Mrs. Nielsen

AP Chemistry

Name Key Date _____ Period _____

Properties of Matter and Separation Techniques

1. Differentiate between chemical and physical properties. Provide an example of each.

Chemical – Ability to undergo a chemical change ex) oil is flammable

physical – Can be observed without changing identity of a substance ex) evaporation

2. A spherical, helium-filled balloon has a diameter of 21.3 cm. The density of helium is 0.1786 g/L. How many moles of helium are contained within the balloon?

$V = \frac{4}{3}\pi r^3$

$= \frac{4}{3}\pi (10.65)^3$

$V = 5059.85\ cm^3 \times \frac{1\ mL}{1\ cm^3} \times \frac{1\ L}{1000\ mL} = 5.06\ L$

$D = \frac{mass}{vol}$ $\quad 0.1786 = \frac{x}{5.06}$ $\quad x = 0.904\ g \times \frac{1\ mol}{4.00\ g} =$ **0.226 mol He**

3. Earth's atmosphere is 78% N_2 (boiling point: -196°C), 21% O_2 (boiling point: -183°C) and 1% water vapor, Ar, and other gases.

   a. Use an Internet search or other reference to find information to help you estimate the density of Earth's atmosphere. Indicate the temperature for your prediction.

* a weighted average *

$(0.78)(1.165)_{N_2} + (0.21)(1.331)_{O_2} + (0.005)(0.804)_{H_2O_{(g)}} + (0.005)(1.661)_{Ar} =$ **≈ 1.2 kg/m³**

@ 20.0°C, 1 atm

* answers may vary slightly *

   b. Briefly describe how you would separate nitrogen and oxygen from air.

→ Cool the air until O_2 condenses out at -183°C, collect the liquid

→ Continue cooling until you reach -196°C (if you wish to collect it as a liquid)

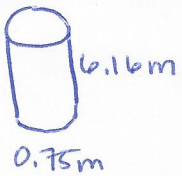
4. Which is more buoyant, Helium gas or the gases that make up Earth's atmosphere? Which is a pure substance? A mixture?

He: 0.1786 g/L ← pure substance

Air: 1.2 g/L ← mixture

* Helium is more buoyant

5. A cylindrical water tower is 6.16 m high and 0.75 m in diameter and is completely filled with water. If the water has a mass of 2.9 x10³ kg, find the density of the water in the tower.



$V = (\pi r^2)(h)$

$= 2.7\ m^3$

$D = \frac{mass}{vol} = \frac{2.9 \times 10^3\ kg}{2.7\ m^3} = 1.074 \times 10^3\ \frac{kg}{m^3}$

$\frac{1.1 \times 10^3\ kg}{m^3} \times \frac{1000\ g}{1\ kg} \times \left[\frac{1\ m^3}{10^6\ cm^3}\right]$ (*) $\times \frac{1\ cm^3}{1\ mL} =$ **1.1 g/mL**

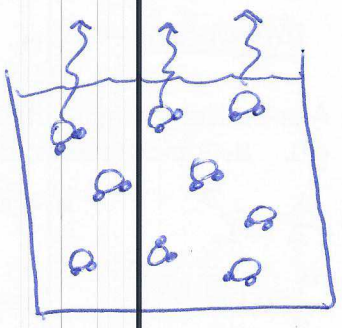
6. What are the two types of vaporization? Differentiate between them.

1) Evaporation : $(\ell) \rightarrow (g)$ occurs only at the surface

2) Boiling : $(\ell) \rightarrow (g)$ occurs throughout the substance, bubbling

7. Explain why liquid water evaporates. Include a drawing in *particle view* to accompany your explanation.

Liquid H_2O evaporates because the molecules at the surface gain enough kinetic energy to enter the gaseous phase.



8. Devise a simple protocol for separating a mixture of sand, sugar, and iron filings. Each material must be recovered in its original solid form. Protocols should consist of numbered, imperative steps that are detailed enough to follow.

1) Use a magnet to remove the iron filings

2) Add water to dissolve the sugar and either filter the sand or decant off the liquid.

3) Evaporate the water to recover the solid sugar

9. Briefly describe how chromatography separates the substances in a mixture.

The mixture is passed through a stationary phase via a flowing liquid or gas (mobile phase). Each substance will flow through the stationary phase at a different rate, depending on the relative affinities for each phase.

10. Which process requires more energy: chromatography or distillation? Explain.

Distillation, because of the heating and cooling required.