Science

Quarter 2 Study Guide

Topic 1 Energy and Motion

Topic 2 Waves and Information

READING MATERIAL

Read About Energy Transfer

DEFINITION OF ENERGY TRANSFER

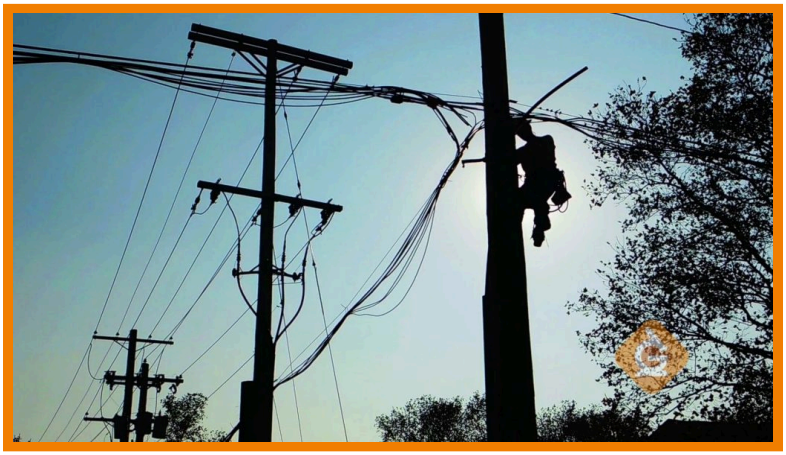
Energy is the ability to do work, or in more simple terms: energy makes things happen. You use energy to ride your bike, play video games, bake cookies, and drive to school. Energy is exciting! Energy can be transferred from one object to another, and energy can be transferred into different forms, such as light, sound, and heat.

To better under how energy transfer works...

LET'S BREAK IT DOWN!

What is energy?

Energy is the ability to do work. There are many different kinds of energy, such as light, sound, and heat.
We need energy for our homes to power lights, refrigerators, air conditioners, and computers. We use energy when we drive cars or pedal a bike. We power our devices with energy stored in batteries. Even sleeping requires energy!



Energy moves and changes form.

Energy transfer takes place when energy moves from one place to another. Energy can move from one object to another, like when the energy from your moving foot is transferred to a soccer ball, or energy can change from one form to another.

When energy in a battery is used to power an electronic device, chemical energy is transformed into electrical energy, which moves along wires.

Three more ways energy can be transferred are through light, sound, and heat.

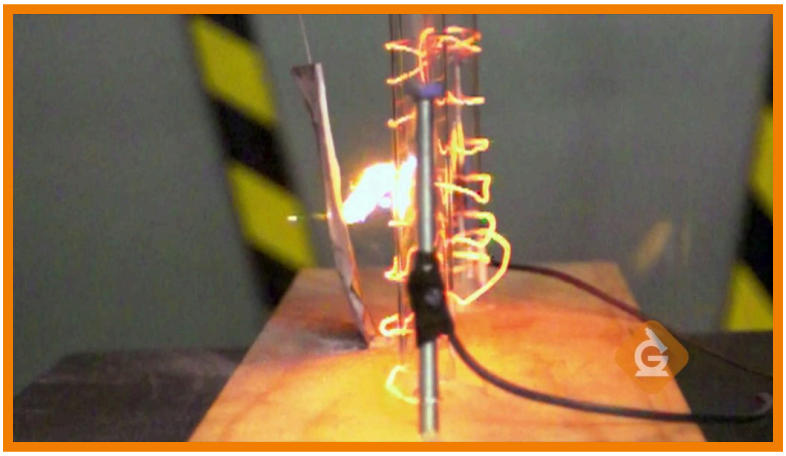
Energy can be transferred as light.

Light energy is the only form of energy we can see. Light from the sun helps plants grow and makes food for us to enjoy. The sun's energy also powers solar cells, which can be used to create electricity.
Light bulbs can also transfer energy, just like in the video when the light bulb's energy powered the singing fish. The light energy moves through space until it encounters a solar cell. The solar cell converts it to electrical energy, which powers the singing fish.

Energy can be transferred as sound.

Have you ever felt sound? Loud concerts or even marching bands can sometimes produce enough energy that you can feel the vibrations in your body.
Sound energy is transferred when a sound wave travels from its source, like a drum, to another object. If the sound is loud enough, the waves will create very intense vibrations that you can feel in your chest.

Energy can be transferred as heat.



When you sit by a campfire, you can feel the heat warm your body. The heat from the burning wood is transferred to your marshmallow, causing it to get soft and gooey. Perfect for your s'mores!
Heat can move from warm objects to cool objects, just like in the video when the heat from the wires made the paper ignite.

ENERGY TRANSFER EXAMPLES

Humans and other animals use sound energy to communicate. When you speak, you create sound waves that travel through the air. When the sound wave reaches the ears of someone nearby, their brain is able to translate the sound waves into words.

The sun is not the only source of light. Light bulbs and candles also produce light, and so do some living things such as fireflies. Light energy powers most things in nature because plants use light energy to grow, and then most animals get their energy from eating plants.

The sun's energy can be transferred to make s'mores. The DIY activity with Zoe shows you how to make your own s'more maker without electricity. It relies on energy transfer from the sun. Yum.

ENERGY TRANSFER VOCABULARY

Energy	It makes things happen! (Or more formally: the ability to do work)
Energy Transfer	Energy being moved from place to place.
Generator	Changes energy from one form to another.
Batteries	Store energy and change it from one form to another.
Solar Cell	Converts energy of sunlight into electrical energy.
Motion Energy	The energy something has due to movement.

ENERGY TRANSFER DISCUSSION QUESTIONS

At the beginning of the video, where did Bert's energy go?

Bert's energy was transferred to several different devices that run on electricity such as Izzy's popcorn maker.

How does Dr. Jeff's mom transfer energy to Bert?

Dr. Jeff's mom uses motion energy to pedal a bike, which spins a wheel that is attached to a generator. The generator changes the motion energy into electrical energy, which flows through wires to Bert. Bert then stores energy in his batteries to use later.

Why is the name "generator" a misnomer (a non-appropriate name)?

Generators don't actually generate energy. Instead, they convert one type of energy to another. In the video you can see a generator convert motion energy into electrical energy when Dr. Jeff's mom pedals the bike.

Can you think of a device that converts electrical energy into heat? How about into light? Sound?

A toaster is an example of a device that converts electrical energy into heat energy. A lamp converts electrical energy into light energy and a boom box converts electrical energy into sound energy.

What are some ways electrical energy can be generated at a power plant?

Power plants might generate electricity by using the power of moving water to spin a generator or by burning coal to produce steam, which also spins a generator.

Do power plants "produce" electricity? Why or why not?

Power plants do not produce energy, they only convert energy from one form to another. For example they can convert the energy from burning coal (chemical energy) into electricity (electrical energy).

READING MATERIAL

Read About Collisions

COLLISION DEFINITION

A collision happens when one object runs into another. When objects collide, the energy transfers from one object to the other. *Energy* is the ability to do work (or in more simple terms: energy makes things happen). The amount of energy transferred during a collision depends on the weight and speed of the moving object.

To better understand how energy transfer and collisions work...

LET'S BREAK IT DOWN!

Collisions happen all around us.

Every day, we see and experience hundreds of collisions. A collision could be as gentle as a puppy licking your face, or as dramatic as a wrecking ball smashing into a building.

Collisions are part of our everyday lives. People drop things which collide with the ground. Drumsticks collide with drums to make sounds.

Sports involve numerous collisions. Think about baseball. The batter tries to collide the bat with the ball. At the instant of impact, the energy **transfers** from the swinging bat to the ball, which makes it fly.

Energy transfers when two objects collide.

Do you enjoy going bowling? When you bowl, you are transferring the energy from the moving ball to the bowling pins.

Bumper cars are another great example. In this case, all the cars are usually in motion. When one bumper car hits another car, the energy is transferred and the passengers in the cars feel a change in their motion. The cars may stop or change direction due to the impact of the collision.

The faster an object is moving, the more energy it can transfer.

The amount of energy transferred between moving objects depends on the object's speed. Objects that are moving faster have a bigger impact because they transfer more energy.

In the video, Dr. Jeff's mom was able to knock Izzy farther when she ran **faster**. That's because she had more energy to transfer. That energy was transferred to Izzy when they collided.

This has an important real-world application for car safety. When cars are traveling fast and they have an accident, the crash is typically much worse than if the car was traveling slowly. Speed limit signs are posted to keep drivers safe for this reason.

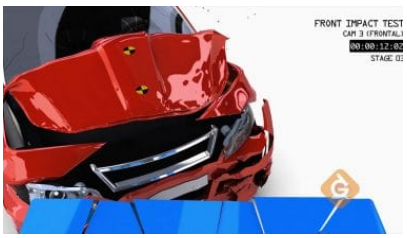
The heavier an object, the more energy it can transfer.

Heavier objects carry more energy. This explains why car accidents involving trucks are so damaging to cars. During a collision, the energy carried by the heavy truck is transferred to the lighter car.

Have you ever noticed that the biggest football players have the most stopping power? If a 300-pound lineman tackles a 100-pound quarterback, the quarterback doesn't have a chance.

Animals sometimes fight over territory. The larger animal is usually more successful in these fights, because it has more weight and can transfer more energy during a collision.

EXAMPLES OF COLLISIONS



Engineers build cars with special crumple zones. The crumple zone absorbs the impact. This reduces the amount of energy transferred to passengers during a crash.

Newton's cradle uses a series of swinging balls that collide. This is a common toy seen on people's desks. As the balls continue to collide, energy is transferred from one ball to the next. Over time the balls stop because some of the energy in each collision becomes sound and heat.

Rube Goldberg machines show energy transfers. This ice dispensing machine from our video transfers energy through a series of collisions. It may not be very useful, but it sure is fun!

COLLISIONS VOCABULARY

Energy	It makes things happen! (Or more formally: the ability to do work)
Rube Goldberg Machine	A complex contraption that performs a simple task, such as pouring a glass of lemonade.
Energy Transfer	When one objects runs into another, energy is transferred.
Collision	When one object runs into another.
Contact	When two objects touch each other.
Stationary Object	An object that is not moving.

ENERGY TRANSFER DISCUSSION QUESTIONS

True or false: Only humans use energy.

False. People use energy to make things happen, such as lifting weight, but it's not just people that use energy. Water uses energy to turn a water wheel, wind use energy to spin wind turbines and animals use energy when running or butting heads.

Explain how energy is transferred to make the Rube Goldberg Machine work.

The weight drops the top ramp, which collides with the metal ball. The metal ball rolls down a series of ramps and collides with a rod that releases the spinning circle. The spinning circle travels down as it spins, which eventually pulls the large hanging metal ball loose. The ball drops slowly as it unwinds, turning the windmill. That eventually pulls a pin holding the ice. The ice slides down the tube and drops into the pitcher. During each collision energy is transferred between objects.

Explain how energy is transferred from a baseball bat to a baseball.

At the moment the bat touches the ball, energy from the moving bat is transferred to the ball, setting it in motion.

What evidence did you see in the video that suggests energy is transferred by a moving object?

In the video we observe a baseball flying after the bat hits it, the chain reaction of motion during the Rube Goldberg machine demonstration and Izzy flying back after Dr. Jeff's Mom collides with him.

Does Izzy fly back further when Dr. Jeff's mom runs faster or slower? Why?

When hit with more speed, Izzy flies back farther.

Explain how the energy transfers when the drum stick hits the gong.

The energy of motion from the swinging drum stick is transferred to the gong, which then vibrates producing sound.

READING MATERIAL

Read About Wave Properties

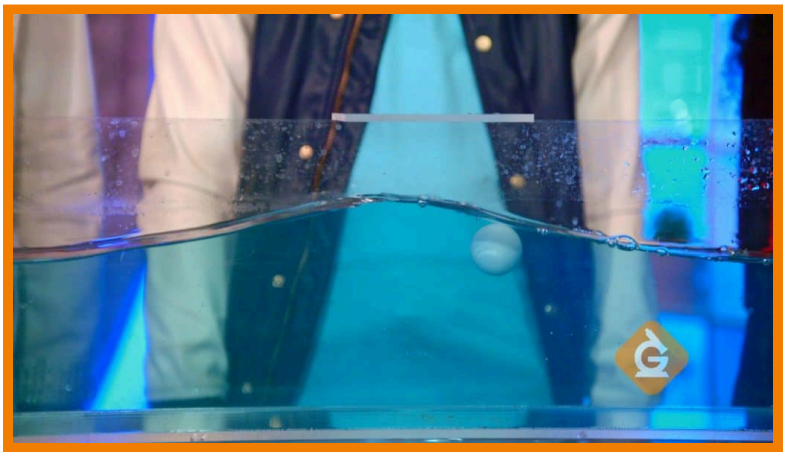
DEFINITION OF WAVES

Waves are a pattern of motion that transfer **energy** from place to place without transferring matter. There are different types of waves. Sound waves travel through air and allow us to hear sound. Water waves move on top of water. Light waves move in straight lines through space. On this page we will focus on sound and water waves.

To better understand the different types of waves...

LET'S BREAK IT DOWN!

Energy travels through waves.



Waves transport energy, not matter, from place to place. Remember that matter is made of particles too small to be seen.

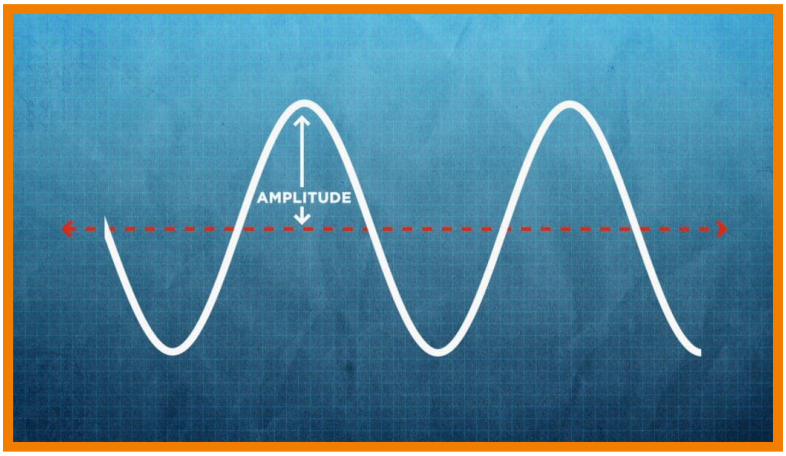
Particles are required to transport some types of waves, such as sound waves. When the wave travels, the particles do not travel with the wave. It may appear that ocean waves are moving particles of water toward you, but in fact, the water is only moving up and down.

We can test this by placing a heavy ping-pong ball in a wave tank. The waves move from one side of the tank to the other, but the ping-pong ball does not travel, it only moves up and down.

Scientists put waves into two general categories: transverse waves and longitudinal waves. *Transverse waves* vibrate perpendicular to the direction that the wave travels. Ocean waves are a great example of a transverse wave. "The wave" at a sporting event is also a transverse wave.

Longitudinal waves vibrate in the same direction that the wave travels. Picture standing at one end of a spring toy, with a friend holding the other end. If you pull your end and let go, you will create a compression in the spring that travels down its length. Sound waves are an example of longitudinal waves.

Amplitude is the height of the wave.



Amplitude is a measure of the wave's height. It also tells us how much energy a wave has. Waves with more energy have higher amplitudes.

The amplitude of a sound wave determines the sound's loudness. When you turn the volume up on the TV, you are increasing the amplitude of the sound waves.

Wavelength is the distance between wave peaks.

Wavelength measures the distance between wave peaks. The closer the peaks of the wave are to each other, the more energy the waves have. The opposite is also true: when the wavelength is longer, the waves have less energy.

Sound waves travel through the air.

Sound waves are caused by vibrations. Since air is made of particles (matter), it transports sound very well. When a speaker vibrates it creates longitudinal waves that travel in ALL directions.

You can easily see how speakers create vibrations by sprinkling something small and light, like salt, onto a speaker. The salt particles will bounce due to the vibrations. Since sound waves travel in all directions you can hear sound even when you are not directly in front of the source.

Most of the sounds we hear travel through the air, but sound can also travel through solids and liquids too. Some solids, like metal and glass, are good at transmitting sounds. Other solids, including heavy fabrics and foam, muffle sounds. Sound can also move through liquids. Some animals, such as dolphins and whales, communicate underwater by using sound waves. We call that "echolocation."

In order for sound to travel, it must move through some type of matter. In outer space, there are no air particles through which sound can travel. In other words, if there is an explosion in space, it will be silent. You can test this by placing a phone in a vacuum. When music is turned on, no sound will be heard.

EXAMPLES OF THE DIFFERENT TYPES OF WAVES

Dolphins make sounds that travel as underwater waves. These sounds help dolphins navigate, communicate with each other, and find food. We call it echolocation.

Earthquakes travel as waves too. Earthquakes can transmit so much energy that they topple buildings and destroy property. By understanding how these waves travel we can warn people when there is an earthquake in their part of the world.

Amplifiers make music louder. Rock stars use electronics to increase the amplitude of their sound waves. That means they use electricity to make the speakers vibrate with more energy, which increases the amplitude. Rock on!

WAVE PROPERTIES VOCABULARY

Amplitude	The height of a wave. Usually measured from the wave's resting point to the peak of the wave.
Wavelength	The distance between wave peaks. Usually measured from the peak of one wave to the peak of the wave next to it.
Energy	It makes things happen! (Or more formally: the ability to do work)
Wave Peak	The highest point on a wave. Also called the crest.
Sound Waves	Vibrations of air particles that transmit sound. Sound waves are a type of longitudinal wave.
Transverse Wave	When the disturbance moves perpendicular to the direction of the wave. Put simply: When a wave moves up and down.

WAVE PROPERTIES DISCUSSION QUESTIONS

Do waves transfer matter?

Waves transfer energy, not matter.

When Zoe and Izzy demonstrated waves using the slinky, which type of wave did they observe?

Zoe and Izzy use the spring to demonstrate both transverse and longitudinal waves. Water waves are transverse waves and sound waves are longitudinal waves.

Why does the salt vibrate on the speaker when the music is turned on?

When the music is turned on sound waves cause the salt to vibrate just like sound waves cause air particles to vibrate.

Why can't sound be heard when the phone playing music is placed inside the vacuum jar? Explain what you think is happening.

When the phone playing music is placed inside the vacuum jar and the vacuum is turned on, all of the air is removed from the jar. Since there are no air particles for the sound waves to travel through, the sound cannot be heard even though the music is still playing.

What kinds of patterns can be observed for transverse waves?

Transverse waves are a repeating pattern of peaks and troughs. This pattern remains the same although changes to the energy cause the peaks and troughs to get closer together or further apart (wavelength) or the peaks and troughs to be higher or lower (amplitude).

What kinds of patterns can be observed for longitudinal waves?

Longitudinal waves are a repeating pattern of compression and expansion. This pattern remains the same although changes to the energy causes the compressed areas to become closer together or further apart (wavelength).

READING MATERIAL

Read About Light Reflection

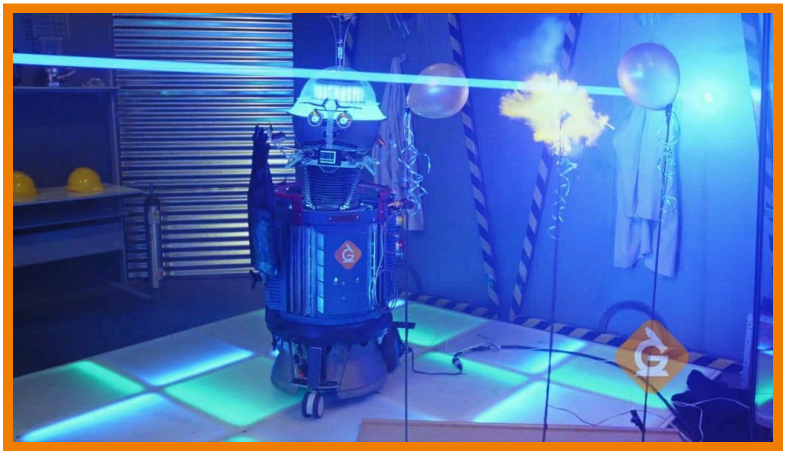
DEFINITION OF LIGHT

We can see because of light. Most light comes from the sun, light bulbs, and lasers. *Light* is a form of energy that moves in straight lines. It also reflects off things, and that reflected light enters our eyes, allowing us to see.

To better understand how light works....

LET'S BREAK IT DOWN!

There are many sources of light.



Sources of light can be divided into two groups: natural and made by humans. The sun is the most important natural source of light. The sun allows us to see during the day. Stars and lava from volcanoes also produce their own light. Some animals can produce their own light, such as fireflies and some glowing jellyfish.

Humans have created other sources of light. Light bulbs help us see in dark areas. Before light bulbs were invented, people used candles to provide light.

Laser beams are another source of light. Some high-powered laser beams can cause chemicals to explode!

Light travels in straight lines and reflects off things.

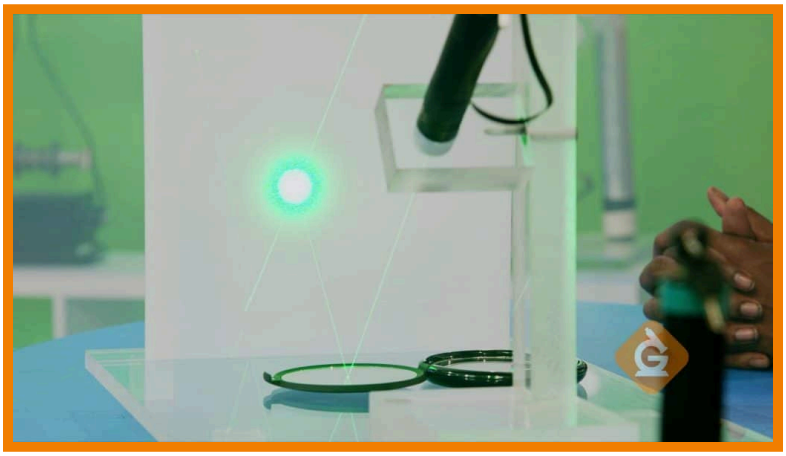
Light travels in a straight line from its source. It will keep moving in a straight line until it hits something.

If you have ever worn a hat on a sunny day, you have tested this idea. The brim of the hat blocks the sun from hitting our eyes.

Light reflects off objects and allows us to see. Some objects reflect light very well, like mirrors and white papers. Other objects, like brown construction paper, do not reflect as much light.

Water is also good at reflecting light off its surface. If you have ever been near a pool on a sunny day, your eyes may have hurt from too much light reflected from the water. Hats help block sunlight, but not the light that is reflected off the surface of water.

Light reflects off things and enters our eyes.



We see objects because they either give off their own light, or light reflects off the objects and enters our eyes.

The moon is an interesting example. It doesn't make its own light - we can see the moon because it reflects light from the sun.

If an object did not reflect any light, we would not be able to see it.

Our eyes do not produce light, they detect it.

Our eyes are amazing and allow us to detect light, focus on images, and see what is around us. The lens of the eye helps make images easier to see by focusing light. There are many other parts of the eye that work together to help you see. Some parts allow you to see color, and other parts detect the shapes of objects.

After the eye collects information about what you are seeing, it quickly sends the information to the brain. Believe it or not, the images that our eyes send to the brain are upside-down! Our brain flips it. The brain also tries to make sense of what we are seeing.

LIGHT REFLECTION AND VISION EXAMPLES

Convex mirrors allow us to see a wider view. This can help drivers see oncoming cars and drive more safely.

CDs, DVDs, and Blu-ray Discs use the science of reflection. Inside a blu-ray player is a laser which reflects light off the disk. This allows the blu-ray player to read the information on the disk.

Fiber optic cables transmit signals very quickly. They are frequently used to transmit information over the internet.

LIGHT REFLECTION AND VISION VOCABULARY

Light	Light comes from things like the sun, light bulbs and candles. It bounces off of things and allows us to see.
Light Reflection	When light bounces off the surface of an object.
Light Source	The place from which light originates.
Reflecting Surface	Surface from which the light bounces off.
Camera Obscura	A darkened box used to project an image of an external object onto a screen inside. It works in the same way as our eyes.
Lens	A curved piece of glass or plastic that concentrates light rays. They are used in magnifying glasses and telescopes.

LIGHT REFLECTION AND VISION DISCUSSION QUESTIONS

What is a laser?

A laser is a very narrow and concentrated beam of light.

Why does fog help us see laser beams?

Fog is made up of tiny particles that the laser light reflects off of. That reflected light is detected by our eyes.

What does the camera obscura model?

The camera obscura models a human eye.

Why is the image the camera obscura produces upside down?

This happens because light always travels in a straight line. BERT appears upside down because if you trace the path of light of his feet through the camera obscura, the feet end up on top. If you trace the straight path of light reflected off his head, it ends up at the bottom of the camera obscura. The same thing happens in our eyes!

If the image produced by the camera obscura is not in focus, what can be done to focus it?

Another lens can help focus the image, just like glasses that help people read.

Are other materials, besides a mirror, reflective? How do you know?

Yes, any object you can see must reflect light. If it did not reflect light you wouldn't be able to see it.