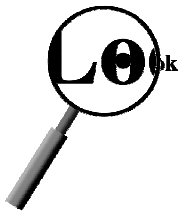
Content Domain III: Physics—Energy, Force, and Motion



A LOOK AT CONTENT DOMAIN III

Test questions in this content domain will measure your ability to investigate and explain how energy works in the world around us. You will also investigate how forces affect matter. Your answers to the questions will help show how well you can perform on the following standards:

- Relate transformations and flow of energy within a system
- Determine relationships among force, mass, and motion

Spotlight on the Standards

★Relate transformations and flow of energy within a system★

Just as matter is conserved, so also is energy. The **law of conservation of energy** states that energy, like matter, cannot be created nor destroyed; it can only be changed from one form of energy to another. Energy takes many forms in the world around us. Each form of energy can be converted to and from other forms of energy. Most people are familiar with sound, light, and electrical energy. **Electrical energy** is used in our homes to produce stereo sound through speakers, light from a fluorescent lamp, and **thermal energy** for cooking and heating. **Thermonuclear energy**, which is stored in the nucleus of atoms, is harnessed to produce electrical energy in modern power plants. **Chemical energy** is stored in the bonds that hold atoms together in molecules. When fuels or foods are broken down, chemical energy is converted to heat energy or to kinetic energy. **Kinetic energy** is the energy contained by moving objects due to their motion. Even objects at rest have energy because of their position. **Potential energy**, also known as stored energy, is the energy of position. When a boulder sits on top of a cliff, it has gravitational potential energy as a result of its height above the ground. When the boulder tumbles off the cliff, its gravitational

SOME TYPES OF ENERGY

- Chemical
- Electrical
- Electromagnetic
- Mechanical
- Nuclear
- Radiant or light
- Sound
- Thermal

potential energy is converted to kinetic energy. When a ball is thrown up into the air, the kinetic energy of the ball is converted into gravitational potential energy as the ball approaches its highest point. As the ball falls back to the ground, the potential energy it gained during its upward flight turns back into kinetic energy. Kinetic and potential energy are types of mechanical energy.

We obtain energy from a variety of sources. The most common source of energy used today is coal. The chemical energy contained in coal is converted to electrical energy through the following series of energy transformations.

$$\textbf{Chemical} \xrightarrow{\textit{burning}} \textbf{Heat} \xrightarrow{\textit{turbine}} \textbf{Mechanical} \xrightarrow{\textit{generator}} \textbf{Electrical}$$

Petroleum and natural gas represent other fuels, which, along with coal, are known collectively as **fossil fuels**. The box to the right shows some other sources of energy.

ENERGY SOURCES

- Fossil fuels
- Geothermal
- Hydroelectric
- Nuclear
- Solar
- Wind

The movement of thermal energy from hot to cold materials is called **heat transfer**. There are three basic types of heat transfer: conduction, convection, and radiation.

- **Conduction** is the transfer of heat energy between materials that are in direct contact with each other. Heat transfer by conduction occurs as hot molecules and free electrons become agitated and collide with less energetic neighbors. These neighbors then become agitated and pass along thermal energy in a process similar to a "fire-bucket brigade." The process of conduction can be felt in the handle of a metal spoon that has been placed in a bowl of hot soup. The hot soup transfers heat to the end of the spoon, then the heat is transferred through the spoon to the handle. The rate of heat transfer depends on the type of material. Good conductors, such as metals, conduct heat rapidly. **Insulators**, such as wood or plastic, conduct heat very slowly.

- **Convection** is the transfer of heat energy by the mass movement of fluids containing heated particles. Fluids are materials that can flow. Liquids and gases are examples of fluids. When particles of a fluid are heated, the particles move farther apart, causing the fluid to expand. This movement of heated particles creates convection currents. Building or home heating systems force heated air into rooms by way of convection currents. These currents heat the colder air in the room.

- **Radiation** is the transfer of heat energy through electromagnetic waves. These waves originate from accelerated charged particles. Electromagnetic waves travel through matter or through empty space. Heat transfer through empty space is unique to radiation. Both conduction and convection require a medium or matter to transfer heat energy. Since the space between the Sun and Earth is essentially a vacuum, the heat energy from the Sun is transferred to Earth only by radiation.

Different substances have varying capacities for storing energy within their molecules. Heat energy can cause molecules to move about faster, increasing their random kinetic energy. An increase in this energy raises the temperature of the substance. Heat energy can also increase the vibrational or rotational energy of molecules, but this does not result in a temperature increase. Each substance has a unique **specific heat capacity**. Values for some common substances are shown in the table to the right. The specific heat capacity is generally defined as the amount of heat energy required to raise the temperature of 1 kilogram of a substance by 1°C. It is a measure of how much heat energy a particular substance can hold. The units most commonly used are joules per kilogram per degree Celsius. The amount of heat energy that a substance gains or loses, Q, depends on the mass, m, the specific heat, c, and the change in the temperature, ΔT, of the substance. The formula for finding the heat energy is simply the product of the three factors, $Q = mc\Delta T$. A question for this standard might look like this:

Specific Heat for Some Common Substances

Substance	**Specific Heat, *c*** $\left(\frac{\text{J}}{\text{kg} \cdot {}^\circ\text{C}}\right)$
Air (dry)	1010
Aluminum	900
Copper	390
Ethanol	2450
Glass	840
Ice (at −15°C)	2000
Mercury	140
Steel	450
Water (at 15°C)	4190

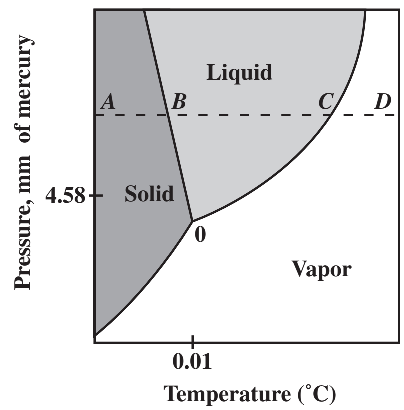
A copper ornament has a mass of 0.0693 kg and changes from a temperature of 20.0°C to 27.4ºC. How much heat energy did it gain?

A 200 J
B 460 J
C 540 J
D 740 J

The correct answer is **A**. Using the value for the specific heat capacity of copper above, $\text{Q} = \text{mc}\ \Delta\text{T} = (0.0693\ \text{kg})\left(390\frac{\text{J}}{\text{kg} \cdot {}^\circ\text{C}}\right)(27.4 - 20.0){}^\circ\text{C} = 200\ \text{J}.$ Answer **B** is incorrect because the specific heat capacity of aluminum was used instead of the specific heat capacity of copper. Answer **C** is incorrect. The initial temperature of 20.0°C was used instead of the 7.4°C change in temperature. Finally, answer **D** is incorrect because the final temperature of 27.4°C was used instead of the 7.4°C change in temperature.

A **phase diagram** shows how a pure substance changes from one phase to another based on the temperature, T, and the pressure, P. The phase (P-T) diagram for water, on the right, shows how water changes phases. At point O on the diagram, T = 0.01ºC and P = 4.58 mm of mercury. At this point, all three phases of water exist in equilibrium. Above point O, pathway AD has been marked on the diagram. Let's see what happens to water as we trace along that pathway. At point A, water exists as a solid. As the temperature increases at constant pressure, we reach point B on the diagram. At that point, solid ice melts and the temperature remains constant until all ice has melted. From point B to point C, water exists as a liquid and the temperature increases. At point C, water boils turning into a vapor (or gas). The temperature remains constant again during this phase change. After vaporization is complete, the temperature of the resulting vapor increases until we reach point *D*. There are no other phase changes after this point. Notice if another pathway is marked out at a constant pressure less than 4.58 mm of mercury (below point *O*), water will experience only one phase change, solid to vapor.

Phase Diagram for Water



Spotlight on the Standards

★***Determine relationships among force, mass, and motion***★

Simply stated, a **force** is a physical quantity that can change the motion of an object. A push or pull is an example of a force. The unit for force is the newton (N). All the forces acting on an object can be combined to determine the net force acting on the object. If all the forces acting on the object are balanced, then the net force is zero and the motion of the object does not change. If an object is already at rest, it will remain at rest. If an object is moving, it will keep on moving. **Balanced forces** do not change the motion of an object, but if the combination of forces acting on an object are not balanced, then the net force is greater than zero and the motion of the object changes. **Unbalanced forces** change the motion of an object.

Word Alert!

Speed and velocity are similar terms used to measure the distance an object moves in a given period of time. Speed may be used in test questions but *velocity* is used in formulas.

The distance an object moves per unit of time is known as the **speed**. The **velocity** is the speed of the object plus its direction. The average velocity can be found by dividing the change in the displacement of an object by the change in time.

$$v_{\text{ave}} = \frac{d_{\text{final}} - d_{\text{initial}}}{t_{\text{final}} - t_{\text{initial}}}$$

Acceleration, like velocity, has magnitude and direction. The average acceleration of an object is found by dividing the change in the velocity of the object by the change in time.

$$a_{\text{ave}} = \frac{v_{\text{final}} - v_{\text{initial}}}{t_{\text{final}} - t_{\text{initial}}}$$

Sir Isaac Newton was the first scientist to describe the relationships among force, mass, and motion clearly. The three laws of motion are named after him.

- **Newton's first law** of motion states that an object *at rest* will stay at rest unless it is acted upon by an unbalanced force. An object *in motion* will stay in motion unless acted upon by an unbalanced force. An object's tendency to resist a change in motion is called **inertia**. Inertia is that property of a body that resists changes in its state of motion. Inertia is directly related to an object's mass. An object with a large mass has a large amount of inertia while an object with a small mass has a small amount of inertia. Large forces are required to change the motion of objects with large masses while small forces can change the motion of objects with low masses.
- **Newton's second law** of motion states that the acceleration, a, of an object is directly related to the net force, F, applied to the object and inversely related to the mass, m, of the object. The following equation represents Newton's second law of motion.

$$a = \frac{F}{m} \quad \textbf{or} \quad F = ma$$

  According to the equation, the greater the net force acting on an object, the greater the acceleration of the object. Also, the greater the mass of the object, the lower the acceleration of the object. For example, a large truck has a much lower acceleration than a compact car given the same applied force by each engine. The larger mass (or inertia) of the truck resists acceleration.

- **Newton's third law** of motion states that forces occur as equal and opposite pairs. For every action force there is an equal and opposite reaction force. For example, when a book is sitting on a table, the weight of the book produces a downward action force on the table. The tabletop in turn pushes on the book with an upward reaction force. These forces are equal in magnitude, but in opposite directions.

TYPES OF FORCES

- Gravitational
- Electromagnetic
- Nuclear (Atomic)
- Frictional

Gravitational force is a universal force between any two objects. The strength of the force is related to the mass of the objects and the distance between them. The more mass an object has, the greater the gravitational force it exerts. The moon has less mass than Earth. The resulting lower gravitational force made the astronauts appear nearly "weightless" as they moved across the lunar surface. One should note that mass and **weight** are not the same quantity. An object has mass regardless of whether gravity or any other force is acting upon it.

Weight, on the other hand, changes depending on the influence of gravity. The relation between weight, *W*, and mass, *m*, can be written as the following.

$$\boxed{W = mg}$$

In this equation, *g* represents the acceleration due to gravity. At the surface of Earth, $g = 9.80\ m / s^2$. The value of *g* decreases the further away from the center of Earth. This means the weight of an object would decrease if it was placed on top of a mountain or put into space. Numerically, as the distance between two objects increases, the force of gravity decreases by a factor equal to the square of the distance. For example, if the distance between two objects is doubled, the force of gravity will decrease by a factor of four.

Other forces include **electromagnetic forces.** These forces are caused by positive and negative electrical charges in matter and include both electric forces and magnetic forces. The forces exerted within the nucleus of an atom are called **nuclear forces**. These forces hold the protons and neutrons together. **Frictional forces** tend to stop the motion of an object by dispersing its energy as heat. There are three types of frictional forces: sliding friction, rolling friction, and static friction. **Sliding friction** occurs when one solid surface slides over another solid surface. **Rolling friction** occurs when an object rolls across a solid surface. **Static friction** occurs between the surfaces of two objects that touch but do not move against each other. Static friction must be overcome for one of the objects to move. A question for this standard might look like this:

A block is placed on a horizontal table. The block is then pulled to the right with a string. The block remains at rest. A spring scale, attached to the string, reads 7.5 N. Which force acting on the block is equal to 7.5 N?

A gravitational force exerted on block
B force to the left exerted by air
C upward force exerted by table
D force exerted by static friction

The correct answer is **D.** Static friction occurs between the surfaces of two objects that are in contact but not moving. Since the block is at rest, static friction is equal to 7.5 N, and **D** is the correct answer. The forces in **A** and **C** do not resist a force to the right so these answers are incorrect. Answer **B** is incorrect because the object is not moving. No drag or force is exerted by the air.

STRATEGY BOX – Picture Perfect

Remember to look carefully at diagrams, illustrations, and other graphics. Information might be provided to help you answer questions on the EOCT.

If a visual aid is not provided, you might want to make a diagram to summarize important information that might help you answer a question.

The idea of work is familiar to most people. For example, it takes more work to move heavier objects like a car at rest than a much lighter bicycle. **Work** is the transfer of energy when an applied force moves an object over a distance. For work to be done, the force applied must be in the same direction as the movement of the object and the object must move a certain distance. A person may push on a wall and get tired muscles as a result, but unless the wall moves, the person has done zero work. Work can be summarized using the following equation:

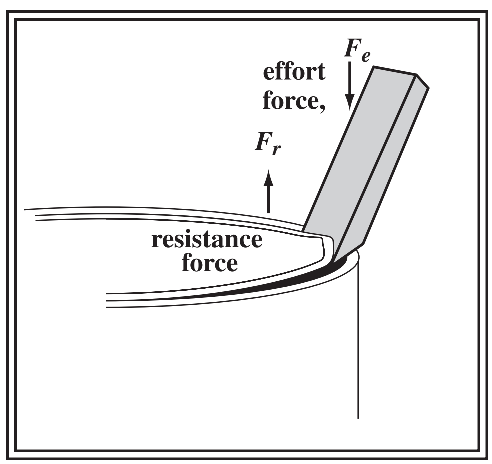
$$\boxed{W = Fd}$$

In the equation, W is equal to work, F is equal to the force applied, and d is equal to the distance that an object has moved. Remember, force is measured in newtons (N) and distance is measured in meters (m). A unit of work is the newton-meter (N-m), or the joule (J).

SIMPLE MACHINES

- Inclined Plane
- Lever
- Pulley
- Screw
- Wedge
- Wheel and Axle

Work can be made easier or done faster by using machines. Machines that work with one movement are called **simple machines**. There are six types of simple machines. These are shown in the box to the right.



Simple machines cannot increase the amount of work done but they can change the size and direction of the force applied. The force applied to a simple machine is called the **effort force**, F_e. For a machine to do work, an effort force must be applied over a distance. The force exerted by the machine is called the **resistance force,** F_r. For example, consider how a painter uses a screwdriver as a lever to pry open the lid on a can of paint. An illustration showing the bottom end of the screwdriver and the top of a paint can is shown on the right. When the painter pushes down on the screwdriver, an effort force is applied over a distance, known as the **effort distance**, d_e. As a result, the tip of the screwdriver exerts a resistance force against the lid of the paint can. This force moves the lid of the can over the **resistance distance,** d_r.

The number of times a machine multiplies the effort force is called the **mechanical advantage**. The mechanical advantage is determined using the following equations.

$$\boxed{MA = \frac{F_r}{F_e} \text{ or } MA = \frac{d_e}{d_r}}$$

For example, if 15 N of force is applied to the handle of the screwdriver to lift a resistance of 150 N, then the mechanical advantage of the screwdriver is 10. The tip of the screwdriver has multiplied the effort force 10 times. Refer to your textbook to see how the mechanical advantage of other simple machines can be calculated.

Sample Questions for Content Domain III

This section has some additional questions for you to practice. 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 explain why the other answer choices are wrong.

1 Which energy transformation takes place when a match is struck against the side of a matchbox and bursts into flames?

A electrical energy → light energy
B heat energy → kinetic energy
C chemical energy → heat energy
D potential energy → electrical energy

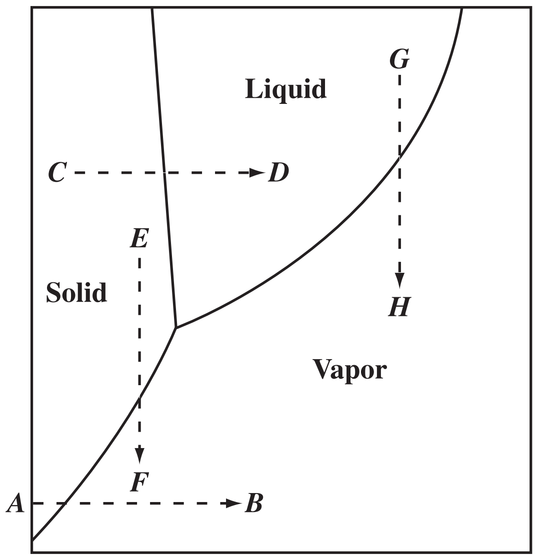
2 Conduction can BEST be described as the transfer of heat energy by

A waves traveling through empty space
B fluids traveling through other fluids
C gases expanding within a fluid medium
D atoms colliding with their neighbors

3 A 0.0150-kg cylinder of zinc cooled from 100.0°C to 20.0°C. The metal lost 466 J of heat energy. What is the specific heat capacity of the zinc?

A $311 \ \frac{\text{J}}{\text{kg} \cdot {}^\circ\text{C}}$
B $388 \ \frac{\text{J}}{\text{kg} \cdot {}^\circ\text{C}}$
C $559 \ \frac{\text{J}}{\text{kg} \cdot {}^\circ\text{C}}$
D $1550 \ \frac{\text{J}}{\text{kg} \cdot {}^\circ\text{C}}$

4 **Use the following phase diagram for water to answer the question.**

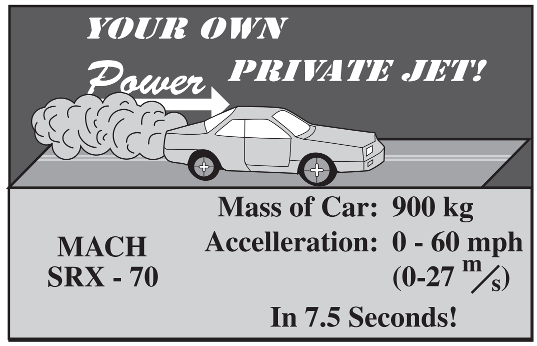


Temperature

Some ice crystals are released from the space shuttle into the near vacuum of space. Solar radiation causes a phase change. Which path indicated in the diagram BEST illustrates what happens to the ice crystals?

A *AB*
B *CD*
C *EF*
D *GH*

5 **The following advertisement shows some data about a new car.**



What is the magnitude of the average acceleration of the car?

A 1.2 m / s²
B 2.0 m / s²
C 3.6 m / s²
D 8.0 m / s²

6 **An object has a mass of 12.5 kg. If the object has moved 2.4 meters and has a constant acceleration of 1.6 m / s² to the right, what is the applied force?**

A 7.8 N to the left
B 20 N to the right
C 30 N to the left
D 48 N to the right

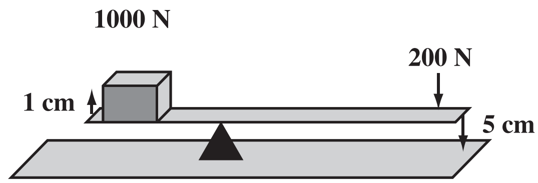
7 On the moon, gravity causes a rock hammer to fall more slowly to the ground than on Earth. Which lunar factor causes the slower rate of fall?

A smaller radius
B slower rotation
C lower density
D lesser mass

8 A stone is carried up Mount Everest, elevation 8850 meters. The weight of the stone decreases while the mass of the stone remains constant. The best explanation for this difference is that the mass is unaffected by outside forces while the weight is influenced by the

A weaker gravitational force
B lower density of air
C weaker magnetic field
D lower air temperature

9 A lever is used to lift a box as shown in the diagram below.



What is the mechanical advantage of the lever?

A 4
B 5
C 10
D 25

Answers to the Content Domain III Sample Questions

1. Answer: **C** **Relate transformations and flow of energy within a system.** *Identify energy transformations within a system.*

When the match is struck, the chemical energy of the phosphorus in the match head and the oxygen in the atmosphere is converted to heat energy, so answer **C** is correct. Answer **A** is incorrect because the match did not have electrical energy. Answer **B** is incorrect because the match did not initially have heat energy. It had to be struck against the side of the box. Answer **D** is incorrect. Though the match may be said to have had potential (chemical) energy, it was not converted to electrical energy. Heat energy is not electrical energy.

2. Answer: **D** **Relate transformations and flow of energy within a system.** *Investigate molecular motion as it relates to thermal energy changes in terms of conduction, convection, and radiation.*

Conduction is the transfer of energy by more energetic atoms colliding with not-so-energetic neighboring atoms, so **D** is the correct answer. Radiation is the transfer of energy by waves traveling through space, while convection is the transfer of energy by the movement of large masses of liquids and gases (fluids). That makes choices **A** and **B** incorrect. Conduction is not the transfer of energy by the expansion of gases, so **C** is incorrect.

3. Answer: **B** **Relate transformations and flow of energy within a system.** *Determine the heat capacity of a substance using mass, specific heat, and temperature.*

The specific heat capacity is found using the formula $c_P = \dfrac{Q}{m\Delta T}$. Plugging into the formula $c_P = \dfrac{466\ \text{J}}{(0.0150\ \text{kg})(100.0 - 20.0)°\text{C}} = 388\ \dfrac{\text{J}}{\text{kg}\cdot°\text{C}}$. Thus, **B** is the correct answer. Answer **A** is incorrect because the final temperature of 100.0°C was used instead of ΔT = 80.0ºC. Answer **C** is wrong because the incorrect formula, $c_P = Qm\Delta T$, was used. Answer **D** is incorrect because the initial temperature of 20.0°C was used instead of ΔT = 80.0ºC.

4. Answer: **A** **Relate transformations and flow of energy within a system.** *Explain the flow of energy in phase changes through the use of a phase diagram.*

In space, the pressure is essentially zero and constant. The path in the phase diagram must be at such a low pressure that an increase in temperature from incoming solar radiation will cause a phase change from solid to vapor. This means answer **A** is correct. Answer **B** is incorrect because the pressure is too high. This path would occur at normal atmospheric pressure. Answers **C** and **D** are incorrect. The temperature does not remain constant while the pressure changes in the near vacuum of space.

5. Answer: **C** **Determine relationships among force, mass, and motion.** *Calculate velocity and acceleration.*

The average acceleration is the change in the velocity (or speed) divided by the change in time $= \dfrac{V_f - V_i}{t_f - t_i} = \dfrac{27\text{ m / s} - 0\text{ m / s}}{7.5\text{ s} - 0.0\text{ s}} = \dfrac{27\text{ m / s}}{7.5\text{ s}} = 3.6\text{ m / s}^2$. Thus, answer **C** is correct.

Answers **A**, **B**, and **D** are incorrect because the wrong numbers were plugged into the formula or the formula itself was incorrect.

6. Answer: **B** **Determine relationships among force, mass, and motion.** *Apply Newton's three laws to everyday situations by explaining the following: inertia, relationship between force, mass and acceleration, and equal and opposite forces.*

The applied force is in the same direction as the acceleration (to the right) and the magnitude is found using $F = ma$. The force is therefore (12.5 kg)(1.6 m / s^2) = 20 N to the right. Answer **B** is correct. Answer **A** is incorrect because the mass was divided by the acceleration rather than multiplied by it. Also, the applied force is to the right, not to the left (the reaction force is to the left). Force is not equal to mass times distance, and the applied force should be to the right not the left, so answer **C** is wrong. Finally, the work was calculated, i.e., $W = Fd = mad,$ for answer **D**. This answer is wrong. Note that work is a scalar quantity not a vector quantity as shown in the answer.

7. Answer: **D** **Determine relationships among force, mass, and motion.** *Relate falling objects to gravitational force.*

The mass of the moon is much less than that of Earth. Since the mass of the attracting object (the moon) is less, the gravitational attraction on the rock hammer is less. This means the rock hammer will fall at a slower rate, so answer **D** is correct. Gravitational attraction is not dependent on an object's relative size or density, but total mass, so answers **A** and **C** are incorrect. Though the rate of rotation can reduce the downward force on an object, the moon's rate of rotation is less than that of Earth so any resistance to downward gravitational force would be less, not more. Thus, answer **B** is incorrect as well.

8. Answer: **A** **Determine relationships among force, mass, and motion.** *Explain the difference in mass and weight.*

Mass is a fundamental property of matter. It is a measure of the quantity of matter contained with an object. Weight is the gravitational force exerted on an object so answer **A** is correct. The lower density of air would actually provide less buoyancy for the stone so the weight would actually appear to increase, so answer **B** is incorrect. Weaker magnetic fields and lower air temperatures would have no effect on the weight of the stone, so answers **C** and **D** are incorrect.

9. Answer: **B Students will determine relationships among force, mass, and motion.**
Calculate amounts of work and mechanical advantage using simple machines.

The mechanical advantage of a lever can be determined by using the equation:

$$MA = \frac{F_r}{F_e} \text{ or } MA = \frac{d_e}{d_r}$$

From the diagram, the effort distance is 5 cm, and the resistance distance is 1 cm, or the effort force is 200 N and the resistance force is 1000 N.
Substituting the known values into either equation, given above, the answer would be determined as $MA = \frac{1000 \text{ N}}{200 \text{ N}}$ or $MA = \frac{5 \text{ cm}}{1 \text{ cm}}$. The mechanical advantage *MA* = 5. So **B** is the correct answer, and answers **A**, **C**, and **D** are incorrect.

Content Domain IV: Physics—Waves, Electricity, and Magnetism

A LOOK AT CONTENT DOMAIN IV

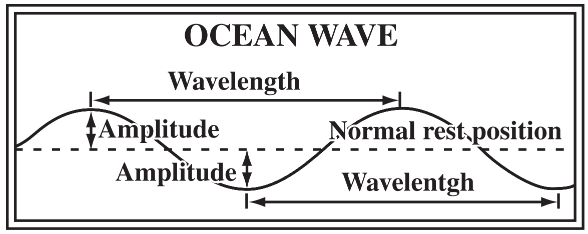
Test questions in this content domain will measure your ability to investigate the energy, characteristics, and phenomena of waves. You will also investigate static electricity, alternating and direct current electricity, and applications of electromagnetism. Your answers to the questions will help reveal how well you can perform on the following standards:

- Investigate the properties of waves
- Investigate the properties of electricity and magnetism

Spotlight on the Standards

★*Investigate the Properties of Waves*★

Waves are phenomena that occur, seen and unseen, all around us. Suppose that a student drops a stone in a pond. The surface of the water becomes disturbed. Some of the kinetic energy of the stone, as it falls in the water, is transferred to surrounding water molecules. This causes the surface of the water to be disturbed as water molecules move up and down while transferring energy through the water. This energy transfer can be seen moving in all directions through waves moving outward in concentric circles. Particles of matter do not move along with the waves. Only the energy that creates the waves moves with them. Waves by definition are disturbances that repeat the same cycle of motion and transfer energy through matter or empty space.



Mechanical waves (such as the water waves described above) and **electromagnetic waves** (such as light and radio waves) share some basic properties.

- **Amplitude** is the distance from the equilibrium point, or normal rest position, to a crest or trough.
- The **wavelength** is the distance between two consecutive crests or troughs of a wave. The symbol lambda (λ) is used to represent wavelength. The diagram to the right shows these properties.
- **Frequency** is the number of complete waves, or cycles of oscillation, in a given period of time. The symbol, *f*, is used to represent frequency. The unit for frequency is hertz (Hz), which is equal to one wave, or cycle, per second. The time it takes to complete one full cycle is called the **period**, which is measured in seconds.
- **Speed** measures how fast a wave is moving. The speed of a mechanical wave depends on the type of medium (substance in which the wave moves), but the speed is constant for any given medium. The speed is directly proportional to the frequency and wavelength of the wave according to the relationship, $v = f\,\lambda$.
- The **energy** transmitted by a mechanical wave is directly proportional to the square of the amplitude of the wave. For electromagnetic waves, the energy is carried by photons (tiny packets of energy). These photons also act like waves. The energy of photons is directly proportional to the frequency of the wave or is inversely proportional to the wavelength of the wave emitted. In other words, if the frequency of a wave is doubled (or the wavelength decreased by one-half), the energy of the wave is doubled, resulting in a different electromagnetic wave.

Mechanical waves (such as sound waves) are similar to electromagnetic waves (such as light waves) in that both types of waves transmit energy over a distance. However, there are some major differences.

- Sound waves require a medium for propagation. Light waves may travel either through a transparent medium or through empty space.
- Sound travels through all substances, but light is absorbed by opaque materials.
- A sound wave travels slowly through air at a speed of about 340 meters per second at 15°C. Electromagnetic waves, on the other hand, travel through air or the vacuum of space at extremely high speeds of about 300,000 kilometers per second.

Speed of Sound (at 25ºC)		
Substance	**State**	**Speed (m/s)**
Air	gas	346
Helium	gas	965
Ethanol	liquid	1497
Water	liquid	1162
Steel	solid	5960
Lead	solid	1960

Sound waves travel by vibrating from particle to particle. Because of this, the nature of a medium has a significant effect on the speed of sound. Sound travels faster through solids and liquids than it does through gases because particles are closer together in solids or liquids than in gases. Sound also travels fastest through elastic materials. For example, sound travels at about 1500 meters per second in water, while in aluminum, which is more elastic, the speed of sound is at about 5000 meters per second. In materials of the same phase, the speed of sound tends to decrease as the density increases. The more massive molecules of a denser substance have greater inertia and do not move as quickly as lighter molecules. The table on the right shows the speed of sound in various substances.

Because waves involve the transfer of energy, the properties of a wave will change when a wave encounters another wave or an object. Waves undergo four basic interactions. **Reflection** occurs when a wave hits an object that it cannot pass through or when it reaches the boundary of the medium of transmission. Both situations involve the return of the wave as it bounces off the object or medium boundary. **Refraction** takes place when a wave passes from one medium into another at an angle and bends (changes direction) due to a change in speed. **Diffraction** results when a wave passes through a hole or moves past a barrier and spreads out in the region behind the hole or barrier. Finally, **interference** occurs when two or more waves arrive at the same point at the same time. As a result, they combine to produce a single wave. This new wave will have different properties from the two waves that composed it.

On the test, you may be asked to identify and explain wave properties and interactions. A question might look like this:

Plastic lenses bend light waves making it possible for a near-sighted person to focus light onto the retina. The interaction of the light waves with the plastic lenses is known as

A diffraction
B interference
C reflection
D refraction

Refraction is the bending of light waves when waves pass from one medium to another, so **D** is the correct answer. Diffraction, interference, and reflection do not involve bending light at a medium boundary so **A**, **B**, and **C** are incorrect.

When a sound source moves toward a listener, the pitch or apparent frequency of the sound increases. This is because the sound waves are compressed closer together and reach the listener with a higher pitch. As the sound source passes by the listener and moves away from the listener, the same sound waves are stretched farther apart. This results in a decrease in the pitch or apparent frequency. This phenomenon is known as the **Doppler Effect**. It can be heard at a train crossing every time a train approaches, passes, and leaves a crossing while blowing its whistle.

Spotlight on the Standards

★*Investigate the Properties of Electricity and Magnetism*★

Electricity sounds very much like the word electron. The similarity between the words is no accident. Electricity is the energy associated with electrons as they move from one position to another. Recall that electrons are negatively charged particles, while protons are positively charged particles. When like charges come near each other, the charges repel each other. When opposite charges come near each other, the charges attract each other. **Static electricity** results from the buildup of electric charges on an object. The buildup of charges can be caused by friction, conduction, and induction.

- Rubbing two objects together can cause the electric charges on the objects to separate. The charging that results is due to **friction**. In this process, only electrons can be transferred from one object to another object. One object will become negatively charged as it gains electrons, while the other object will become positively charged as it loses electrons.

- In **conduction,** electrons flow through one object into another by direct contact. Silver, copper, aluminum, and magnesium are examples of good conductors. These materials allow electrons to flow freely.

- **Induction** involves electrons being rearranged. No contact need occur between two objects for induction to take place. A neutral object only needs to approach a charged object. For example, a negatively charged rubber rod picks up tiny slips of paper by induction. The electrons on the parts of the paper nearest the rod are pushed away leaving positive charges. Because the positive charges are closer to the negatively charged rod, the slips of paper are attracted to the rod.

Electric charges leave a charged object during an **electric discharge**. Lightning is probably the most dramatic example of an electric discharge. The repulsion and attraction of particles can be described in terms of **electric fields**, the area in which the electric force is noticeable. The strength of the electric field depends on the distance from the charged particle. A question on the test may ask you to distinguish electric charges and forces in static electricity situations. It might look something like this.

What particle do objects MOST likely lose or gain to become electrically charged?

A atoms
B electrons
C neutrons
D protons

When an object becomes electrically charged, only electrons are transferred, so **B** is the correct answer.

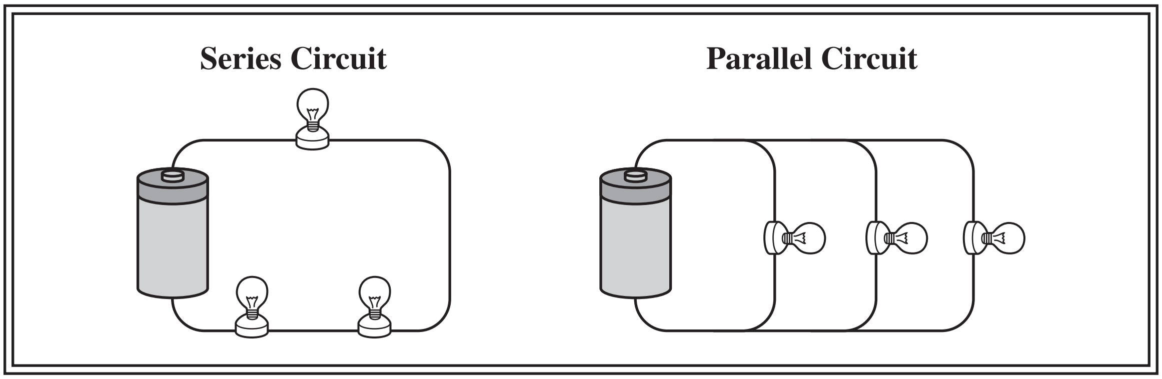
Electric current results from the movement of electric charges. A **circuit** is a complete, closed path for electron flow. A circuit consists of a source of electrons, such as a battery, a resistance or load, conducting wires, and a switch. In a battery, electrical energy is produced by a chemical reaction. When charged particles flow through the wire in a circuit, an **electric current** (I) results. The current is measured in amperes (A). The electron is the charged particle that most likely moves through the circuit. To get electrons flowing through a circuit, a voltage (V) is applied. **Voltage**, which is measured in volts (V), is the potential difference in electrical potential energy between two places in a circuit. In other words, voltage is the energy per unit of charge that causes charges to move. The opposition to current is called **resistance** (R), which is measured in ohms (Ω). Light bulbs and resistors are examples of objects with a resistance. Materials, like copper, that are good conductors of electricity, have low resistance. The resistance of wires that are good conductors depends on the wire's thickness, length, and temperature. Insulators keep electrons from flowing easily. Although electrons move one way through a wire, the current, by convention, is the relative movement of a positive charge. Electrons flow opposite the direction of the current.

Charges can move through a circuit continuously in the same direction producing a **direct current** or **DC**. Electrons can also change direction moving back and forth in cycles. This kind of current is known as **alternating current** or **AC**. Batteries, such as those found in cars, produce DC, while a gasoline-driven generator usually produces AC.

Ohm's law relates electric current, voltage, and resistance and can be summarized in the following equation.

$$\boxed{V = IR}$$

When the electric charges in a circuit have only one path in which to flow, the circuit is called a **series circuit**. If the circuit has different branches in which the electric charges can flow, the circuit is called a **parallel circuit**. Parallel circuits are used in houses. The following box shows examples of these circuits. Refer to your textbook to determine how to apply Ohm's law to different circuits.



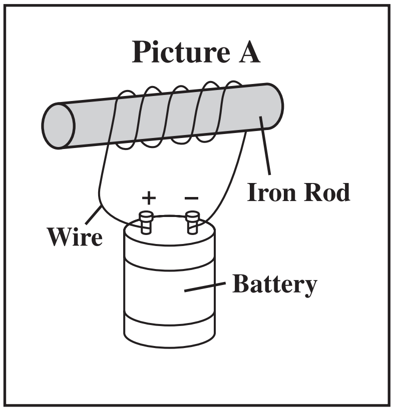
An electric current will also produce a magnetic field. A **magnetic field** is a region around a magnet or current-carrying wire where magnetic forces can be measured. **Magnetism** is the force of attraction or repulsion that is produced by an arrangement of electrons. Magnets have two poles, a north pole and a south pole. *Unlike* magnetic poles attract each other, while *like* magnetic poles repel each other. Groups of atoms with magnetic poles aligned are called **magnetic domains**. Materials with most of these domains lined up are considered magnetized. When a metal bar or other object is composed of stable, magnetic domains, a **permanent magnet** results.

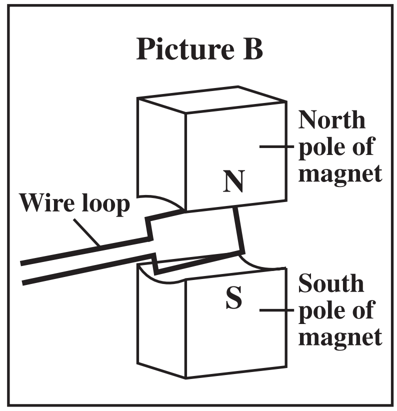
When an electric current is used to produce a magnetic field in a coil of wire, the coil becomes an electromagnet. A rotating electromagnet is used in **electric motors** to convert electrical energy to mechanical energy.

When a magnet is moved near a wire, an electric current is generated. This process, called **electromagnetic induction**, is used to operate a **generator**. A generator is a device that converts mechanical energy to electrical energy. In a commercial generator, an electric current is produced when a large coil of wire is rotated in a strong magnetic field.

For this standard on the test, you may be asked to compare methods of generating an electric current or to identify examples of electric and magnetic interactions. A question might look something like the following.

Use the diagram to answer the question.





Which of the following statements correctly identifies both devices illustrated in the pictures above?

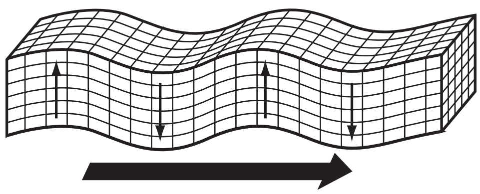
A Picture A shows an electric generator while Picture B shows an electromagnet.
B Picture A shows an electromagnet while Picture B shows an electric motor.
C Picture A shows an electric motor while Picture B shows an electromagnet.
D Picture A shows an electric generator while Picture B shows an electric motor.

Picture A shows an iron rod surrounded by a coil of wire through which an electric current is passed. An electromagnet has been constructed. Picture B could show an electric generator if mechanical energy rotated the coil or an electric motor if a current was forced through the coil of wire. Answer **B** is the only answer that could be correct, and choices **A**, **C**, and **D** are incorrect answers. An electric generator uses electromagnetic induction to change mechanical energy to electrical energy (electricity), while an electric motor uses electromagnetism to change electrical energy to mechanical energy to do work.

Sample Questions for Content Domain IV

This section has some questions for you to practice so you can master the concepts of waves, electricity, and magnetism. After you have answered all of the questions, check your answers in the "Answers to the Content Domain IV Sample Questions" section that follows. This section will show you the correct answer for each question, and tell why the other answer choices are wrong.

1 **The following diagram shows a type of earthquake wave called an s-wave.**



Besides the wave, what else is moving to the right?

A rocks in the wave
B the wavelength
C energy of the wave
D electromagnetic waves

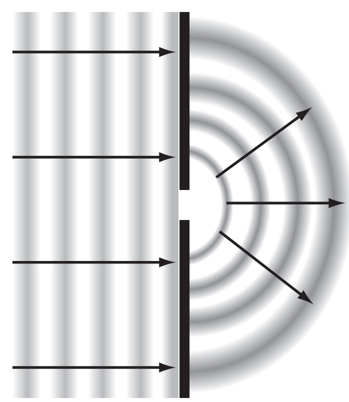
2 **A system of filters gradually turns a beam of orange light ($f = 5.0 \times 10^{14}$ Hz) into green light ($f = 6.0 \times 10^{14}$ Hz). Which of the following experiences an increase during the color change?**

A wavelength of the wave
B speed of the wave
C average number of photons
D average energy of the photons

3 **Sound waves and ultraviolet light waves both share the property of being able to**

A move through space
B travel at $300{,}000\ \frac{\text{m}}{\text{s}}$
C carry energy
D propagate through rock

4 **The following diagram shows what happens to some water waves.**



What process are the waves undergoing?

A refraction
B diffraction
C reflection
D interference

5 The following chart shows the density of four different mediums for sound under normal conditions.

Medium	Density $\left(\frac{kg}{m^3}\right)$
Chlorine ($C1_2$)	3.214
Hydrogen (H_2)	0.090
Magnesium (Mg)	1738
Mercury (Hg)	13,546

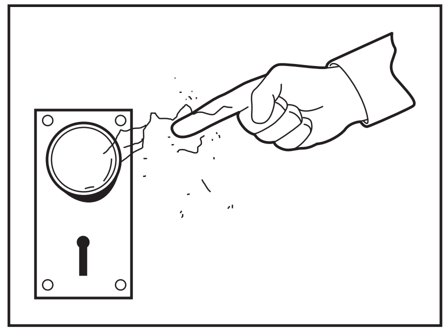
In which medium will sound waves have the *slowest* speed?

A chlorine
B hydrogen
C magnesium
D mercury

6 A truck is blowing its horn as it approaches a bystander at an intersection. According to the Doppler Effect, the bystander will notice that the sound

A decreases in frequency
B increases in wavelength
C increases in pitch
D decreases in speed

7 Use the diagram to answer the following question.



A person received an electrical shock when reaching for the metal doorknob. The shock was caused by the

A high number of electrons on the doorknob
B discharge of an imbalance of electrons
C highly conductive surface of the doorknob
D low resistance of the person's skin

8 What is the resistance of an electrical device that allows a current of 10 amperes with 120 volts?

A 12Ω
B 110Ω
C 130Ω
D 1200Ω

9 When a loop of wire is turned at a right angle to Earth's magnetic field, the wire and magnetic field will create a weak

A electric transformer
B electromagnet
C electric motor
D electric generator

Answers to the Content Domain IV Sample Questions

1. Answer: **C** **Investigate the properties of waves.** *Recognize that all waves transfer energy.*

An earthquake is an example of a mechanical wave. All waves carry energy in the same direction as the wave disturbance, so answer **C** is correct. Answer **A** is incorrect because the rocks (or particles of the medium) do not move in the direction of the wave. They just cycle up and down. Answer **B** is incorrect because the wavelength of a wave is the distance between two crests of a wave. It does not change or move. Mechanical waves do not produce electromagnetic waves, so answer **D** is incorrect.

2. Answer: **D** **Investigate the properties of waves.** *Relate frequency and wavelength to the energy of different types of electromagnetic waves and mechanical waves.*

When the frequency of an electromagnetic wave increases, so does the energy. The energy of the photons is directly proportional to the frequency of the wave. Therefore, answer **D** is the correct response. Answer **A** is incorrect because the wavelength of a wave is inversely proportional to the frequency. Answer **B** is incorrect because the speed of light waves is constant. The frequency of a wave is not related to the number of photons, so answer **C** is also incorrect.

3. Answer: **C** **Investigate the properties of waves.** *Compare and contrast the characteristics of electromagnetic and mechanical (sound) waves.*

All waves have the ability to carry energy along with them, so answer **C** is correct. Answer **A** is incorrect because only electromagnetic waves can travel through the vacuum of space. Sound waves do not travel at such high speeds as 300,000 km/s. That is the speed of light, so answer **B** is incorrect. Ultraviolet light does not propagate through rock while sound waves do, making answer **D** incorrect.

4. Answer: **B** **Investigate the properties of waves.** *Investigate the phenomena of reflection, refraction, interference, and diffraction.*

Diffraction results when a wave passes through a hole and spreads out in the region behind the hole, so answer **B** is correct. Refraction involves bending of light waves, so answer **A** is incorrect. The waves do not undergo reflection because they do not bounce off a surface, so answer **C** is incorrect. Finally, **D** is wrong because the waves are not being superimposed.

5. Answer: **A** **Investigate the properties of waves.** *Relate the speed of sound to different mediums.*

Sound tends to travel slowest in gases since the molecules are far apart. Since chlorine gas is much denser than hydrogen gas, the slowest speed for sound will occur in chlorine gas, so answer **A** is correct. Hydrogen is very light, so sound will travel faster in it than in chlorine, making answer **B** incorrect. Magnesium and mercury are a solid and liquid, respectively. Sound travels much faster in these phases than in the gas phase, so answers **C** and **D** are incorrect.

6. Answer: **C** **Investigate the properties of waves.** *Explain the Doppler Effect in terms of everyday interactions.*

As the sound source approaches the bystander, the sound waves bunch up, increasing the pitch or perceived frequency of the sound, so answer **C** is correct. Answers **A** and **B** are incorrect because the actual frequency, or wavelength, of the sound waves does not change. The speed of sound in air is constant and does not change, so answer **D** is incorrect as well.

7. Answer: **B** **Investigate the properties of electricity and magnetism.** *Investigate static electricity in terms of friction, induction, and conduction.*

The person received a shock when reaching for the doorknob because electrons moved between the person's hand and the doorknob. This resulted in a static discharge and a loss of static electricity. Static electricity is a build up of electric charge in one place creating an imbalance of electrons. Choice **B** is the correct answer. There is not an extra high number of electrons on the doorknob, the conducting surface of the doorknob does not create the shock, and the person's skin having a low resistance does not cause an electrical discharge, so choices **A**, **C**, and **D** are incorrect.

8. Answer: **A** **Investigate the properties of electricity and magnetism.** *Explain the flow of electrons in terms of alternating and direct current, the relationship among voltage, resistance, and current, and simple series and parallel circuits.*

To determine the resistance of the device, the equation $V = IR$ is used. The equation must be solved for resistance, resulting in the equation, $R = \frac{V}{I}$. Substituting the values given in the question results in the solution, $R = \frac{120\text{ V}}{10\text{ A}} = 12\ \Omega$. The correct answer is **A**. Choices **B**, **C**, and **D** are incorrect due to the equation being used incorrectly.

9. Answer: **D** **Investigate the properties of electricity and magnetism.** *Investigate applications of magnetism and/or its relationship to the movement of electrical charge as it relates to electromagnets, simple motors, and permanent magnets.*

When a loop of wire is turned in a magnetic field, electrical charges move through the wire, creating an electrical current. This is the basis for an electric generator, so answer **D** is correct. An electric transformer does not produce electricity; it increases or decreases the voltage or current, so answer **A** is incorrect. Answer **B** is incorrect because an electromagnet consists of loops of wire, surrounding an iron core, which carry a current from an electrical source. This creates a magnetic field. Finally, answer **C** is incorrect because an electric motor converts electrical energy to mechanical energy through rotation of loops of wire.

Co-requisite Domain: Characteristics (and Nature) of Science

A LOOK AT THE CO-REQUISITE DOMAIN

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 this domain.

This part of the domain will test how well you understand the importance of ethics in science. Scientists should be curious, honest, open, and skeptical in the pursuit of knowledge. You should develop these traits during your own activities in the lab and classroom. In the lab, you might have noticed that different explanations can often be given for the same evidence. The four qualities, just mentioned, should lead you and others to find the most accurate explanation for the evidence. This requires further understanding of the scientific problem. It will require you to design and perform new experiments. These experiments will either support or weaken the opposing explanations.

Before starting the experiments, you and your classmates should use standard safety practices. These should be carefully followed in the classroom, laboratory and out in the field. These practices include:

- Always use correct procedures when working with scientific apparatus
- Always use proper techniques in the laboratory
- Immediately identify and report safety problems and violations

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

Below is an example of a question on safety practices.

A student plans an experiment to separate a water solution containing borax by heating the solution over a Bunsen burner. In this way, the water is evaporated. Which piece of safety clothing or equipment is MOST appropriate for this experiment?

A cotton gloves
B dust mask
C fume hood
D safety goggles

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 and borax is a dissolved solid, a fume hood is not necessary, so **C** is incorrect. Choices **A** and **B** do not represent equipment that is needed for this experiment.

By this time, you should have addressed all safety issues. Now you are ready to identify and investigate a scientific problem. First, reasonable hypotheses should be suggested for an identified problem. Then procedures should be developed to solve the problem. These procedures, when carried out, will require you and your lab group to gather, organize and record data. At the end of the experiment, the data points should be graphed so you can compare and analyze your results. Statistics should be summarized as well. Based on this work you should develop reasonable conclusions based on the data. You will evaluate whether your conclusions are reasonable by reviewing the process and checking your data against all other available information.

You will find that good data collection and organization are vital for success. As a result, you should learn to use tools and instruments for observing and measuring data. As part of this process, you should do the following:

- Develop and use orderly procedures for recording and organizing information.
- Use technology to produce tables and graphs
- Use technology to develop, test, and revise your experimental or mathematical models

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.

On the test, you will need computation and estimation skills to analyze data and create scientific explanations. Sometimes you will notice large differences between your estimates and your calculated answers. Measurement errors may have a noticeable effect on calculations. Good computation and estimation skills are needed to produce reliable results. You should know that accuracy indicates how close your measurements approach the accepted value. Precision is the agreement between two or more measurements. You should be able to express the correct number of significant figures in your calculations. Scientific notation should be used to report very large or very small values. Finally, you should be able to solve problems by substituting values into simple algebraic formulas. You might also use dimensional analysis. Below is an example of a question about proper use of significant digits.

A lab student used the following mathematical setup to calculate the density of a solid sphere of ice.

$$\boxed{d = \frac{\mathbf{121\,kg}}{\frac{4}{3}(\mathbf{3.1416})(\mathbf{0.3158\,m})^{3}}}$$

What is the density of the ice, using the proper number of significant figures?

A 900 kg / m^3
B 917 kg / m^3
C 917.19 kg / m^3
D 917.2 kg / m^3

The correct number of significant figures is 3 in accordance with the rules for computing values and measurements. The value with the fewest significant digits (121 kg) dictates how many digits can be used in the answer after the multiplication and division is completed. Answer **B** is the correct answer. The fraction 4 / 3 is an exact number, not a measurement, so the answer should not contain 1 significant figure as appears in the fraction, so answer **A** is incorrect. The answer should not contain the same number of significant figures as the number with the most digits as with π, so answer **C** is incorrect. Answer **D** is incorrect because 0.3158 m (with 4 significant figures) is not the measurement with the least number of significant figures.

One of the goals of scientists is to communicate scientific investigations and information clearly. With this in mind, you should be able to write clear, logical laboratory reports. You should also be able to write clear, understandable critiques of current scientific issues, including possible alternative interpretations of scientific data. When presenting data, you should use it to support scientific arguments and claims during a group discussion.

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

To understand how science leads to new discoveries, you should be able to analyze how scientific knowledge is developed. In order for science to grow and develop, certain assumptions are required. First, scientists assume that the universe is a vast single system in which basic principles are the same everywhere.

These universal principles are discovered through observation and experimental confirmation. Science is not exact or perfect. From time to time, scientific explanations may change as new data result in changes in the scientific view of how the world works. Most of the time, small changes to previous models lead to shifts in scientific knowledge. Major changes in scientific views typically occur when a new phenomenon is observed. These changes also occur when an individual or research group gives an insightful interpretation of existing data. Hypotheses often cause scientists to develop new experiments. These experiments produce additional data. The results of these experiments are tested and revised. New and old theories may occasionally be rejected. The process of testing and fine-tuning theories never ends as scientists try to gain new insights into old problems. A question on the test might look something like this:

The development of a scientific model may be hindered by errors and mistaken beliefs many times. The scientific method, however, should eventually lead to better scientific models because

A contemporary scientists appreciate the scientific method more than ever.
B new computer technology immediately detects the scientists' errors.
C more complex scientific models lower the probability of inaccurate results.
D additional scientific research either confirms or replaces flawed theories.

Answer **D** is the correct answer. Continuing research leads to better explanations of phenomena. This leads to the revision or rejection of present-day theories. Answer **A** is incorrect because it is incorrect to assume that scientists today appreciate the scientific method more than previous scientists did. Computers do not eliminate human error, so answer **B** is incorrect. Just because a model is more complex, it does not lessen the likelihood of inaccurate results; it could make inaccurate results more likely. Answer **C** is therefore incorrect.

Finally, you should understand the important characteristics of the process of scientific inquiry. These characteristics include the following:

- The conditions of the experiment should be controlled to obtain valuable data,
- The quality of data, including possible sources of bias in hypotheses, observations, data analyses, and interpretations, should be critically examined and tested.
- Peer review and publication should be employed to increase the reliability of scientific activity and reporting.
- It should be remembered that the merit of a new theory is judged by how well scientific data are explained by the new theory.
- The ultimate goal of science should be to develop an understanding of the natural universe which is free of human bias.
- It should be remembered that scientific disciplines and traditions differ from one another. These differences include what is being studied, the techniques used, and the outcomes being sought.

If you develop a good understanding of all the concepts presented here, then you will be successful answering the questions in this co-requisite domain.

EOCT Sample Overall Study Plan Sheet

Here is a sample of what an OVERALL study plan might look like. You can use the Blank Overall Study Plan Sheet in Appendix B or create your own.

Materials/Resources I May Need When I Study:
(You can look back at page 2 for ideas.)

1. *This study guide*
2. *Pens*
3. *Highlighter*
4. *Notebook*
5. *Dictionary*

Possible Study Locations:

- First Choice: *The library*
- Second Choice: *My room*
- Third Choice: *My mom's office*

Overall Study Goals:

1. *Read and work through the entire study guide*
2. *Answer the sample questions and study the answers*
3. *Practice reading and answering the general questions*

Number of Weeks I Will Study: *6 weeks*

Number of Days a Week I Will Study: *5 days a week*

Best Study Times for Me:

- Weekdays: *7:00 p.m. – 9:00 p.m.*
- Saturday: *9:00 a.m. – 11:00 a.m.*
- Sunday: *2:00 p.m. – 4:00 p.m.*

Blank Overall Study Plan Sheet

Materials/Resources I May Need When I Study:
(You can look back at page 2 for ideas.)

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________

Possible Study Locations:

- First Choice: ______________________________
- Second Choice: ______________________________
- Third Choice: ______________________________

Overall Study Goals:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Number of Weeks I Will Study: ______________________________

Number of Days a Week I Will Study: ______________________________

Best Study Times for Me:

- Weekdays: ______________________________
- Saturday: ______________________________
- Sunday: ______________________________

EOCT Sample Daily Study Plan Sheet

Here is a sample of what a DAILY study plan might look like. You can use the Blank Daily Study Plan Sheet in Appendix D or create your own.

Materials I May Need Today:

1. *Study Guide*
2. *Pen*
3. *Notebook*

Today's Study Location: *the desk in my room*

Study Time Today: *From 7:00 p.m. to 8:00 p.m. with a short break at 7:30 p.m.*
(Be sure to consider how long you can actively study in one sitting. Can you sit for 20 minutes? 30 minutes? An hour? If you say you will study for three hours, but get restless after 40 minutes, anything beyond 40 minutes may not be productive—you will most likely fidget and daydream your time away. "Doing time" at your desk doesn't count for real studying.)

If I start to get tired or lose focus today, I will: *do some sit-ups.*

Today's Study Goals and Accomplishments: (Be specific. Include things like number of pages, sections, or standards. The more specific you are, the better able you will be to tell if you reached your goals. Keep it REALISTIC. You will retain more if you study small "chunks" or blocks of material at a time.)

Study Task	*Completed*	*Needs more work*	*Needs more information*
1. Review what I learned last time	X		
2. Study the first standard in Content Domain I	X		
3. Study the second standard in Content Domain I		X	

What I learned today:

1. *How to balance a synthesis reaction*
2. *What the questions about covalent bonds might look like*
3. *How to tell the difference between nuclear fission and nuclear fusion*

Today's reward for meeting my study goals: *Eating some popcorn*

Blank Daily Study Plan Sheet

Materials I May Need Today:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Today's Study Location:

Study Time Today: ________
(Be sure to consider how long you can actively study in one sitting. Can you sit for 20 minutes? 30 minutes? An hour? If you say you will study for three hours, but get restless after 40 minutes, anything beyond 40 minutes may not be productive—you will most likely fidget and daydream your time away. "Doing time" at your desk doesn't count for real studying.)

If I start to get tired or lose focus today, I will: ______________________

Today's Study Goals and Accomplishments: (Be specific. Include things like number of pages, sections, or standards. The more specific you are, the better able you will be to tell if you reached your goals. Keep it REALISTIC. You will retain more if you study small "chunks" or blocks of material at a time.)

Study Task	*Completed*	*Needs More Work*	*Needs More Information*
1.			
2.			
3.			
4.			
5.			

What I learned today:

1. ______________________________
2. ______________________________
3. ______________________________

Today's reward for meeting my study goals: ______________________________