ANSWER KEY

Summer Enrichment Packet for Rising Chemistry Students

PRINCE GEORGE'S COUNTY PUBLIC SCHOOLS
Division of Academics
Department of Curriculum and Instruction

Answer Key
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Rising Chemistry Students

Week	Answers
Week One **Periodic Table Basics**	**Periodic Table Questions** 1. Helium (He), Neon (Ne), Argon (Ar) 2. Hydrogen (H), Lithium (Li), Sodium (Na) 3. The number of valence electrons increases by one as you move across the table from left to right. 4. The number of energy levels increases by one as you move down the group. 5. The name of each family should be placed at the top of each column. 6. The elements in each family are located in the same column. 7. Hydrogen could be classified in either Alkali Metals or Halides. Alkali Metals – Hydrogen has only one valence electron so it could be classified with the alkali metals. Halides – Hydrogen only needs one more valence electron to fill its outer shell so it could be classified with the halides. 8. Radium – Alkaline Earth Metal, Tin – Carbon Family, Iodine – Halide, Cesium – Alkali Metal 9. Barium = 2, Lead = 4, Bismuth = 5, Potassium = 1
Week Two **Atoms and Bonding**	**Ionic Bonds** 1. Two. A sulfide ion has a charge of 2-. Since potassium ions only have a charge of 1+, two potassium ions are needed to balance the charge. 2. $CaCl_2$, K_3PO_4 3. Magnesium sulfide, ammonium chloride, and potassium oxide 4. Ammonium and phosphate are polyatomic.
	Pulling Away Electrons 1. Atomic radius increases from top to bottom; atomic radius decreases from left to right. 2. Cesium; barium. These two should be the most reactive of their groups because each has the largest atomic radius in its group. The element with the largest atomic radius holds some of its electrons less tightly, so the electrons are easier to remove. 3. The Group 1 element is more reactive in each case because the atomic radius of the Group 1 element is larger than the atomic radius of the corresponding Group 2 element. This means the Group 1 element holds onto some of its electrons less tightly, so the electrons require less energy to remove. Also, two electrons must be removed from Group 2 atoms, which would require more energy than needed to remove one electron from Group 1 atoms. 4. Across a period, the noble gas elements would have the smallest atomic radii of any group, which means that their electrons would be held onto the tightest. To remove an electron and get these elements to react would require large amounts of energy.

	Covalent Bonds 1. Students should have drawn one circle around the shared electrons in each diagram (one electron pair in HF and F_2, two electron pairs shared in O_2 and three electron pairs in N_2) 2. The bond in O_2. 3. The bond in N_2. 4. The polar bond is a result of the fluorine atom pulling more strongly on the shared electrons than the hydrogen atom. 5. N_2, O_2, and F_2 have nonpolar bonds. 6. Compared to ionic compounds, molecular compounds have lower melting and boiling points. Most molecular compounds are poor conductors of electricity when melted or dissolved.
	Oil Spills 1. Oil will not mix with polar water because oil is nonpolar. It will only float on the water's surface. This allows floating barriers to keep oil contained until it can be removed with nets. If oil mixed with water, it could not be separated from water as easily. 2. Because the bonds are made up of two of the same kind of atom bonded together, they both would have an equal pull on the electrons involved in the bond. That means the valence electrons are shared equally and the bonds are nonpolar. 3. One end of a detergent molecule attracts a water molecule, while the other end attracts an oil molecule. This attraction pulls apart a large oil spill bit by bit. 4. No. No matter how small the oil particles are, they will never mix with the water, because oil is nonpolar and water is polar. Even if they look lie they are mixed, the oil and water will eventually separate.
Week Three **Chemical Reactions (Part I)**	**Observing Chemical Change** 1. Answers will vary. Sample response: Change in texture, from gooey liquid to dry and crumbly solid. 2. Chemical change 3. Answers will vary. Sample response: Change in color, from brown log to black ashes 4. Chemical change 5. Answers will vary. Sample response: Change in state, from liquid water to solid ice 6. Physical change
	Separation Science 1. In filtration, a liquid-solid mixture is passed through a filter to remove solid particles from the mixture. Filters that you can install on your kitchen faucet or the type you buy and place inside a pitcher of drinking water use filtration to remove small particles. 2. Evaporation can be used to separate salt from seawater to produce fresh water and also salt for commercial purposes. This can ben done by pumping the seawater into large, shallow holding tanks. When the water evaporates, the salt remains. 3. Mixtures that have solid particles large enough and heavy enough to settle out of the mixture on standing can be decanted. Decanting can be done almost anywhere because it does not require special equipment. You only need a container with a spout and another container to hold the separated liquid. 4. Separations of the types mentioned here cause physical changes because no new substances form. The individual substances you get after separation were present in the mixture at the start.
	What is a Chemical Reaction? Answers and Annotations will vary.

	Describing Chemical Reactions 1. a. $FeS + 2HCl \rightarrow FeCl_2 + H_2S$ b. Replacement 2. a. $2Na + F2 \rightarrow 2NaF$ b. Synthesis 3. a. $2HgO \rightarrow 2Hg + O_2$ b. Decomposition 4. Two molecules of hydrogen combine with one molecule of oxygen to form two molecules of water. Each hydrogen molecule is formed by two hydrogen atoms, the oxygen molecule is formed by two atoms of oxygen, and each water molecule is made of two hydrogen atoms bonded with one oxygen atom. **5.** The conservation of mass states that mass is neither created nor destroyed during a chemical reaction. The equation is balanced because both the reactants and the product contain the same number of atoms of each element: four hydrogen atoms and two oxygen atoms.
	The Decomposition of Water 1. $2H_2O \rightarrow 2H_2 + O_2$ 2. There are four hydrogen atoms and two oxygen atoms on each side o the equation. 3. The missing mass is due to oxygen gas and hydrogen gas that have escaped from the beaker. These gases are produced by the decomposition of water. 4. 36 g; the total mass of the reactants must equal the total mass of the products. 5. Gas bubbles are being produced.
Week Four **Chemical Reactions (Part II)**	**Controlling Chemical Reactions** Graphic organizer responses will vary. Text Annotations will vary. 1. Surface area, temperature, concentration, use of a catalyst, and use of an inhibitor 2. Sugar crystals, because more particles of sugar are exposed than in a sugar cube.
	Endothermic and Exothermic Reactions 1. In the graph of the exothermic reaction, the products are at a lower level of energy than the reactants. This is because an exothermic reaction releases energy. The products in the endothermic reaction are at a higher level of energy than the reactants. This is because an endothermic reaction absorbs energy. 2. Activation energy is the amount of energy that has to be added to start a reaction. With enough energy, reactants can get "over the hump" and form products. 3. Increasing the temperature of a reaction makes the reacting particles move faster, increasing the rate of the reaction. Other ways to increase the rate of a chemical reaction are to increase the concentration of a reactant, or to add a catalyst.
	Making and Breaking Bonds 1. The reaction is an endothermic reaction. During the reaction, five bonds are broken while only three bonds are made. 2. The reaction is an exothermic reaction. During the reaction, three bonds are broken while four bonds are made.
	Flameless Ration Heaters 1. They are catalysts for the reaction. 2. If an FRH came with water already in it, the exothermic reaction would already have taken place and no more heat would be given off. 3. The smaller the pieces of magnesium, the larger their surface area. As the surface area of a reactant increases, so does the rate of reaction. For this reason, the pieces of magnesium in an FRH are probably very small. 4. It is important that the reaction be fast so that a large amount of heat will be given off in a short period of time. In this way, the MRE can be quickly heated to a fairly warm temperature.

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<tr><td>Week Five
Cycling of Energy in Ecosystems</td><td>The Water Cycle
Answers and Annotations will vary.</td></tr>
<tr><td></td><td>Biogeochemical Cycles
Carbon Cycle
Answers will vary. Student models should contain factual explanations of the role of photosynthesis and cellular respiration in the cycling of carbon. Equations included in student models should be correct.

Nitrogen Cycle
Answers will vary. Students should recognize that microscopic organisms, which are small in scale, have a large-scale impact on life on Earth. Plants use the nitrates releases by soil bacteria to create molecules that the plants need, such as amino acids and proteins. Other organisms in the food web also use the nitrogen compounds created by the plants to create the proteins and amino acids needed in their own bodies.

Phosphorus Cycle
Answers will vary. Sample response: Animals participate in the phosphorus cycle by eating plants that absorb phosphorus.</td></tr>
<tr><td>Week Six
Energy Transformations</td><td>Hydroelectric Station Model: Downspout Generator
1. C
2. Energy Inputs: Kinetic energy of water, Gravitational potential energy of water
Energy Outputs: Electrical energy, Thermal energy, Sound energy
3. D
4. Gravitational, mechanical, electrical
Rainwater on the roof has (chemical/gravitational/mechanical) energy, which is converted to (electrical/gravitational/mechanical) energy when it flows to the downspout and spins the waterwheel. As the waterwheel spins, the generator converts the energy to (chemical/electrical/gravitational) energy.
5. B
6. Answers will vary. Sample response:
A way to improve the prototype is to add multiple waterwheels to it. If you have larger cups and a wider funnel, more water could be put into the wheel causing it to spin faster and create more kinetic energy that would be converted to electrical energy by the generator. If more wheels are added, the efficiency of the waterwheel prototype would be a lot higher due to a more constant heavy flow of mechanical energy from the spinning of the wheel that can contain more water than its counterpart. A trade-off for the modification would be the higher expense and a larger amount of space that it would be occupying.</td></tr>
<tr><td>Week Seven
Acid, Bases, and Solutions</td><td>Understanding Solutions
Graphic organizers on solutions, colloids, and suspensions will vary.
The Chemistry of Ice Cream
1. The water would freeze at a higher temperature than the other ingredients do. All of the water in ice cream would exist as ice. Large crystals of ice would form, which would prevent the ice cream from having a smooth texture.
2. As the particles of the colloid clump together, the air would escape from the mixture.
3. There would be no pint in adding air to the mixture until the particles became sufficiently mixed and their temperature is cool enough to trap the air.
4. Milk is more stable because it remains a colloid at a much wider range of temperatures than does ice cream.</td></tr>
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	Temperature and Solubility 1. For both graphs, solubility is the dependent variable (responding variable), and temperature is the independent variable (manipulated variable). 2. In general, the solubilities of solids increase with increasing temperature. The solubilities of gases decrease with the increasing temperature. 3. No. $Yb_2(SO_4)_3$ is less soluble at higher temperatures. The solubility of NaCl is relatively constant. 4. The solubility of KNO_3 increases significantly between 30 °C and 80 °C. 5. The particles of a gas have much more energy at higher temperatures and escape from the liquid solvent more easily.
	Acid and Bases in Solution 1. As pH increases, the amount of hypochlorous acid decreases and the amount of hypochlorite ion increases. 2. An acid added to the water will decrease the pH. The acid will separate into hydrogen ions and negative ions. As the concentration of hydrogen ions increases, pH decreases. 3. A base added to the water will increase pH. The base will neutralize some of the acid in the water to produce water and a salt. This reaction will remove hydrogen ions from the water. As the concentration of hydrogen ions decreases, pH increases.