Name: _____

Period: _____

Metals vs. Non-Metals; Dot Diagrams; Ions

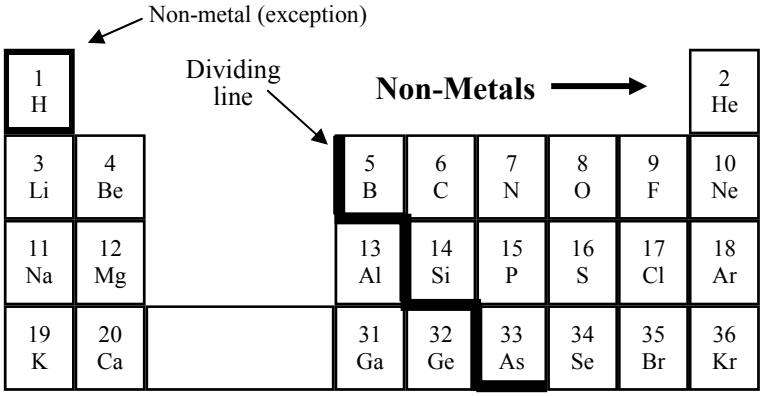
Metals versus Non-Metals

Metals are on the left side. Non-metals on the right.
Metals tend to lose electrons. Non-metals gain them tight.

The dividing line is the red or bold black line from between Boron and Aluminum down and to the right. Everything to the left is a metal: to the right, non-metal. One exception (don't ya just hate that?!) is hydrogen – a non-metal.

Sodium (Na) is a metal.
Oxygen is a non-metal.

Metal or Non-metal?	
Potassium: _____	Fluorine: _____
Bromine: _____	Hydrogen _____
Beryllium: _____	Silver _____
Helium: _____	Nitrogen _____



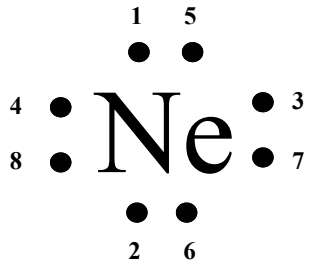
Easy to remember by which side iron (Fe) is on—the left side!

On either side of the divide are the metalloids or semi-metals—they have characteristics of both: B, Si, Ge, As.

Dot Diagrams

Dot Diagrams (sometimes known as Lewis dot diagrams) are a depiction of an atom's valence electrons. They are a powerful tool in helping you understand, see, and even predict molecular bonding.

Put the correct number of <u>valence electrons</u> around the chemical symbol in this order in pairs:

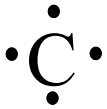


Neon has 8 valence electrons (in the right hand column). Neon has no unoccupied spaces. It is full.

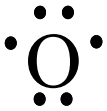
Notice that the electrons are in pairs not a circle.

Why would the electrons spread out around the atom instead of bunching up?

Lithium, with 1 valence electron (first column).



Carbon has 4 valence electrons



Oxygen has 6 valence electrons. How many more before it's full?

_____.

Draw the Dot Diagrams for the following elements:

<u>Beryllium</u> <u>Sodium</u> <u>Helium</u> <u>Carbon</u> <u>Boron</u>

Name: _____

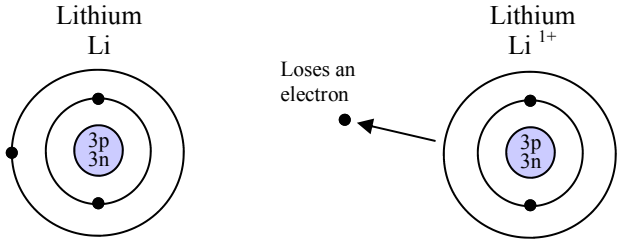
Period: _____

Ions

If you change the number of protons you change the *element*.
If you change the number of neutrons you change the *isotope*.
If you change the number of electrons you change the *ion*.

Neutral atoms have an equal number of protons and electrons. A neutral atom has a net electrical charge of zero.

Why would atoms gain or lose electrons? To fulfill the octet rule and end up with a full outer shell of electrons. Metals will lose electrons and make positive ions (cations); non-metals will gain electrons and make negative ions (anions).



3 protons (+3)
3 electrons (-3)
+3 –3 = 0
Neutral atom!

3 protons (+3)
2 electrons (-2)
+3 –2 = +1
positive *ion*!

An ion is an atom with a net charge; that has gained or lost electrons.

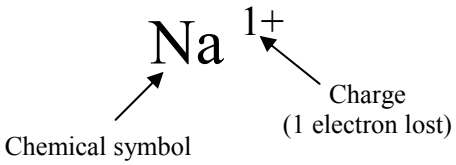
Protons – electrons = ion charge OR p – e = charge

Cations cough up electrons -
Lose electrons (+ ion).
METALS

Anions accept electrons -
Gain electrons (- ion).
NON-METALS

What is the charge of an atom with 16 protons and 18 electrons?	If Oxygen gains 2 electrons what charge will it have?	If Beryllium loses 2 electrons what charge will it have?

Ion Notation



Ex. How many electrons does Mg^{2+} have?

p - e = charge
12 (Mg) - e = +2
12 = 2 + e
12—2 = e
e = 10 electrons

You also could have found this by knowing Mg has 12 protons and electrons if neutral. A 2+ charge means it is a cation—it lost 2 electrons = 12—2 = 10 electrons.

How many electrons does Cl^{1-} have?	How many electrons does N^{3-} have?	How many electrons does Al^{3+}
Give the ion notation for an atom with 20 protons and 18 electrons.	Give the ion notation for an atom with 6 protons and 2 electrons.	Give the ion notation for an atom with 15 protons and 18 electrons.

Name: _____

Period: _____

Bonding

Chemical Bonding

Why haven't you grown up recognizing all of the elements around you? Because most substances are *compounds*. Very few elements are stable enough to exist pure. Instead they react with other elements to form compounds. Why?...

Octet Rule—atoms strive to achieve a full set of valence electrons. This is usually 8 (what are the exceptions). Atoms are more stable with a full outer shell.

To fulfill the octet rule atoms will lose, gain, or share electrons. Atoms will get 8 valence electrons the fastest way: metals will lose electrons; non-metals will gain electrons.

Why? Having a few more protons more than closest noble gas, metals have too much shielding—the electrons don't fell much attraction to the nucleus. Non-metal have more protons and can attract more electrons to the energy level.

Ion Notation Review

Ion—a non-neutral atom (different number of protons and electrons). To find charge or number of electrons, use: **protons—electrons = charge OR p - e = charge**

Mg^{2+}

Chemical symbol

Charge (2 electrons lost)

Cations — positive ions (metals); Losers of electrons.

Anions — negative ions (non-metals); Gainers of electrons.

Give the ion notation for an atom with 20 protons and 18 electrons.

Give the ion notation for Sulfur with 18 electrons.

What force will the two above ions feel?

Why?

Ionic Bonds—Bonds of attraction

Ionic bonds occur between *metal* and *non-metal* ions.

By itself sodium is very reactive (it will explode in water).

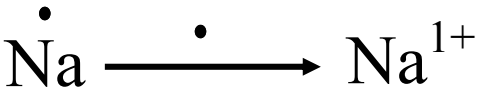
So it loses one electron.

Now, it has a full set of 8 outer electrons. It becomes a positive ion (a cation).

Chlorine (a poisonous gas) has 7 valence electrons so it needs one more to be stable.

So it gains one electron.

Now, it has a full set of 8 outer electrons. It is a ion with a 1+ charge (a cation).



And opposites attract

$Na^{1+} \longleftrightarrow Cl^{1-}$

To form a stable compound.

$NaCl$ Sodium Chloride — Table salt.

Will these ions make compounds?

Mg^{2+} and Li^{1+}? _____ Ca^{2+} and F^{1-}? _____

Na^{1+} and O^{2-}? _____ O^{2-} and Cl^{1-}? _____

Will these elements make ionic compounds?

K and Li? _____ Al and F? _____

Be and Cl? _____ Fe and O? _____

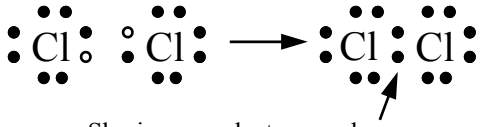
Name: _____

Period: _____

Covalent Bonds—Cooperative Bonding

Covalent bonds happen between two non-metals.

Sometimes there are no opposites around to form ionic bonds (Oh, NO!), but atoms will still find a way to get to that full shell of 8 valence electrons. So instead of gaining extra electrons they SHARE THEM. This is called a **COVALENT BOND**.

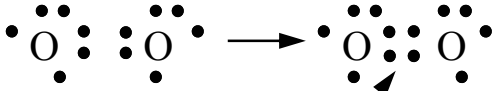


Sharing one electron each

Cl—Cl

Short cut notation for a *single* bond.

Each oxygen needs 2 more electrons.



Sharing 2 electrons each

O=O

Short cut notation for a *double* bond.

Draw the covalent bond between 2 Nitrogens:

Draw the covalent bond between 2 Fluorines:

Ionic or covalent bonds?

MgO _____ PO_5 _____ CaO _____

CO_2 _____ BeF_2 _____ SO_2 _____

Oxidation Numbers

The ions charges that atoms gain when they lose or gain their valence electrons are the number of electrons they can gain or lose when bonding. We call these Oxidation Numbers.

Oxidation Numbers

1							0
1 H	2		3	4	3-	2-	1-	2 He
3 Li	4 Be		5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg		13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	Transition Metals	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr

Find the Oxidation Numbers for the following:

Be _____ H _____

O _____ He _____

Cl _____ Al _____

N _____ P _____

Li _____ Ar _____

Making Ionic Compounds

You can figure out how to make stable ionic compounds from the oxidation numbers. Lithium (1+) can give 1 electron; Oxygen (2-) needs 2 to be full. So Oxygen needs 2 Lithiums to balance as a compound.

1 $Li^{1+}\ O^{2-}$ Write the chemical symbols with the oxidation numbers.

2 $Li_{2}^{1+}\ O_{1}^{2-}$ Cross the numbers not the signs.

3 Li_2O Reduce numbers or drop ones.

Ex. Make a balanced ionic compound of Calcium and Oxygen.

1. $Ca^{2+}\ O^{2-}$ Chemical symbols and oxidation numbers.
2. $Ca_{2}^{2+}\ O_{2}^{2-}$ Cross the numbers not the signs
3. CaO (2s reduce) Reduce numbers and drop ones.

Make ionic compounds from:

Al and Cl:	Na and S:

Name: _____

Period: _____

More Chemical Bonding

Bonding Review

Most elements react to form compounds. Elements do this to gain a full set of valence electrons (Octet Rule— "If I 8 I full").

Ionic Compounds occur between metals and non-metals because metals become *cations* (positive ions) and non-metals become *anions* (negative ions). And opposites attract.

Opposites attract

$Be^{2+} \longleftrightarrow Cl^{1-}$

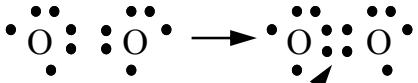
Cross the number not the sign to get:

$BeCl_2$

Beryllium Chloride

Covalent Compounds occur between non-metals. Because neither element will give up their electrons (too many protons), they share electrons to complete the full set of 8.

Oxygens sharing to gain 8 electrons each



4 shared electrons (2 from each)

O=O

Short cut notation for a *double* bond.

Polyatomic Compounds are compounds with 3 or more elements. These are just large ionic compounds. They happen because sometimes when two elements react they don't fulfill the octet rule and end up with a net electrical charge.

Big opposites attract, too

$Mg^{2+} \longleftrightarrow NO_3^{-}$

$Mg(NO_3)_2$

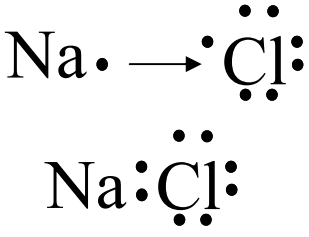
Magnesium nitrate

Ionic, Covalent, or Polyatomic?

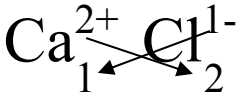
K_2O _____ (Potassium oxide)	AlF_3 _____ (Aluminum fluoride)	Li_2CrO_4 _____ (Lithium chromate)	Ca_3N_2_____ (Calcium nitride)
CO_2 _____ (Carbon dioxide)	$MgCO_3$ _____ (Magnesium carbonate)	$SiCl_4$ _____ (Silicon tetrachloride)	NaCl _____ (Sodium chloride—table salt)

Making Ionic Compounds

Use dot diagrams like puzzle pieces. For ionic compounds remember that the metal is actually *losing* the electron to the non-metal.

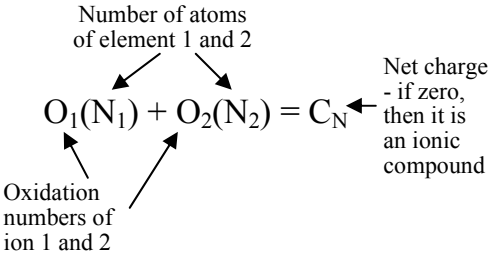


Or use the "*cross the number not the sign*" method:



This compound will be stable because the net charge is zero.
1(2) + 2(-1) = 2 - 2 = 0

Ionic compounds are balanced if the net charge is zero. Use this formula:



Make Balanced Ionic Compounds			
Li and N	Ca and O	Al and Cl	Na and Ne

Using the formula above show that Na2O is balanced.

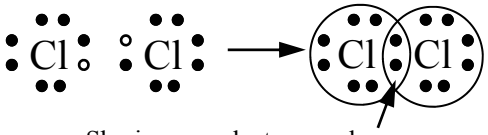
Name: _____

Period: _____

Covalent Bonds—Diatomic Molecules

Diatomic molecules have 2 atoms of the same element. N, O, F, Cl

Seeing how covalent bonds connect together is easy for single bonds, like chlorine. Yet it can be hard to see for triple bonds like Nitrogen. For compounds it can get even more difficult.

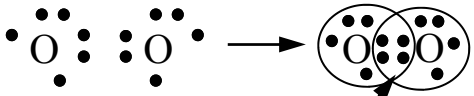


Sharing one electron each

Cl—Cl

Short cut notation for a *single* bond.

Each oxygen needs 2 more electrons.



Sharing 2 electrons each

Each line stands for a shared pair of electrons: 1 from each

O═O

Short cut notation for a *double* bond.

Draw the covalent bond between two Bromine atoms:
Draw the covalent bond between two Fluorine atoms:

Two Tricks—

1) If you cover one of the atoms up with a piece of paper (or a finger) you can see if the other atom has the necessary 8 electrons.

2) The number of extra electrons you need to make 8 goes on the sharing side of the chemical symbol. Ex. Nitrogen has 5 valence electrons and needs 3 more to be full, so put 3 electrons on the side toward the other N.

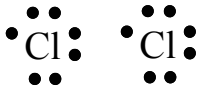
Covalent Compounds

When trying to figure out covalent compounds, it may take some time and creativity. Remember to look at the atoms as puzzle pieces.

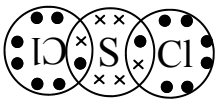
Ex. Make Sulfur Dichloride (SCl_2)

6 valence electrons

7 valence electrons



Move them around until each atom has 8 electrons by sharing.



Tip: it can help to draw the electrons differently (like x's and o's) for the different elements. This can help you keep track from where the electrons came.

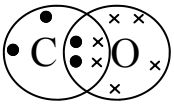
Short hand notation

Cl—S—Cl

Each bar is a <u>*shared*</u> electron pair

Make Carbon monoxide (CO)

Carbon has only 6



Oxygen needs 2 more electrons, but carbon needs 4. Either oxygen will have too many, or carbon will have too few.

This is why CO is an unstable, poisonous compound! It will react with oxygen in your body to form CO_2 and could kill you!

Draw the covalent compound of CO_2:
Draw the covalent compound of NF_3:
Draw the covalent compound of CH_4 (methane):

Flinn Scientific's Student Safety Contract

PURPOSE

Science is a hands-on laboratory class. You will be doing many laboratory activities which require the use of hazardous chemicals. Safety in the science classroom is the #1 priority for students, teachers, and parents. To ensure a safe science classroom, a list of rules has been developed and provided to you in this student safety contract. These rules must be followed at all times. Two copies of the contract are provided. One copy must be signed by both you and a parent or guardian before you can participate in the laboratory. The second copy is to be kept in your science notebook as a constant reminder of the safety rules.

GENERAL RULES

1. Conduct yourself in a responsible manner at all times in the laboratory.
2. Follow all written and verbal instructions carefully. If you do not understand a direction or part of a procedure, ask the instructor before proceeding.
3. Never work alone. No student may work in the laboratory without an instructor present.
4. When first entering a science room, do not touch any equipment, chemicals, or other materials in the laboratory area until you are instructed to do so.
5. Do not eat food, drink beverages, or chew gum in the laboratory. Do not use laboratory glassware as containers for food or beverages.
6. Perform only those experiments authorized by the instructor. Never do anything in the laboratory that is not called for in the laboratory procedures or by your instructor. Carefully follow all instructions, both written and oral. Unauthorized experiments are prohibited.
7. Be prepared for your work in the laboratory. Read all procedures thoroughly before entering the laboratory.
8. Never fool around in the laboratory. Horseplay, practical jokes, and pranks are dangerous and prohibited.
9. Observe good housekeeping practices. Work areas should be kept clean and tidy at all times. Bring only your laboratory instructions, worksheets, and/or reports to the work area. Other materials (books, purses, backpacks, etc.) should be stored in the classroom area.
10. Keep aisles clear. Push your chair under the desk when not in use.
11. Know the locations and operating procedures of all safety equipment including the first aid kit, eyewash station, safety shower, fire extinguisher, and fire blanket. Know where the fire alarm and the exits are located.
12. Always work in a well-ventilated area. Use the fume hood when working with volatile substances or poisonous vapors. Never place your head into the fume hood.
13. Be alert and proceed with caution at all times in the laboratory. Notify the instructor immediately of any unsafe conditions you observe.
14. Dispose of all chemical waste properly. Never mix chemicals in sink drains. Sinks are to be used only for water and those solutions designated by the instructor. Solid chemicals, metals, matches, filter paper, and all other insoluble materials are to be disposed of in the proper waste containers, not in the sink. Check the label of all waste containers twice before adding your chemical waste to the container.
15. Labels and equipment instructions must be read carefully before use. Set up and use the prescribed apparatus as directed in the laboratory instructions or by your instructor.
16. Keep hands away from face, eyes, mouth and body while using chemicals or preserved specimens. Wash your hands with soap and water after performing all experiments. Clean all work surfaces and apparatus at the end of the experiment. Return all equipment clean and in working order to the proper storage area.
17. Experiments must be personally monitored at all times. You will be assigned a laboratory station at which to work. Do not wander around the room, distract other students, or interfere with the laboratory experiments of others.
18. Students are never permitted in the science storage rooms or preparation areas unless given specific permission by their instructor.
19. Know what to do if there is a fire drill during a laboratory period; containers must be closed, gas valves turned off, fume hoods turned off, and any electrical equipment turned off.
20. Handle all living organisms used in a laboratory activity in a humane manner. Preserved biological materials are to be treated with respect and disposed of properly.
21. When using knives and other sharp instruments, always carry with tips and points pointing down and away. Always cut away from your body. Never try to catch falling sharp instruments. Grasp sharp instruments only by the handles.
22. If you have a medical condition (e.g., allergies, pregnancy, etc.), check with your physician prior to working in lab.

CLOTHING

23. Any time chemicals, heat, or glassware are used, students will wear laboratory goggles. There will be no exceptions to this rule!
24. Contact lenses should not be worn in the laboratory unless you have permission from your instructor.
25. Dress properly during a laboratory activity. Long hair, dangling jewelry, and loose or baggy clothing are a hazard in the laboratory. Long hair must be tied back and dangling jewelry and loose or baggy clothing must be secured. Shoes must completely cover the foot. No sandals allowed.
26. Lab aprons have been provided for your use and should be worn during laboratory activities.

ACCIDENTS AND INJURIES

27. Report any accident (spill, breakage, etc.) or injury (cut, burn, etc.) to the instructor immediately, no matter how trivial it may appear.
28. If you or your lab partner are hurt, immediately yell out "Code one, Code one" to get the instructor's attention.
29. If a chemical splashes in your eye(s) or on your skin, immediately flush with running water from the eyewash station or safety shower for at least 20 minutes. Notify the instructor immediately.
30. When mercury thermometers are broken, mercury must not be touched. Notify the instructor immediately.

HANDLING CHEMICALS

31. All chemicals in the laboratory are to be considered dangerous. Do not touch, taste, or smell any chemicals unless specifically instructed to do so. The proper technique for smelling chemical fumes will be demonstrated to you.
32. Check the label on chemical bottles twice before removing any of the contents. Take only as much chemical as you need.
33. Never return unused chemicals to their original containers.

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Flinn Scientific's Student Safety Contract

34. Never use mouth suction to fill a pipet. Use a rubber bulb or pipet pump.
35. When transferring reagents from one container to another, hold the containers away from your body.
36. Acids must be handled with extreme care. You will be shown the proper method for diluting strong acids. Always add acid to water, swirl or stir the solution and be careful of the heat produced, particularly with sulfuric acid.
37. Handle flammable hazardous liquids over a pan to contain spills. Never dispense flammable liquids anywhere near an open flame or source of heat.
38. Never remove chemicals or other materials from the laboratory area.
39. Take great care when transporting acids and other chemicals from one part of the laboratory to another. Hold them securely and walk carefully.

HANDLING GLASSWARE AND EQUIPMENT

40. Carry glass tubing, especially long pieces, in a vertical position to minimize the likelihood of breakage and injury.
41. Never handle broken glass with your bare hands. Use a brush and dustpan to clean up broken glass. Place broken or waste glassware in the designated glass disposal container.
42. Inserting and removing glass tubing from rubber stoppers can be dangerous. Always lubricate glassware (tubing, thistle tubes, thermometers, etc.) before attempting to insert it in a stopper. Always protect your hands with towels or cotton gloves when inserting glass tubing into, or removing it from, a rubber stopper. If a piece of glassware becomes "frozen" in a stopper, take it to your instructor for removal.
43. Fill wash bottles only with distilled water and use only as intended, e.g., rinsing glassware and equipment, or adding water to a container.
44. When removing an electrical plug from its socket, grasp the plug, not the electrical cord. Hands must be completely dry before touching an electrical switch, plug, or outlet.
45. Examine glassware before each use. Never use chipped or cracked glassware. Never use dirty glassware.
46. Report damaged electrical equipment immediately. Look for things such as frayed cords, exposed wires, and loose connections. Do not use damaged electrical equipment.
47. If you do not understand how to use a piece of equipment, ask the instructor for help.
48. Do not immerse hot glassware in cold water; it may shatter.

HEATING SUBSTANCES

49. Exercise extreme caution when using a gas burner. Take care that hair, clothing and hands are a safe distance from the flame at all times. Do not put any substance into the flame unless specifically instructed to do so. Never reach over an exposed flame. Light gas (or alcohol) burners only as instructed by the teacher.
50. Never leave a lit burner unattended. Never leave anything that is being heated or is visibly reacting unattended. Always turn the burner or hot plate off when not in use.
51. You will be instructed in the proper method of heating and boiling liquids in test tubes. Do not point the open end of a test tube being heated at yourself or anyone else.
52. Heated metals and glass remain very hot for a long time. They should be set aside to cool and picked up with caution. Use tongs or heat-protective gloves if necessary.
53. Never look into a container that is being heated.
54. Do not place hot apparatus directly on the laboratory desk. Always use an insulating pad. Allow plenty of time for hot apparatus to cool before touching it.
55. When bending glass, allow time for the glass to cool before further handling. Hot and cold glass have the same visual appearance. Determine if an object is hot by bringing the back of your hand close to it prior to grasping it.

QUESTIONS

56. Do you wear contact lenses?
    ☐ YES ☐ NO
57. Are you color blind?
    ☐ YES ☐ NO
58. Do you have allergies?
    ☐ YES ☐ NO

    If so, list specific allergies _____

    _____

    _____

AGREEMENT

I, _____ , (student's name) have read and agree to follow all of the safety rules set forth in this contract. I realize that I must obey these rules to ensure my own safety, and that of my fellow students and instructors. I will cooperate to the fullest extent with my instructor and fellow students to maintain a safe lab environment. I will also closely follow the oral and written instructions provided by the instructor. I am aware that any violation of this safety contract that results in unsafe conduct in the laboratory or misbehavior on my part, may result in being removed from the laboratory, detention, receiving a failing grade, and/or dismissal from the course.

_____
Student Signature

_____
Date

Dear Parent or Guardian:

We feel that you should be informed regarding the school's effort to create and maintain a safe science classroom/laboratory environment.

With the cooperation of the instructors, parents, and students, a safety instruction program can eliminate, prevent, and correct possible hazards.

You should be aware of the safety instructions your son/daughter will receive before engaging in any laboratory work. Please read the list of safety rules above. No student will be permitted to perform laboratory activities unless this contract is signed by both the student and parent/guardian and is on file with the teacher.

Your signature on this contract indicates that you have read this Student Safety Contract, are aware of the measures taken to ensure the safety of your son/daughter in the science laboratory, and will instruct your son/daughter to uphold his/her agreement to follow these rules and procedures in the laboratory.

_____
Parent/Guardian Signature

_____
Date

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