Why do some things get colder (or hotter) when they react?

Lesson Routine	Questions	Phenomena / Problems	What we figured out
L1 Anchoring phenomena	What happens when room temperature substances are mixed together?		Sometimes mixing two room temperature substances together causes the temperature to drop dramatically. We think this is a chemical reaction. We have lots of questions about related phenomena.
L2 Investigation	Will the temperature still drop if we mix two things together and no chemical reaction occurs?		Dissolving potassium chloride in water, which we determined was a physical change, also caused the temperature to drop. We were still confused why the temperature was dropping so quickly and started wondering if this phenomenon is similar to how things generally cool down (or warm up)
Investigation	Why does leaving any cold or warm thing out in the room cause it to change temperature?		When particles collide with one another they can transfer some of their kinetic energy. This results in changes in temperature even though the total energy is conserved.
L3 Putting pieces together	Why is the thermal energy decreasing when potassium chloride dissolves in water?	Phenomena from L1 through L4	Thermal energy (kinetic energy of the particles) is being used to break the salt apart into smaller pieces. Something holds the particles in solids together before it dissolves.
L4 Investigation	What are some different ways that different parts can be held together?		There are many different ways that different parts can be held together (e.g. tape, glue, magnets, staples, rubber bands, nails)
Putting pieces together	How can we best represent the connections between particles in a salt that can dissolve?		We think particles that make up matter have an "at a distance force" between them. We are not sure if particles really act like magnets or not, but we know they have positive and negative pieces. So we decided magnets are the most productive physical model to use (for now) for representing the connections (bonds) between particles.

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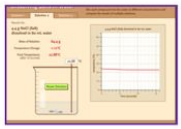
L5 Investigation	How can magnets help us explain why the temperature of substances drops when the bonds between particles are broken?		Collisions between marbles and and magnets provided evidence of kinetic energy loss in the system when a bond was broken. Breaking stronger bonds seemed to require more kinetic energy. Water particles must also lose kinetic energy in collisions with bonded salt particles when the collision results in a bond breaking.
L6 Investigation	Are all bonds the same?		Dissolving more salt requires breaking more bonds. Dissolving different kinds of salts breaks bonds of different strengths. Breaking more bonds or breaking stronger bonds requires more energy, which would result in a greater drop in the temperature of the water used to dissolve those salts.
L7 Putting pieces together	Why does the temperature drop when room temperature barium hydroxide and ammonium chloride are mixed together?	Previous phenomena L1 through L6	Bonds in the reactants must be being broken in a chemical reaction too. Breaking bonds results in a temperature drop because it requires a loss of kinetic energy from particles in the surroundings.
L8 Problematizing	Do all complex reactions absorb energy and make their environment colder?		We are a little confused now because mixing room temperature substances together can sometimes make the temperature of the surroundings increase even though we know that bonds are still breaking when this happens.
L9 Investigation	How can we use magnets to model changes in particle energy when bonds form?		Chemical reactions involve forming bonds too. Releasing marbles and and magnets near each other to form a bond provided evidence that the average kinetic energy of the particles in the system increased.

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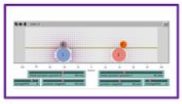
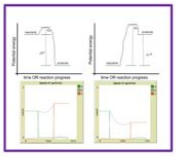
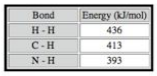
Investigation ↓	Why does bond formation cause particles to speed up?		Forces between particles can cause them to speed up or slow down depending on whether the particles are moving in the same direction or the opposite direction as the forces acting on them. Kinetic energy is converted to and from potential energy in this process.
Putting pieces together ↘↓↙	Why do some reactions warm things up?	Previous phenomena In L8 through L9	Since forming bonds converts potential energy between the particles into kinetic energy, this process would result in a temperature increase in the system, because the particles in it will have sped up.
L10 *Investigation* ↓	How could we use magnets to investigate what happens when bonds are both broken and formed in a chemical reaction?		When the particles in a system break weaker bonds and form stronger ones, the average speed of those particles will increase. When the particles in a system break stronger bonds, and form weaker ones, the average speed of those particles will decrease.
Putting pieces together ↘↓↙	Why do some chemical reactions get cold and others get hot?	All previous phenomena In L1 through L9	How much energy a reaction releases or absorbs can be explained by comparing the relative strengths of all the bonds broken in the reactants to all the bonds formed in the products.
L11 *Problematizing* ↙↓↘	How do scientists represent the changes in energy in endothermic and exothermic reactions?		Scientists represent exothermic and endothermic reactions by tracking changes in potential energy while we tracked changes in kinetic energy.
L12 *Putting pieces together* ↘↓↙	How can we predict the amount of energy absorbed or released in any chemical reaction?	 And all previous phenomena In L1 through L10	We developed a mathematical equation to calculate how much energy would be released or absorbed for any chemical reaction, using information on the amount of energy it takes to break every kind of bond in the reactants and products.

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