Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

Grade: _____3_ Unit:_______Physics of Sound_____ Lesson: __Tension and Pitch______

Identify what data students will be using:

Observation sheets from all previous sound experiments.

Question:

Gwen wants to build a guitar that can produce the lowest pitch possible. She has three design choices to make. What should she choose??? Help her design a guitar that can produce the lowest pitch possible.

Choice 1	 Long Guitar	 Short Guitar
Choice 2	 Tighter Strings	 Looser Strings
Choice 3	 Thick Strings	 Thin Strings

Ideal Student Response:

If Gwen wants to produce the lowest pitch possible, she should make a big guitar with looser strings, and thick strings. In class, the longest xylophone bar made the lowest pitch

Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

sound, and the shortest xylophone bar made the highest pitch sound. The long string on the Foss-Ulele makes a lower pitch than the short string. The shorter something is, the faster the vibration, so the higher the frequency is. A high frequency produces a high pitch, so she should choose the big long guitar. She should also choose the looser strings. The more tension in the string of the mini-gutbucket, the higher the pitch. This is because more tension makes a faster frequency. She should choose the looser string for the lower pitch. Finally, she should choose the thicker strings. On Mr. K's guitar, the thicker string made the lower pitch, and the thinnest string made the highest pitch. Thicker strings have lower frequencies than thinner strings, and produce a lower pitch. That is why Gwen should make the long guitar, with looser strings and thicker strings.

Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

Grade: _____3___ Unit: ________Structures of Life___ Lesson: ______Crayfish Structures___

Identify what data students will be using:

Their group's crayfish, FOSS diagram of male and female crayfish

Question:

Is your group's crayfish male or female?

Ideal Student Response:

Our group is working with a male crayfish. We know our crayfish is male because it has two pieces on its bottom side called modified swimmerets. A male crayfish has modified swimmerets and a female crayfish does not. Our crayfish is also larger than most of the class female crayfish. Male crayfish are typically larger than female crayfish.

Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

Grade: _____3__ Unit: _________Water_______ Lesson: Choose your own inquiry project

Identify what data students will be using:

Data table – how much water can different materials hold (sponge, washcloth, paper towel, sham-wow)

Question:

When Mr. K was setting up the water wheels project, he accidentally spilled one of the water basins. Which classroom item should he choose to clean up – the sponge, the aluminum foil, the paper towel, or the sham-wow? Why?

Ideal Student Response:

Mr. K should choose to clean up his spill with the sham-wow. When we placed water on different surfaces, the aluminum foil did not absorb any water, so he should not try to clean up with aluminum foil. The paper towel absorbed water quickly, but when we measured, one paper towel can only hold about 25 mL of water, so he should not choose the paper towel. The sponge also absorbs water quickly, but it holds 40 mL of water while the sham-wow holds 65 mL of water. That is why Mr. K should choose to clean up with the sham-wow, because it can absorb the most water quickly.

Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

Grade: ___4___ Unit: _____Motion and Design___________ Lesson: ____Sail Vehicle_____

Identify what data students will be using:

Data tables from previous investigations

Question:

A group of fourth grade students went to a car show. These two cars were having a contest to see which would travel farther:

Car 1	Car 2
	
Weight: 4000 pounds	Weight: 12000 pounds

<u>The same force will be applied to each car</u>. Which one will travel farther?

Ideal Student Response:

Car one will travel farther than car two. One reason car one will travel farther is because it weighs less than car two. When we tested our standard vehicles with the rubber band wrapped around the back axle 8 times, the vehicle that was carrying zero blocks traveled 100 cm. The vehicle that was carrying one block traveled 70 cm, and the vehicle that was carrying two blocks traveled 40 cm. The reason that heavier vehicles travel a shorter distance is because the vehicles need a force to make it move. The heavier something is, the more force needed to make it move. Car two would need more force to make it move the same distance as car one. Since they both got the same applied force, car one would travel farther.

Another reason car one will travel farther is because the design of car two has a big rectangle on the back. When we tested our standard vehicles with the rubber band wrapped around the back axle 8 times, the vehicle with the sail traveled 35 cm, and the vehicle without the sail traveled 100 cm. The reason that the big rectangle on car two would make it travel less far is because it would create air resistance, just like our sail. The more air resistance that a vehicle has, the more friction the vehicle has with the air, and the less far it will travel. Since the same force is applied to both cars, and car two has more air resistance, car one would travel farther.

Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

Grade: _____4_ Unit: _____Animal Studies__________ Lesson: ___Fiddler crabs _______

Identify what data students will be using:

Notebook entries from previous lessons

Question:

When Nahdia and Sami got to school on Monday, they saw their dwarf African frog habitat was a little bit dirty. Sami said, "I guess we have to empty out the dirty habitat, and give our frogs clean water." Nahdia said, "That will take too long. Let's just put the frogs into our fiddler crab habitat. They both have water in them…what's the big deal?"
What should Nahdia and Sami do with their frogs? Use evidence and reasoning to support your claim. Think about all the things we've learned about animals and their habitats.

Ideal Student Response:

Nahdia and Sami should empty out the dirty habitat and give the frogs clean water. Responses should have at least three of the following lines of evidence/reasoning (or other appropriate evidence/reasoning not listed):

- We built the habitats, and dwarf African frogs live in fresh water, and fiddler crab habitats have only salt water. Dwarf African frogs are very sensitive, and their bodies would not be used to salt water. This could make them sick or die.
- Dwarf African frogs eat brine shimp. Fiddler crabs eat plankton. If the frogs were in the fiddler crab habitat, they would have nothing to eat. If they did not eat for several days, they might die.
- Male fiddler crabs have large claws. Dwarf African frogs don't have anything to defend themselves if the fiddler crab tried to hurt them. The would not be able to hide since the pool is so small, and their strong legs that help them swim would not help them get away, because there would be nowhere for them to go.
- Dwarf African frogs need water to keep their skin moist. If they were in the fiddler crab habitat, they would not want to go in the salt water. If they stayed on the sand, their skin would dry out.

Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

Grade: ______4_ Unit: _____Motion and Design_____ Lesson: _Rubber Band Energy____

Identify what data students will be using:

Data table from rubber band energy investigation

Question:

Jin and Dahmien built standard vehicles out of Kinex. They want to have a contest to see whose will move farther with rubber band energy. Jin said, "I am going to wind my back axle eight times, because in our class experiment, that's when the vehicle moved farthest." Dahmien said, " I am going to wind my back axle twelve times. I think twelve winds will move the vehicle even farther!"

Whose car will move farther? Make a good scientific claim, and use evidence and reasoning to convince your audience that you are correct. (Think about the scientific concepts and vocabulary that you have been learning.)

Ideal Student Response:

Dahmien's car will move farther. In class, our car traveled 25 centimeters when we wound up the axle 2 times. The car traveled 45 centimeters when we wound up the axle 4 times. The car traveled 100 centimeters when we wound up the axle 8 times. Each time we increased the number of winds, the car traveled farther. If we wound the axle 12 times, the vehicle would move even farther. This is because when you wind up the rubber band around the axle, you are storing potential energy in the rubber band. When you let go of the car, that potential energy is transformed to kinetic energy when the car is moving. The more potential energy that is stored by more winds of the rubber band, the more kinetic the car can get, and the more it can move. Since 12 winds would give the care more potential energy than 8 winds, Dahmien is correct.

Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

Grade: ___5___ Unit: _____MCAS practice________

Identify what data students will be using:

Data table provided

Question:

The school is planning a trip to observe rock formations. Based on the club's calendar, they can schedule the trip in either May or September. The table below shows the average weather conditions at the coast for May and September.

Average Weather Conditions

Condition	May	October
Average temperature (°F)	56	68
number of days with precipitation	9	16
number of days with sunshine	16	14
wind speed (mi. per hr)	19	11

Ideal Student Response:

There is no real "correct answer" to this prompt, as long as students use evidence from the data table, and reasoning to support that. Some possible examples for each:

The field trip should be in May...

- In May there is only nine days of precipitation. In October there are 16 days of precipitation. We would not want to go observe rocks when there is rain, and there is a better chance of that happening in May.
- In May there are 16 days of sunshine. In October there are 14 days of sunshine. It would be easier to observe the rocks on a sunny day, and there's a better chance of that happening in May.

The field trip should be in October...

- In October the average temperature is 68 degrees F. In May, the average temperature is 56 degrees F. It would be better to go observe rocks in the warm weather, and there's a better chance of that happening in October.
- In October, the average wind speed is 11mph. In May, the average wind speed is 19mph. The strong winds might blow sand in the way, or make the temperature feel colder, so it would be better to go when there was not as much wind. There is a better chance of this happening in October.

Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

Grade: _____5__ Unit: _____Measuring Time________ Lesson: _____Sun Clocks_____

Identify what data students will be using:

Class sun clock data (shadow length)

Question:

Etinnah walked into the science room and saw that the class sun clock was casting a shadow that was about 5.75 centimeters tall. Using her class data chart, how can she tell what time it was? Use evidence and reasoning to support your claim.

Ideal Student Response:

It was probably around 12:00 pm when Etinnah saw that shadow. When we traced the shadows cast by our sun-clock's gnomon over the course of the day, we saw that their heights changed. They started out being pretty long shadows. At 9:15 am, the shadow height was 19 cm. Then they started getting smaller. By 11:00 am, the shadow was only 10 cm tall. The shadow was smallest when we measured it at 12:05 pm, when it was 6 cm tall. After noon, the shadows got longer again. By 2:30 pm, the shadow was back to 11 cm tall. As you can see, these shadow heights move in a cycle. They don't just jump all over the place. Since 5.75 cm is close to 6 cm, and the shadows will never get that short again on that day, we can tell that Etinnah probably saw the shadow at about 12:00 pm. The reason the shadows move like this is because at sunrise, the sun looks like it is down low in the sky, and this makes a long shadow. The sun looks like it moves up across the sky during the day because the earth is rotating on its axis, and when the sun is at its highest, at noon, the shadow cast by the gnomon blocking the sun will be shortest. As the sun sets, it goes back to looking like it is lower in the sky, and the shadow will get longer again, but on the other side of the gnomon.

Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

Grade: _____5_ Unit: ________Levers and Pulleys_ Lesson: ___Lever Classes_______

Identify what data students will be using:

Data tables from previous investigations.

Question:

After completing all of their lever investigations, two fifth graders had a conversation. Yuen said, "Levers are a kind of simple machine. They always make things feel easier to lift." Daquan said, "I disagree. Sometimes levers make things feel easier to lift, but sometimes they don't."

Who is correct? Think about all the different lever systems that we built in class. Use evidence and reasoning to support your claim.

Ideal Student Response:

Daquan is correct, depending on the kind of lever system, the lever could make things feel easier to lift, feel the same, or feel more difficult to lift. In class we built a class-2 lever. That is when the load is in between the effort and the fulcrum. With this lever system, the effort needed to lift the 2.5N load was always less than 2.5N, no matter where we put the load on the lever arm. When the effort was 25 cm from the fulcrum and the load was 5 cm from the fulcrum, we only needed .5 N of force to lift a 2.5N load. When the load was 20 cm from the fulcrum, we only needed 2.0N of force to lift a 2.5 N load. When a lever lets you apply less effort to lift a load, this is called mechanical advantage. A class-2 lever always give you mechanical advantage.
However, we also built a class-1 lever, and put the load 5 cm from the fulcrum and the effort 25 cm from the fulcrum. Using this lever system, it only took .5N to lift a 2.5N load. In a class-1 lever, the fulcrum is between the load and the effort. However, when we moved the effort to be 5 cm from the fulcrum, and the load to be 25 cm from the fulcrum it took 10N to lift the 2.5N load. This actually made it more difficult to lift the load. That's why Daquan is correct. Sometimes levers give you mechanical advantage, and sometimes they don't.

(students could also include evidence of class-3 levers, where the effort is always greater than the load)

[redacted]
Grade 3
Water unit
Evaporation lesson

Data students will be using	Students measured where water evaporated quicker in the room, using thermometer to compare air temperature. They also compared the weather, when it rains on a cold day versus on a hot day. Also using background knowledge about the heat and water.
Question	Does air temperature affect evaporation?
Ideal student responses	Yes, air temperature does affect evaporation. The warmer the air becomes the quicker water evaporates. In the section of the room that had a warmer temperature, the water dried quicker than the section of the room that had a cold temperature. Also, the wet ground after it rains dried quicker on a warm day, then it did on a colder day. When we go swimming in the fall and winter, my hair takes longer to dry, but during the spring and summer, my hair dries quickly. Air temperature does affect evaporation because in order for evaporation to happen, water needs warm air. The warmer the air the quicker the water will dry.

[redacted]

Grade 4 Unit: **Motion and Design** Lesson: **Rubber Band Energy**

Identify what data students will be using:
Students collect data from the investigation, using the rubber band energy. Students will record:

Record the distance the vehicle travels using rubber band energy.				
Number of turns on the axle	Distance the vehicle traveled Trial 1	Distance the vehicle traveled Trial 2	Distance the vehicle traveled Trial 3	Distance the vehicle traveled Trial 4
8	24"	24"	26"	26"
16	50"	49"	49"	50"
24	66"	66"	64"	64"

Students will wind the rubber band around the axle on the vehicle 8 times, then measure and record the number of inches the vehicle traveled. The students will record 4 trials. The students will then wind the rubber band on the axle 16 times and record the measure and record the number of inches the vehicle traveled. The students will record 4 trials. The students will then wind the rubber band around the axle 24 times and measure and record the distance the vehicle travels.

Question:

Does the number of winds of the rubber band around the axle affect the distance the vehicle travels?

Ideal Student Response:

Yes, the number of winds if the rubber band around the does affect the distance the vehicle travels.

To measure distance you must use a measuring tape, and measure the distance the vehicle traveled from a designated starting point until the vehicle stops. You must use the same starting point each time the only thing that is changed is the number of winds of the rubber band around the axle

I found that the vehicle with 8 winds on the axle traveled a distance of 24 inches, the vehicle with 8 winds around the axle traveled 36 inches, but the vehicle with 16 winds around the axle, traveled a distance of 50 inches, that is 14" more than the vehicle with the 8 winds around the axle. The vehicle with the 24 winds around the axle traveled 42 inches farther than the vehicle with the 8 winds around the axle.

The more winds around the around the axle the more stored energy in the rubber band. The more stored energy in the rubber band, the more potential energy, the more potential energy, and the farther the vehicle will travel.

The vehicle with the most winds around the axle traveled the farthest distance.

[redacted]

Mason Pilot Elementary School
Grade 4 Unit: **Motion and Design** Lesson: **Common Writing Assignment**

Identify what data students will be using:
Student will use their science journals with the colleted data, as well as information from previous **CER**s from the entire unit.

Question:
Can you make a K'nex vehicle go faster?

Ideal Student Response: The two examples are two students from the fourth grade class. I had Dean Martin look the papers and agreed that these are two ideal responses.

Response Number 1:

Yes, I can make a K'nex vehicle go faster. The tan hub connector keeps the tires from rubbing against the gray rod, which is called wasteful friction. In class we investigated the job of the tan hub connectors, I found that without the tan hub connectors the tires rub against the gray rods, which makes the vehicle go slower. But with the tan hub connectors the vehicle goes faster because the tires are not rubbing against the gray rod, no friction.

Another way to make my vehicle go faster is to use the crossbars. The crossbars keep the vehicle from twisting, which can sometimes cause wasteful friction. In class I learned that the crossbar hold the gray rod in place. The vehicle moves faster with the crossbars in place because there is less chance for friction. To move the vehicle I will give it a BIG push, that push, which is a force, will make the vehicle move faster because there is strong force moving the vehicle.

The last way I chose to move the vehicle is a propeller driven vehicle. In class we learned that the more winds with the propeller, the faster the vehicle goes. Using the tan hub connectors, the crossbars and setting up the propeller driven vehicle, with little friction are three ways to make my vehicle go faster.

Response Number 2:

Yes, I can make my K'nex vehicle go faster by adding tires. This is how. If you add tires to the front and back of the vehicle, the tires will grip on the table and the vehicle will go faster. In class I learned the job of the tires is to help the vehicle and move and grip the surface, this makes traction. This is useful friction. If you have tires on your vehicle your vehicle will not move but the wheels spin. But if put the vehicle on the rug your vehicle will move. If you have tires on the vehicle your vehicle will move on both surfaces, the rug and the table.

Friction is when something rubs together and makes the vehicle goes slower. The tan hub connector helps keep the gray rod and the wheels from rubbing together. When the gray rods rub together the vehicle will not move. I will put the tan connector between the wheels and the gray rod so the tire and gray rod will not rub against each other and the vehicle will move.

I can make the K'nex vehicle move faster by adding a propeller. This is how. If you add a propeller to the vehicle and spin the propeller, there is going to be knots on the rubber band. The more knots on the rubber band the more stored energy or potential energy. The more stored energy the more kinetic energy or energy of motion. I know this because in class we did a test with the propeller driven vehicle and we spun the propeller until it had lots of knots on the rubber band. The more knots on the rubber band the faster the vehicle will move. This is Newton's Third Law of Motion. The propeller spins, pushes the air back and moves the vehicle forward.

Another way I can make the K'nex car go faster by adding washers to the FWS (falling weight system). To give more force add more washers to the FWS and the vehicle will move faster. Gravity pulls the washers down and moves the vehicle forward and fast. This is Newton's Second Law of Motion, the more force on the vehicle the faster the vehicle will move.

[redacted]

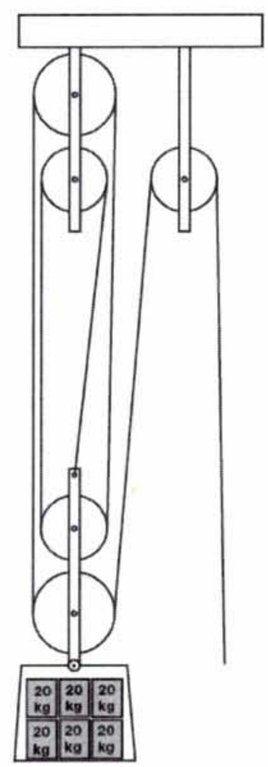
Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

Grade: Five   Unit: Levers and Pulleys   Lesson: Investigation4, Part 2

Identify what data students will be using:
Students will use data collected from Investigation 4, Parts 1 and 2. Data will be on four pulley systems (single fixed, single movable, single-fixed/single-movable with effort going down, and single-fixed/single-movable with effort going up). Data collected will be:

- Number of pulleys
- Direction of effort
- Weight of load
- Amount of effort needed to lift the load
- Number of ropes supporting the load

Question:
Derek is helping the staff from his school's cafeteria lift six boxes up to the loading dock. Each crate has a mass of 20 kilograms (kg). Derek can lift only one box at a time.



Derek decided to put together a pulley system to lift the crates up to the loading dock.
He said, *"With this system, I will be able to lift six crates at a time."*

Is Derek right about being able to lift six boxes at the same time? Explain, and use data from your notebook to support your claim.

Ideal Student Response:
Derek is not right about being to lift the 6 crates to the loading dock using the pulley system he set up because he will require 24kg of effort to lift the load, and he can only lift 20kg. The total mass of the load is 120kg (20kg X 6 crates). Since Derek's pulley system has a total of 5 ropes supporting the load, it will require 24kg of force to lift the load (120kg divided 5 ropes equals 24kg). Although the pulley system provides Derek with mechanical advantage, it does not provide enough. Hence, since Derek can only lift 20kg, he will not be able to lift the load using his pulley system because he will require 24kg of force.

* fee free to edit as needed

Directions: Identify 3 CER questions you think you might use next year. These can be questions you used this year and were successful, questions you used this year that you then adapt or new questions. These will be posted in a question bank on the website as a source for teachers.

Grade: Five Unit: Introductory Lesson Lesson: Fresh Water vs. Salt Water

Identify what data students will be using:
Data is collected in class during investigations where students explore if an ice cube melts faster in fresh water or salt water. Data would include: temperature of salt water and fresh water; mass of ice cubes; and time it takes for the ice cube to melt completely.

Question:
David was curious about a discussion from his science class. The teacher had mentioned that ice cubes melt at different rates when they are surrounded by different substances (for example, air, water, oil, etc.). David was wondering if an ice cube would melt faster in fresh water or salt water. Knowing what you have learned in class, which would melt faster: an ice cube in salt water, or an ice cube in fresh water?

Ideal Student Response:
The fresh-water ice cube placed in fresh water would melt faster than the fresh-water ice cube placed in salt water. This claim is backed up by data I collected in class. Using two cups with fresh and salt water at room temperature, I placed a fresh-water ice cube in each cup and measured how long it took each one to melt. The ice cube in fresh water melted in 15 minutes 33 seconds, and the ice cube in salt water melted in 43 minutes 32 seconds.

There two reasons for this. As the ice cube melts in fresh water, the cold water from the ice cube would sink to the bottom. As the ice cube continues to melt, the cold water at the bottom would be replaced by colder water from the ice cube. This creates currents, causing the water to continuously circulate from top to bottom, back to top, etc. Conversely, since the salt water is denser than the cold fresh water from the ice cube, the cold water will stay on top. Hence, there would be no currents to circulate the water. The second reason is that in fresh water, the circulating water would keep the top of the water warmer (causing the ice cube to melt faster). In the salt water, the water would stay colder at the top because the cold water from the ice cube does not sink. This cold water would slow down the rate at which the ice cube melts in salt water.