DHS • Honors Chemistry Name ______________________ Per ___

Alchemy–Subatomic Particles (Nuclear) Lab-Detecting Nuclear Radiation

Introduction: A cloud chamber is a simple device for detecting low levels of nuclear radiation. Just as "seeding" a cloud with crystals produces rain or snow, passing ionizing radiation through a chamber saturated with vapor leaves a trail of liquid droplets in its wake. The cloud chamber we will be using was the first device used for detecting ionizing radiation. Inspired by the beautiful colored lights observed when the sun shone on the clouds in the Scottish hills, the Scottish physicist C.T.R. Wilson built an apparatus to observe and study the tracks made by alpha and beta particles.

Very large, unstable nuclei usually decay by emitting alpha particles. An alpha (α) particle has nuclear charge of +2 and a relative mass of 4 amu (atomic mass units), identical to a helium nucleus in composition (two protons and two neutrons). Alpha particles are heavy and relatively slow moving….they do not ravel very far in air and will not penetrate paper or skin.

Lighter nuclei often decay by emitting beta particles (β). A beta particle has a charge of -1 and a relative mass equal to that of an electron. Fast moving beta particles, being much smaller and lighter in mass than alpha particles, have penetrating power about ten times greater that of alpha particles. A block of wood, a sheet of metal, or layers of clothing will shield an object from beta-particle radiation.

Gamma radiation is pure electromagnetic radiation (high energy photons). The symbol for a gamma ray is γ. Gamma rays often accompany the release of alpha or beta particles during radioactive decay. Gamma radiation is highly penetrating - no amount of absorbent material will completely stop or block gamma rays. A thick block of heavy metal, such as lead, may be used to reduce exposure to gamma rays. Beta particles can be either high energy or low energy particles.

Materials:

Beral-type pipet	Flashlight	Cloud Chamber with blotting paper and lid
Cotton Ball	Dry Ice	Isopropyl Alcohol (70%), 2-3 mL
Lantern Mantle Source	Card Stock	Graduated Cylinder

Procedure:

1. Your cloud chamber will already be assembled for you.
2. Add 3 mL of 91% Isopropyl Alcohol to the Cloud Chamber and place the lid on it.
3. Bring your plastic bowl and obtain some dry ice from your teacher.
4. Place the Cloud Chamber on top of the dry ice in the plastic bowl. DO NOT let the dry ice touch your unprotected skin.
5. Allow the Cloud Chamber to sit on the dry ice for approximately 5 minutes to cool the air and liquid and thus produce "supercooled" (supersaturated) alcohol vapor inside the chamber. There

will be a misty layer on the bottom of the cloud chamber, but the chamber should not cloud up completely or the liquid alcohol cooled to a solid.

6. Remove the cotton ball and insert the "puffy" side of the lantern mantel on the side of the cloud chamber. The knotted end can remain outside the chamber. When the lantern mantel is inserted into the side of the chamber, radiation from the source will ionize air molecules in its path, and the resulting ions will cause alcohol droplets to condense on them and form tracks. The condensation trails will be observed by shining a flashlight into the chamber.

7. Shine the light from a flashlight through the cloud chamber window opposite the radioactive source. Sometimes shining the light through the top will work as well.

8. Observe the condensation tails against the dark, black bottom of the cloud chamber. Several different patterns will be observed and the will change over time. Hint: The trails may look like wisps of smoke shooting out randomly through the chamber. The particles you will be observing are alpha, high energy beta, and low energy beta particles.

9. Observe the **thickness, length, and shape** of the different kinds of tracks for about 5 minutes, and record all observations in the data table.

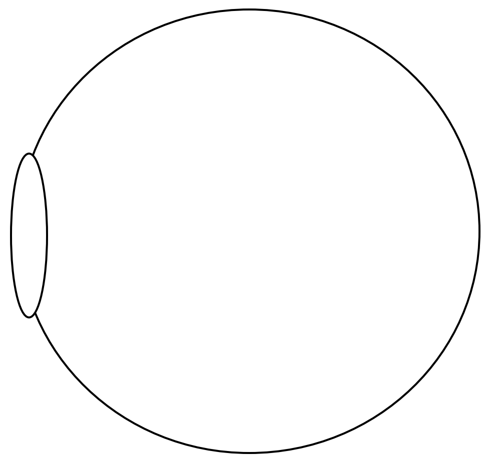
10. After your observation is complete, take the piece of silk material and rub it over the chamber lid. What happens to the tracks in the Cloud Chamber?

11. Remover the Cloud Chamber from the dry ice and place it on the table top.

12. Take the lantern mantel out of the Cloud Chamber and return it to its zip lock bag. Replace the cotton ball into the Cloud Chamber and open the chamber to allow the paper to dry out.

13. Please return the dry ice in your bowl/plate to your teacher. Make sure your lab kit looks as it did when you entered the lab.

Data Table:

Particles	**Observations/Track Drawings**
Alpha	
High Energy Beta	
Low Energy Beta	
Particles	**Predict Observations/Cloud Chamber Drawing**
	

Lab Questions: Answer all questions in complete sentences using your own words.

1. Complete the following table, summarizing the properties of alpha, beta and gamma radiation.

	Alpha Particles	**Beta Particles**	**Gamma Radiation**
Mass			
Charge			
Composition			
Symbol			
Penetrating Power			

2. What kinds of materials can be used to shield or protect an object from alpha and beta radiation?

3. Compare the penetrating power and the ionizing ability of alpha and beta particles. Which type of radiation should produce longer tracks in the cloud chamber? Which type of radiation will probably give thicker tracks due to the production of lots of ions?

4. When you placed the card stock into the Cloud Chamber describe what you observed. Which type of radiation do you think was closest to the radioactive source? Which type of radiation do you think was furthest from the radioactive source?

5. What is the purpose of using dry ice to cool the Cloud Chamber? What would happen if the entire chamber, including the sides and the paper, were too cold? What would happen if the Cloud Chamber were too warm?

6. Some cloud tracks will be observed in the chamber even in the absence of an external radioactive source. What is the possible origin of these tracks?