Energy Show Outline

Idea	**Who**	**Slide(s)**	**Demos**
Intro	All	1: Terms	
Kinetic	K (P)	2-5: Kinetic	Tennis/Medicine balls
Potential	P (E)	6 (7): Potential	Medicine ball/ladder
Cons. of Energy	T (K,P)	8: bar graphs	Nose basher
Cons. of Energy	E (P)	9	Stopped pendulum
Cons. of Energy	P	10	Loop the loop
Dissipation	K	--	Pendulum, hands
Microscopic KE	K	Overhead proj.	Temperature simulator
Microscopic PE	All	11	Mousetraps
Energy conversion	E (P,K)		Bike generator
Energy conversion	T (P,K)		Jumping ring
Hands-on	All		Bike, loops, mini-generator

Energy Script (4 presenter version)

Four presenters: "K" for Kinetic Energy (dressed in Blue).
"P" for Potential Energy (dressed in Red).
"T" for Total Energy (dressed in Green).
"E" for Emcee

=> Equipment Required from School Custodian
Overhead Projector
Projection Screen
Ladder
(3) Small Tables at back & sides of room for mini generators.

Slide #1: The terms Kinetic, Potential, and Total Energy are displayed in their respective colors on the overhead.

Note: Briefly explain what you are studying in terms the students can understand and, if you wish, why you are studying. For example, you might say, "I am studying biology—the science of life—because I hope to be a doctor someday."

K: Welcome to our physics assembly about energy. My name is _____ and I'm studying _______ at UC Irvine. I'm dressed in blue and will be teaching you about the energy of motion, kinetic energy.

P: My name is ______ and I'm studying ________ at UC Irvine. I'm dressed in red and will be teaching you about stored-up energy, potential energy.

T: My name is _______ and I'm studying ______ at UC Irvine. I'm dressed in green and will be teaching you about how energy changes from one form to another but is never lost.

E: My name is ________ and I'm studying _______ at UC Irvine. I'll explain how the different energy ideas fit together.

=> Equipment : (2) Tennis balls and medicine ball

K: All moving things have ki-ne-tic energy. (*Elementary* In a loud voice , help me say the say the words" ki-ne-tic energy.") (*K uses the laser pointer to underscore these words on the overhead display as he pronounces them).*
As you look around, notice at all the moving things you see. ***K** tosses a tennis ball up and down;* ***P** is tossing the medicine ball;* ***T** advances the slides throughout this introduction to kinetic energy*.. Let's look at the medicine ball as it moves. How much kinetic energy this ball has depends on two things: how much mass it has and how fast it moves.

Slide #2: Comparison of stationary and moving tennis ball.

E: Let me see if you understand about kinetic energy. Which ball has more kinetic energy? *(Elementary* Raise your hand if you think it is the upper ball. Raise your hand if you think it is the lower ball.*)*

K: Right, it's the lower ball. In fact, the upper ball does not have any kinetic energy because it is not moving.

Slide #3: Tennis balls with different speeds

E: Which ball has more kinetic energy now? Everyone have their answer?

K: It's still the lower one. The lower one has more kinetic energy because it is moving faster.

(Middle school only Slide #4: Kinetic energy math problem

E: I have a math problem about kinetic energy. To be good at science, it is very important to be good at math. The mathematical formula for kinetic energy is K=1/2 m v^2, where K stands for kinetic energy, m stands for mass and v^2 stands for the speed squared. These two balls have the same mass. If the lower one is going twice is fast, how much more kinetic energy does it have? How many think it's twice as much? How many think it's four times as much? Actually, it is four times as much because 2 squared equals four. *End of middle school problem)*

Slide #5 Comparison of light and heavy ball moving at same speed

E: Which of these two balls has more kinetic energy? *(Elementary* Think of your answer in your head.*)*

K: It's the lower one again. This time the lower one has more energy because it has more mass.

=> Equipment : Tennis ball, medicine ball, and ladder.

Slide # 6: Potential energy intro.

P: Every moving thing gets its kinetic energy from stored up energy called po-ten-tial energy. The stored-up energy comes from the forces that two things put on each other. The earth's gravity is one kind of force that stores up energy around us.

P *moves the medicine ball with him up the ladder and lifts the ball as high as is safe.*

P: With gravity, the further I lift this medicine ball above the ground the more potential energy it has. The earth puts a force on the ball that wants to pull the ball back to the ground. Right now, before I let go, the ball isn't moving, so it doesn't have any kinetic energy. But it does have lots of stored-up potential energy that can become kinetic energy.

P *drops the medicine ball and it crashes to the ground.*

P: Did you see the potential energy change into kinetic energy?

E *prepares to offer her head as an energy detector and* **P** *climbs the ladder positioned behind* **E.**

P: Let's do an experiment with the tennis ball and medicine ball. If I drop each of these two balls from just 3 inches above K's head, which ball do you think has more potential energy, the light tennis ball or the heavier medicine ball?

P *drops first the tennis ball on E's head and then the medicine ball. E hams it up when the medicine ball hits her head.*

P: Now, the two balls were dropped from the same height, but did you see that the heavier medicine ball had more potential energy than the tennis ball to knock K out?

So, the stored-up, potential energy, depends on; how heavy a thing is and how far it is from the thing that is putting a force on it.

P: *(Elementary* Please help me say this new word: " po-ten-tial " energy.) (*P uses the laser pointer to underscore these words on the overhead display as she pronounces them).*

E: *(Middle* Slide #7 Potential energy formula The potential energy is the product of the weight times the height. If the light ball weighs 1 and we lift it up 2 meters, how much potential energy does it have? 1 x 2 =2, right? So how much potential energy does the heavy ball have if it weighs 10?*)*

=> Equipment : Nose basher & Slide #8

T: (*elementary version)* I'm going to teach you about total energy. How many of you know how to add? Good, you all do. If you add up the kinetic energy and the potential energy, you get the total energy. Now, one of the important laws of nature is that the total energy never changes—it always stays the same. Energy can change from one form to another but the total amount stays the same. We call this idea Con-ser-va-tion of Energy. Please help me say these words: Con-ser-va-tion of Energy. I will use this bowling ball to show you how this works.

T: *(middle school version)*. I'm going to teach you about total energy. If you take what we call a system and add up all the energy in it, the total amount of energy stays the same. The energy may appear in many different forms—different types of potential or kinetic energy—and, in fact, the energy may change from one form to another—but, if the system is isolated, the total energy always remains the same. This important law of nature is called Conservation of Energy. In ordinary language, when we say we "conserve" something, we mean that we save it, like conserving water, for instance. Conservation of Energy means that the total energy is always saved, no matter what we do. I'm going to use this bowling ball to demonstrate this idea.

T *begins to pull the bowling ball close to his nose.*

T: I'm going to pull the bowling ball right up to my nose. If I let it go, without pushing it, and stay perfectly still, what will happen?

After waiting for a few responses and letting the drama build, T releases the ball.

T: The reason the ball didn't bash my nose is because of Conservation of Energy.

E: *Point to slide #8 and refer to its bar graphs of potential, kinetic, and total energy while discussing the following.* The ball only had a certain amount of energy to start with—and, since it wasn't moving, it was all potential energy at the start. To go higher than the starting point, it would have needed more potential energy than it had to begin with. But, since the total amount of energy always stays the same, that was impossible. When the ball is released, it gains kinetic energy. It has the most kinetic energy when it reaches the bottom. Then, when it climbs back up the other side, it gains potential energy. But, wherever the ball is, it has the same amount of total energy.

T *positions the ball at his nose but does not release the ball.*

P: What kind of energy does the ball have right now ? *P waits for and acknowledges a correct response.*

K *positions herself right at the bottom of the swing , safely behind the ball's trajectory, and points to the low point of the swing just above the ground.*
And when the ball is at the bottom of its swing, just barely above the floor where I am pointing, what kind of energy does the ball have ? *K waits for and acknowledges a correct response.* That is correct, and between the high and low points the ball has both potential and kinetic energy. So the energy flows smoothly back and forth between all potential and all kinetic, but the total of those two amounts should always be the same.

T *releases ball;* ***K*** *and* ***P*** *yell out the following when the ball reaches the appropriate points.*

K: *(Times it so K is maximum)* Kinetic

P: *(Times it so P is maximum)* Potential

K: *(Times it so K is maximum)* Kinetic

P: *(Times it so P is maximum)* Potential

T: but the total energy always remains the same because energy is conserved.

Slide #8 Conservation of Energy math problem. P+K at top=P+K at bottom. If potential energy at the top is P=10, how big is the kinetic energy at the bottom? *E advances animations*.

T: *(Elementary* We use math a lot in science and, if you want to get a job as a scientist, you need to learn a lot of math. Here's a math problem for the experiment we just did In math, we often use a letter to stand for something.*)* In this problem, we'll call potential energy P and kinetic energy K. The total energy is P+K. Now, because of conservation of energy, we know that the total energy always stays the same. If the potential energy when I held the ball in front of my nose was 100, what is the kinetic energy when the ball is at the bottom of the swing? Well, we know K=0 at the top.

K: I'm not moving.

T: We also know P=0 at the bottom.

P: That's as low as I can get.

T: So we have P+K=100+0=0+K, which means: K=100.

=> Equipment: K and P insert stop bar in pendulum apparatus.

E: Now I am going to do a different experiment with the bowling ball. We will put a bar here in the middle of the swing. I will pull the bowling ball over here to my waist and let it go. The ball will swing down, then the cord will hit the bar and it will swing up. *Demonstrate in slow motion*. The question is: how high will it go? In science, we call an idea or guess about how something will turn out a hy-po-the-sis. Show me your hypothesis by raising your hands. How many of you think the ball will end up *lower* than my waist? How many think it will end up *higher* than my waist? How many think it will end up at the same height? Let's try it and see.

Release ball. This is easiest if P measures waist height relative to his own body, then stands over on the other side of the pendulum.

Slide # 9 : Total=P+K=P_initial=P+K=P_final

E: It comes out about the same height! Conservation of energy helps us understand this. When the ball was at my waist, did it have potential energy or kinetic energy?

P: Potential, you lifted it up.

K: It's not moving.

E: Now, when it swung over to the other side and was at the top of its swing, what kind of energy did it have?

P: That's potential again.

K: Right when it switches directions at the top of its swing, it's not moving, so the kinetic energy is zero.

T: We know that the total energy stays the same. So the potential energy on the two sides of the swing must be equal. This means that they must be equal on both sides.

=> Equipment*: Loop the loop & Slide #10*

P: This experiment is kind of like a roller coaster ride. I'm going to take this ball and let it go. Now pretend this is a roller coaster and you are riding on the ball. How high does the roller coaster need to start to make it all the way around this loop? Show me your hypothesis by raising your hand. Should it start below the loop? At the same height as the loop? Higher than the loop? Let's try it and see.

Launch it at the same height as the top of the loop.

P: Argh! Our roller coaster crashed. We're all dead!

T: That was a good guess though. The students who chose the same height were thinking about conservation of energy. They realized that, to get up to the same height, you need the same amount of potential energy.

K: What they forgot is that, once the roller coaster gets to that height, there is no energy left for the roller coaster to move. They forgot that I need some kinetic energy to get the roller coaster the rest of the way around the loop.

P performs it again from the same height, pointing out how it falls off just as it reaches the top of the loop.

P: Now let's do it again from a little bit higher. This way some of the extra potential energy is available to keep the roller coaster moving. *Performs it. Scream or ham it up.*

=> Equipment: *Point back at bowling ball/pendulum.*

E: T told us that the total energy should be the same as the bowling ball swings back and forth, but look at the bowling ball now. It has very little (still swinging) or no energy (no motion).

K: Where did all that energy go? (K accepts a few audience answers), One place the energy goes is an invisible form of energy called heat. As the ball swings it rubs against the metal hook where it hangs from. The friction in this rubbing causes the hook to warm up.

K : Let's rub our hands together quickly like this. Do you feel that the kinetic energy of your hands cause them to get hot as they rub? This is exactly what is happening to the metal hooks rubbing each other where the bowling ball is hanging from.
*=> **T** removes and hides bowling ball.*

=> Equipment : Brownian motion simulator, overhead projector, and screen.

K: Heat is a form of kinetic energy of the invisible atoms that are all around us. [Note: technically speaking, heat is energy that is transferred from one body to another. This invisible kinetic energy is more properly associated with temperature.] If we were able to use a very powerful microscope to see inside of something, say the air we breathe, we would see a crazy motion of the tiny atoms that looks like this:

The air table is turned on and simulated Brownian motion is displayed.

K: As the atoms rub against and hit each other, they heat each other up, just as you felt with your rubbing hands.

*=> Equipment: Chain reaction mousetraps & slide #11 **(already prepared and carefully protected from being triggered before the show)**.*

T: One way it can seem like energy is not conserved is if some of the energy disappears into invisible heat. When this happens, it seems like energy is being lost, even though it's not really disappearing. But, sometimes, it seems like energy appears out of nowhere—like when a bomb blows up. But energy is still conserved even then. What happens then is invisible potential energy changes into kinetic energy we can see.

P : *P pulls back the spring on a sample mousetrap*. This mousetrap has a strong spring. I have to pull hard to pull it over to here. When I let go *(P releases spring)*, it snaps shut with lots of kinetic energy. When I pull it back here *(demonstrates),* before the spring of the trap snaps shut, what kind of energy does the spring have? Potential energy is correct. In this demonstration, I have many mousetraps, with their springs loaded, and super balls sitting on each trap. This is kind of like what happens in a bomb. Each of the invisible nuclei or atoms or molecules in the bomb have potential energy stored up inside of them. In this model of a bomb, all the traps and balls have been lined up inside this plastic box. So we have stored up a lot of potential energy inside the mousetrap springs.

K: Now we need a volunteer. *Bring up pre-selected student volunteer*. He/she is going to drop a single ball with just a little bit of kinetic into the box. This is like the trigger for a bomb.

Volunteer drops the ball and triggers a chain reaction of flying balls within the box.

E : What happened ? We triggered a big chain reaction that made lots of kinetic energy with just a little bit of energy from a single ball. One mousetrap going off caused another to go, and another, and another… Since all of this happened very fast, it seemed like one big explosion, but it was really a chain reaction of many small ones.

P: All my stored-up potential energy was rapidly converted into kinetic energy.

T: When a reaction like this happens, it can seem like total energy is not conserved. But really energy is just changing fast from one form to another. Energy is always conserved.

=> Equipment: Bike generator and light bulb bank.

E: Now we are going to show you some examples that involve lots of different forms of energy. I need a volunteer to ride my bicycle.

A volunteer teacher is assisted onto the bike generator.

P: _______, did you eat breakfast today? The chemical energy in your food is a form of potential energy.

K: Please start pedaling the bike. Your moving legs are a form of kinetic energy.

E: Pedal harder. We want to light up these light bulbs.
The volunteer is challenged to pedal harder and harder as additional lights are switched on until the entire bank is lit. The kinetic energy turns this generator, which converts the energy into electrical energy,

P: which is another type of potential energy,

T: then the electrical energy drives current through the light bulbs, which produces light energy.

K: It also heats them up, which is invisible kinetic energy.

E: *Asks Mr./Ms/ Mrs .if it required lots of work to light the bulbs.*

=> Equipment: Jumping Ring w/ liquid Nitrogen.

T : Here's another experiment that shows energy changing from one form to another. In this case, we start with electrical energy,

P: which is a form of potential energy,

T: then the electrical energy is converted into magnetic energy,

P: which is another form of potential energy,

T: then the magnetic energy shoots this ring up,

K: which is kinetic energy because the ring is moving fast,

T: then the ring goes up high in the air,

P: where it has lots of potential energy.

K: Also, some of the energy heats up the wires and the aluminum ring, which is invisible kinetic energy.

T performs the Jumping Ring demo.

T: I wonder what would happen if I cool the ring down with liquid Nitrogen. This makes it so less of the energy goes into heating up the ring. By the way, you need to be careful with liquid nitrogen because, even though it is very cold, it can burn you.

T repeats the Jumping Ring demo with a cooled down ring. (Launch the ring from the floor if the ceiling is low.)

K: When the ring is colder, less of the energy goes into invisible kinetic energy,

P: so more energy is available to raise the ring up high where it has lots of potential energy.

E : Before you begin your own experiments, let's review today's main ideas. *Project slide #12. The audience is asked what kind of energy the car has at three positions: the starting point (potential), the loop's bottom (kinetic), the loop's top (potential and kinetic).*

K and P are preparing the bike generator and two loop the loops for student use.

E: Thank you for coming to our energy show. Now you get to do experiments yourself. Stay seated while I explain all of your choices. We have small generators on the table that are small versions of the bicycle experiment. *(Demonstrate with one.)* It is very easy to turn the crank if the light bulb is disconnected because you don't need any extra energy to heat up the light bulb and make light. But, when you connect the light bulb, it gets harder

to turn the crank. You connect the bulb with these little clips—we call them alligator clips. Teachers, I'd like you to supervise this activity for us.
P: We also have two loop-the-loops you can use. The lines for these will start here and here.
T: Our final choice is the bicycle generator. The line for it starts here.
Have a teacher supervise dismissal to the stations.

(2)loop the loops,
(1)bike generator,
(9)mini generators

The lines for the bike generators and loops will be long. Teachers should quickly be recruited and trained to man the mini generator stations. Try to divert those children at the end of the longer lines to use the mini generator.