- Combustion
- Corrosion
- Electrolysis
- Fermentation
- Metabolism
- Photosynthesis

Another chemical change that occurs in living things is fermentation. **Fermentation** is the process by which living things partially break down carbohydrates, in the absence of oxygen, producing new substances and releasing energy. Fermentation is used in the food industry to produce new food products. For example, bacteria are used to change milk into yogurt.

When electricity is used to break down a compound the process is called **electrolysis**. For example, in a lab experiment, you might have split water into hydrogen gas and oxygen

gas by running an electric current through the water. Another use for electrolysis is extracting, or removing, metals from their ores. Aluminum and magnesium are examples of metals extracted from ores by electrolysis.

STRATEGY BOX REVISITED – Analyze the Word by Its Parts

Remember to look for familiar word parts when faced with an unknown term. Look at the following word parts:

electro- = electricity *-lysis* = decompose (split up)

Knowing these meanings will help you determine the meaning of words like *electrolysis.*

A question for this standard may look like this:

Which is an example of a chemical change?

A dissolving sugar in tea
B breaking a pencil
C spraying on perfume
D burning a candle

Burning a candle changes the wax in the candle to new substances emitting light and heat, so D is the correct answer. Choices A, B, and C are examples of physical changes because there are no new substances (compounds) formed.

Sample Questions for Content Domain II

This section has some sample questions for you to try. After you have answered all of the questions, check your answers in the "Answers to the Content Domain II Sample Questions" section that follows. This section will give you the correct answer to each question, and it will explain why the other answer choices are incorrect.

1 Chocolate is made from cocoa beans. The main component of cocoa beans is theobromine, $C_7H_8N_4O_2$. Which BEST describes theobromine?

A atom
B compound
C element
D mixture

2 Which is an example of a physical property?

A ability to support burning
B ability to corrode
C malleability
D flammability

3 **Silver is a white metal that is an excellent conductor of heat and electricity. The density of silver is 10.49 g/cm^3. The melting point of silver is 962 °C, while its boiling point is 2000 °C. Silver is not attacked by water but reacts with nitric acid. Which property of silver is a chemical property?**

A conductor of heat
B density is 10.49 g/cm^3
C boiling point is 2000 °C
D reacts with nitric acid

4 **A 10-g sample of calcium chloride is added to 5 g of baking soda in a beaker. When 50 mL of red cabbage juice is added, bubbles form. Two minutes later, the beaker feels hot and the red cabbage juice changes from purple to green and then to pink. Which of the following represents a physical change in the experiment?**

A mixing
B bubbles
C temperature increase
D color change

Answers to the Content Domain II Sample Questions

1. Answer: **B** Standard: *Identify and describe the characteristics of matter*
Since theobromine contains more than one element in a certain ratio, it is a compound, so **B** is the correct answer. An atom is the smallest particle of an element, while an element contains only one type of atom; therefore, **A** and **C** are incorrect. A mixture is a combination of two or more substances in no particular ratio, which retain the properties of the beginning substances, so **D** is incorrect.

2. Answer: **C** Standard: *Describe physical properties and distinguish between physical and chemical properties*
Malleability is the ability to be hammered into a thin sheet, which is a physical property since there is not a change in the identity of the substance; therefore, **C** is the correct answer. Chemical properties result in a substance changing its chemical composition. Ability to support burning, ability to corrode, and flammability are all chemical properties, so choices **A**, **B**, and **D** are incorrect.

3. Answer: **D** Standard: *Describe physical properties and distinguish between physical and chemical properties*
A chemical property is a property that describes how a substance can change to form new substances, which occurs when a substance has the ability to react with chemicals, so **D** is the correct answer. Choices **A**, **B**, and **C** are examples of physical properties.

4. Answer: **A** Standard: *Identify and describe the characteristics of matter*
Mixing is a physical change. Since the calcium chloride and baking soda are added together, **A** is the correct answer. Chemical changes may form bubbles, produce heat, or cause a color change, so choices **B**, **C**, and **D** are incorrect.

Content Domain III: Chemistry—Atomic Theory and Periodicity

A LOOK AT CONTENT DOMAIN III

Test questions in this content domain will measure your ability to understand the atomic theory and periodic trends of the elements. Your answers to the questions will help show how well you can perform on the following standards:

* Describe basic atomic structure
* Use the periodic table to locate information

Spotlight on the Standards

* *Describe Basic Atomic Structure* *

In Content Domain II, you learned that an atom is the smallest particle of matter that retains its properties. The ancient Greeks first thought of the idea of atoms. But it wasn't until the 1800s that an atomic theory was proposed. Since then, different models of the atom have been proposed as new information is gathered. However, all atoms share the same basic structure.

The current model suggests that an atom consists of a positively charged, small, dense central region surrounded by a negatively charged cloud. The central region is called the **nucleus**, and it contains most of the atom's mass. There are three particles that comprise an atom—electrons, protons, and neutrons.

- **Electrons** are negatively charged subatomic particles that move around the nucleus forming a cloud.
- **Protons** are positively charged subatomic particles found in the nucleus.
- **Neutrons** have no charge and are also found in the nucleus.

Protons and neutrons are about equal in mass, which is 1800 times the mass of an electron.

All atoms of a particular element will have the same number of protons. For example, all carbon atoms have six protons in their nuclei. All oxygen atoms have eight protons in their nuclei. The number of protons in an atom, which is called the **atomic number**, is unique to each element.

Because neutrons and protons contribute to the mass of the atom, the total number of protons plus neutrons is called the **mass number**. The number of neutrons can be determined by subtracting the atomic number from the mass number. Atoms of the same element can have different numbers of neutrons. These varying forms of the same element are called **isotopes**.

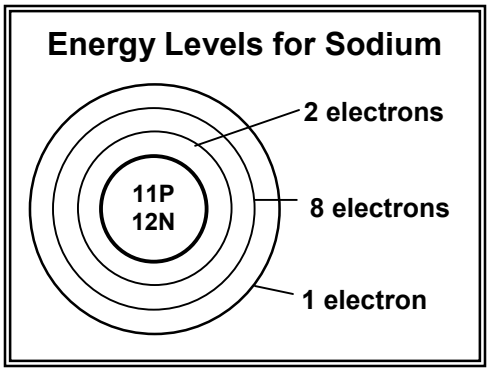
Since atoms are electrically neutral, the number of protons is equal to the number of electrons. Electrons are found moving around the atom's nucleus. The region around the nucleus where electrons might be found is called the **electron cloud**. The electron cloud is divided into **energy levels**, which are sometimes referred to as energy shells. Each energy level can hold a certain number of electrons. The first energy level, which is closest to the nucleus and has the lowest amount of energy, can only hold two electrons. See the box to the right. Electrons with higher energy are found in energy levels farther from the nucleus.

ENERGY LEVELS

Maximum number of electrons for each energy level:

energy level	# of electrons
1	2
2	8
3	18
4	32

As an example, let's look at the element sodium. Sodium has an atomic number of 11, which means that each atom has 11 protons and 11 electrons. The first energy level has two electrons, the second energy level has eight electrons, and the third energy level has one electron. For the ***Physical Science*** **EOCT**, you may be asked to identify and describe the characteristics of subatomic particles. To help you answer questions, you may want to determine the number of electrons in the outer energy level for the first 20 elements. A question might look like this:



Argon has an atomic number of 18 and a mass number of 40. How many neutrons does an atom of argon have?

A 18
B 22
C 40
D 58

The atomic number is equal to the number of protons, while the mass number is equal to the number of protons and neutrons. To determine the number of neutrons, subtract the atomic number (18) from the mass number (40) to get 22. Choice B is the correct answer.

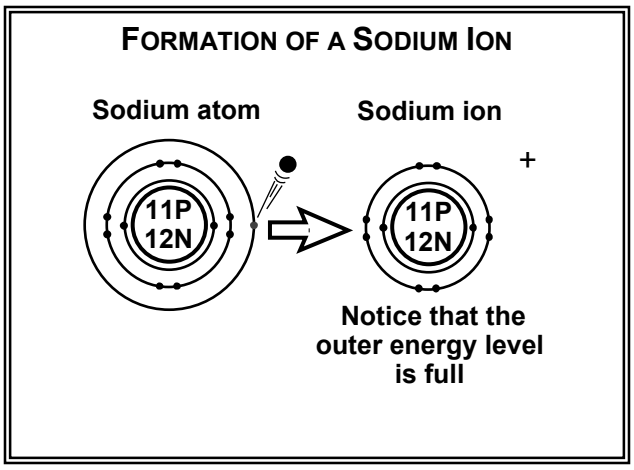
The elements are arranged in order of increasing atomic number in a definite pattern of rows and columns. Each row is called a **period** and each column is called a **group** or family. The simplest atom is at the top left while the most complex is at the bottom right.

The periods on the periodic table correspond to the energy levels that contain electrons. The elements in the first period have one energy level, the elements in the second period have two energy levels, etc. So as you go across the periodic table, the atoms are getting heavier and as you go down the periodic table the atoms are getting bigger.

The groups consist of families of elements that have similar properties. As you go down each group, the atoms have the same number of electrons in the outer energy level. The number of electrons in the outer energy level determines the chemical reactivity of an element.

Atoms are reactive because their outer energy levels are not filled. Atoms that do not have the maximum number of electrons in the outer energy level may lose, gain, or share electrons so that the outermost energy level is full. If an atom gains or loses electrons, the atom is no longer neutral but is positively or negatively charged. This charged particle formed from an atom is called an **ion**. An atom that gains an electron is a **negatively charged** ion, while an atom that loses an electron is a **positively charged** ion.

The element sodium has one electron in its third and outermost energy level. The third energy level can hold up to eight electrons. Since energy is required to gain or lose electrons, it requires less energy for the sodium atom to remove one electron from the outer energy level than to add seven electrons. If sodium loses its one outer electron, it would then drop from three to only having two energy levels, and its outermost energy level would be filled. The removal of one electron forms a positively charged sodium ion.



On the ***Physical Science*** **EOCT** you may be asked to relate the number of outer energy level electrons to reactivity by determining the number of electrons typically lost, gained or shared. A question might look something like this:

The element oxygen has an atomic number of eight. What happens to an oxygen atom to have a filled outer energy level?

A it would lose two electrons
B it would gain two electrons
C it would lose six electrons
D it would gain six electrons

The element oxygen has an atomic number of eight and is electrically neutral, so it has eight protons and eight electrons. Two electrons are in the first energy level; six electrons are in the second and outermost energy level, which can hold up to eight electrons. An oxygen atom would gain two electrons to fill its outermost energy level, so B is the correct answer.

Sometimes the nucleus of an atom breaks down in a process called **radioactivity**. Recall that elements have isotopes, atoms with different numbers of neutrons. Some isotopes are unstable, which means that the nucleus emits a particle or radiation with a large amount of energy to help it become more stable. This process is called **radioactive decay**.

When the nucleus in a radioactive material breaks down, it can produce three types of nuclear radiation—alpha, beta, and gamma.

- An **alpha** particle is a helium nucleus with two protons and two neutrons. Alpha particles do not have any electrons and are positively charged. Alpha particles can be stopped by a thin piece of paper and will not travel very far in air.
- A **beta** particle is a negatively charged electron, which travels farther and faster than alpha particles. Beta particles can be stopped by thin sheets of metal, such as a one-centimeter thick sheet of aluminum. Beta particles are possible producers of X-rays.
- A **gamma** ray isn't a particle but a form of short wave electromagnetic energy. Gamma rays are much more difficult to stop than alpha or beta particles. Only thick sheets of lead or materials like concrete can be used to stop gamma rays.

After decaying, radioactive atoms change into other atoms. During alpha decay, the nucleus loses two protons and two neutrons. During beta decay, the nucleus gains a proton and loses a neutron. During gamma decay, the energy content of the nucleus changes but the atomic number of the element does not change. An example of this process is uranium-238 decaying to form a stable (non-radioactive) lead isotope, lead-206. The process involves a series of nuclear changes, which emit alpha and beta particles. Each step in the decay process occurs at a different rate called the half-life. The **half-life** is the time it takes for one-half of a sample of radioactive material to decay.

Radioactive elements can become stable elements by undergoing different reactions. When a neutron bombards a uranium-235 nucleus, the nucleus splits into two lighter nuclei, emitting more neutrons and large amounts of energy. This process is called **fission**. Nuclear fission can take place in elements with an atomic number greater than 90.

Sometimes two low-mass nuclei combine to form one nucleus in a process called **fusion**. A tremendous amount of energy is released in the process. Extremely high temperatures, like those found in stars, are needed for nuclear fusion to take place.

STRATEGY BOX – Fission/Fusion Confusion

Here is a way to help remember the difference between these two terms. Fission is similar to fissure, the process of splitting. So fission is when the nucleus splits in two. Fusion is like fuse, to unite two things. So fusion is where two nuclei join.

Sometimes people react negatively to the word *radiation*. But not all radiation is dangerous. Visible light is a form of radiation but has a wavelength that does not harm us. We are exposed to radiation from natural sources on a daily basis. This kind of radiation is called **background radiation**. Background radiation comes from the Sun, soil, rocks, building materials, water, plants, and from the food we eat. Other exposures to radiation come from dental X-rays and medical X-rays. Most organisms are unaffected by these low levels of radiation.

Radiation is used positively in a variety of ways, including its uses in medicine, in industry, and to generate electrical power. For example, radiation and radioactive tracers are used to diagnose and treat medical problems. A **radioactive tracer** is a radioactive isotope that is added to a substance so that the substance can be detected later. Radioactive tracers are used to locate tumors, to study the functioning of a particular organ, or to monitor the flow of blood. For example, radioactive iodine-131 is used to diagnose thyroid problems. Radiation therapy used to treat cancer may involve the use of implanted radioactive isotopes such as gold-198 or iridium-192.

Manufacturers can also use radiation to check the thickness of metal containers by measuring the amount of radiation that passes through. Small amounts of radioactive isotopes, like magnesium-28, can be introduced in a water source to determine the flow of underground water or to determine if an underground water system is leaking. Radioactive isotopes are even used in smoke alarms. Nuclear fission is used to generate electricity as an alternative energy source. Even the age of fossils or rocks can be determined by using radioactive isotopes.

For the ***Physical Science*** **EOCT**, it is important that you are able to describe the properties and uses of radioactive elements and isotopes.

∗ *Use the Periodic Table to Locate Information* ∗

The periodic table of elements is arranged in order of increasing atomic number. The periodic table gives information about each element, such as its name, symbol, atomic number, and atomic mass. For the ***Physical Science*** **EOCT**, you will have access to a periodic table. It is important that you understand the arrangement of the periodic table and the location of

Look it Up!

Use the periodic table to locate the following information about the first 20 elements:

- Element name
- Symbol
- Atomic number
- Atomic mass

information about the first 20 elements. This will help you answer a question like this:

The atomic number of phosphorous is 15. On the periodic table, sulfur is the next element to the right. How many electrons will an atom of sulfur have?

A 14
B 16
C 31
D 32

The atomic number is equal to the number of protons. Since atoms are electrically neutral, the number of electrons is also equal to the number of protons. Since the periodic table is arranged according to increasing atomic number, sulfur has an atomic number of 16, which means it has 16 protons and 16 electrons, so B is the correct answer. Choice A is the atomic number of the element to the *left* of phosphorous. Phosphorous has an *atomic mass* of 31 and sulfur has an *atomic mass* of 32, so A, C, and D are incorrect.

The periodic table is arranged in such a way that the elements vary in a regular, or periodic, way from right to left across the table. One property is the metallic nature of the elements. The elements on the left side of the table are **metals**. Most metals generally have three or fewer electrons in the outermost energy level of their atoms. Copper, gold, silver, and iron are examples of metals. On the right side of the periodic table, the elements are **nonmetals**. Atoms of nonmetals usually have five or more electrons in the outermost energy level of their atoms. Sulfur and oxygen are examples of nonmetals.

If you look at a periodic table, you will see a zigzag line that divides the table. The elements located on either side of this line are called **metalloids** because they have some properties of both metals and nonmetals. Boron, silicon, germanium, and arsenic are examples of metalloids. For the ***Physical Science*** **EOCT**, you may be asked to identify an element as a metal, metalloid, or nonmetal.

Remember, the rows of the periodic table are called **periods**, which represent the number of energy levels present. The columns of the periodic table are arranged in **groups**, or **families** based on the number of electrons in the outermost energy level. These electrons are called **valence** electrons. The groups are numbered 1 to 18. Sometimes a periodic table will identify the groups using roman numerals. Look at a periodic table to locate the various groups of elements.

There are eight principal columns in the periodic table. These columns are sometimes designated with the letter "A" following the roman numerals. From the table that follows, you can see the relationship between the valence state, the number of outermost electrons, and the group number of the eight principal columns.

	Group Number							
	1	**2**	**13**	**14**	**15**	**16**	**17**	**18**
	IA	**IIA**	**IIIA**	**IVA**	**VA**	**VIA**	**VIIA**	**VIIIA**
Number of outermost electrons	1	2	3	4	5	6	7	8
Representative valence state	1+	2+	3+	4+	3-	2-	1-	0

STRATEGY BOX – Set the Table

On the EOCT, a question might refer you to a table of information. When working with tables, carefully read the headings of the columns and rows. When you think you have the answer, double check the information given in the table.

The elements in a group share certain characteristics including similar chemical properties. For example, Group 18 (VIIIA) is called the **noble gas** family. All the elements of the noble gas family have a filled outer energy level; therefore, the noble gases do not readily react with other substances. The most chemically active metals are found in Group 1 (IA), the **alkali metals**. Alkali metals, such as sodium and potassium, are reactive because their atoms have one valence electron. The most reactive alkali metals are found at the bottom of Group 1 (IA). Atoms of Group 1 (IA) will easily give up their one valence electron to have an outermost energy level that is filled. Atoms of Group 1, such as sodium (Na), form ions with one positive charge (Na^+).

The **alkaline earth metals** make up Group 2 (IIA). Alkaline earth metals, such as magnesium and calcium, are not as reactive as the alkali metals. The atoms of the alkaline earth metals have two valence electrons. To have a filled outer energy level, atoms of the alkaline earth metals will give up the two valence electrons, forming an ion with a positive charge of two. For example, calcium (Ca) will form a calcium ion with two positive charges (Ca^{2+}).

On the right side of the periodic table you can find the most active nonmetals, the **halogens**, which are the elements in Group 17 (VIIA). The most reactive halogens are found at the top of Group 17 (VIIA). The atoms of the halogens, such as bromine and chlorine have seven valence electrons. Halogens, like fluorine (F), will gain an electron to fill the outermost energy level, forming a negative ion (F^-).

The questions on the ***Physical Science*** **EOCT** for this standard will measure whether you can describe the trends in chemical properties of the periods and groups of the periodic table. A question for this standard might look like this:

Which statement about halogens is correct?

A They are nonreactive.
B They form positive ions.
C They are in Group 17.
D They are metals.

Halogens are in Group 17, so C is the correct answer. Halogens are very reactive nonmetals that form an ion with a 1- charge.

Sample Questions for Content Domain III

This section has some sample questions for you to try. After you have answered all of the questions, check your answers in the "Answers to the Content Domain III Sample Questions" section that follows. This section will give you the correct answer to each question, and it will explain why the other answer choices are incorrect.

1 **What is the name of the subatomic particle that has no charge and is the MOST massive of the subatomic particles?**

A electron
B neutron
C positron
D proton

2 **Which group on the periodic table represents the elements used to produce colorful, lighted signs?**

A alkali metals
B alkaline earth metals
C halogens
D noble gases

3 **Highly reactive metallic elements will react spontaneously with nonmetals. Where on the periodic table are the more reactive metallic elements found?**

A bottom left
B bottom right
C top left
D top right

4 **A radioactive substance has a half-life of 10 years. What fraction of a sample of the substance would be left after 30 years?**

A 1/2
B 1/3
C 1/8
D 1/9

Answers to the Content Domain III Sample Questions

1. Answer: **B** Standard: *Describe basic atomic structure*
Neutrons are subatomic particles with no charge, so **B** is the correct answer. An electron is a negatively charged subatomic particle, while a proton is a positively charged subatomic particle, so **A** and **D** are incorrect. A positron is an elementary particle the same size as an electron but with a positive charge, so **C** is incorrect.

2. Answer: **D** Standard: *Use the periodic table to locate information*
Neon is used to produce colorful, lighted signs. The element neon is found in Group 18 (VIIIA), the noble gas family, so **D** is the correct answer. The alkali metals are Group 1 (IA), the alkaline earth metals are group 2 (IIA), and the halogens are Group 17 (VIIA), so choices **A**, **B**, and **C** are incorrect.

3. Answer: **A** Standard: *Use the periodic table to locate information*
Metals are on the left side of the periodic table. Reactivity of metals increases as you go down the column, so the most highly reactive metals are located at the bottom of the periodic table. Choice **A** is the correct answer and choice **B** is incorrect. The nonmetals are located on the right side of the periodic table with the most reactive nonmetals at the top of the periodic table, so choices **C** and **D** are incorrect.

4. Answer: **C** Standard: *Describe basic atomic structure*
The half-life is the time it takes for half the atoms in a sample of a radioactive element to decay. For this substance, one-half of the sample would remain after 10 years. After another 10 years (20 years total), one-half of that amount would remain, which means one-fourth of the sample remains. After another 10 years (30 years total), one-half of the last amount would remain, which would leave one-eighth of the sample remaining. Therefore, **C** is the correct answer. Choices **A**, **B**, and **D** are incorrect.