Demonstration [15 pts]
Reactivity of Metals and Non-metals

NAME_____
Period _____ Date_____

Introduction: Chemical reactions involve the interactions of electrons. The purpose of this demonstration is to make a connection between periodic trends and chemical reactivity of metals and non-metals.

Observations:

Metal	Observations in water	Observations in acid	Nonmetal (Halogens)	Observations when heated in the presence of iron
Al			Cl_2	
Mg			Br_2	
Ca			I_2	
Li				
Na				
K				

Analysis: The elements in this demo have been arranged below in the manner of a partial periodic table.

1) [0.5 pt] Use your observations concerning the reactivity of metals to answer the following questions:
   a) As one moves vertically down the table, the reactivity of metals **(increases, decreases).**
   b) As one moves across to the right, the reactivity of the metals **(increases decreases).**
   c) Thus, **(smaller, larger)** metals are more reactive.

Periodic Table

I	II	III	IV	V	VI	VII	VIII
Li						F	
Na	Mg	Al				Cl	
K	Ca					Br	
Rb						I	
Cs							

2) [0.5 pt] Use your observations concerning the reactivity of non-metals to answer the following questions:
   a) As one moves vertically down the table, the reactivity of non-metals **(increases, decreases.)**
   b) Thus, **(smaller, larger)** non-metals are more reactive.

3) [0.5 pt] Using your reactivity trends determined above,
   a) …of all the metals listed, what metal would be the most metallic (the most reactive)? _____
   b) …of all the non-metals, what non-metal would be the most non-metallic (the most reactive)? _____

4) [3 pts] For the following reactions show how reactants are transformed into products. To do so…
   - write Lewis Dot Structures (either covalent or ionic) for each of the substances in the reaction. *(Make sure covalent bonds are shown in covalent substances and separate ions with charges are shown for ionic substances. All valence electrons must be shown.)*
   - write in any needed arrows from one reactant to another to show how electrons are transferred.

   a) $2\ K\ (l) + 2\ H_2O \rightarrow H_2\ (g) + 2\ KOH\ (aq)$

   b) $Ca\ (s) + 2\ HCl\ (aq) \rightarrow H_2\ (g) + CaCl_2\ (aq)$

   c) $Fe\ (s) + Br_2\ (g) \rightarrow FeBr_2\ (s)$

5) [0.5 pt] In each of the reactions above, metals reacted with non-metals to form ionic compounds. In each reaction, the metals **(gained, lost)** electrons and the non-metals **(gained, lost)** electrons.

6) [1.5 pts] As you stated in question #1c, **(Smaller, Larger)** metals are more reactive than other metals. Explain why. *(Your explanation must discuss the location of electrons, their attraction to a nucleus and their ability to be gained or lost. Do NOT use the specific terms* radius*,* ionization energy *or* electronegativity*.)*

7) [1.5 pts] As you stated in question #2b, **(Smaller, Larger)** non-metals are more reactive than other non-metals. Explain why. *(Your explanation must discuss the location of electrons, their attraction to a nucleus and their ability to be gained or lost. Again, do NOT use the specific terms* radius*,* ionization energy *or* electronegativity*.)*

8) **Read the article about Halogen lights on the next page. Answer the following questions:**.

a) [1 pts] The basic reaction that takes place in a halogen bulb is the following: $W(s) + I_2(g) \rightarrow WI_2(g)$
Draw Lewis Dot Structures of each substance in rxn and draw arrows to show how electrons are transferred. (Do as in #4)
Tungsten (W) is a weak metal with two valence electrons, and forms covalent *bonds to each I atom.*

b) [4.5 pts] A halogen light functions so well because of this tungsten/halogen cycle that occurs. There are three basic steps in this cycle. Explain each of the three steps in your own words. *(For each step you must include, what happens, where it happens and why it happens.)*

Step 1:
Step 2:
Step 3:

c) [1.5 pts] Compared to conventional lights, halogen lights have the following three advantages. Explain why halogen lights have each of these three advantages.

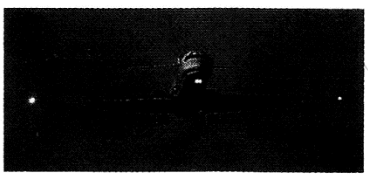
1. Brighter:
2. Smaller
3. Last longer

HALOGEN LIGHTS

by Terry McGowan

During the 1950s, researchers at General Electric wanted to build tiny, powerful lights that could fit within the razorlike wing tips of supersonic jet aircraft. They first tried increasing the temperature of the tungsten filament to boost its light output. But, as expected, the tungsten metal quickly evaporated, blackening the bulb and causing the filament to break.

Then they hit on a clever idea. Rather than filling the bulb with an inert gas, as in standard bulbs, they used a highly reactive element, iodine. This experiment spawned a variety of lamps now known as halogens for the type of gas that fills the interior (usually iodine or bromine).



DON WILSON/West Stock

AIRCRAFT LIGHTS have to be small and bright. Such demanding requirements first spurred scientists and engineers at General Electric to develop the halogen lamp.

LAURIE GRACE

1) TUNGSTEN FILAMENT, when heated by an electric current, gives off light. The immensely hot temperatures that result cause the metal filament to evaporate rapidly, sending out tungsten vapor.

2) COOLING TUNGSTEN in the vicinity of the glass wall can combine with the halogen gas (I_2) that fills the bulb. The tungsten halide gas created in this way can migrate freely back to the hot filament.

3) DECOMPOSITION of the tungsten halide occurs when these molecules are heated by the filament. This process deposits tungsten metal on the filament and releases halogen gas to the bulb, completing the ongoing "halogen cycle."

CONVENTIONAL BULBS contain a chemically inert gas, and so the tungsten vapor given off by the hot filament is simply deposited on the glass, darkening it. Standard bulbs thus have to be made large enough so that the tungsten coating does not become opaque.

Halogen lights take advantage of the peculiar chemistry of tungsten. At the extreme temperatures around the hot filament—about 3,000 degrees Celsius—tungsten vapor does not chemically combine with halogen gas. As the tungsten atoms approach the glass, however, they cool to below 800 degrees C and spontaneously react with the halogen, creating gaseous tungsten halide.

Molecules formed in this way migrate toward the center of the bulb and reach the eroding filament. Because the tungsten halide is unstable there, it decomposes, releasing halogen gas and depositing solid tungsten back on the glowing filament.

Halogen lamps thus shine brighter for longer because tungsten metal does not darken the glass but instead cycles back to help "heal" the eroding filament. Halogen lights are widely employed as floodlights, for automobile headlights and as desk lamps for the home or office. Some still find their way into airplane wings.

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