Robotics (period 5) Blizzard Bags

Day 1: Read the article titled "How to Make a Better Robot".

Answer the 10 questions that follow on a sheet of paper.

Day 2: Read the article titled "Short Circuits".

Answer the 11 question that follow on a sheet of paper.

Day 3: Read the article titled "Everyday Energy".

Answer the 10 question that follow on a sheet of paper.

How to Make a Better Robot

Many people think that robots are an inevitable part of the future. It would be pretty cool to have a droid friend around to save the day, or even just to keep you company when you got bored. While it may seem like something out of science fiction, researchers are already imagining a world in which robots become a more integrated part of our lives. We already have robots among us: some are designed to work in factories, creating uniform products continuously. You may even have one in your home, in the form of a little vacuum cleaner that self-drives itself around the floor.

But for robots to make it to the next level, scientists think they'll need to be a bit more versatile. The robots scientists are imagining look nothing like the stiff creatures you might be thinking of. No need for an awkward robot with stiff legs that attempts to walk and act like we walk and act—researchers are hoping to cook up something entirely different from what we're used to seeing.

How to Design a Robot

A group of researchers at Cornell University thinks the future of robots will actually be full of softbots. A softbot is simply a robot made out of soft tissue, so it can move more flexibly than a hard-bodied robot. And with the rise of 3D printers, building softbots is easier now than ever before. The question that remains is: what will these robots look like? How will they move? How will they carry things, or navigate small quarters?

These are precisely the questions these scientists are trying to answer. It's easy enough to build a robot that mimics a human. We already know what we look like and how we move. But how do we know this is the best way for robots to move? To put it simply, we don't.

The researchers are trying to figure out all the different ways robots could move. They're basically in the middle of a very long brainstorming session. Once they realize what the options are, they can figure out which motions are best suited to which actions, and create a final model that will perform the best in all scenarios.

In order to do this, they've built a computer program that simulates the growth and movement of several kinds of softbots. They can use animated tissue, muscle, and bone to build a large number of different kinds of softbots. Then the computer program runs the robots through tests, checking out things like balance, coordination, or noisiness. In one example, they're looking for speed, so the fastest robots get to stick around, while the slowest robots get cut.

The Possibilities

We're going to take a look at all of the different options for how a robot can move from one point to another—this is the speed test. Scientists run a computer program several times, and each time, the robots are a little bit different. Sometimes, they focus on giving the robots legs—either two legs like humans have, or four, like many animals have. And sometimes they see if they can make a mover without legs.

The fastest robot they created has legs and runs in a bounding motion—the front legs move together and the back legs bound forward, similar to how a cheetah moves. Another robot was made to have long legs that were mostly made of bone. These legs became long and skinny, so it wasn't surprising when the robot started to gallop like a horse.

Other times, they try to make robots that can move in non-traditional ways. In one instance, they created a funny sort of robot that doesn't have very much structure, just a big blob of muscle. This robot moves by inching its body forward, pulling its body in tight, and then releasing it to go long, much like an inch worm. It's not a very fast robot, but it does have an advantage, the researchers realized. If they picked this robot up and dropped it randomly somewhere else, the robot would just keep on moving as if nothing had happened. The researchers realized this trade-off—the bot may not be very fast, but it certainly is durable.

They even make some robots that seem almost silly from the outset. For example, some of their creations are designed to have no legs at all, but they still had to figure out a way to move them forward. One of the designs that resulted from this is a big robot that, instead of legs, has two large wings, and it flaps them back and forth to move. The design is almost like a gorilla relying primarily on its arms to move, but it's a bit bulkier. Another robot that came out of this is a little guy who looks like an open jack-in-the-box. The bottom of the body is box-shaped, but at the top, out pops two little arms. This robot moves by flailing its arms back and forth, which make the little guy slowly progress forward. It may seem silly, but an advantage this robot has is that it could easily hold things in its hands, or its empty lower-box while still moving forward.

Putting Ideas into Action

Now that the researchers have a number of ideas in mind, they can start performing other tests to see which robots perform better at tasks besides moving themselves along. Maybe they'll have to measure how much energy the robot requires to function for a long period of time, or how much space it takes up. All three of these aspects will play into the future success of the robot, so it's important to consider them all separately. Even if something ends up looking silly in a trial, the underlying reason behind its success may still warrant a characteristic to be considered for the final design.

For example, perhaps one of the softbot's tasks will be to take out the garbage (wouldn't that be nice?). For that, you'd want a robot that could carry things and one not likely to fall. You'd also want a robot that was pretty quick, but you'd have to balance your desire for speed with steadiness. If the bot drops its load half the time, on average, it won't be so fast. Therefore, you have to incorporate a number of skills.

When making the robot, the researchers will have to look through all of the ideas they've created in their computer program, and pick and choose which characteristics will work best together to create a robot that can easily take out the garbage. They'll have to balance their desire for speed with a steady hand, and the ability to carry heavy loads with a desire to make the robot light enough for a human to move around if the robot's turned off.

A good way to think about it may be through imagining yourself picking out your favorite clothes to wear. One day you may be torn between wearing the T-shirt that's extra soft, so it's really comfortable to wear, and another shirt that's your favorite color. Having to pick between these options will probably convince you to eventually find a new shirt that is both the fabric that you like and the color that you like. Now this new shirt will probably be your favorite, since it has all of the positive qualities you love.

The Final Product

Going back to designing our robot that will help take out the trash, it might be nice for the robot to be fast, but is that really the most important thing? It might be better to have a slower robot take out the trash. That way, there's less of a chance the robot will fall and drop the trash (making it necessary for you to clean it up). In that case, let's go back to the robot that moves sort of like an inchworm. That robot had a lot of body mass on the ground, so it was tough to tip over—think about tipping over a butter dish versus a candlestick.

Maybe when the robot has taken the trash out, you will want it to be fast. The best thing to do then is allow it to separate its front section into two legs, and its back section into two legs. Then it can move in that cheetah-like style, going faster. Perhaps the design of incorporating both ideas into one will result in a final product that isn't completely an inch-wormer, and isn't completely a cheetah either. The robot's body is a little too sleek to be a worm and a little too lumpy to be a cheetah. But the beauty of the final design is that the robot is more versatile, and can do everything you need it to do.

Hopefully, these types of robots will enter our lives soon. The Cornell researchers will just have to keep brainstorming different types of robot bodies, so we can always have the best selection of traits to pick from.

Name: _______________________________________ **Date:** ___________________

1. What are scientists at Cornell University trying to figure out?

A) how to build a computer program that simulates the movement of softbots
B) all the different tasks robots could perform
C) all the different materials robots could be made of
D) all the different ways robots could move

2. Why does the author describe the different robots scientists are creating with a computer program?

A) to show that scientists are unsure about what type of robot to build
B) to show how complex these computer programs can be
C) to show that the scientists' brainstorm session will take a long time
D) to show a variety of ways that robots could move

3. Scientists must consider a variety of factors when designing a robot. What evidence from the text supports this conclusion?

A) Researchers are already imagining a world in which robots become a more integrated part of our lives.
B) Scientists at Cornell University have built a computer program that allows them to simulate the movement of a robot before they develop a final design of the robot.
C) If a softbot is being designed to take out the trash, the softbot's ability to be steady must be balanced with its ability to be quick.
D) The fastest robot created by scientists runs in a bounding motion, similar to how a cheetah moves.

4. What can be concluded about the purpose many robots will have in the future?

A) Robots will be created to allow scientists to use computer programs.
B) Robots will be created to move in non-traditional ways.
C) Robots will be created to make life easier for humans.
D) Robots will be created to help scientists brainstorm.

5. What is this passage mainly about?

A) scientists who work at Cornell University
B) the process scientists are using to design robots
C) computer programs scientists are using to design robots
D) robots that can move like humans

6. Read the following sentences: "But maybe when the robot has taken the trash out, you will want it to be fast. The best thing to do then is allow it to separate its front section into two legs, and its back section into two legs. Then it can move in that cheetah-like style, going faster. Perhaps the design of **incorporating** both ideas into one will result in a final product isn't completely an inch-wormer, and isn't completely a cheetah either."
What does the word "**incorporating**" mean above?

A) crushing
B) eliminating
C) combining
D) explaining

7. Choose the answer that best completes the sentence below.
Scientists have built a computer program that simulates several kinds of softbots, ___________ they can figure out which model works best.

A) however
B) so
C) although
D) after

8. After scientists have a number of ideas about robot movement in mind, what types of tests do they then perform?

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9. According to the passage, what would be a good design for a softbot that would take out the trash?

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10. Scientists need to test different abilities of the robots. While scientists perform these tests, they measure how much energy the robots require to function for a long period of time and how much space they take up.

Why do the scientists run these tests and track these measurements to create a final model?

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Short Circuits

By Charles Piddock

How Small can transistors get?

Ladies and gentlemen, boys and girls, consider the amazing shrinking transistor! Watch it contract a million times until it becomes a tiny dot visible only under a powerful microscope!

We all know that technological progress is not an actual magic show. Still, it almost seems like magic the way the *transistor*, the main component in all modern electronics, has diminished in size since being invented in 1947.

The first transistor, made of gold, plastic, and *germanium* (a metallic crystal), was about the size of an adult's fingernail. Today's transistors, etched on silicon wafers, can't be seen with the naked eye. The minimum size of a transistor is now 45 *nanometers*. A nanometer is one-billionth of a meter—roughly the width of three or four atoms.

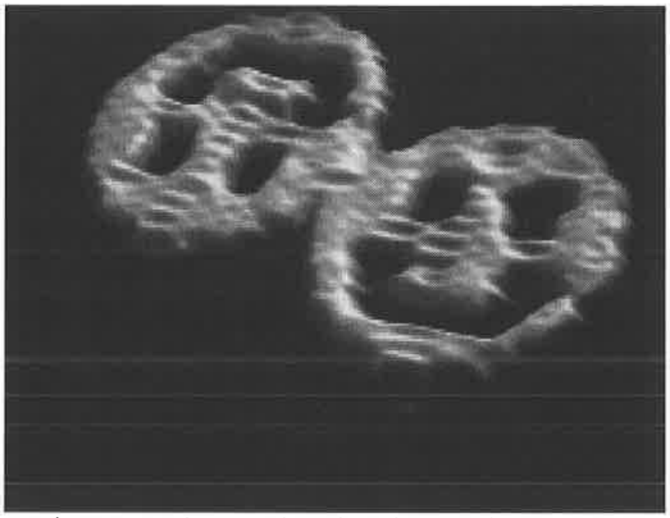
Computer engineers are trying to make transistors even smaller. How tiny can they go?

Chip Switches

Every transistor has the same basic properties: It can both conduct and stop the flow of electricity. The word *transistor* is a combination of two words: *transfer* and *resistor*.

All transistors are made from materials called *semiconductors.* A semiconductor is a cross between a good conductor (such as copper) and a good insulator (such as rubber). It can be made to accept or reject the flow of electrons in a circuit. Germanium, used in the first transistors, is a semiconductor. So is silicon, widely used today.

A transistor's ability to control the flow of electricity has made possible our entire computerized world. All computers depend on the *binary system* to convert electric signals into useful information. The binary system has only two numbers: 1 and 0. When a transistor allows electricity to flow through, it registers a 1. When the transistor stops the flow of electrons, it registers a 0. Millions or billions of those 1s and 0s, flashing off and on hundreds of millions of times a second in programmed patterns, enable your computer to do everything it does—from allowing you to play *World of Warcraft* to letting you type up a school science report.

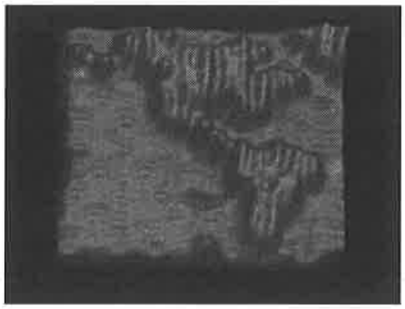


Paul W.K. Rothemund and Nick Papadakis
DNA strands twisted into smiley faces (above) and a map of North and South America (below)

Inner Limits

A transistor that is only a few atoms wide is incredibly small. But researchers want to make transistors even smaller and cheaper to produce. Chip-making technology has run into a big problem, however. Transistors smaller than 45 nanometers and etched on silicon chips don't work very well. They tend to leak electrons, making them less efficient.

To get around that problem, scientists are using *nanotechnology* to look at new materials and new methods to produce transistors. Nanotechnology is the engineering of materials on the atomic level, building new materials from the bottom up by manipulating atoms and molecules.



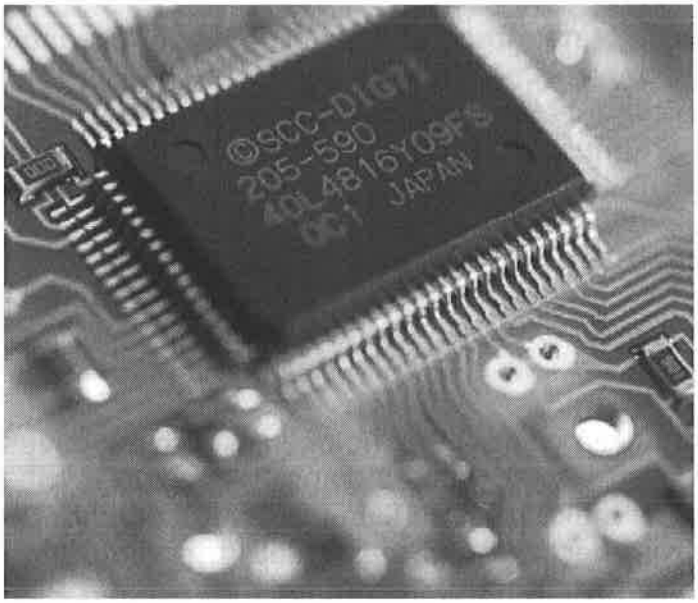
Paul W.K. Rothemund

One promising area of nanotechnology is the use of *graphene*, a carbon fabric that is only one carbon atom thick. Graphene is strong, stable, and can act as a semiconductor. If researchers can find a practical way to etch transistors onto graphene, smaller and immensely faster computer chips can be more cheaply made.

"[The ultimate goal] of electronic engineers is the so-called ballistic transistor," physicist Andre Geim, a graphene researcher at the University of Manchester, told *LiveScience.* "It would be very, very fast, ultimately fast, in fact."

Another promising area of nanotechnology research involves using strands of *deoxyribonucleic acid* (*DNA*) to build transistors. DNA is the genetic material that determines the makeup of all living cells. Researchers can now take strands of DNA from bacteria and manipulate them into almost any shape they want. California Institute of Technology researcher Paul Rothemund has helped pioneer that technique. He has twisted DNA strands into smiley faces and maps of North and South America. Rothemund coined the phrase *DNA origami*, after the Japanese art of paper folding.

Rothemund and others are looking to shape DNA strands into a kind of scaffolding that could be attached to silicon wafers to make transistors. Because DNA does not conduct electricity, scientists are experimenting with ways to combine DNA with atoms of conducting materials, such as gold, to build transistors. DNA *replicates* (copies) itself. So if researchers can produce a DNA transistor, all they have to do is add the right "soup" of chemicals, and the DNA would reproduce itself, making millions of new nano-sized transistors at little or no cost.



Science Photo Library/Photolibrary
This is a *microprocessor,* the brain of a computer. It holds data and instructions, performs calculations, and organizes operations. In most computers, the microprocessor is a chip made of a semiconducting material. Etched onto that chip are millions of transistors, which control the flow of electricity through the microprocessor. Today's microprocessors can each contain up to 1 billion transistors. Intel Corporation is now working on a microprocessor that has more than 2 billion transistors.

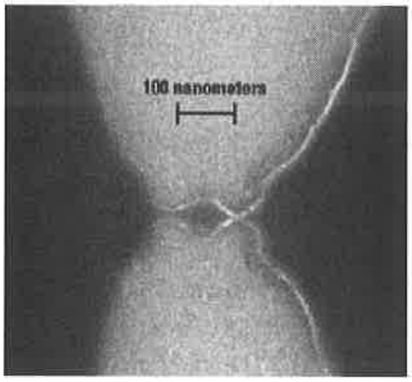
Smart Dust

Making transistors much smaller and much more cheaply could transform our lives. Tiny, smart nanomachines could do any number of things quickly and invisibly. Their greatest use might be in medicine. Swallowed in a pill or injected, tiny, computerized "nanobots" might be able to repair damaged cells one at a time, restoring health invisibly and painlessly before destroying themselves.

The nanobots might repair pipes, bridges, airplane engines, and electrical equipment too. They might even help with housework. Kris Pister, a University of California physicist, envisions what he calls smart dust—

nanobots that move around the house at night, eating dirt and generally cleaning up.

Such things are possible in your lifetime—all because scientists are now "thinking small."



Left: Mesoscopic Physics Group/University of Manchester; Right: Kris Pister

Left: A closeup of a graphene semiconductor. 1 nanometer = 1 billionth of a meter.
Right: The smallest experimental model of smart dust, shown on a penny

Name: ______________________________ Date: ____________________

1. When was the transistor invented?

A 1947
B 1945
C 2007
D 2000

2. How does the author describe the changes transistors have undergone over time?

A Transistors are used for the same things they were used for when first invented.
B Transistors haven't changed much since they were invented.
C Transistors have shrunk in size and become less useful.
D Transistors have shrunk in size but increased in usefulness.

3. How do you think the author feels about the future of transistors and nanotechnology?

A hopeful and excited
B concerned and worried
C cautious and uncertain
D to little information to determine

4. Read the following sentences and answer the question below: "Ladies and gentlemen, boys and girls, consider the amazing shrinking transistor! Watch it contract a million times until it becomes a tiny dot visible only under a powerful microscope!"

What does the word **contract** mean?

A agreement or pact
B form an agreement
C shrink
D to get or incur, as in a virus or disease

5. This passage is mostly about...

A technology
B nanotechnology
C transistors
D science

6. How are today's transistors different from the first ones that were invented?

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7. What does the author mean by the use of the word "soup"?

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8. The question below is an incomplete sentence. Choose the word that best completes the sentence.

If scientists can figure out how to etch transistors onto graphene, __________ they will be able to create much smaller and much faster computer chips.

- **A** so
- **B** however
- **C** but
- **D** then

9. Answer the following questions based on the sentence below.

Transistors have shrunk in size since they were invented in 1947 due to chip-making technology and nanotechnology.

What? transistors

(have) What? ____

(since) When? ____

Why? ____

Directions: Read the vocabulary word and definition below to complete questions 10a, 10b, and 11.

Vocabulary Word: **scaffolding** (scaf · fold · ing): material used as a temporary structure or support for something.

10a. Read the sentences below and underline all forms of the word **scaffolding**.

1. The scaffolding didn't look like it was strong enough to hold up the large building.
2. The bank was covered in scaffolding while it underwent a major reconstruction effort.
3. Despite all the scaffolding outside, the coffee shop was still open for business.
4. To prepare for the bridge building, they built some scaffolding over the river.
5. Some teachers use scaffolding techniques in their teaching to provide extra support for the learning process.

10b. Which building has scaffolding in front of it?

11. Would a single piece of wood provide enough scaffolding to hold up a small house? Why or why not?

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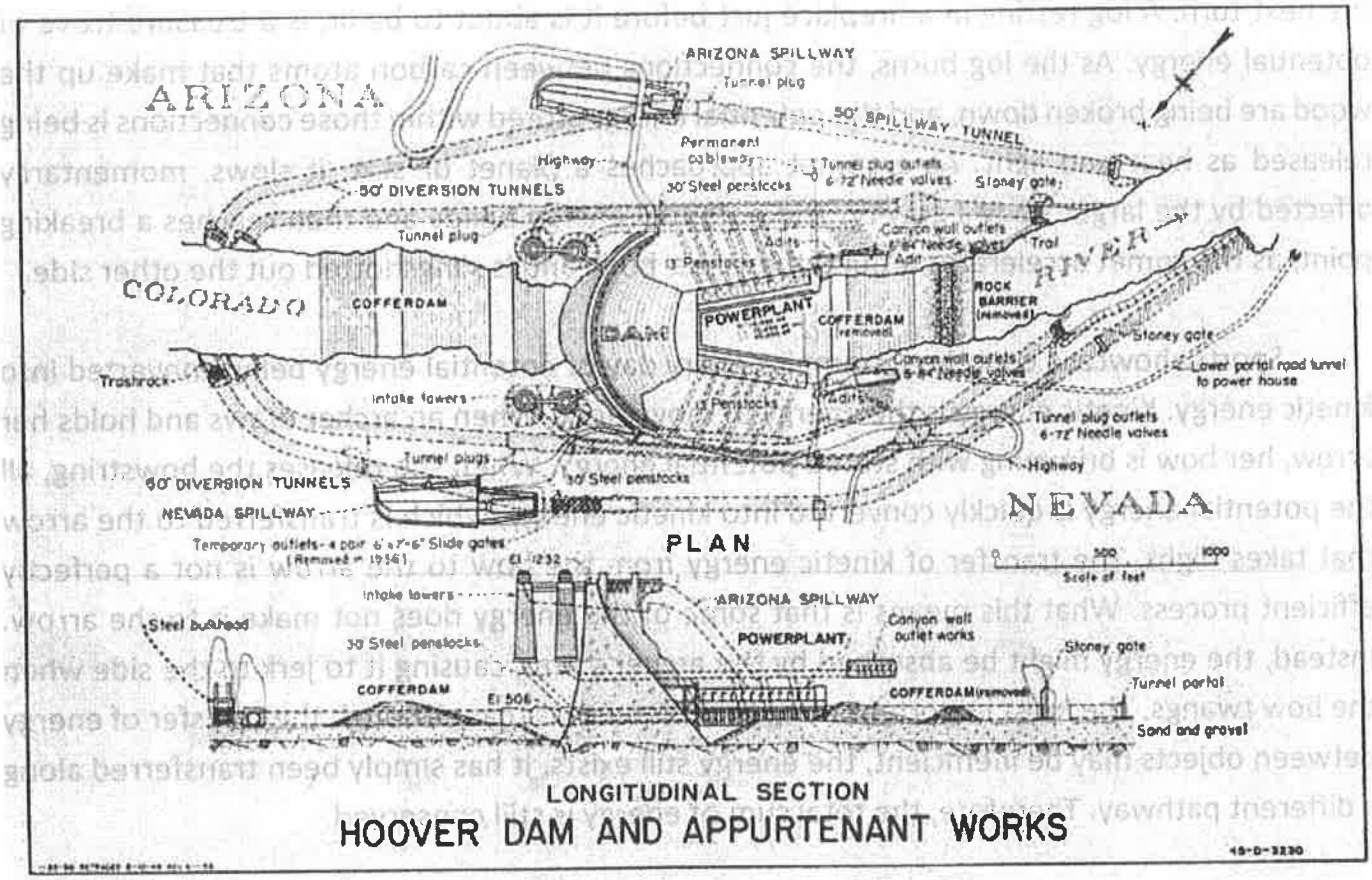
Everyday Energy

Edward I. Maxwell



The pitcher gets into her set. Her glove and pitching hand come together by her chin, and she then lowers them to her belt. She looks at the catcher and nods. She brings her front leg up and pauses, standing perfectly balanced on her back leg. Then, in an instant, she steps forward with her front leg. Her whole body lurches toward home plate and her pitching arm swings out after it like a whip. At the furthest point, when a whip would crack, she lets the ball fly toward the catcher's mitt. The batter steps forward with her front leg and rotates her torso, swinging the bat with her eyes fixed on the incoming fastball.

"STRIKE THREE! BATTER'S OUT!"

Moments like these happen all across the physical world, whether on the molecular or cosmic level. Potential energy is the energy, chemical or physical, stored within an object, atom or molecule. Think about a car at the top of a roller-coaster, pausing just before it plunges into the next turn. A log resting in a fireplace just before it is about to be lit, is a treasure trove of potential energy. As the log burns, the connections between carbon atoms that make up the wood are being broken down, and the potential energy stored within those connections is being released as heat and light. As a comet approaches a planet or star, it slows, momentarily affected by the larger body's gravity. The potential energy builds and then reaches a breaking point, as the comet accelerates around the larger body and is slingshotted out the other side.

Sports showcase countless examples every day of potential energy being converted into kinetic energy. Kinetic energy is the energy of movement. When an archer draws and holds her arrow, her bow is brimming with stored potential energy. When she releases the bowstring, all the potential energy is quickly converted into kinetic energy, which is transferred to the arrow that takes flight. The transfer of kinetic energy from the bow to the arrow is not a perfectly efficient process. What this means is that some of the energy does not make it to the arrow. Instead, the energy might be absorbed by the archer's arm, causing it to jerk to the side when the bow twangs. The most important thing to remember is that although the transfer of energy between objects may be inefficient, the energy still exists. It has simply been transferred along a different pathway. Therefore, the total sum of energy is still conserved.

The conversion of stored potential energy into kinetic energy can also be harnessed to power homes, factories and entire cities. The most notable example is the Hoover Dam. The Hoover Dam is an arch-gravity dam by design. This design name is the first clue as to how exactly the dam harnesses energy. Located in the Black Canyon of the Colorado River, the Hoover Dam formed, and now holds back, Lake Mead—the largest reservoir in the United States. The dam was built toward the beginning of the Great Depression. Constructed between 1931 and 1936, the dam had been the subject of planning and design sessions since 1900. Deliberations included discussions of potential catastrophes, should the dam fail or the lake grow beyond expectations.

Gravity acts as a force upon Lake Mead. Held at bay by the Hoover Dam, the waters of Lake Mead and the Colorado River gain greater potential energy with each passing moment. The

Arizona and Nevada spillways are two means by which the waters of Lake Mead can escape the dam. As the lake water tumbles over the walls into a spillway, potential energy is instantly converted into kinetic energy. The channels through which the water normally escapes every day are the four intake towers. These towers funnel the water through sluices, or passageways, to the powerhouse and hydroelectric generators. When the water reaches the intake towers and is allowed to flow down through the sluices, all the stored potential energy created by the force of gravity acting upon the water is converted into kinetic energy, just as when water flows over the wall into a spillway.

By harnessing the converted potential energy of Lake Mead, the Hoover Dam provides power to California, Nevada and Arizona. Well over a dozen turbines are housed within the power plant at the base of the dam. Electricity production varies annually depending on how much water is required downriver from the dam and the water levels of Lake Mead. The greatest amount of energy was produced during 1984; a year after floods brought the lake to its highest levels. As of 2009 the American Southwest has entered a prolonged period of seasonal droughts. As a result, compared to its peak periods of energy production, the Hoover Dam has been recently generating much less energy.

Name: ______________________________ Date: ____________________

1. A rollercoaster car at the top of the hill, an archer preparing to release an arrow, and a lake that sits above a dam are all examples of what kind of energy?

A potential energy
B kinetic energy
C gravitational energy
D consumption of energy

2. What does the author describe in the passage?

A the history of human energy use in the United States
B the ways in which potential energy is converted to kinetic energy
C the best reasons to build new dams in the American Southwest
D the consequences of drought for people who rely on dams

3. The conversion of stored potential energy into kinetic energy can also be harnessed to power homes, factories and entire cities. Which example from the text supports this conclusion?

A the softball pitcher
B the slingshotting comet
C the archer
D the Hoover Dam

4. Which of the following conclusions is supported by the text?

A Nuclear power is the most efficient kind of energy for powering cities.
B Professional athletes should study the science of energy to play better.
C Dams power cities by converting stored potential energy into kinetic energy.
D Drought is a serious problem for farmers in the American Southwest.

5. What is this passage mainly about?

A The movement of comets through our solar system.
B The scientific forces behind our favorite roller-coasters.
C The unusual properties of water molecules in rivers.
D The conversion of potential energy into kinetic energy.

6. Read the following sentences: "The Arizona and Nevada spillways are two means by which the waters of Lake Mead can escape the dam. As the lake water tumbles over the walls into a **spillway**, potential energy is instantly converted into kinetic energy."

As used in the passage, what does the word "**spillway**" mean?

A A place where water flows over the top of a dam, creating energy.
B A place where water accidentally spills, causing problems for engineers.
C A place where water flows underground, into tunnels.
D A place where water flows into nearby farms, watering crops.

7. Choose the answer that best completes the sentence below.

"The conversion of stored potential energy into kinetic energy can be harnessed to power homes, factories and entire cities. __________, the Hoover Dam provides power to California, Nevada and Arizona.

A Even though
B Initially
C For instance
D However

8. How does the Hoover Dam provide power to California, Nevada and Arizona?

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9. What two factors determine the energy production of the Hoover Dam?

10. Explain why the prolonged period of drought (a time where there is little rain, and little water flowing into rivers and lakes) would cause the Hoover Dam to generate much less energy since 2009. Use evidence from the text to support your answer.