Attachment 1: Particle Nature of Matter Activity Sheet

Part One

1. Pass the balloon around and let each group member smell it. Can you identify the “mystery substance” inside?

2. How do your observations provide evidence that the “mystery substance” is made of tiny particles that are in constant motion?

3. From your observations, what can you infer about the rubber material of the balloon?

Part Two

1. In a clean and dry graduated cylinder, measure 50 mL of sugar. Transfer the sugar to the beaker.

2. Use the graduated cylinder to measure 50 mL of water. Pour the water into the beaker with the sugar. Stir thoroughly.

3. What changes do you observe in the sugar and/or water?

4. How do your observations provide evidence that matter is composed of discrete particles? What can you infer about the nature of these particles?

Particle Nature of Matter Activity Sheet (Teacher Key)

Part One

1. Pass the balloon around and let each group member smell it. Can you identify the "mystery substance" inside?

Answers vary depending on balloon contents (vanilla, lemon, rootbeer, etc.)

2. How do your observations provide evidence that the "mystery substance" is made of tiny particles that are in constant motion?

Because students were able to "smell" the substance, some of the substance must have entered their nostrils. The portion of the substance entering their nose must have been made of microscopically small (or smaller) particles since they were able to pass through the balloon wall and could not be seen. Also, these particles must have been in motion since they were able to rapidly travel from the balloon to the nose of the observer.

3. From your observations, what can you infer about the rubber material of the balloon?

There must be spaces within the rubber material of the balloon that allowed the particles of the extract to pass through. Thus, the rubber balloon material is NOT continuous and may, perhaps, also be made of tiny particles.

Part Two

1.In a clean and dry graduated cylinder, measure 50 mL of sugar. Transfer the sugar to the beaker.

2. Use the graduated cylinder to measure 50 mL of water. Pour the water into the beaker with the sugar. Stir thoroughly.

3. What changes do you observe in the sugar and/or water?

The sugar "disappears" but is still present as evidenced by the sweet taste of the solution and the fact that the total mass of sugar plus water has not changed. The combined volume of the sugar plus water is considerably less than the sum of their individual volumes.

4. How do your observations provide evidence that matter is composed of discrete particles? What can you infer about the nature of these particles?

The fact that the combined volume was less than the sum of the individual volumes is evidence that water must be made of tiny particles with spaces between them.

The sugar must have also been made of tiny particles that were able to fit into these spaces and were so small that they could not be seen with the naked eye. The fact that the sugar-water solution was uniformly sweet is evidence that the sugar particles were in motion and able to spread out through the water. Also, it was probably the motion of the water particles bombarding the sugar crystals that broke them apart and allowed them to dissolve and disperse.

Attachment 2: MATTER CIRCUS TASK CARDS

Station 1 Task Card

Syringes
Observe the contents of each syringe. Gently try to depress the plunger on each. For each syringe, draw a before and an after "particle picture" showing your ideas about the particles of matter in the syringe that could account for your observations. Write labels or descriptions to explain your pictures.

Station 2 Task Card

Solids
Observe the different solids. How are they alike? How are they different? Draw a "particle picture" for each solid that could account for the similarities and differences you noted. Write labels or descriptions to explain your pictures.

Station 3 Task Card

Copper Wire
Measure the length of the copper wire. Holding the wire by each end, pull on it really hard. Re-measure its length. From your observations, what can you infer about the copper atoms of which the wire is made? Draw "particle pictures" that represent the copper atoms in the wire before and after you pulled on it.

Station 4 Task Card

Food Coloring and Water
Add a few drops of food coloring to a glass or beaker of clean water. DO NOT STIR. Observe what happens. Draw one "particle picture" showing the particles of food coloring and water immediately after you added the coloring, and another "particle picture" showing them after a couple of minutes. Be sure to clean your station, leaving it as you found it, for the next group.

Station 5 Task Card

Room Deodorizer
Observe the closed deodorizer. What happens when you open the deodorizer? Close the deodorizer again and notice any changes. Draw a "particle picture" that shows the particles in the open deodorizer in a way that accounts for your observations. Leave the deodorizer closed for the next group.

Station 6 Task Card

Thermometer
Place the thermometer in the beaker of ice water, then wait a few moments and notice the level of the red liquid. Place the thermometer in the warm water, then wait a few moments and notice the level of the red liquid. Draw a "particle picture" showing the particles of the red liquid in the thermometer when it is placed in the ice water, and another "particle picture" that shows the particles of the red liquid when the thermometer is placed in the warm water.

MATTER CIRCUS OBSERVATION SHEET

STATON 1: Syringes	**STATION 2: Solids**
STATION 3: Copper Wire	**STATION 4: Food Coloring**
STATION 5: Room Deodorizer	**STATION 6: Thermometer**

Attachment 3: MAKING INFERENCES: MATTER CIRCUS

PHASES	PARTICLE CHARACTERISTICS
SOLID	
LIQUID	
GAS	

Attachment 4:

ASSESSING UNDERSTANDING: KINETIC MOLECULAR THEORY

Use the kinetic molecular theory to explain what happens at the particle level in each of the situations below. For each situation, draw a BEFORE and AFTER particle picture that represents what has happened.

1. A crayon left on the sidewalk melts into a puddle on a hot sunny day.

EXPLAIN:

BEFORE	AFTER

2. An inflated balloon is placed in the refrigerator. When it is removed an hour later, it has shrunk to about half of its original size.

EXPLAIN:

BEFORE	AFTER

3. A woman places several moth balls in a ziplock bag and seals the bag. Several days later, she notices that the bag has become inflated and the moth balls are much smaller.

EXPLAIN:

BEFORE	AFTER

4. A pharmacist prepares a tincture of iodine by adding a few iodine crystals to a beaker containing 50 mL of liquid alcohol. After a period of time, the pharmacist notices that the liquid has become uniformly brown in color, the solid iodine crystals have disappeared, and the total volume of the tincture is only slightly more than 50 mL even though the iodine crystals were fairly large in size.

EXPLAIN:

BEFORE	AFTER

5. An aerosol can is inadvertently placed on a kitchen counter very near the stove. A stove burner is turned on and several minutes later the aerosol can explodes.

EXPLAIN:

BEFORE	AFTER

ASSESSING UNDERSTANDING: KINETIC MOLECULAR THEORY
(Teacher Key)

Use the kinetic molecular theory to explain what happens at the particle level in each of the situations below. For each situation, draw a BEFORE and AFTER particle picture that represents what has happened.

1. A crayon left on the sidewalk melts into a puddle on a hot sunny day.

EXPLAIN:
Particles in the solid crayon are very close together, strongly attracted to one another, and vibrating about a fixed position. This is why the crayon has a definite shape and volume. Heat from the sun provides the energy for the particles to break away from one another and to begin to move freely.

BEFORE	AFTER

2. An inflated balloon is placed in the refrigerator. When it is removed an hour later, it has shrunk to about half of its original size.

EXPLAIN: *The air inside the balloon is a gas, so the particles are moving very fast in random directions and separated by lots of space. They collide frequently with the inside wall of the balloon, which is what keeps the balloon fully inflated.*
When the balloon is placed in the refrigerator and cooled (or heat is removed), the particles of air slow down. They don't collide as frequently or as hard with the balloon wall. The balloon wall squeezes the air particles closer together as the balloon shrinks in size.

BEFORE	AFTER

3. A woman places several mothballs in a ziplock bag and seals the bag. Several days later, she notices that the bag has become inflated and the moth balls are much smaller.

EXPLAIN: *Originally, because the mothballs are solid, the particles are close together and vibrating in fixed positions. The fact that the bag becomes inflated and the mothballs become smaller indicates that part of the moth balls must have become a gas (or sublimed). As a gas, the mothball particles move freely and are separated by a great deal more space, which is why the bag became inflated.*

BEFORE	AFTER

4. A pharmacist prepares a tincture of iodine by adding a few iodine crystals to a beaker containing 50 mL of liquid alcohol. After a period of time, the pharmacist notices that the liquid has become uniformly brown in color, the solid iodine crystals have disappeared, and the total volume of the tincture is only slightly more than 50 mL even though the iodine crystals were fairly large in size.

EXPLAIN: *The particles of iodine in the solid crystals are close together and vibrating in place. The particles in the liquid alcohol move freely and there is some space between them. When the alcohol particles collide with iodine particles in the crystals, they transfer some energy to them. The energy allows these iodine particles to break away from the other iodine particles in the crystal and to begin to move through the spaces between the alcohol particles.*

BEFORE	AFTER

5. An aerosol can is inadvertently placed on a kitchen counter very near the stove. A stove burner is turned on and several minutes later the aerosol can explodes.

EXPLAIN: *Particles of the gas inside the aerosol can are compressed or squeezed very close together. (They may even have become a liquid.) Heat energy from the stove causes these particles to move faster and to exert greater pressure on the inside surface of the can, enough to cause the can to explode.*

BEFORE	AFTER