Name: _____ Per_____ Date: _____

# Case 1: Baby & The Bottle Assessment
## States & Properties of Matter

*Read the scenario and carefully analyze the data presented below. Answer all questions.*

## SCENARIO:

Zookeepers at the Southington Zoo are alerted to a sick giraffe, Mr. Spot. Caretakers for Mr. Spot have reported that the giraffe has been exhibiting increased thirst, more frequent urination, and has lost 20lbs over the last week. In addition, Mr. Spot is sleeping a lot and does not appear to have the strength to pull the leaves that it typically eats off of the tree.

The medical team at the zoo begins to look at the Mr. Spot's environment and takes samples of the giraffe's food and water to submit for testing. The zoo approaches you, a local chemist, for your professional opinion as to what is going on with Mr. Spot. All of the data is presented in the case file below.
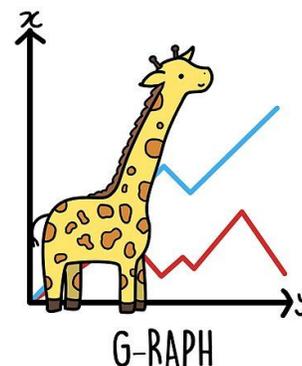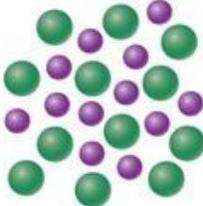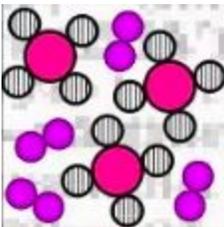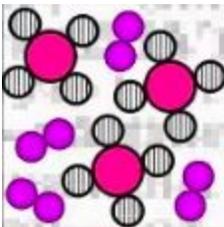
**Table 1: Chemical analysis of distilled water compared to giraffe's water.**

| Property | Distilled Water | Mr. Spot's Water | Standard Giraffe Food | Mr. Spot's Food |
|---|---|---|---|---|
| **Particle View** |  |  |  |  |
| **Color** | Clear | Clear | Brown | Brown |
| **Odor** | None | None | Earthy | Earthy |
| **Density (g/mL)** | 1.00 | 1.06 | 3.4 | 3.39 |
| **Freezing Point (ºC)** | 0 | -1 | 75 | 75 |
| **Conductivity** | None | None | None | None |
| **Reactivity with Acid** | Heat Released | Black solid formed, heat released. | None | None |
| **Reactivity when heating** | None | Turns brown | Ignites | Ignites |

1. _____ It can be inferred from the introduction and data in Table 1 that…

    A. The giraffe's food was contaminated and may be causing it to be ill.
    B. The giraffe's water was contaminated and may be causing it to be ill.
    C. Neither the giraffe's food or water are likely to be the reason the giraffe is sick.
    D. The giraffe's food and water were both contaminated, and more tests will have to be done to see which one is causing the giraffe to be sick.

2. _____ Which of the following best supports the claim made in Question 1?

    A. The distilled water had the same odor, color, and conductivity as the giraffe's water.
    B. The distilled water had a different odor, color, and conductivity as the giraffe's water.
    C. The distilled water had the same density, acid reactivity, and reaction with heat as the giraffe's water.
    D. The distilled water had a differing density, acid reactivity, and reaction with heat as the giraffe's water.

3. _____ Which of the following best interprets the particle data in Table 1?

    A. The distilled water is a pure substance, while the giraffe's water and food samples are mixtures.
    B. Both water samples are pure substances, while both food samples are mixtures.
    C. Both water samples are mixtures, while both food samples are pure substances.
    D. The distilled water is an element, while the giraffe's water is a compound.

4. _____ Which of the following best explains how one could distinguish a pure substance from a mixture using the particle diagrams?

    A. Pure substances have different particles while mixtures have the same particles.
    B. Pure substances and mixtures both have all of the same type of particles, but the particles in mixtures are different sizes.
    C. Pure substances have all of the same particles while mixtures have different types of particles.
    D. Pure substances are penguins while mixtures are spotted giraffes.

5. _____ One of the scientists working on the team states "*I believe that the giraffe's water is a mixture,*

*so we should separate out the contaminant by reacting it with an acid*". Which of the following statement would **best** explain to the scientist the error in his statement?

    A. If the giraffe's water is a mixture, it must be reacted with oxygen to remove the contaminant.
    B. If the giraffe's water is a mixture, causing it to react with an acid will have no effect, which will not remove the contaminant.
    C. Mixtures should be separated by physical means, not chemical means, which will leave the contaminant intact (the same) for further testing.
    D. Mixtures should be separated by chemical means, so that the contaminant can be removed quickly.

6. _____ The scientist from Question 5 asks you to take the lead in separating the contaminant out of Mr. Spot's water. Given the information about the contaminant and water below, what should you propose as the most effective way to separate the mixture?

| Property | Water | Contaminant |
| --- | --- | --- |
| Density | 1.0 g/cm$^3$ | 1.13 g/cm$^3$ |
| Boiling Point | 100°C | 697°C |
| Attracted to Magnet? | No | No |
| Particle size | 2.75 Å | 2.77 Å |

    A. Density extraction
    B. Evaporation
    C. Pull out the contaminant with a magnet
    D. Separate out the contaminant by pouring the mixture through a coffee filter.

7. _____ In the stomach of the giraffe, the following process occurs:

$$\textbf{Before} \qquad\qquad \textbf{After}$$
$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$
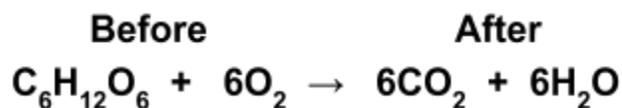
This process can be classified as a…

    A. Physical change because the same elements are present before and after the change.
    B. Chemical change because the same elements are present before and after the change.
    C. Physical change because the compounds are different before and after the change.
    D. Chemical change because the compounds are different before and after the change.

8. _____ While you are working on this case, a little girl approaches you and asks you to explain the difference between matter and energy. Which statement best explains the difference between the two?
    A. Matter has mass and volume, while energy does not.
    B. Energy has mass and volume, while matter does not.
    C. Matter is the ability to do work, while energy is not.
    D. Energy is the ability to create mass, while matter is not.

9.  You are asked to determine whether or not Mr. Spot's food is a heterogeneous or a homogeneous mixture.  In the boxes below, DRAW A PARTICLE DIAGRAM that best represents each type of mixture.

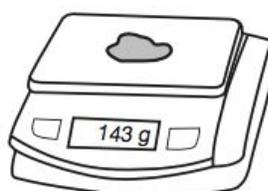| Homogeneous Mixture | Heterogeneous Mixture |
|---|---|
|  |  |

10. You are instructed to carefully measure out a sample of Mr. Spot's food for additional testing.  The balances that are available for you to use are shown below:
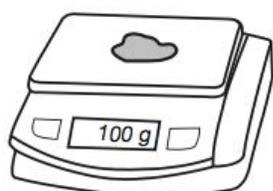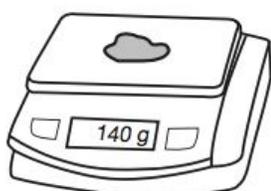


| 100 g | 140 g | 143 g | 143.0 g |
|---|---|---|---|
| Econo-Balance | Good Balance | Balance Pro | Exacto-Balance |

A.  For each balance shown above, **CIRCLE THE PHRASE** below that best describes how closely the mass can be determined with each balance.

| | | | | |
|---|---|---|---|---|
| **Econo-Balance** | estimated to the nearest 100 g | estimated to the nearest 10 g | estimated to the nearest 1 g | estimated to the nearest 0.1 g |
| **Good Balance** | estimated to the nearest 100 g | estimated to the nearest 10 g | estimated to the nearest 1 g | estimated to the nearest 0.1 g |
| **Balance Pro** | estimated to the nearest 100 g | estimated to the nearest 10 g | estimated to the nearest 1 g | estimated to the nearest 0.1 g |
| **Exacto-Balance** | estimated to the nearest 100 g | estimated to the nearest 10 g | estimated to the nearest 1 g | estimated to the nearest 0.1 g |

B.  Which of the four balances in the best quality instrument?  Explain.

_____

_____

_____

_____

11. You and your team decide to determine the boiling point of both of the water samples.



LIQUID                    GAS

A. In each box, **DRAW A DIAGRAM** of how the particles would be situated (packed) for each state of matter.  Make sure to **INCLUDE ARROWS** to represent particle movement.

B. **CIRCLE** the correct response to complete the following statements:

   i.   Moving from a liquid to a gas is a **physical / chemical** change because the chemical composition of the substance in the **same / different** after the change.

   ii.  Liquid water has the **same / different** chemical properties as water in the gas phase (water vapor).

   iii. Liquid water has a **definite / indefinite** shape and a **definite / indefinite** volume**.**

   iv.  Gaseous water has a **definite / indefinite** shape and a **definite / indefinite** volume**.**

12. As you conduct your analysis of Mr. Spot's food and water, you have spent a lot of time focusing on the physical properties of your samples.

| Intensive Properties | Extensive Properties |
|---|---|
| Density<br>Color<br>Magnetism<br>Boiling, Melting, Freezing Points | Mass<br>Length<br>Volume<br>Shape |

A. Using the information in the table above, complete the following statement:

   ***The difference between intensive and extensive properties is that...***

_____

_____

_____

B. Which **category** of these physical properties have you found to be the most useful in this investigation?  Explain your answer.

_____

_____

_____

13. One of the intensive properties that you have found to be particularly useful is density. In the table below, you have 3 unknown materials and their mass and volume measurements.
Using the formula of $d = \frac{m}{V}$ , **CALCULATE THE DENSITY OF EACH UNKNOWN** and use the information to **IDENTIFY THEM.**

*\*\*SHOW ALL WORK & MAKE SURE TO INCLUDE UNITS\*\**

| Sample # | Volume (cm³) | Mass (g) | Density | Identity |
|----------|--------------|----------|---------|----------|
| 1 | 64.00 | 321.28 | | |
| 2 | 55.00 | 392.15 | | |
| 3 | 1400.00 | 1.86 | | |

**Table 1 Densities of Common Substances***

| Substance | Density (g/cm³) | Substance | Density (g/cm³) |
|-----------|-----------------|-----------|-----------------|
| Helium (gas) | 0.0001663 | Zinc (solid) | 7.13 |
| Oxygen (gas) | 0.001331 | Silver (solid) | 10.50 |
| Water (liquid) | 1.00 | Lead (solid) | 11.35 |
| Pyrite (solid) | 5.02 | Mercury (liquid) | 13.55 |

*at 20°C and 1.0 atm

You and your team have scientists have worked to isolate the contaminant that may have been making Mr. Spot ill. You have now tested your unknown against several known substances to try to identify it. The data from your tests is recorded below.

| Substance | Physical Properties | Dissolves in water? | Reacts with water? | Color with universal indicator? | Reacts with vinegar (acid)? | Reacts with heat? |
|-----------|---------------------|---------------------|--------------------|--------------------------------|-----------------------------|-------------------|
| **UNKNOWN from Bottle** | White crystal/ powder | Yes | No | Green | No | Turns yellow/brown. |
| **Cornstarch** $(C_6H_{12}O_6)_n$ | White powder | No, cloudy | No | Green | No | Burns |
| **Baking soda** $NaHCO_3$ | White powder | Yes | No | Blue | Yes, Bubbles | No |
| **Sugar** $C_{12}H_{22}O_{11}$ | White crystal | Yes | No | Green | No | Turns yellow/brown. |
| **Salt** $NaCl$ | White crystal | Yes | No | Green | No | No |

14. It can be inferred from the data that _____ is the unknown substance that is causing Mr. Spot to be ill.

15. Signs of a chemical change include….. **Check all that apply**.

- ☐     Heat
- ☐     Reduced mass
- ☐     Increased volume
- ☐     Bubbles
- ☐     Color change
- ☐     Tearing

16. To **identify** an unknown substance when compared to known substance….. **Check all that apply**.

- ☐     The unknown sample should have all of the same extensive properties as the known sample.
- ☐     The unknown sample should have all of the same intensive properties as the known sample.
- ☐     The unknown sample should have all of the same chemical properties as the known sample.
- ☐     The unknown sample should have different chemical properties from the known sample.
- ☐     The unknown sample should only have the same physical properties as the known sample; the chemical properties do not matter.

17. A colleague of yours at the zoo says that they believe that the unknown that is causing Mr. Spot to be ill is baking soda.  What would you expect the unknown data to look like if your colleague was correct?  Fill in the table below.

| Substance | Physical Properties | Dissolves in water? | Reacts with water? | Color with universal indicator? | Reacts with vinegar (acid)? | Reacts with heat? |
|---|---|---|---|---|---|---|
| **UNKNOWN from Bottle** | | | | | | |